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1 About this handbook

1.1 Notes and rules

The program exists of several subjects (e.g. Fundamentals of Engineering). Every subject is split into modules and every module itself consists of one or more interrelated module component exams. The extent of every module is indicated by credit points (CP), which will be credited after the successful completion of the module. Some of the modules are obligatory. According to the interdisciplinary character of the program, a great variety of individual specialization and deepening possibilities exists for a large number of modules. This enables the student to customize content and time schedule of the program according to personal needs, interest and job perspective. The module handbook describes the modules belonging to the program. It describes particularly:

- the structure of the modules
- the extent (in CP),
- the dependencies of the modules,
- the learning outcomes,
- the assessment and examinations.

The module handbook serves as a necessary orientation and as a helpful guide throughout the studies. The module handbook does not replace the course catalog, which provides important information concerning each semester and variable course details (e.g. time and location of the course).

1.1.1 Begin and completion of a module

Each module and each examination can only be selected once. The decision on the assignment of an examination to a module (if, for example, an examination in several modules is selectable) is made by the student at the moment when he / she is registered for the appropriate examination. A module is completed or passed when the module examination is passed (grade 4.0 or better). For modules in which the module examination is carried out over several partial examinations, the following applies: The module is completed when all necessary module partial examinations have been passed. In the case of modules which offer alternative partial examinations, the module examination is concluded with the examination with which the required total credit points are reached or exceeded. The module grade, however, is combined with the weight of the predefined credit points for the module in the overall grade calculation.

1.1.2 Module versions

It is not uncommon for modules to be revised due to, for example, new courses or cancelled examinations. As a rule, a new module version is created, which applies to all students who are new to the module. On the other hand, students who have already started the module enjoy confidence and remain in the old module version. These students can complete the module on the same conditions as at the beginning of the module (exceptions are regulated by the examination committee). The date of the student's "binding declaration" on the choice of the module in the sense of \( \Phi 5(2) \) of the Study and Examination Regulation is decisive. This binding declaration is made by registering for the first examination in this module.

In the module handbook, all modules are presented in their current version. The version number is given in the module description. Older module versions can be accessed via the previous module handbooks in the archive.

1.1.3 General and partial examinations

Module examinations can be either taken in a general examination or in partial examinations. If the module examination is offered as a general examination, the entire learning content of the module will be examined in a single examination. If the module examination is subdivided into partial examinations, the content of each course will be examined in corresponding partial examinations. Registration for examinations can be done online at the campus management portal. The following functions can be accessed on https://campus.studium.kit.edu/:

- Register/unregister for examinations
- Check for examination results
- Create transcript of records

For further and more detailed information, https://studium.kit.edu/Seiten/FAQ.aspx.

1.1.4 Types of exams

Exams are split into written exams, oral exams and alternative exam assessments. Exams are always graded. Non exam assessments can be repeated several times and are not graded.

1.1.5 Repeating exams

Principally, a failed written exam, oral exam or alternative exam assessment can repeated only once. If the repeat examination (including an eventually provided verbal repeat examination) will be failed as well, the examination claim is
lost. A request for a second repetition has to be made in written form to the examination committee two months after loosing the examination claim.

1.1.6 Additional accomplishments
Additional accomplishments are voluntarily taken exams, which have no impact on the overall grade of the student and can take place on the level of single courses or on entire modules. It is also mandatory to declare an additional accomplishment as such at the time of registration for an exam.

1.1.7 Further information
More detailed information about the legal and general conditions of the program can be found in the examination regulation of the program (http://www.sle.kit.edu/amtlicheBekanntmachungen.php).
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0 Abkürzungsverzeichnis

Vertiefungsrichtungen:  
MB  Allgemeiner Maschinenbau  
E+U  Energie- und Umwelttechnik  
FzgT  Fahrzeugtechnik  
M+M  Mechatronik und Mikrosystemtechnik  
PEK  Produktentwicklung und Konstruktion  
PT  Produktionstechnik  
ThM  Theoretischer Maschinenbau  
W+S  Werkstoffe und Strukturen für Hochleistungssysteme

Semester:  
WS  Wintersemester  
SS  Sommersemester

Schwerpunkte:  
K, KP  Teilleistung im Kernbereich, ggf. Pflicht des Schwerpunkts  
E  Teilleistung im Ergänzungsbereich des Schwerpunkts  
EM  Teilleistung im Ergänzungsbereich ist nur im Masterstudiengang wählbar

Lehrveranstaltung:  
V  Vorlesung  
Ü  Übung  
P  Praktikum  
SWS  Semesterwochenstunden

Teilleistung:  
LP  Leistungspunkte  
Pr  Prüfung  
Pr (h)  Prüfungsdauer in Stunden  
mPr  mündliche Prüfung  
sPr  schriftliche Prüfung  
PraA  Prüfungsleistung anderer Art  
Schein  unbenotete Moduleistung  
TL  Teilleistung  
Gew  Gewichtung einer Prüfungsleistung im Modul bzw. in der Gesamtnote

Sonstiges:  
SPO  Studien- und Prüfungsordnung  
w  wählbar  
p  verpflichtend
1 Studienpläne, Module und Prüfungen

Das Masterstudium kann sowohl zum Winter- als auch zum Sommersemester aufgenommen werden. Wegen der freien Wahl der Module lässt sich für das Masterstudium kein exemplarischer Studienverlauf angeben.

Die Angabe der Leistungspunkte (LP) erfolgt gemäß dem „European Credit Transfer and Accumulation System“ (ECTS) und basiert auf dem von den Studierenden zu absolviierenden Arbeitspensum.

1.1 Prüfungsmodalitäten

In jedem Semester wird für Prüfungen mindestens ein Prüfungstermin angeboten. Prüfungstermine sowie Termine, zu denen die Anmeldung zu den Prüfungen spätestens erfolgen muss, werden vom Prüfungsausschuss festgelegt. Die Anmeldung für die Prüfungen erfolgt in der Regel mindestens eine Woche vor der Prüfung. Anmelde- und Prüfungstermine werden rechtzeitig bekanntgegeben, bei schriftlichen Prüfungen mindestens 6 Wochen vor der Prüfung.


Studienleistungen/Scheine können solange beliebig oft wiederholt werden, bis diese erfolgreich absolviert wurden.

1.2 Vertiefungsrichtungen

Es stehen folgende Vertiefungsrichtungen zur Auswahl:

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Folgende Module sind im Masterstudiengang zu belegen:

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1 Bei der Veranstaltung „Wahrscheinlichkeitstheorie und Statistik“ beträgt die Prüfungsdauer abweichend 1,5 h.
2 Zugelassene Teilleistungen in den Wahlpflichtmodulen

Jedes Fach, jedes Modul und jede Teilleistung kann nur einmal im Rahmen des Bachelorstudienganges und des konsekutiven Masterstudiengangs Maschinenbau gewählt werden.

2.1 Wahlpflichtmodul Grundlagen und Methoden der Vertiefungsrichtung

Im Masterstudiengang müssen zwei Teilleistungen mit jeweils 4 LP im Modul Grundlagen und Methoden der jeweiligen Vertiefungsrichtung erbracht werden. Wählbare Teilleistungen siehe Modulhandbuch.

2.2 Mathematische Methoden

Wählbare Teilleistungen siehe Modulhandbuch.

2.3 Wahlpflichtmodul aus dem Bereich Naturwissenschaften/Informatik/Elektrotechnik


2.4 Wahlpflichtmodul aus dem Bereich Wirtschaft/Recht


2.5 Wahlpflichtmodul aus dem Bereich Maschinenbau

Wählbare Teilleistungen siehe Modulhandbuch. Andere Teilleistungen, auch aus anderen Fakultäten, können mit Genehmigung des Prüfungsausschusses gewählt werden.

2.6 Laborpraktikum

Wählbare Teilleistungen siehe Modulhandbuch. Der Wechsel der gewählten Teilleistung ist bis zum Bestehen der Erfolgskontrolle möglich.

3 Schwerpunkte

Generell gilt, dass jede Teilleistung und jeder Schwerpunkt nur einmal entweder im Rahmen des Bachelorstudienganges und des konsekutiven Masterstudiengangs Maschinenbau gewählt werden kann.

3.1 Zuordnung der Schwerpunkte zu den Vertiefungsrichtungen

Folgende Schwerpunkte sind derzeit vom Fakultätsrat genehmigt. In einigen Vertiefungsrichtungen ist die Wahl des ersten Schwerpunkts eingeschränkt (einer der mit „p“ gekennzeichneten Schwerpunkte ist zu wählen).

In einem konsekutiven Masterstudium kann der erste Masterschwerpunkt auch als w-Schwerpunkt gewählt werden, wenn ein p-Schwerpunkt dieser Vertiefungsrichtung bereits im Bachelorstudium gewählt wurde.
<table>
<thead>
<tr>
<th>Schwerpunkt</th>
<th>SP-Verantwortlicher</th>
<th>SP-Nr.</th>
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Für jeden Schwerpunkt werden Teilleistungen im Umfang von 16 LP gewählt, davon werden mindestens 8 LP im Kernbereich (K) erworben. „KP“ bedeutet, dass die Lehrveranstaltung im Kernbereich Pflicht ist, sofern sie nicht bereits belegt wurde. Die übrigen 8 LP können aus dem Ergänzungsbereich kommen. Dabei dürfen im Rahmen von Praktika höchstens 4 LP erworben werden, die auch als Studienleistung erbracht werden können.

Die im Ergänzungsbereich (E) angegebenen Teilleistungen verstehen sich als Empfehlung, andere Teilleistungen (auch aus anderen KIT-Fakultäten) können mit Genehmigung des jeweiligen Schwerpunktverantwortlichen gewählt werden. Dabei ist eine Kombination mit Teilleistungen aus den Bereichen Informatik, Elektrotechnik und Mathematik in einigen Vertiefungsrichtungen besonders willkommen.

Ein Absolvieren des Schwerpunktmoduls mit mehr als 16 LP ist nur im Fall, dass die Addition innerhalb des Schwerpunktmoduls nicht auf 16 LP aufgeht, erlaubt. Nicht zulässig ist es jedoch, noch weitere Teilleistungen anzumelden, wenn bereits 16 LP erreicht oder überschritten wurden.

Für die Prüfungsleistungen in den Schwerpunkten gelten folgende Regeln:

Die Prüfungen werden grundsätzlich mündlich abgenommen, bei unvertretbar hohem Prüfungsaufwand kann eine mündlich durchzuführende Prüfung auch schriftlich abgenommen werden. Es wird empfohlen, die Kernbereichsprüfung im Block abzulegen. Bei mündlichen Prüfungen im Schwerpunkt soll die Prüfungsdauer fünf Minuten pro Leistungspunkt betragen. Erstreckt sich eine mündliche Prüfung über mehr als 12 LP, soll die Prüfungsdauer 60 Minuten betragen.


Die Beschreibung der Schwerpunkte hinsichtlich der jeweils darin enthaltenen Teilleistungen und den damit verbundenen Lehrveranstaltungen ist im aktuellen Modulhandbuch des Masterstudiengangs festgelegt.
Für die Betreuung der Masterarbeit stehen je nach Vertiefungssrichtung folgende Institute (●) zur Wahl:

<table>
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<tr>
<th>Institut für</th>
<th>Abk.</th>
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<th>E+UT</th>
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In interdisziplinär ausgerichteten Vertiefungssrichtungen ist die Beteiligung von Instituten anderer Fakultäten erwünscht. Mit Zustimmung der Vertiefungssrichtungsverantwortlichen kann der Prüfungsausschuss auch Masterarbeiten an anderen Instituten der Fakultät für Maschinenbau genehmigen. Zustimmung und Genehmigung sind vor Beginn der Arbeit einzuholen.
5 Änderungshistorie (ab 22.04.2015)

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### WS 2019-2020: M.Sc. Maschinenbau: Pflichtmodule; WPM Nat/inEng; WPM Wirtschaft/Recht; MM

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### WS 2019-2020: M.Sc. Maschinenbau: Pflichtmodule; Grundlagen und Methoden

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Stand: 06.09.2019
Amtliche Bekanntmachung

2015 Ausgegeben Karlsruhe, den 06. August 2015 Nr. 61

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Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Masterstudiengang Maschinenbau 366
Studien- und Prüfungsordnung
des Karlsruher Instituts für Technologie (KIT) für den Master-
studienangang Maschinenbau

vom 04. August 2015


Der Präsident hat seine Zustimmung gemäß § 20 Absatz 2 KITG iVm. § 32 Absatz 3 Satz 1 LHG am 04. August 2015 erteilt.

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   § 16 Prüfungsausschuss
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Präambel

Das KIT hat sich im Rahmen der Umsetzung des Bolognaprozesses zum Aufbau eines Europäischen Hochschulraumes zum Ziel gesetzt, dass am Abschluss des Studiums am KIT der Mastergrad stehen soll. Das KIT sieht daher die am KIT angebotenen konsekutiven Bachelor- und Masterstudiengänge als Gesamtkonzept mit konsekutivem Curriculum.

I. Allgemeine Bestimmungen

§ 1 Geltungsbereich
Diese Masterprüfungsordnung regelt Studienablauf, Prüfungen und den Abschluss des Studiums im Masterstudiengang Maschinenbau am KIT.

§ 2 Ziel des Studiums, Akademischer Grad
(1) Im konsekutiven Masterstudium sollen die im Bachelorstudium erworbenen wissenschaftlichen Qualifikationen weiter vertieft, verbreitert, erweitert oder ergänzt werden. Ziel des Studiums ist die Fähigkeit, die wissenschaftlichen Erkenntnisse und Methoden selbstständig anzuwenden und ihre Bedeutung und Reichweite für die Lösung komplexer wissenschaftlicher und gesellschaftlicher Problemstellungen zu bewerten.
(2) Aufgrund der bestandenen Masterprüfung wird der akademische Grad „Master of Science (M.Sc.)“ für den Masterstudiengang Maschinenbau verliehen.

§ 3 Regelstudienzeit, Studienaufbau, Leistungspunkte
(1) Die Regelstudienzeit beträgt vier Semester.
(4) Der Umfang der für den erfolgreichen Abschluss des Studiums erforderlichen Studien- und Prüfungsleistungen wird in Leistungspunkten gemessen und beträgt insgesamt 120 Leistungspunkte.
(5) Lehrveranstaltungen können nach vorheriger Ankündigung auch in englischer Sprache angeboten werden, sofern es deutschsprachige Wahlmöglichkeiten gibt.

§ 4 Modulprüfungen, Studien- und Prüfungsleistungen
Erfolgskontrollen gliedern sich in Studien- oder Prüfungsleistungen.
(2) Prüfungsleistungen sind:
1. schriftliche Prüfungen,
2. mündliche Prüfungen oder
3. Prüfungsleistungen anderer Art.

(3) Studienleistungen sind schriftliche, mündliche oder praktische Leistungen, die von den Studierenden in der Regel lehrveranstaltungsbegleitend erbracht werden. Die Masterprüfung darf nicht mit einer Studienleistung abgeschlossen werden.

(4) Von den Modulprüfungen sollen mindestens 70 % benotet sein.

(5) Bei sich ergänzenden Inhalten können die Modulprüfungen mehrerer Module durch eine auch modulübergreifende Prüfungsleistung (Absatz 2 Nr. 1 bis 3) ersetzt werden.

§ 5 Anmeldung und Zulassung zu den Modulprüfungen und Lehrveranstaltungen

(1) Um an den Modulprüfungen teilnehmen zu können, müssen sich die Studierenden online im Studierendenportal zu den jeweiligen Erfolgskontrollen anmelden. In Ausnahmefällen kann eine Anmeldung schriftlich im Studierendenservice oder in einer anderen vom Studierendenservice autorisierten Einrichtung erfolgen. Für die Erfolgskontrollen können durch die Prüfenden Anmeldefristen festgelegt werden. Die Anmeldung der Masterarbeit ist im Modulhandbuch geregelt.


(3) Zu einer Erfolgskontrolle ist zuzulassen, wer
1. in den Masterstudiengang Maschinenbau am KIT eingeschrieben ist; die Zulassung beurlaubter Studierender ist auf Prüfungsleistungen beschränkt und
2. nachweist, dass er die im Modulhandbuch für die Zulassung zu einer Erfolgskontrolle festgelegten Voraussetzungen erfüllt und
3. nachweist, dass er in dem Masterstudiengang Maschinenbau den Prüfungsanspruch nicht verloren hat.

(4) Nach Maßgabe von § 30 Abs. 5 LHG kann die Zulassung zu einzelnen Pflichtveranstaltungen beschränkt werden. Der/die Prüfende entscheidet über die Auswahl unter den Studierenden, die sich rechtzeitig bis zu dem von dem/der Prüfenden festgesetzten Termin angemeldet haben unter Berücksichtigung des Studienfortschritts dieser Studierenden und unter Beachtung von § 13 Abs. 1 Satz 1 und 2, sofern ein Abbau des Überhangs durch andere oder zusätzliche Veranstaltungen nicht möglich ist. Für den Fall gleichen Studienfortschritts sind durch die KIT-Fakultäten weitere Kriterien festzulegen. Das Ergebnis wird den Studierenden rechtzeitig bekannt gegeben.


§ 6 Durchführung von Erfolgskontrollen

(1) Erfolgskontrollen werden studienbegleitend, in der Regel im Verlauf der Vermittlung der Lehrinhalte der einzelnen Module oder zeitnah danach, durchgeführt.
(2) Die Art der Erfolgskontrolle (§ 4 Abs. 2 Nr. 1 bis 3, Abs. 3) wird von der/dem Prüfenden der betreffenden Lehrveranstaltung in Bezug auf die Lerninhalte der Lehrveranstaltung und die Lernziele des Moduls festgelegt. Die Art der Erfolgskontrolle, ihre Häufigkeit, Reihenfolge und Gewichtung sowie gegebenenfalls die Bildung der Modulnote müssen mindestens sechs Wochen vor Vorlesungsbeginn im Modulhandbuch bekannt gemacht werden. Im Einvernehmen von Prüfendem und Studierender bzw. Studierendem können die Art der Prüfungsleistung sowie die Prüfungssprache auch nachträglich geändert werden; im ersten Fall ist jedoch § 4 Abs. 4 zu berücksichtigen. Bei der Prüfungsorganisation sind die Belange Studierender mit Behinderung oder chronischer Erkrankung gemäß § 13 Abs. 1 zu berücksichtigen. § 13 Abs. 1 Satz 3 und 4 gelten entsprechend. 

(3) Bei unverzüglich hohem Prüfungsaufwand kann eine schriftlich durchzuführende Prüfungsleistung auch mündlich, oder eine mündlich durchzuführende Prüfungsleistung auch schriftlich abgenommen werden. Diese Änderung muss mindestens sechs Wochen vor der Prüfungsleistung bekannt gegeben werden. 

(4) Bei Lehrveranstaltungen in englischer Sprache (§ 3 Abs. 6) können die entsprechenden Erfolgskontrollen in dieser Sprache abgenommen werden. § 6 Abs. 2 gilt entsprechend. 

(5) **Schriftliche Prüfungen** (§ 4 Abs. 2 Nr. 1) sind in der Regel von einer/einem Prüfenden nach § 18 Abs. 2 oder 3 zu bewerten. Sofern eine Bewertung durch mehrere Prüfende erfolgt, ergibt sich die Note aus dem arithmetischen Mittel der Einzelbewertungen. Entspricht das arithmetische Mittel keiner der in § 7 Abs. 2 Satz 2 definierten Notenstufen, ist auf die nächsthöhere Notenstufe auf- oder abzurunden. Bei gleichem Abstand ist auf die nächsthöhere Notenstufe zu runden. Die Bewertungsverfahren sollen sechs Wochen nicht überschreiten. Schriftliche Prüfungen dauern mindestens 60 und höchstens 300 Minuten. 

(6) **Mündliche Prüfungen** (§ 4 Abs. 2 Nr. 2) sind von mehreren Prüfenden (Kollegialprüfung) oder von einer/m Prüfendin in Gegenwart einer oder eines Beisitzenden als Gruppen- oder Einzelprüfungen abzunehmen und zu bewerten. Vor der Festsetzung der Note hört die/der Prüfende die anderen an der Kollegialprüfung mitwirkenden Prüfenden an. Mündliche Prüfungen dauern in der Regel mindestens 15 Minuten und maximal 60 Minuten pro Studierenden. Die wesentlichen Gegenstände und Ergebnisse der mündlichen Prüfung sind in einem Protokoll festzuhalten. Das Ergebnis der Prüfung ist den Studierenden im Anschluss an die mündliche Prüfung bekannt zu geben. 

Studierende, die sich in einem späteren Semester der gleichen Prüfung unterziehen wollen, werden entsprechend den räumlichen Verhältnissen und nach Zustimmung des Prüfungsleiters als Zuhörerinnen und Zuhörer bei mündlichen Prüfungen zugelassen. Die Zulassung erstreckt sich nicht auf die Beratung und Bekanntgabe der Prüfungsergebnisse. 

(7) Für **Prüfungsleistungen anderer Art** (§ 4 Abs. 2 Nr. 3) sind angemessene Bearbeitungsfristen einzuräumen und Abgabetermine festzulegen. Dabei ist durch die Art der Aufgabenstellung und durch entsprechende Dokumentation sicherzustellen, dass die erbrachte Prüfungsleistung dem/der Studierenden zurechenbar ist. Die wesentlichen Gegenstände und Ergebnisse der Erfolgskontrolle sind in einem Protokoll festzuhalten. 

Bei mündlich durchgeführten **Prüfungsleistungen anderer Art** muss neben der/den Prüfenden ein/e Beisitzende/r anwesend sein, die/der zusätzlich zum/er Prüfenden das Protokoll zeichnet. 

**Schriftliche Arbeiten** im Rahmen einer **Prüfungsleistung anderer Art** haben dabei die folgende Erklärung zu tragen: „Ich versichere wahrheitsgemäß, die Arbeit selbstständig angefertigt, alle benutzten Hilfsmittel vollständig und genau angegeben und alles kenntlich gemacht zu haben, was aus Arbeiten anderer unverändert oder mit Abänderungen entnommen wurde.“ Trägt die Arbeit diese Erklärung nicht, wird sie nicht angenommen. Die wesentlichen Gegenstände und Ergebnisse einer solchen Erfolgskontrolle sind in einem Protokoll festzuhalten. 

§ 6 a Erfolgskontrollen im Antwort-Wahl-Verfahren
Das Modulhandbuch regelt, ob und in welchem Umfang Erfolgskontrollen im Wege des Antwort-Wahl-Verfahrens abgelegt werden können.

§ 6 b Computergestützte Erfolgskontrollen


(2) Vor der computergestützten Erfolgskontrolle hat die/der Prüfende sicherzustellen, dass die elektronischen Daten eindeutig identifiziert und unverwechselbar und dauerhaft den Studierenden zugeordnet werden können. Der störungsfreie Verlauf einer computergestützten Erfolgskontrolle ist durch entsprechende technische Betreuung zu gewährleisten, insbesondere ist die Erfolgskontrolle in Anwesenheit einer fachlich sachkundigen Person durchzuführen. Alle Prüfungsaufgaben müssen während der gesamten Bearbeitungszeit zur Verfügung stehen.

(3) Im Übrigen gelten für die Durchführung von computergestützten Erfolgskontrollen die §§ 6 bzw. 6 a.

§ 7 Bewertung von Studien- und Prüfungsleistungen

(1) Das Ergebnis einer Prüfungsleistung wird von den jeweiligen Prüfenden in Form einer Note festgesetzt.

(2) Folgende Noten sollen verwendet werden:

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<td>hervorragende Leistung</td>
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<tr>
<td>gut (good)</td>
<td>eine Leistung, die erheblich über den durchschnittlichen Anforderungen liegt,</td>
</tr>
<tr>
<td>befriedigend (satisfactory)</td>
<td>eine Leistung, die durchschnittlichen Anforderungen entspricht,</td>
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<tr>
<td>ausreichend (sufficient)</td>
<td>eine Leistung, die trotz ihrer Mängel noch den Anforderungen genügt,</td>
</tr>
<tr>
<td>nicht ausreichend (failed)</td>
<td>eine Leistung, die wegen erheblicher Mängel nicht den Anforderungen genügt.</td>
</tr>
</tbody>
</table>

Zur differenzierten Bewertung einzelner Prüfungsleistungen sind nur folgende Noten zugelassen:

<table>
<thead>
<tr>
<th>Note</th>
<th>Bewertung</th>
</tr>
</thead>
<tbody>
<tr>
<td>1,0; 1,3</td>
<td>sehr gut</td>
</tr>
<tr>
<td>1,7; 2,0; 2,3</td>
<td>gut</td>
</tr>
<tr>
<td>2,7; 3,0; 3,3</td>
<td>befriedigend</td>
</tr>
<tr>
<td>3,7; 4,0</td>
<td>ausreichend</td>
</tr>
<tr>
<td>5,0</td>
<td>nicht ausreichend</td>
</tr>
</tbody>
</table>

(3) Studienleistungen werden mit „bestanden“ oder mit „nicht bestanden“ gewertet.

(4) Bei der Bildung der gewichteten Durchschnitte der Modulnoten, der Fachnoten und der Gesamtnote wird nur die erste Dezimalstelle hinter dem Komma berücksichtigt; alle weiteren Stellen werden ohne Rundung gestrichen.

(5) Jedes Modul und jede Erfolgskontrolle darf in demselben Studiengang nur einmal gewertet werden.
Eine Prüfungsleistung ist bestanden, wenn die Note mindestens „ausreichend“ (4,0) ist.


Die Ergebnisse der Erfolgskontrollen sowie die erworbenen Leistungspunkte werden durch den Studierendenservice des KIT verwaltet.

Die Noten der Module eines Faches gehen in die Fachnote mit einem Gewicht proportional zu den ausgewiesenen Leistungspunkten der Module ein.

Die Gesamtnote der Masterprüfung, die Fachnoten und die Modulnoten lauten:

- bis 1,5 = sehr gut
- von 1,6 bis 2,5 = gut
- von 2,6 bis 3,5 = befriedigend
- von 3,6 bis 4,0 = ausreichend

§ 8 Wiederholung von Erfolgskontrollen, endgültiges Nichtbestehen

(1) Studierende können eine nicht bestandene schriftliche Prüfung (§ 4 Absatz 2 Nr. 1) einmal wiederholen. Wird eine schriftliche Wiederholungsprüfung mit „nicht ausreichend“ (5,0) bewertet, so findet eine mündliche Nachprüfung im zeitlichen Zusammenhang mit dem Termin der nicht bestandenen Prüfung statt. In diesem Falle kann die Note dieser Prüfung nicht besser als „ausreichend“ (4,0) sein.

(2) Studierende können eine nicht bestandene mündliche Prüfung (§ 4 Absatz 2 Nr. 2) einmal wiederholen.

(3) Wiederholungsprüfungen nach Absatz 1 und 2 müssen in Inhalt, Umfang und Form (mündlich oder schriftlich) der ersten entsprechen. Ausnahmen kann der zuständige Prüfungsausschuss auf Antrag zulassen.

(4) Prüfungsleistungen anderer Art (§ 4 Absatz 2 Nr. 3) können einmal wiederholt werden.

(5) Studienleistungen können mehrfach wiederholt werden.

(6) Die Wiederholung von Prüfungsleistungen hat spätestens bis zum Ende des Prüfungszeitraumes des übernächsten Semesters zu erfolgen.

(7) Die Prüfungsleistung ist endgültig nicht bestanden, wenn die mündliche Nachprüfung im Sinne des Absatzes 1 mit „nicht ausreichend“ (5,0) bewertet wurde. Die Prüfungsleistung ist ferner endgültig nicht bestanden, wenn die mündliche Prüfung im Sinne des Absatzes 2 oder die Prüfungslaten der anderen Art gemäß Absatz 4 zweimal mit „nicht bestanden“ bewertet wurde.

(8) Das Modul ist endgültig nicht bestanden, wenn eine für sein Bestehen erforderliche Prüfungsleistung endgültig nicht bestanden ist.

(9) Eine zweite Wiederholung derselben Prüfungsleistung gemäß § 4 Abs. 2 ist nur in Ausnahmefällen auf Antrag des/der Studierenden zulässig („Antrag auf Zweitwiederholung“). Der Antrag ist schriftlich beim Prüfungsausschuss in der Regel bis zwei Monate nach Bekanntgabe der Note zu stellen.

der Antrag genehmigt, hat die Zweitwiederholung spätestens zum übernächsten Prüfungstermin zu erfolgen. Absatz 1 Satz 2 und 3 gelten entsprechend.

(10) Die Wiederholung einer bestandenen Prüfungsleistung ist nicht zulässig.


§ 9 Verlust des Prüfungsanspruchs

Ist eine nach dieser Studien- und Prüfungsordnung erforderliche Studien- oder Prüfungsleistung endgültig nicht bestanden oder eine Wiederholungsprüfung nach § 8 Abs. 6 nicht rechtzeitig erbracht oder die Masterprüfung bis zum Ende des Prüfungszeitraums des siebenten Fachsemesters einschließlich etwaiger Wiederholungen nicht vollständig abgelegt, so erlischt der Prüfungsanspruch im Studiengang Maschinenbau, es sei denn, dass die Fristüberschreitung nicht selbst zu vertreten ist. Die Entscheidung über eine Fristverlängerung und über Ausnahmen von der Fristregelung trifft der Prüfungsausschuss unter Beachtung der in § 32 Abs. 6 LHG genannten Tätigkeiten auf Antrag des/der Studierenden. Der Antrag ist schriftlich in der Regel bis sechs Wochen vor Ablauf der Frist zu stellen.

§ 10 Abmeldung; Versäumnis, Rücktritt

(1) Studierende können ihre Anmeldung zu schriftlichen Prüfungen ohne Angabe von Gründen bis zur Ausgabe der Prüfungsaufgaben widerrufen (Abmeldung). Eine Abmeldung kann online im Studierendenportal bis 24:00 Uhr des Vortages der Prüfung oder in begründeten Ausnahmefällen beim Studierendenservice innerhalb der Geschäftszeiten erfolgen. Erfolgt die Abmeldung gegenüber dem/der Prüfenden hat diese/r Sorge zu tragen, dass die Abmeldung im Campus Management System verbucht wird.


(3) Die Abmeldung von Prüfungsleistungen anderer Art sowie von Studienleistungen ist im Modulhandbuch geregelt.

(4) Eine Erfolgskontrolle gilt als mit „nicht ausreichend“ (5,0) bewertet, wenn die Studierenden einen Prüfungstermin ohne triftigen Grund versäumen oder wenn sie nach Beginn der Erfolgskontrolle ohne triftigen Grund von dieser zurücktreten. Dasselbe gilt, wenn die Masterarbeit nicht innerhalb der vorgesehenen Bearbeitungszeit erbracht wird, es sei denn, der/die Studierende hat die Fristüberschreitung nicht zu vertreten.


§ 11 Täuschung, Ordnungsverstoß

(1) Versuchen Studierende das Ergebnis ihrer Erfolgskontrolle durch Täuschung oder Benutzung nicht zugelassener Hilfsmittel zu beeinflussen, gilt die betreffende Erfolgskontrolle als mit „nicht ausreichend“ (5,0) bewertet.

(2) Studierende, die den ordnungsgemäßen Ablauf einer Erfolgskontrolle stören, können von der/dem Prüfenden oder der Aufsicht führenden Person von der Fortsetzung der Erfolgskontrolle ausgeschlossen werden. In diesem Fall gilt die betreffende Erfolgskontrolle als mit „nicht ausrei-
chend“ (5,0) bewertet. In schwerwiegenderen Fällen kann der Prüfungsausschuss diese Studierenden von der Erbringung weiterer Erfolgskontrollen ausschließen.

(3) Näheres regelt die Allgemeine Satzung des KIT zur Redlichkeit bei Prüfungen und Praktika in der jeweils gültigen Fassung.

§ 12 Mutterschutz, Elternzeit, Wahrnehmung von Familienpflichten


(3) Der Prüfungsausschuss entscheidet auf Antrag über die flexible Handhabung von Prüfungsfristen entsprechend den Bestimmungen des Landeshochschulgesetzes, wenn Studierende Familienpflichten wahrzunehmen haben. Absatz 2 Satz 4 bis 6 gelten entsprechend.

§ 13 Studierende mit Behinderung oder chronischer Erkrankung


(2) Weisen Studierende eine Behinderung oder chronische Erkrankung nach und folgt daraus, dass sie nicht in der Lage sind, Erfolgskontrollen ganz oder teilweise in der vorgeschriebenen Zeit oder Form abzulegen, kann der Prüfungsausschuss gestatten, die Erfolgskontrollen in einem anderen Zeitraum oder einer anderen Form zu erbringen. Insbesondere ist behinderten Studierenden zu gestatten, notwendige Hilfsmittel zu benutzen.

(3) Weisen Studierende eine Behinderung oder chronische Erkrankung nach und folgt daraus, dass sie nicht in der Lage sind, die Lehrveranstaltungen regelmäßig zu besuchen oder die gemäß § 19 erforderlichen Studien- und Prüfungsleistungen zu erbringen, kann der Prüfungsausschuss auf Antrag gestatten, dass einzelne Studien- und Prüfungsleistungen nach Ablauf der in dieser Studien- und Prüfungsordnung vorgesehenen Fristen absolviert werden können.
§ 14 Modul Masterarbeit

(1) Voraussetzung für die Zulassung zum Modul Masterarbeit ist, dass die/der Studierende Modulprüfungen im Umfang von 74 LP erfolgreich abgelegt hat. Über Ausnahmen entscheidet der Prüfungsausschuss auf Antrag der/des Studierenden.

(1 a) Dem Modul Masterarbeit sind 30 LP zugeordnet. Es besteht aus der Masterarbeit und einer Präsentation. Die Präsentation hat spätestens sechs Wochen nach Abgabe der Masterarbeit zu erfolgen.


(3) Thema, Aufgabenstellung und Umfang der Masterarbeit sind von dem Betreuer bzw. der Betreuerin so zu begrenzen, dass sie mit dem in Absatz 4 festgelegten Arbeitsaufwand bearbeitet werden kann.


(5) Bei der Abgabe der Masterarbeit haben die Studierenden schriftlich zu versichern, dass sie die Arbeit selbstständig verfasst und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt haben, die wörtlich oder inhaltlich übernommenen Stellen als solche kenntlich gemacht und die Satzung des KIT zur Sicherung guter wissenschaftlicher Praxis in der jeweils gültigen Fassung beachtet haben. Wenn diese Erklärung nicht enthalten ist, wird die Arbeit nicht angenommen. Die Erklärung kann wie folgt lauten: „Ich versichere wahrheitsgemäß, die Arbeit selbstständig verfasst, alle benutzten Hilfsmittel vollständig und genau angegeben und alles kenntlich gemacht zu haben, was aus Arbeiten anderer unverändert oder mit Abänderungen entnommen wurde sowie die Satzung des KIT zur Sicherung guter wissenschaftlicher Praxis in der jeweils gültigen Fassung beachtet zu haben.“ Bei Abgabe einer unwahren Versicherung wird die Masterarbeit mit „nicht ausreichend“ (5,0) bewertet.


(7) Die Masterarbeit wird von mindestens einem/einer Hochschullehrer/in oder einem/einer leitenden Wissenschaftler/in gemäß § 14 abs. 3 Ziff. 1 KITG und einem/einer weiteren Prüfenden bewertet. In der Regel ist eine/r der Prüfenden die Person, die die Arbeit gemäß Absatz 2 vergibt. Bei nicht übereinstimmender Beurteilung dieser beiden Personen setzt der Prüfungs-
ausschuss im Rahmen der Bewertung dieser beiden Personen die Note der Masterarbeit fest; er kann auch einen weiteren Gutachter bestellen. Die Bewertung hat innerhalb von sechs Wochen nach Abgabe der Masterarbeit zu erfolgen.

§ 15 Zusatzleistungen

(2) Die Studierenden haben bereits bei der Anmeldung zu einer Prüfung in einem Modul diese als Zusatzleistung zu deklarieren.

§ 16 Prüfungsausschuss


(4) Der Prüfungsausschuss kann die Erledigung seiner Aufgaben für alle Regelfälle auf die/den Vorsitzende/n des Prüfungsausschusses übertragen. In dringenden Angelegenheiten, deren Erledigung nicht bis zu der nächsten Sitzung des Prüfungsausschusses warten kann, entscheidet die/den Vorsitzende/n des Prüfungsausschusses.

In Angelegenheiten des Prüfungsausschusses, die eine an einer anderen KIT-Fakultät zu absolvierende Prüfungsleistung betreffen, ist auf Antrag eines Mitgliedes des Prüfungsausschusses eine fachlich zuständige und von der betroffenen KIT-Fakultät zu nennende prüfungsberechtigte Person hinzuzuziehen.


§ 17 Prüfende und Beisitzende

(1) Der Prüfungsausschuss bestellt die Prüfenden. Er kann die Bestellung der/dem Vorsitzenden übertragen.

(2) Prüfende sind Hochschullehrer/innen sowie leitende Wissenschaftler/innen gemäß § 14 Abs. 3 Ziff. 1 KITG, habilitierte Mitglieder und akademische Mitarbeiter/innen gemäß § 52 LHG, welche die KIT-Fakultät angehören und denen die Prüfungsbeauftragung übertragen wurde; desgleichen kann wissenschaftlichen Mitarbeitern gemäß § 14 Abs. 3 Ziff. 2 KITG die Prüfungsbeauftragung übertragen werden. Bestellt werden darf nur, wer mindestens die dem jeweiligen Prüfungsszweig entsprechende fachwissenschaftliche Qualifikation erworben hat.

(3) Soweit Lehrveranstaltungen von anderen als den unter Absatz 2 genannten Personen durchgeführt werden, sollen diese zu Prüfenden bestellt werden, sofern die KIT-Fakultät eine Prüfungsbeauftragung erteilt hat und sie die gemäß Absatz 2 Satz 2 vorausgesetzte Qualifikation nachweisen können.

(4) Die Beisitzenden werden durch die Prüfenden benannt. Zu Beisitzenden darf nur bestellt werden, wer einen akademischen Abschluss in einem mathematisch-naturwissenschaftlichen oder ingenieurwissenschaftlichen Studiengang oder einen gleichwertigen akademischen Abschluss erworben hat.

§ 18 Anerkennung von Studien- und Prüfungsleistungen, Studienzeiten

(1) Studien- und Prüfungsleistungen sowie Studienzeiten, die in Studiengängen an staatlichen oder staatlich anerkannten Hochschulen und Berufsakademien der Bundesrepublik Deutschland oder an ausländischen staatlichen oder staatlich anerkannten Hochschulen erbracht wurden, werden auf Antrag der Studierenden anerkannt, sofern hinsichtlich der erworbenen Kompetenzen kein wesentlicher Unterschied zu den Leistungen oder Abschlüssen besteht, die ersetzt werden sollen. Dabei ist kein schematischer Vergleich, sondern eine Gesamtbetrachtung vorzunehmen. Bezüglich des Umfangs einer zur Anerkennung vorgelegten Studienleistung bzw. Prüfungsleistung (Anrechnung) werden die Grundsätze des ECTS herangezogen.

(2) Die Studierenden haben die für die Anerkennung erforderlichen Unterlagen vorzulegen. Studierende, die neu in den Masterstudiengang Maschinenbau immatrikuliert wurden, haben den Antrag mit den für die Anerkennung erforderlichen Unterlagen innerhalb eines Semesters nach Immatrikulation zu stellen. Bei Unterlagen, die nicht in deutscher oder englischer Sprache vorliegen, kann eine amtlich beglaubigte Übersetzung verlangt werden. Die Beweislast dafür, dass der Antrag die Voraussetzungen für die Anerkennung nicht erfüllt, liegt beim Prüfungsausschuss.

(3) Werden Leistungen angerechnet, die nicht am KIT erbracht wurden, werden sie im Zeugnis als „anerkannt“ ausgewiesen. Liegen Noten vor, werden die Noten, soweit die Notensysteme vergleichbar sind, übernommen und in die Berechnung der Modulnoten und der Gesamtnote einbezogen. Sind die Notensysteme nicht vergleichbar, können die Noten umgerechnet werden. Liegen keine Noten vor, wird der Vermerk „bestanden“ aufgenommen.

(4) Bei der Anerkennung von Studien- und Prüfungsleistungen, die außerhalb der Bundesrepublik Deutschland erbracht wurden, sind die von der Kultusministerkonferenz und der Hochschul-
rektorenkonferenz gebilligten Äquivalenzvereinbarungen sowie Absprachen im Rahmen der Hochschulpartenchaften zu beachten.

(5) Außerhalb des Hochschulsystems erworbene Kenntnisse und Fähigkeiten werden angerechnet, wenn sie nach Inhalt und Niveau den Studien- und Prüfungsleistungen gleichwertig sind, die ersetzt werden sollen und die Institution, in der die Kenntnisse und Fähigkeiten erworben wurden, ein genormtes Qualitätssicherungssystem hat. Die Anrechnung kann in Teilen versagt werden, wenn mehr als 50 Prozent des Hochschulstudiums ersetzt werden soll.


II. Masterprüfung

§ 19 Umfang und Art der Masterprüfung

(1) Die Masterprüfung besteht aus den Modulprüfungen nach Absatz 2 und 3 sowie der Modul Masterarbeit (§ 14).

(2) Es sind Modulprüfungen im Pflichtfach „Vertiefung ingenieurwissenschaftlicher Grundlagen“ im Umfang von 50 LP abzulegen. Die Festlegung der zur Auswahl stehenden Module wird im Modulhandbuch getroffen.

(3) Im Wahlpflichtbereich ist ein Wahlpflichtfach im Umfang von 40 LP zu absolvieren. Zur Auswahl stehen mindestens das Fach „Allgemeiner Maschinenbau“. Die Festlegung der weiteren zur Auswahl stehenden Fächer und der den Fächern zugeordneten Module wird im Modulhandbuch getroffen.

§ 20 Bestehen der Masterprüfung, Bildung der Gesamtnote

(1) Die Masterprüfung ist bestanden, wenn alle in § 19 genannten Modulprüfungen mindestens mit „ausreichend“ bewertet wurden.

(2) Die Gesamtnote der Masterprüfung errechnet sich als ein mit Leistungspunkten gewichteter Notendurchschnitt der Fachnoten und dem Modul Masterarbeit.

(3) Haben Studierende die Masterarbeit mit der Note 1,0 und die Masterprüfung mit einem Durchschnitt von 1,2 oder besser abgeschlossen, so wird das Prädikat „mit Auszeichnung“ (with distinction) verliehen.

§ 21 Masterzeugnis, Masterurkunde, Diploma Supplement und Transcript of Records


(2) Das Zeugnis enthält die Fach- und Modulnoten sowie die den Modulen und Fächern zugeordnete Leistungspunkte und die Gesamtnote. Sofern gemäß § 7 Abs. 2 Satz 2 eine differenzier-

(3) Mit dem Zeugnis erhalten die Studierenden ein Diploma Supplement in deutscher und englischer Sprache, das den Vorgaben des jeweils gültigen ECTS Users' Guide entspricht, sowie ein Transcript of Records in deutscher und englischer Sprache.


III. Schlussbestimmungen

§ 22 Bescheinigung von Prüfungsleistungen
Haben Studierende die Masterprüfung endgültig nicht bestanden, wird ihnen auf Antrag und gegen Vorlage der Exmatrikulationsbescheinigung eine schriftliche Bescheinigung ausgestellt, die die erbrachten Studien- und Prüfungsleistungen und deren Noten enthält und erkennen lässt, dass die Prüfung insgesamt nicht bestanden ist. Dasselbe gilt, wenn der Prüfungsanspruch erloschen ist.

§ 23 Aberkennung des Mastergrades
(1) Haben Studierende bei einer Prüfungsleistung getäuscht und wird diese Tatsache nach der Aushändigung des Zeugnisses bekannt, so können die Noten der Modulprüfungen, bei denen getäuscht wurde, berichtigt werden. Gegebenenfalls kann die Modulprüfung für „nicht ausreichend“ (5,0) und die Masterprüfung für „nicht bestanden“ erklärt werden.

(2) Waren die Voraussetzungen für die Zulassung zu einer Prüfung nicht erfüllt, ohne dass die/der Studierende darüber täuschen wollte, und wird diese Tatsache erst nach Aushändigung des Zeugnisses bekannt, wird dieser Mangel durch das Bestehen der Prüfung geheilt. Hat die/der Studierende die Zulassung vorsätzlich zu Unrecht erwirkt, so kann die Modulprüfung für „nicht ausreichend“ (5,0) und die Masterprüfung für „nicht bestanden“ erklärt werden.

(3) Vor einer Entscheidung des Prüfungsausschusses ist Gelegenheit zur Äußerung zu geben.

(4) Das unrichtige Zeugnis ist zu entziehen und gegebenenfalls ein neues zu erteilen. Mit dem unrichtigen Zeugnis ist auch die Masterurkunde einzuziehen, wenn die Masterprüfung aufgrund einer Täuschung für „nicht bestanden“ erklärt wurde.


(6) Die Aberkennung des akademischen Grades richtet sich nach § 36 Abs. 7 LHG.
§ 24 Einsicht in die Prüfungsakten
(1) Nach Abschluss der Masterprüfung wird den Studierenden auf Antrag innerhalb eines Jahres Einsicht in das Prüfungsexemplar ihrer Masterarbeit, die darauf bezogenen Gutachten und in die Prüfungsprotokolle gewährt.

(2) Für die Einsichtnahme in die schriftlichen Modulprüfungen, schriftlichen Modulteilprüfungen bzw. Prüfungsprotokolle gilt eine Frist von einem Monat nach Bekanntgabe des Prüfungsergebnisses.

(3) Der/die Prüfende bestimmt Ort und Zeit der Einsichtnahme.

(4) Prüfungsunterlagen sind mindestens fünf Jahre aufzubewahren.

§ 25 Inkrafttreten, Übergangsvorschriften
(1) Diese Studien- und Prüfungsordnung tritt am 01. Oktober 2016 in Kraft.


Karlsruhe, den 04. August 2015

Professor Dr.-Ing. Holger Hanselka
(Präsident)
Inhalt

Satzung zur Änderung der Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Master-studiengang Maschinenbau Seite 28
Satzung zur Änderung der Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Masterstudiengang Maschinenbau

vom 21. Februar 2019


Der Präsident hat seine Zustimmung gemäß § 20 Absatz 2 Satz 1 KITG i.V.m. § 32 Absatz 3 Satz 1 LHG am 21. Februar 2019 erteilt.

Artikel 1 – Änderung der Studien- und Prüfungsordnung

1. § 12 Absatz 1 wird wie folgt geändert:
   a) Satz 1 wird wie folgt gefasst:
      „Es gelten die Vorschriften des Gesetzes zum Schutz von Müttern bei der Arbeit, in der Ausbildung und im Studium (Mutterschutzgesetz – MuSchG) in seiner jeweils geltenden Fassung.“
   b) Satz 2 wird aufgehoben.
   c) Die bisherigen Sätze 3 und 4 werden die Sätze 2 und 3

2. § 14 wird wie folgt geändert:
   a) In Absatz 2 Satz 1 werden nach den Wörtern „Hochschullehrer/innen“ das Wort “und” durch ein Komma ersetzt und nach der Angabe „§ 14 Abs. 3 Ziff. 1 KITG“ die Wörter „und habilitierten Mitgliedern der KIT-Fakultät für Maschinenbau“ eingefügt.
   b) In Absatz 7 Satz 1 werden nach den Wörtern „Hochschullehrer/innen“ das Wort “oder“ durch ein Komma ersetzt und nach der Angabe „§ 14 abs. 3 Ziff. 1 KITG“ die Wörter „oder einem habilitierten Mitglied der KIT-Fakultät für Maschinenbau“ eingefügt.

3. § 16 wird wie folgt geändert:
   a) In Absatz 1 Satz 3 wird das Wort „stammt“ durch die Wörter „stammen soll“ ersetzt.
   b) In Absatz 7 Satz 4 werden nach dem Wort „Entscheidung“ die Wörter „schriftlich oder zur Niederschrift“ gestrichen.
4. § 17 Absatz 3 wird wie folgt geändert:
Nach dem Wort „sofern“ werden die Wörter „die KIT-Fakultät eine Prüfungsbeugnis erteilt hat und“ gestrichen.

Artikel 2 – Inkrafttreten

Diese Änderungssatzung tritt zum 01. April 2019 in Kraft.

Karlsruhe, den 21. Februar 2019

gez. Prof. Dr.-Ing. Holger Hanselka
(Präsident)
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<tr>
<td>Satzung für den Zugang zu dem Masterstudiengang</td>
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<td>Maschinenbau am Karlsruher Institut für Technologie (KIT)</td>
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Satzung für den Zugang zu dem Masterstudiengang Maschinenbau am Karlsruher Institut für Technologie (KIT)

vom 22. November 2017


§ 1 Anwendungsbereich

Die Satzung regelt den Zugang zu dem Masterstudiengang Maschinenbau am Karlsruher Institut für Technologie (im Folgenden: KIT).

§ 2 Fristen

(1) Eine Immatrikulation erfolgt sowohl zum Winter- als auch zum Sommersemester.

(2) Der Antrag auf Immatrikulation einschließlich aller erforderlichen Unterlagen muss

- für das Wintersemester bis zum 30. September eines Jahres
- für das Sommersemester bis zum 31. März eines Jahres

beim KIT eingegangen sein.

§ 3 Form des Antrages

(1) Die Form des Antrags richtet sich nach den allgemeinen für das Zulassungs- und Immatrikulationsverfahren geltenden Bestimmungen in der jeweils gültigen Zulassungs- und Immatrikulationsordnung des KIT.

(2) Dem Antrag sind folgende Unterlagen beizufügen:

1. eine Kopie des Nachweises über den Bachelorabschluss oder gleichwertigen Abschluss gemäß § 5 Abs. 1 Nr. 1 samt Diploma Supplement und Transcript of Records (unter Angabe der erbrachten Leistungspunkte/ECTS),

2. Nachweise der in § 5 Abs. 1 Nr. 3 genannten Mindestkenntnisse und Mindestleistungen, aus denen die Lernziele, Studieninhalte und Leistungspunkte hervorgehen, ggfs. Nachweis einer erfolgreichen Aufnahmeprüfung gemäß § 7 Abs. 2,

3. ein Nachweis über ein mindestens 18-wöchiges Berufspraktikum, welches durch das Praktikantenamt der KIT-Fakultät für Maschinenbau anerkannt wurde (§ 6),

4. eine schriftliche Erklärung der/des Bewerber/in darüber, ob sie/er in dem Masterstudiengang Maschinenbau oder einem verwandten Studiengang mit im Wesentlichen gleichem
Inhalt gemäß § 5 Abs. 2 eine nach der Prüfungsordnung erforderliche Prüfung endgültig nicht bestanden hat oder der Prüfungsanspruch aus sonstigen Gründen nicht mehr besteht,

5. Nachweise über die in § 5 Abs. 1 Nr. 5 a) oder b) genannten Sprachkenntnisse,

6. die in der jeweils gültigen Zulassungs- und Immatrikulationsordnung genannten weiteren Unterlagen.

Das KIT kann verlangen, dass diese der Zugangsentscheidung zugrundeliegenden Dokumente bei der Einschreibung im Original vorzulegen sind.


In diesem Fall sind die bis zu diesem Zeitpunkt erbrachten Studien- und Prüfungsleistungen im Rahmen der Zugangsentscheidung zu berücksichtigen. Das spätere Ergebnis des Bachelorabschlusses bleibt unbeachtet. Der Bewerbung ist

a) eine Bescheinigung über die bis zum Ende der Bewerbungsfrist erbrachten Prüfungsleistungen (z.B. Notenauszug) sowie

b) eine Übersicht aller noch nicht nachgewiesenen Prüfungs- und Studienleistungen mit Angabe des Prüfungsdatums und des Nachweises der Prüfungsanmeldung beizulegen.

§ 4 Zugangskommission


(3) Die Zugangskommission berichtet dem KIT-Fakultätsrat nach Abschluss des Zugangsverfahrens über die gesammelten Erfahrungen und macht Vorschläge zur Verbesserung und Weiterentwicklung des Zugangsverfahrens.


§ 5 Zugangsvoraussetzungen

(1) Voraussetzungen für den Zugang zum Masterstudiengang Maschinenbau sind:
1. Ein bestandener Bachelorabschluss oder mindestens gleichwertiger Abschluss in dem Studiengang Maschinenbau oder einem Studiengang mit im Wesentlichen gleichem Inhalt an einer Universität, Fachhochschule oder Berufsakademie bzw. Dualen Hochschule oder an einer ausländischen Hochschule; das Studium muss im Rahmen einer mindestens dreijährigen Regelstudienzeit und mit einer Mindestanzahl von 180 ECTS-Punkten absolviert worden sein;

2. ein mindestens 18-wöchiges Berufspraktikum, welches durch das Praktikantenamt der KIT-Fakultät für Maschinenbau anerkannt wurde (§ 6);

3. notwendige durch den Bachelorabschluss vermittelte Mindestkenntnisse und Mindestleistungen gemäß § 7;

4. dass im Masterstudiengang Maschinenbau oder einem verwandten Studiengang mit im Wesentlichen gleichem Inhalt kein endgültiges Nichtbestehen einer nach der Prüfungsordnung erforderlichen Prüfung vorliegt und der Prüfungsanspruch auch aus sonstigen Gründen noch besteht;

5. für Bewerber/innen, deren Muttersprache nicht Deutsch oder Englisch ist, der Nachweis von
   a) ausreichenden Kenntnissen der deutschen Sprache gemäß den Voraussetzungen der Zulassungs- und Immatrikulationsordnung des KIT oder

§ 6 Berufspraktikum


(2) Die Tätigkeiten im Grundpraktikum können aus folgenden Gebieten gewählt werden:

1. spanende Fertigungsverfahren,
2. umformende Fertigungsverfahren,
3. urformende Fertigungsverfahren und
thermische Füge- und Trennverfahren.

Es sollen Tätigkeiten in mindestens drei der o.g. Gebiete nachgewiesen werden.

(3) Die Tätigkeiten im Fachpraktikum müssen inhaltlich denen eines Ingenieurs entsprechen und können beispielsweise aus folgenden Gebieten gewählt werden:

1. Wärmebehandlung,
2. Werkzeug- und Vorrichtungsbau,
3. Planung von Instandhaltung, Wartung und Reparatur,
4. Planung von Messen, Prüfen und Qualitätskontrolle,
5. Oberflächentechnik,
6. Entwicklung, Konstruktion und Arbeitsvorbereitung,
7. Montage/Demontageplanung und
dere Tätigkeiten

Näheres regelt die Praktikumsordnung für den Bachelor- und Masterstudiengang Maschinenbau der KIT-Fakultät für Maschinenbau.


§ 7 Mindestkenntnisse und Mindestleistungen

(1) Die Zulassung zum Masterstudiengang Maschinenbau setzt den Nachweis voraus, dass sich der/die Bewerber/in mindestens in folgenden Fächern Fähigkeiten erworben hat, die nach Maßgabe der Lernziele, Inhalte und Leistungspunkte entsprechend des aktuellen Modulhandbuchs des Bachelorstudiengangs Maschinenbau zu denen im Bachelorstudiengang Maschinenbau am KIT gleichwertig sind:

1. Höhere Mathematik
2. Technische Thermodynamik und Wärmeübertragung
3. Technische Mechanik
4. Maschinenkonstruktionslehre
5. Werkstoffkunde
6. Strömungslehre
7. Mess- und Regelungstechnik
8. Elektrotechnik

Über die Gleichwertigkeit nach Satz 1 entscheidet die Zugangskommission des Masterstudiengangs Maschinenbau im Benehmen mit dem Prüfungsausschuss des Masterstudiengangs Maschinenbau.

(2) Sofern Bewerber die unter Absatz 1 beschriebenen Fähigkeiten nicht nachweisen können, können sie dennoch in den Studiengang immatrikuliert werden, sofern sie die für den Studiengang erforderlichen Fähigkeiten durch Bestehen einer schriftlichen Aufnahmeprüfung gemäß Anlage 1 am KIT nachweisen. Für einen erfolgreichen Nachweis darf die erfolgreiche Teilnahme an der Aufnahmeprüfung nicht länger als vier Bewerbungsverfahren zurückliegen. Ein Bewerbungsverfahren ist die auf einen bestimmten Studienbeginn bezogene Vergabe von Studienplätzen.

§ 8 Immatrikulationsentscheidung

(1) Die Entscheidung über das Erfüllen der Zugangsvoraussetzungen und die Immatrikulation trifft die/der Präsident/in auf Vorschlag der Zugangskommission.

(2) Die Immatrikulation ist zu versagen, wenn

a) die Bewerbungsunterlagen nicht fristgemäß im Sinne des § 2 oder nicht vollständig im Sinne des § 3 vorgelegt wurden,

b) die in § 5 geregelten Voraussetzungen nicht erfüllt sind,

c) im Studiengang Maschinenbau oder in einem verwandten Studiengang mit im Wesentlichen gleichem Inhalt eine nach der Prüfungsordnung erforderliche Prüfung endgültig nicht bestanden wurde oder der Prüfungsanspruch aus sonstigen Gründen nicht mehr besteht (§ 60 Abs. 2 Nr. 2 LHG, § 9 Abs. 2 HZG).
Im Fall des § 3 Abs. 3 kann die Immatrikulation unter dem Vorbehalt zugesichert werden, dass der endgültige Nachweis über den Bachelorabschluss unverzüglich, spätestens bis zwei Monate nach Beginn des Semesters, für das die Immatrikulation beantragt wurde, nachgereicht wird. Wird der Nachweis nicht fristgerecht erbracht, erlischt die Zusicherung, und eine Immatrikulation erfolgt nicht. Hat die/der Bewerber/in die Fristüberschreitung nicht zu vertreten, hat sie/er dies gegenüber der Zugangskommission zu belegen und schriftlich nachzuweisen. Die Zugangskommission kann im begründeten Einzelfall die Frist für das Nachreichen des endgültigen Zeugnisses verlängern.

(3) Erfüllt die/der Bewerber/in die Zugangsvoraussetzungen nicht und/oder kann sie/er nicht immatrikuliert werden, wird ihr/ihm das Ergebnis des Zugangsverfahrens schriftlich mitgeteilt. Der Bescheid ist zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen.

(4) Über den Ablauf des Zugangsverfahrens ist eine Niederschrift anzufertigen.

(5) Im Übrigen bleiben die allgemein für das Zulassungs- und Immatrikulationsverfahren gelten- den Bestimmungen in der Zulassungs- und Immatrikulationsordnung des KIT unberührt.

§ 9 Inkrafttreten


Karlsruhe, den. 22. November 2017

Prof. Dr. Holger Hanselka
(Präsident)
Anlage 1

Aufnahmeprüfung

1. Zweck

Die Aufnahmeprüfung soll zeigen, dass die/der Bewerber/in geeignet ist, den Masterstudien-
gang Maschinenbau erfolgreich zu absolvieren. Die Eignungsfeststellung erfolgt nach Maß-
gabe des Berufsbildes des Berufes/der Berufe, die dem Abschlussziel typischerweise folgen
und anhand von Qualifikationen, die denen, welche im Bachelorstudiengang Maschinenbau
am KIT erworben werden können, entsprechen.

2. Anmeldung zur Prüfung

2.1 Der Antrag auf Zulassung zur Aufnahmeprüfung erfolgt schriftlich bis spätestens 14 Tage
vor dem Termin der Aufnahmeprüfung bei der KIT-

2.2 Dem Antrag ist der Nachweis über die Bewerbung für den Masterstudiengang Maschi-

2.3 Die Entscheidung über die Zulassung zur Aufnahmeprüfung gemäß Nr. 3 trifft die Zu-
gangskommission der KIT-Fakultät für Maschinenbau (§ 4). Zur Aufnahmeprüfung zuge-
lassene Bewerber erhalten eine Anmeldebestätigung.

3. Zulassung zur Prüfung

3.1 An der Aufnahmeprüfung nimmt nur teil, wer

a) sich ordnungsgemäß zur Aufnahmeprüfung angemeldet hat,

b) sich gemäß § 3 form- und fristgerecht für den Masterstudiengang Maschinenbau be-

3.2 Die Teilnahme ist zu versagen, wenn die unter 3.1 genannten Voraussetzungen nicht er-
füllt sind.

4. Durchführung

4.1 Die genauen Termine sowie der Ort der Aufnahmeprüfung werden spätestens sechs
Wochen vor dem Prüfungstermin durch das KIT auf den Internetseiten der KIT-Fakultät für
Maschinenbau bekannt gegeben.

4.2 Die Aufnahmeprüfung findet in schriftlicher Form statt und dauert 90 Minuten. Sie besteht
aus vier Prüfungsteilen, die Fähigkeiten aus in § 7 Abs. 1 genannten Bereichen ermitteln und
zu gleichen Teilen mit 25 Punkten bewertet werden. Die mit der Aufnahmeprüfung maximal
erreichtbare Punktzahl beträgt 100 Punkte. Die Aufnahmeprüfung kann zu Teilen auch im
Wege des Antwort-Wahl-Verfahrens durchgeführt werden. In diesem Fall findet die Satzung
durch die Durchführung von Antwort-Wahl-Verfahren Anwendung.

4.3 Zur Bewertung der Aufnahmeprüfung setzt die Zugangskommission (§ 4) eine Prüfungs-
kommission ein. Sie besteht aus mindestens zwei stimmrechtsfähigen Mitgliedern, ei-
inem/einer Hochschullehrer/in / leitenden/leitender Wissenschaftler/in gemäß § 14 Abs. 3 Ziff.
KITG / Privatdozentin bzw. -dozenten, und einer akademischen Mitarbeiterin/ einem aka-


4.5 Versucht die/der Bewerber/in das Ergebnis der Aufnahmeprüfung durch Täuschung oder Benutzung nicht zugelassener Hilfsmittel zu beeinflussen, wird die Prüfung mit 0 Punkten bewertet. Ein/e Bewerber/in, die/der den ordnungsgemäßen Ablauf der Prüfung stört, kann von dem jeweiligen Aufsichtsführenden von der Fortsetzung der Prüfung ausgeschlossen werden; in diesem Fall wird die Prüfung mit 0 Punkten bewertet.

4.6 Das KIT übernimmt keine Kosten, die durch die Aufnahmeprüfung für die Bewerber/innen entstehen.

5. Ermittlung der Eignung und Mitteilung des Ergebnisses

5.1 Die Aufnahmeprüfung ist bestanden, wenn die/der Bewerber/in mindestens 75 Punkte, dabei mindestens 15 Punkte in jedem der vier Teilbereiche erreicht.

5.2 Die Zugangskommission (§ 4) stellt die Eignung der Bewerberin/ des Bewerbers auf Vorschlag der Prüfungskommission fest. Das Ergebnis der Aufnahmeprüfung wird den Bewerberinnen/Bewerbern schriftlich durch die KIT-Fakultät für Maschinenbau mitgeteilt. Der Bescheid ist zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen.

6. Wiederholung

Bewerber/innen, die einmal erfolglos an einer Aufnahmeprüfung für den Masterstudiengang Maschinenbau am KIT teilgenommen haben, können sich frühestens im nächsten Bewerbungszeitraum einmalig erneut zur Aufnahmeprüfung für diesen Studiengang anmelden. Eine weitere Wiederholung ist nicht möglich.
Inhalt

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Satzung zur Änderung der Satzung für den Zugang zu dem Masterstudiengang Maschinenbau am Karlsruher Institut für Technologie (KIT)

vom 28. November 2018


Artikel 1

1. § 3 Abs. 2 Ziff. 3 wird wie folgt geändert:

Nach dem Wort „Berufspraktikum“ werden die Worte „welches durch das Praktikantenamt der KIT-Fakultät für Maschinenbau anerkannt wurde“ gestrichen.

2. § 5 Abs. 1 Ziff. 3 wird wie folgt geändert:

Nach dem Wort „notwendige“ werden die Worte „durch den Bachelorabschluss vermittelte“ gestrichen.

3. § 5 Abs. 1 Ziff. 5 Buchst. b) erhält folgende Fassung:

„b) ausreichenden englischen Sprachkenntnisse, die mindestens dem Niveau B2 des Gemeinsamen Europäischen Referenzrahmens für Sprachen (GER) oder gleichwertig entsprechen, nachgewiesen beispielsweise durch einen der folgenden international anerkannten Tests:

   aa) Test of English as Foreign Language (TOEFL) mit mindestens 550 Punkten im paper-based Test, oder 88 Punkten im internet-based Test oder
   bb) IELTS mit einem Gesamtergebnis von mindestens 6.5 und keiner Section unter 5.5.

Der Nachweis englischer Sprachkenntnisse entfällt für Bewerber/innen, die ihren Bachelorabschluss in einem englischsprachigen Studiengang oder im englischsprachigen Ausland erworben haben. Die offizielle Sprache des Studienprogramms muss auf dem Abschlusszeugnis, dessen Ergänzung, im Transcript of Records oder in einer entsprechenden Bescheinigung der Hochschule vermerkt sein.“

4. § 6 Abs. 5 erhält folgende Fassung:

„(5) Liegt das Berufspraktikum oder die Anerkennung des Praktikums bis zum Zeitpunkt der Antragsstellung noch nicht vor, kann die/der Bewerber/in im Einzelfall trotzdem unter der Auflage zugelassen werden, dass sie/er das Berufspraktikum bis zum Ende des Prüfungszeitraums des dritten Fachsemesters, spätestens aber bei der Anmeldung der Masterarbeit, nachweist. Eine etwaige Auflage wird von der Zulassungskommission festgesetzt und der/dem Bewerber/in im Rahmen der Zulassung mitgeteilt.“
5. **Anlage 1 Ziff. 5.1 erhält folgende Fassung:**

   „5.1 Die Aufnahmeprüfung ist bestanden, wenn die/der Bewerber/in mindestens 50 Punkte, dabei mindestens 12 Punkte in jedem der vier Teilbereiche erreicht.“

**Artikel 2**


Karlsruhe, 28. November 2018

*gez. Prof. Dr. Holger Hanselka  
(Präsident)*
Zweite Satzung zur Änderung der Satzung für den Zugang zu dem Masterstudiengang Maschinenbau am Karlsruher Institut für Technologie (KIT)
Zweite Satzung zur Änderung der Satzung für den Zugang zu dem Masterstudiengang Maschinenbau am Karlsruher Institut für Technologie (KIT)

vom 29. Juli 2019


Artikel 1

„5.1 Die Aufnahmeprüfung ist bestanden, wenn die/der Bewerber/in mindestens 50 Punkte erreicht."

Artikel 2

Karlsruhe, 29. Juli 2019

gez. Prof. Dr. Holger Hanselka
(Präsident)
## 9 Field of study structure

<table>
<thead>
<tr>
<th>Mandatory</th>
<th>Credits</th>
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<tbody>
<tr>
<td><strong>Master Thesis</strong></td>
<td>30 CR</td>
</tr>
<tr>
<td><strong>Advanced Engineering Fundamentals</strong></td>
<td>50 CR</td>
</tr>
<tr>
<td><strong>Specialization</strong></td>
<td>40 CR</td>
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### 9.1 Master Thesis

<table>
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<tr>
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### 9.2 Advanced Engineering Fundamentals

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<thead>
<tr>
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<tbody>
<tr>
<td><strong>M-MACH-102593 Product Development - Dimensioning of Components</strong></td>
<td>7 CR</td>
</tr>
<tr>
<td><strong>M-MACH-102718 Product Development - Methods of Product Development</strong></td>
<td>6 CR</td>
</tr>
<tr>
<td><strong>M-MACH-102592 Modeling and Simulation</strong></td>
<td>7 CR</td>
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<td><strong>M-MACH-102594 Mathematical Methods</strong></td>
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<td><strong>M-MACH-102591 Laboratory Course</strong></td>
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<tr>
<td><strong>M-MACH-102597 Compulsory Elective Module Mechanical Engineering</strong></td>
<td>8 CR</td>
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<tr>
<td><strong>M-MACH-102595 Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering</strong></td>
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</tr>
<tr>
<td><strong>M-MACH-102596 Compulsory Elective Subject Economics/Law</strong></td>
<td>4 CR</td>
</tr>
<tr>
<td><strong>M-MACH-102824 Key Competences</strong></td>
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### 9.3 Specialization

<table>
<thead>
<tr>
<th>Election block: Vertiefungsrichtung (1 item)</th>
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<tbody>
<tr>
<td>Specialization: General Mechanical Engineering</td>
<td>40 CR</td>
</tr>
<tr>
<td>Specialization: Energy- and Environment Engineering</td>
<td>40 CR</td>
</tr>
<tr>
<td>Specialization: Vehicle Technology</td>
<td>40 CR</td>
</tr>
<tr>
<td>Specialization: Mechatronics and Microsystems Technology</td>
<td>40 CR</td>
</tr>
<tr>
<td>Specialization: Product Development and Engineering Design</td>
<td>40 CR</td>
</tr>
<tr>
<td>Specialization: Production Technology</td>
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<tr>
<td>Specialization: Theoretical Mechanical Engineering</td>
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</tr>
<tr>
<td>Specialization: Materials and Structures for High Performance Systems</td>
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### 9.3.1 Specialization: General Mechanical Engineering

<table>
<thead>
<tr>
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<tbody>
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### Mandatory

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### Election block: Schwerpunkte (2 items)

<table>
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<tr>
<td>M-MACH-102649</td>
<td>Major Field: Advanced Materials Modelling</td>
</tr>
<tr>
<td>M-MACH-102598</td>
<td>Major Field: Advanced Mechatronics</td>
</tr>
<tr>
<td>M-MACH-102646</td>
<td>Major Field: Applied Mechanics</td>
</tr>
<tr>
<td>M-MACH-102599</td>
<td>Major Field: Powertrain Systems</td>
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<tr>
<td>M-MACH-102601</td>
<td>Major Field: Automation Technology</td>
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<td>M-MACH-102641</td>
<td>Major Field: Rail System Technology</td>
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<tr>
<td>M-MACH-102604</td>
<td>Major Field: Computational Mechanics</td>
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<tr>
<td>M-MACH-102642</td>
<td>Major Field: Development of Innovative Appliances and Power Tools</td>
</tr>
<tr>
<td>M-MACH-102605</td>
<td>Major Field: Engineering Design</td>
</tr>
<tr>
<td>M-MACH-102606</td>
<td>Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics</td>
</tr>
<tr>
<td>M-MACH-102643</td>
<td>Major Field: Fusion Technology</td>
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<tr>
<td>M-MACH-102648</td>
<td>Major Field: Energy Technology for Buildings</td>
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<td>M-MACH-102623</td>
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<tr>
<td>M-MACH-102624</td>
<td>Major Field: Information Technology</td>
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<tr>
<td>M-MACH-102625</td>
<td>Major Field: Information Technology of Logistic Systems</td>
</tr>
<tr>
<td>M-MACH-102626</td>
<td>Major Field: Integrated Product Development</td>
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<tr>
<td>M-MACH-102608</td>
<td>Major Field: Nuclear Energy</td>
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<td>M-MACH-102609</td>
<td>Major Field: Cognitive Technical Systems</td>
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<td>M-MACH-102627</td>
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<td>M-MACH-102628</td>
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<td>M-MACH-102600</td>
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<tr>
<td>M-MACH-102647</td>
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</tr>
<tr>
<td>M-MACH-102616</td>
<td>Major Field: Microsystem Technology</td>
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</tbody>
</table>
## Field of Study Structure

<table>
<thead>
<tr>
<th>Major Field: Mobile Machines</th>
<th>16 CR</th>
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<tbody>
<tr>
<td>Major Field: Modeling and Simulation in Dynamics</td>
<td>16 CR</td>
</tr>
<tr>
<td>Major Field: Modeling and Simulation in Energy- and Fluid Engineering</td>
<td>16 CR</td>
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<td>Major Field: Polymer Engineering</td>
<td>16 CR</td>
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<tr>
<td>Major Field: Production Technology</td>
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<td>Major Field: Robotics</td>
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<td>Major Field: Vibration Theory</td>
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<td>Major Field: Fluid Mechanic</td>
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<tr>
<td>Major Field: Technical Ceramics and Powder Materials</td>
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<tr>
<td>Major Field: Technical Logistics</td>
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<td>Major Field: Engineering Thermodynamics</td>
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<td>Major Field: Thermal Turbomachines</td>
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<tr>
<td>Major Field: Tribology</td>
<td>16 CR</td>
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<tr>
<td>Major Field: Combustion Engines Based Powertrains</td>
<td>16 CR</td>
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<tr>
<td>Major Field: Reliability in Mechanical Engineering</td>
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### 9.3.2 Specialization: Energy- and Environment Engineering

Part of: Specialization

| Credits | 40 |

#### Mandatory

| Major Field: Fundamentals and Methods of Energy and Environmental Engineering | 8 CR |
| Major Field: Fundamentals of Energy Technology | 16 CR |

#### Election block: Schwerpunkt (1 item)

| Major Field: Advanced Mechatronics | 16 CR |
| Major Field: Applied Mechanics | 16 CR |
| Major Field: Automation Technology | 16 CR |
| Major Field: Development of Innovative Appliances and Power Tools | 16 CR |
| Major Field: Engineering Design | 16 CR |
| Major Field: Fusion Technology | 16 CR |
| Major Field: Energy Technology for Buildings | 16 CR |
| Major Field: Information Technology | 16 CR |
| Major Field: Innovation and Entrepreneurship | 16 CR |
| Major Field: Integrated Product Development | 16 CR |
| Major Field: Nuclear Energy | 16 CR |
| Major Field: Energy Converting Engines | 16 CR |
| Major Field: Power Plant Technology | 16 CR |
| Major Field: Lightweight Construction | 16 CR |
| Major Field: Materials Science and Engineering | 16 CR |
| Major Field: Mechatronics | 16 CR |
| Major Field: Man - Technology - Organisation | 16 CR |
| Major Field: Microactuators and Microsensors | 16 CR |
| Major Field: Microsystem Technology | 16 CR |
| Major Field: Modeling and Simulation in Dynamics | 16 CR |
| Major Field: Modeling and Simulation in Energy- and Fluid Engineering | 16 CR |
| Major Field: Polymer Engineering | 16 CR |
| Major Field: Vibration Theory | 16 CR |
| Major Field: Fluid Mechanic | 16 CR |
| Major Field: Technical Ceramics and Powder Materials | 16 CR |
| Major Field: Engineering Thermodynamics | 16 CR |
| Major Field: Thermal Turbomachines | 16 CR |
### 9.3.3 Specialization: Vehicle Technology

**Part of:** Specialization  
**Credits:** 40

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<td>M-MACH-102739</td>
<td>Fundamentals and Methods of Automotive Engineering</td>
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**Elective block: Schwerpunkt (p) (between 1 and 2 items)**

| M-MACH-102641 | Major Field: Rail System Technology | 16 CR |
| M-MACH-102607 | Major Field: Vehicle Technology | 16 CR |
| M-MACH-102630 | Major Field: Mobile Machines | 16 CR |
| M-MACH-102650 | Major Field: Combustion Engines Based Powertrains | 16 CR |

**Elective block: Schwerpunkt (between 0 and 1 items)**

| M-MACH-102598 | Major Field: Advanced Mechatronics | 16 CR |
| M-MACH-102646 | Major Field: Applied Mechanics | 16 CR |
| M-MACH-102599 | Major Field: Powertrain Systems | 16 CR |
| M-MACH-102601 | Major Field: Automation Technology | 16 CR |
| M-MACH-102604 | Major Field: Computational Mechanics | 16 CR |
| M-MACH-102642 | Major Field: Development of Innovative Appliances and Power Tools | 16 CR |
| M-MACH-102605 | Major Field: Engineering Design | 16 CR |
| M-MACH-102606 | Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics | 16 CR |
| M-MACH-102623 | Major Field: Fundamentals of Energy Technology | 16 CR |
| M-MACH-102624 | Major Field: Information Technology | 16 CR |
| M-MACH-102626 | Major Field: Integrated Product Development | 16 CR |
| M-MACH-102609 | Major Field: Cognitive Technical Systems | 16 CR |
| M-MACH-102627 | Major Field: Energy Converting Engines | 16 CR |
| M-MACH-102628 | Major Field: Lightweight Construction | 16 CR |
| M-MACH-102613 | Major Field: Lifecycle Engineering | 16 CR |
| M-MACH-102611 | Major Field: Materials Science and Engineering | 16 CR |
| M-MACH-102614 | Major Field: Mechatronics | 16 CR |
| M-MACH-102647 | Major Field: Microactuators and Microsensors | 16 CR |
| M-MACH-102616 | Major Field: Microsystem Technology | 16 CR |
| M-MACH-104434 | Major Field: Modeling and Simulation in Dynamics | 16 CR |
| M-MACH-102612 | Major Field: Modeling and Simulation in Energy- and Fluid Engineering | 16 CR |
| M-MACH-102632 | Major Field: Polymer Engineering | 16 CR |
| M-MACH-102618 | Major Field: Production Technology | 16 CR |
| M-MACH-104443 | Major Field: Vibration Theory | 16 CR |
| M-MACH-102634 | Major Field: Fluid Mechanic | 16 CR |
| M-MACH-102619 | Major Field: Technical Ceramics and Powder Materials | 16 CR |
| M-MACH-102635 | Major Field: Engineering Thermodynamics | 16 CR |
| M-MACH-102636 | Major Field: Thermal Turbomachines | 16 CR |
| M-MACH-102637 | Major Field: Tribology | 16 CR |
| M-MACH-102602 | Major Field: Reliability in Mechanical Engineering | 16 CR |

### 9.3.4 Specialization: Mechatronics and Microsystems Technology

**Part of:** Specialization  
**Credits:** 40
### 9. FIELD OF STUDY STRUCTURE

#### Specialization

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**Election block: Schwerpunkt (p) (between 1 and 2 items)**

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<td>Major Field: Microsystem Technology</td>
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**Election block: Schwerpunkt (between 0 and 1 items)**

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<td>Major Field: Computational Mechanics</td>
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<td>M-MACH-102606</td>
<td>Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics</td>
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<td>M-MACH-102624</td>
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<td>M-MACH-102609</td>
<td>Major Field: Cognitive Technical Systems</td>
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<td>Major Field: Combustion Engines Based Powertrains</td>
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<td>M-MACH-102602</td>
<td>Major Field: Reliability in Mechanical Engineering</td>
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### 9.3.5 Specialization: Product Development and Engineering Design

**Part of: Specialization**

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**Election block: Schwerpunkt (between 0 and 1 items)**

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<td>Major Field: Fundamentals of Energy Technology</td>
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**9.3.6 Specialization: Production Technology**

**Part of: Specialization**

**Credits** 40

**Mandatory**

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**Election block: Schwerpunkt (p) (between 1 and 2 items)**

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**Election block: Schwerpunkt (between 0 and 1 items)**

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## 9.3.7 Specialization: Theoretical Mechanical Engineering

**Part of:** Specialization  
**Credits:** 40

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**Election block: Schwerpunkt (p) (between 1 and 2 items)**

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<td>Major Field: Automation Technology</td>
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<td>Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics</td>
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## 9.3.8 Specialization: Materials and Structures for High Performance Systems

**Part of:** Specialization  
**Credits:** 40

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**Election block: Schwerpunkt (p) (between 1 and 2 items)**

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<td>M-MACH-102611</td>
<td>Major Field: Materials Science and Engineering</td>
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<tr>
<td>M-MACH-102602</td>
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# 10 Modules

## 10.1 Module: Compulsory Elective Module Mechanical Engineering (MSc-Modul 04, WF) [M-MACH-102597]

**Responsible:** Prof. Dr.-Ing. Martin Heilmayer  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** Advanced Engineering Fundamentals  

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**Election block: Wahlpflichtmodul Maschinenbau (2 items)**

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<td>T-MACH-107632</td>
<td>Exercises for Solid State Reactions and Kinetics of Phase Transformations</td>
<td>2 CR</td>
<td>Franke, Seifert</td>
</tr>
<tr>
<td>T-MACH-110333</td>
<td>Tutorial Continuum Mechanics of solids and fluids</td>
<td>1 CR</td>
<td>Böhlke, Frohnapfel</td>
</tr>
<tr>
<td>T-MACH-110376</td>
<td>Tutorial Mathematical Methods in Continuum Mechanics</td>
<td>1 CR</td>
<td>Böhlke</td>
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<tr>
<td>T-MACH-107669</td>
<td>Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria</td>
<td>2 CR</td>
<td>Seifert</td>
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</table>

**Competence Certificate**

Written or oral exam

**Competence Goal**
The elective course serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

**Prerequisites**

None

**Content**

See chosen brick courses.

**Workload**
The work load is about 240 hours, corresponding to 8 credit points. The work load varies from lecture to lecture, for example a lecture consisting of 4 credit points includes 28 h of presence during the lecture and 92 h preparation and rework time at home, 120 hours in total.

**Learning type**

Lecture, Tutorial, Lab Course
10.2 Module: Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering (MSc-Modul WPF-Modul NIE) [M-MACH-102595]

**Responsible:** Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Advanced Engineering Fundamentals

<table>
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<tr>
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**Election block:** Wahlpflichtmodul Naturwissenschaften/Informatik/Elektrotechnik (1 item)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>T-MACH-108847</td>
<td>Applied Mathematics in Natural Science: Flows with chemical reactions</td>
<td>6 CR</td>
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<tr>
<td>T-MACH-108845</td>
<td>Magnetohydrodynamics</td>
<td>6 CR</td>
<td>Bühler</td>
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<tr>
<td>T-ETIT-100694</td>
<td>Methods of Signal Processing</td>
<td>6 CR</td>
<td>Puente León</td>
</tr>
<tr>
<td>T-ETIT-101939</td>
<td>Photovoltaics</td>
<td>6 CR</td>
<td>Powalla</td>
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<tr>
<td>T-MACH-109084</td>
<td>Physical Basics of Laser Technology</td>
<td>6 CR</td>
<td>Schneider</td>
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<tr>
<td>T-ETIT-109313</td>
<td>Signals and Systems</td>
<td>6 CR</td>
<td>Puente León</td>
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<td>T-MACH-108846</td>
<td>Stability: from order to chaos</td>
<td>6 CR</td>
<td>Class</td>
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<tr>
<td>T-MACH-105360</td>
<td>Computer Engineering</td>
<td>6 CR</td>
<td>Keller, Lorch</td>
</tr>
</tbody>
</table>

**Competence Certificate**
The success is monitored within the framework of academic achievements, it can vary according to the individually choice. The module is not graded, and remains not graded even after the choice of one or several graded brick courses.

**Competence Goal**
After completing the elective module "Wahlpflichtmodul" the attendants are able to extend their knowledge in the field of mechanical engineering in the disciplines natural sciences, electrical engineering or the informatics. The attendants are aware of example approaches and know specific methods and fundamentals of these fields. Thus, the attendants are able to solve interdisciplinary problems by applying this knowledge and to adopt specialist skills by themselves later.

**Prerequisites**
none

**Content**
Please refer to the description of the listed courses.

**Workload**
The work load is about 180 hours, corresponding to 6 credit points.

**Learning type**
Lecture
Exercise course (depending on the course)
10.3 Module: Compulsory Elective Subject Economics/Law (MSc-Modul WPF-Modul WR) [M-MACH-102596]

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Advanced Engineering Fundamentals

<table>
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**Election block: Wahlpflichtmodul Wirtschaft/Recht (1 item)**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
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<tr>
<td>T-MACH-105519</td>
<td>Human Factors Engineering II</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105231</td>
<td>Leadership and Management Development</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ploch</td>
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<tr>
<td>T-MACH-105440</td>
<td>Leadership and Conflict Management</td>
<td>4 CR</td>
<td>Hatzl</td>
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<td>T-MACH-102107</td>
<td>Quality Management</td>
<td>4 CR</td>
<td>Lanza</td>
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<tr>
<td>T-INFO-101310</td>
<td>Patent Law</td>
<td>4 CR</td>
<td>Dreier</td>
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<tr>
<td>T-INFO-101963</td>
<td>Public Law I - Basic Principles</td>
<td>4 CR</td>
<td>Marsch</td>
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**Competence Certificate**

The success is monitored within the framework of academic achievements, it can vary according to the individually choice. The module is not graded, and remains not graded even after the choice of one or several graded brick courses.

**Competence Goal**

Students can enlarge their knowledge about law and economics which affect mechanical engineering self-determined. They are able to describe circumstances of the case considering law or economics and apply it to simple cases. Later on in work life, they are able to evaluate, if and which subject specific support is necessary.

**Prerequisites**

none

**Content**

see chosen subject

**Workload**

The work load is about 120 hours, corresponding to 4 credit points.

**Learning type**

Lectures and practices; self-study
10 MODULES

Module: Fundamentals and Methods of Automotive Engineering (MSc-WPfM-GuM-FzgT) [M-MACH-102739]

### 10.4 Module: Fundamentals and Methods of Automotive Engineering (MSc-WPfM-GuM-FzgT) [M-MACH-102739]

**Responsible:** Prof. Dr. Frank Gauterin  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** Specialization / Specialization: Vehicle Technology (mandatory)

<table>
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**Election block: Grundlagen und Methoden der Fahrzeugtechnik (2 items)**

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<td>T-MACH-105518</td>
<td>Human Factors Engineering I</td>
<td>4 CR</td>
<td>Deml</td>
</tr>
<tr>
<td>T-MACH-105212</td>
<td>CAE-Workshop</td>
<td>4 CR</td>
<td>Albers, Matthiesen</td>
</tr>
<tr>
<td>T-MACH-100535</td>
<td>Introduction into Mechatronics</td>
<td>6 CR</td>
<td>Böhlard, Lorch, Reischl</td>
</tr>
<tr>
<td>T-MACH-105209</td>
<td>Introduction into the Multi-Body Dynamics</td>
<td>5 CR</td>
<td>Seemann</td>
</tr>
<tr>
<td>T-ETIT-100534</td>
<td>Electrical Engineering for Business Engineers, Part II</td>
<td>5 CR</td>
<td>Meneskiou</td>
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<td>T-MACH-102093</td>
<td>Fluid Power Systems</td>
<td>4 CR</td>
<td>Geimer, Pult</td>
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<tr>
<td>T-MACH-102163</td>
<td>Basics of Technical Logistics</td>
<td>6 CR</td>
<td>Mittwollen, Oellerich</td>
</tr>
<tr>
<td>T-MACH-105213</td>
<td>Fundamentals of Combustion I</td>
<td>4 CR</td>
<td>Maas, Sommerer</td>
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<tr>
<td>T-MACH-105210</td>
<td>Machine Dynamics</td>
<td>5 CR</td>
<td>Proppe</td>
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<td>T-MACH-105293</td>
<td>Mathematical Methods in Dynamics</td>
<td>6 CR</td>
<td>Proppe</td>
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<tr>
<td>T-MACH-100297</td>
<td>Mathematical Methods in Strength of Materials</td>
<td>5 CR</td>
<td>Böhlke</td>
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<td>T-MACH-105294</td>
<td>Mathematical Methods of Vibration Theory</td>
<td>6 CR</td>
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<td>Mathematical Methods in Fluid Mechanics</td>
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<td>T-MACH-100300</td>
<td>Modelling and Simulation</td>
<td>5 CR</td>
<td>Gumbsch, Nestler</td>
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<td>T-MACH-102152</td>
<td>Novel Actuators and Sensors</td>
<td>4 CR</td>
<td>Kohl, Sommer</td>
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<tr>
<td>T-MATH-102242</td>
<td>Numerical Mathematics for Students of Computer Science</td>
<td>6 CR</td>
<td>Rieder, Weiß, Wiener</td>
</tr>
<tr>
<td>T-MACH-102102</td>
<td>Physical Basics of Laser Technology</td>
<td>5 CR</td>
<td>Schneider</td>
</tr>
<tr>
<td>T-MACH-100530</td>
<td>Physics for Engineers</td>
<td>5 CR</td>
<td>Dienwiebel, Gumbsch, Nesterov-Müller, Weygand</td>
</tr>
<tr>
<td>T-MACH-105147</td>
<td>Product Lifecycle Management</td>
<td>4 CR</td>
<td>Ovtcharova</td>
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<tr>
<td>T-MACH-100531</td>
<td>Systematic Materials Selection</td>
<td>4 CR</td>
<td>Dietrich</td>
</tr>
<tr>
<td>T-MACH-105652</td>
<td>Fundamentals of Combustion Engine Technology</td>
<td>5 CR</td>
<td>Bernhardt, Kubach, Pfeil, Toedter, Wagner</td>
</tr>
<tr>
<td>T-MACH-102083</td>
<td>Integrated Information Systems for Engineers</td>
<td>4 CR</td>
<td>Ovtcharova</td>
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<tr>
<td>T-MACH-105290</td>
<td>Vibration Theory</td>
<td>5 CR</td>
<td>Fidlin, Seemann</td>
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<td>T-MATH-109620</td>
<td>Probability Theory and Statistics</td>
<td>6 CR</td>
<td>Hug</td>
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<td>T-MACH-105292</td>
<td>Heat and Mass Transfer</td>
<td>4 CR</td>
<td>Bockhorn, Maas</td>
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<tr>
<td>T-MACH-100532</td>
<td>Scientific Computing for Engineers</td>
<td>5 CR</td>
<td>Gumbsch, Weygand</td>
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**Election block: Grundlagen und Methoden der Fahrzeugtechnik (Ü) ()**

<table>
<thead>
<tr>
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<th>Course Title</th>
<th>Credits</th>
<th>Instructor(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-106830</td>
<td>Tutorial Mathematical Methods in Strength of Materials</td>
<td>1 CR</td>
<td>Böhlke</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
2 individual exams: written or oral, graded

**Competence Goal**  
"Fundamentals and Methods of Automotive Engineering" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.
**Prerequisites**
None

**Content**
see chosen course

**Workload**
The work load is about 240 hours, corresponding to 8 credit points.

**Learning type**
Lecture, exercise.
10.5 Module: Fundamentals and Methods of Energy and Environmental Engineering (MSc-WPfM-GuM-E+U) [M-MACH-102575]

**Responsible:** Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Energy- and Environment Engineering (mandatory)

<table>
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<tr>
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<th>Duration</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
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<td>1 term</td>
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**Mandatory**

- T-MACH-105292 **Heat and Mass Transfer** 4 CR Bockhorn, Maas

**Election block: Grundlagen und Methoden der Energie- und Umwelttechnik (1 item)**

- T-MACH-105212 **CAE-Workshop** 4 CR Albers, Matthiesen
- T-MACH-100535 **Introduction into Mechatronics** 6 CR Böhl, Lorch, Reischl
- T-MACH-105209 **Introduction into the Multi-Body Dynamics** 5 CR Seemann
- T-MACH-102093 **Fluid Power Systems** 4 CR Geimer, Pult
- T-MACH-102163 **Basics of Technical Logistics** 6 CR Mittwollen, Oellerich
- T-MACH-105213 **Fundamentals of Combustion I** 4 CR Maas, Sommerer
- T-MACH-105210 **Machine Dynamics** 5 CR Proppe
- T-MACH-105295 **Mathematical Methods in Fluid Mechanics** 6 CR Frohnapfel
- T-MACH-102152 **Novel Actuators and Sensors** 4 CR Kohl, Sommer
- T-MATH-102242 **Numerical Mathematics for Students of Computer Science** 6 CR Rieder, Weiß, Wieners
- T-MACH-100530 **Physics for Engineers** 5 CR Dienwiebel, Gumbsch, Nesterov-Müller, Weygand
- T-MACH-102102 **Physical Basics of Laser Technology** 5 CR Schneider
- T-MACH-100531 **Systematic Materials Selection** 4 CR Dietrich
- T-MACH-105652 **Fundamentals of Combustion Engine Technology** 5 CR Bernhardt, Kubach, Pfeil, Toedter, Wagner
- T-MACH-105290 **Vibration Theory** 5 CR Fidlin, Seemann

**Competence Certificate**

2 individual exams: written or oral, graded

**Competence Goal**

"Fundamentals and Methods of Energy and Environmental Engineering" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

**Module grade calculation**

weight according to CP

**Prerequisites**

none

**Content**

see chosen course

**Workload**

The work load is about 240 hours, corresponding to 8 credit points.

**Learning type**

Lecture, exercise
Module: Fundamentals and Methods of General Mechanical Engineering (MSc-WPfM-GuM-MB) [M-MACH-102405]

Responsible: Prof. Dr.-Ing. Kai Furmans
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (mandatory)

<table>
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Election block: Grundlagen und Methoden des Maschinenbaus (2 items)

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<td>CAE-Workshop</td>
<td>4</td>
<td>Albers, Matthiesen</td>
</tr>
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<td>T-MACH-100535</td>
<td>Introduction into Mechatronics</td>
<td>6</td>
<td>Böhland, Lorch, Reischl</td>
</tr>
<tr>
<td>T-MACH-105209</td>
<td>Introduction into the Multi-Body Dynamics</td>
<td>5</td>
<td>Seemann</td>
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<td>T-MACH-102093</td>
<td>Fluid Power Systems</td>
<td>4</td>
<td>Geimer, Pult</td>
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<tr>
<td>T-MACH-105182</td>
<td>Introduction to Microsystem Technology I</td>
<td>4</td>
<td>Badili, Jouda, Korvink</td>
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<tr>
<td>T-MACH-105183</td>
<td>Introduction to Microsystem Technology II</td>
<td>4</td>
<td>Jouda, Korvink</td>
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<td>T-MACH-102163</td>
<td>Basics of Technical Logistics</td>
<td>6</td>
<td>Mittwollen, Oellerich</td>
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<td>Fundamentals of Combustion I</td>
<td>4</td>
<td>Maas, Sommerer</td>
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<td>T-MACH-105210</td>
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<td>Mathematical Methods in Dynamics</td>
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<td>Mathematical Methods in Strength of Materials</td>
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<td>Böhle</td>
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<td>Frohnapfel</td>
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<td>Mathematical Models and Methods for Production Systems</td>
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<td>T-MACH-105303</td>
<td>Modelling of Microstructures</td>
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<td>August, Nestler</td>
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<td>T-MACH-100300</td>
<td>Modelling and Simulation</td>
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<td>Gumbsch, Nestler</td>
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<td>Novel Actuators and Sensors</td>
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<td>Kohl, Sommer</td>
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<td>Schneider</td>
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<td>T-MACH-100530</td>
<td>Physics for Engineers</td>
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<td>Dienwiebel, Gumbsch, Nesterov-Müller, Weygand</td>
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<tr>
<td>T-MACH-105147</td>
<td>Product Lifecycle Management</td>
<td>4</td>
<td>Ovtcharova</td>
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<td>Systematic Materials Selection</td>
<td>4</td>
<td>Dietrich</td>
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<tr>
<td>T-MACH-105652</td>
<td>Fundamentals of Combustion Engine Technology</td>
<td>5</td>
<td>Bernhardt, Kubach, Pfeil, Toedter, Wagner</td>
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<tr>
<td>T-MACH-102083</td>
<td>Integrated Information Systems for Engineers</td>
<td>4</td>
<td>Ovtcharova</td>
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<td>T-MACH-105290</td>
<td>Vibration Theory</td>
<td>5</td>
<td>Fidlin, Seemann</td>
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<td>Heat and Mass Transfer</td>
<td>4</td>
<td>Bockhorn, Maas</td>
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<td>Scientific Computing for Engineers</td>
<td>5</td>
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Election block: Grundlagen und Methoden des Maschinenbaus (Ü) ()

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<tr>
<td>T-MACH-106831</td>
<td>Tutorial Mathematical Methods in Structural Mechanics</td>
<td>1</td>
<td>Böhle</td>
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</table>

Competence Certificate
2 individual exams: written or oral, graded
Competence Goal
"Fundamentals and Methods of General Mechanical Engineering" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

Prerequisites
None.

Content
see chosen course

Workload
The work load is about 240 hours, corresponding to 8 credit points.

Learning type
Lecture, exercise
10.7 Module: Fundamentals and Methods of Materials and Structures for High Performance Systems (MSc-WPfPM-W+S) [M-MACH-102744]

Responsible: Prof. Dr.-Ing. Martin Heilmäier
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: Materials and Structures for High Performance Systems (mandatory)

<table>
<thead>
<tr>
<th>Credits</th>
<th>Language</th>
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Mandatory

- T-MACH-100531 Systematic Materials Selection
- T-MACH-105212 CAE-Workshop
- T-MACH-105209 Introduction into the Multi-Body Dynamics
- T-MACH-102163 Basics of Technical Logistics
- T-MACH-105210 Machine Dynamics
- T-MACH-105303 Modelling of Microstructures
- T-MACH-100300 Modelling and Simulation
- T-MACH-100530 Physics for Engineers

Election block: Grundlagen und Methoden der Werkstoffe und Strukturen für Hochleistungssysteme (1 item)

- T-MACH-102102 Physical Basics of Laser Technology
- T-MACH-105290 Vibration Theory
- T-MACH-100532 Scientific Computing for Engineers
- T-MACH-110375 Mathematical Methods in Continuum Mechanics
- T-MACH-110378 Mathematical Methods in Micromechanics

Election block: Grundlagen und Methoden der Werkstoffe und Strukturen für Hochleistungssysteme (Ü) ()

- T-MACH-110379 Tutorial Mathematical Methods in Micromechanics
- T-MACH-110376 Tutorial Mathematical Methods in Continuum Mechanics

Competence Certificate

2 individual exams: written or oral, graded

Competence Goal

"Fundamentals and Methods of Materials and Structures for High Performance Systems" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

Content

see chosen course

Workload

The work load is about 240 hours, corresponding to 8 credit points.

Learning type

Lecture, exercise.
### Module: Fundamentals and Methods of Mechatronics and Microsystem Technology (MSc-WPfM-M+M) [M-MACH-102740]

**Responsible:** Prof. Dr. Jan Gerrit Korvink  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Mechatronics and Microsystems Technology (mandatory)

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**Election block: Grundlagen und Methoden der Mechatronik und Mikrosystemtechnik, Pflicht (1 item)**

<table>
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<td>T-MACH-105182</td>
<td>Introduction to Microsystem Technology I</td>
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**Election block: Grundlagen und Methoden der Mechatronik und Mikrosystemtechnik (1 item)**

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<td>T-MACH-105209</td>
<td>Introduction into the Multi-Body Dynamics</td>
<td>5</td>
<td>Seemann</td>
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<td>Badilita, Jouda, Korvink</td>
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<tr>
<td>T-MACH-105183</td>
<td>Introduction to Microsystem Technology II</td>
<td>4</td>
<td>Jouda, Korvink</td>
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<tr>
<td>T-MACH-102163</td>
<td>Basics of Technical Logistics</td>
<td>6</td>
<td>Mittwollen, Oellerich</td>
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<td>Fundamentals of Combustion I</td>
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<td>Maas, Sommerer</td>
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<td>Machine Dynamics</td>
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<td>Mathematical Methods in Dynamics</td>
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<td>Novel Actuators and Sensors</td>
<td>4</td>
<td>Kohl, Sommer</td>
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<td>6</td>
<td>Rieder, Weiß, Wieners</td>
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<td>T-MACH-100530</td>
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<td>Product Lifecycle Management</td>
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<td>Fundamentals of Combustion Engine Technology</td>
<td>5</td>
<td>Bernhardt, Kubach, Pfeil, Toedter, Wagner</td>
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<td>T-MACH-102083</td>
<td>Integrated Information Systems for Engineers</td>
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<td>Probability Theory and Statistics</td>
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<td>Heat and Mass Transfer</td>
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**Election block: Grundlagen und Methoden der Mechatronik und Mikrosystemtechnik (Ü) ()**

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<td>Tutorial Mathematical Methods in Structural Mechanics</td>
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### Competence Certificate
2 individual exams: written or oral, graded

### Competence Goal
"Fundamentals and Methods of Mechatronics and Microsystem Technology" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.
Prerequisites
None

Content
see chosen course

Workload
The work load is about 240 hours, corresponding to 8 credit points.

Learning type
Lecture, exercise
Module: Fundamentals and Methods of Product Development and Construction (MSc-WPfM-GuM-PEK) [M-MACH-102741]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Product Development and Engineering Design (mandatory)

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**Election block: Grundlagen und Methoden der Produktentwicklung und Konstruktion (2 items)**

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<td>6 CR</td>
<td>Böhland, Lorch, Reischl</td>
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<td>Introduction to Microsystem Technology II</td>
<td>4 CR</td>
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<td>Novel Actuators and Sensors</td>
<td>4 CR</td>
<td>Kohl, Sommer</td>
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<td>Physical Basics of Laser Technology</td>
<td>5 CR</td>
<td>Schneider</td>
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<td>Heat and Mass Transfer</td>
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**Election block: Grundlagen und Methoden der Produktentwicklung und Konstruktion (Ü) ()**

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<td>Tutorial Mathematical Methods in Structural Mechanics</td>
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**Competence Certificate**  
2 individual exams: written or oral, graded

**Competence Goal**  
"Fundamentals and Methods of Product Development and Construction" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical Engineering.

**Prerequisites**  
None
10 MODULES

Module: Fundamentals and Methods of Product Development and Construction (MSc-WPM-GuM-PEK) [M-MACH-102741]

Content
See courses.

Workload
The work load is about 240 hours, corresponding to 8 credit points.

Learning type
Lecture, exercise.
**10.10 Module: Fundamentals and Methods of Production Technology (MSc-WPf-GuM-PT) [M-MACH-102742]**

**Responsible:** Prof. Dr.-Ing. Volker Schulze  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Production Technology (mandatory)

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**Election block: Grundlagen und Methoden der Produktionstechnik (2 items)**

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<td>Albers, Matthiesen</td>
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<td>Fluid Power Systems</td>
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<td>Geimer, Pult</td>
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<td>T-MACH-105182</td>
<td>Introduction to Microsystem Technology I</td>
<td>4 CR</td>
<td>Badili, Jouda, Korvink</td>
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<tr>
<td>T-MACH-105183</td>
<td>Introduction to Microsystem Technology II</td>
<td>4 CR</td>
<td>Jouda, Korvink</td>
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<td>T-MACH-102163</td>
<td>Basics of Technical Logistics</td>
<td>6 CR</td>
<td>Mittwollen, Oellerich</td>
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**Election block: Grundlagen und Methoden der Produktionstechnik (Ü) ()**

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<tbody>
<tr>
<td>T-MACH-106830</td>
<td>Tutorial Mathematical Methods in Strength of Materials</td>
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**Competence Certificate**

2 exams:

Oral exams: duration approx. 5 min per credit point  
Written exams: duration approx. 20 - 25 min per credit point

Amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**

"Fundamentals and Methods of Production Technology" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

**Prerequisites**

none

**Content**

Fundamentals and Methods of Production Technology

**Workload**

The work load is about 240 hours, corresponding to 8 credit points.
Learning type
Lectures, seminars, workshops, excursions
### Module: Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering (MSc-WPfM-GuM-ThM) [M-MACH-102743]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Theoretical Mechanical Engineering (mandatory)

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<th>Election block: Grundlagen und Methoden des Theoretischen Maschinenbaus (2 items)</th>
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<tbody>
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**Election block: Grundlagen und Methoden des Theoretischen Maschinenbaus (Ü) ()**

| T-MACH-110333 | Tutorial Continuum Mechanics of solids and fluids | 1 CR | Böhlke, Frohnapfel |
| T-MACH-110376 | Tutorial Mathematical Methods in Continuum Mechanics | 1 CR | Böhlke |
| T-MACH-110379 | Tutorial Mathematical Methods in Micromechanics | 1 CR | Böhlke |

**Competence Certificate**

2 individual exams: written or oral, graded

**Competence Goal**

"Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering" serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

**Prerequisites**

None
Content
see chosen course

Workload
The work load is about 240 hours, corresponding to 8 credit points.

Learning type
Lecture, tutorial
Module: Key Competences [M-MACH-102824]

Responsible: Prof. Dr.-Ing. Martin Heilmaier
Organisation: KIT Department of Mechanical Engineering
Part of: Advanced Engineering Fundamentals

Credits: 2  Recurrence: Once  Duration: 2 term  Level: 4  Version: 2

Election block: Schlüsselqualifikationen (1 item)

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<td>2 CR</td>
<td>Doppelbauer, Gratzfeld</td>
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<td>T-MACH-106375</td>
<td>Value stream within enterprises – The value chain at Bosch</td>
<td>2 CR</td>
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<td>T-MACH-106376</td>
<td>ZAK lectures</td>
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<td>Heilmaier</td>
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Competence Certificate
Success is monitored within the framework of academic achievements.
Amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
After completing the module Key Competences students can

- determine and coordinate work steps, projects and goals, proceed systematically and purposefully, set priorities as well as assess the feasibility of a task,
- apply methods for the planning of a specific task under given framework conditions in a goal- and resource-oriented way,
- describe methods for scientific research and selection of technical information according to pre-established quality criteria and apply them to given problems,
- discuss empirical methods and apply them to selected examples,
- present technical information in a clear, readable, and convincingly argued manner in various forms of presentation (e.g. poster, exposé, abstract) in writing and appropriately visualize it graphically (e.g. engineering drawings, flowcharts),
- present and stand up for technical content in a convincing and appealing way,
- work as a team in a task-oriented manner, handle any conflicts on their own and take responsibility for themselves and others,
- communicate as a team in an objective, goal-oriented and interpersonal manner, represent their own interests, reflect and take into account the interests of others in their own words, and successfully organize the course of the conversation.

Module grade calculation
Certification without note

Prerequisites
none

Content
The module Key Competences consists of freely selectable courses offered by the KIT-House of Competence (HoC), the KIT Language Centre (SPZ) and the Centre for Cultural and General Studies (ZAK) with a work load corresponding to a total of at least 2 ECTS. Upon request, the examination board may approve further courses as freely selectable subjects in the module "Key Competences".

Annotation
Only HoC/SPZ/ZAK courses can be chosen.

Workload
The work load is about 60 hours, corresponding to 2 credit points in the Master of Science program.
Learning type
The teaching and learning methods depend on the respectively chosen courses. The courses can be lectures, seminars, tutorials, or lab courses.
### 10.13 Module: Laboratory Course (MSc-Modul 07, FP) [M-MACH-102591]

**Responsible:** Prof. Dr.-Ing. Kai Furmans  
Prof. Dr.-Ing. Christoph Stiller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Advanced Engineering Fundamentals

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**Election block: Laborpraktikum (1 item)**

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<td>Decently Controlled Intralogistic Systems</td>
<td>4 CR</td>
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<td>T-MACH-105447</td>
<td>Metallographic Lab Class</td>
<td>4 CR</td>
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<td>T-MACH-105222</td>
<td>Motor Vehicle Labor</td>
<td>4 CR</td>
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<td>T-MACH-108312</td>
<td>Introduction to Microsystem Technology - Practical Course</td>
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<td>T-MACH-105331</td>
<td>Laboratory Exercise in Energy Technology</td>
<td>4 CR</td>
<td>Bauer, Maas, Wirbser</td>
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<td>Laboratory Mechatronics</td>
<td>4 CR</td>
<td>Lorch, Seemann, Stiller</td>
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<tr>
<td>T-MACH-105300</td>
<td>Measurement Instrumentation Lab</td>
<td>4 CR</td>
<td>Spindler, Stiller</td>
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<tr>
<td>T-MACH-105337</td>
<td>Engine Laboratory</td>
<td>4 CR</td>
<td>Wagner</td>
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<tr>
<td>T-MACH-106693</td>
<td>Plug-and-play material handling</td>
<td>4 CR</td>
<td>Dziedzitz, Furmans</td>
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<tr>
<td>T-MACH-106707</td>
<td>Workshop on computer-based flow measurement techniques</td>
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<td>Laboratory Laser Materials Processing</td>
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<td>T-MACH-105343</td>
<td>Lab Course Experimental Solid Mechanics</td>
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<td>Laboratory Production Metrology</td>
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<td>Practical Course “Tribology”</td>
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<tr>
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<td>Deml, Fleischer, Furmans, Ovtcharova</td>
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<td>T-MACH-106738</td>
<td>ProVIL - Product development in a Virtual Idea Laboratory</td>
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<td>Practical Training in Measurement of Vibrations</td>
<td>4 CR</td>
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<td>Flow Measurement Techniques</td>
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**Competence Certificate**

The success is monitored within the framework of academic achievements, it can vary according to the individually choice. The module is not graded, and remains not graded even after the choice of one or several graded brick courses.

**Competence Goal**

Students are able to:

- Model typical problems in the laboratory and use typical methods of mecanical science to inquire,
- Built experiment designs, while choosing appropriate system components and models,
- Accomplish experiments goal-oriented,
- Analyse and evaluate results of experiments.

**Prerequisites**

none

**Content**

see chosen practical training

**Workload**

The work load is about 120 hours, corresponding to 4 credit points.
Learning type
practical training, self-study
10.14 Module: Major Field: Advanced Materials Modelling (SP 56) [M-MACH-102649]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)  
Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

**Credits:** 16  
**Recurrence:** Once  
**Language:** German/English  
**Level:** 4  
**Version:** 1

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

### Mandatory

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<tr>
<td>T-MACH-105308</td>
<td>Atomistic Simulations and Molecular Dynamics</td>
<td>4</td>
<td>Brandl, Gumbsch, Schneider</td>
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<tr>
<td>T-MACH-105532</td>
<td>Nonlinear Continuum Mechanics</td>
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**Election block: Advanced Materials Modelling (E) ()

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<td>T-MACH-105459</td>
<td>High Temperature Materials</td>
<td>4</td>
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<td>T-MACH-105554</td>
<td>Thin Film and Small-scale Mechanical Behavior</td>
<td>4</td>
<td>Gruber, Schwaiger, Weygand</td>
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</table>

**Competence Certificate**  
Oral exams: duration approx. 5 min. per credit point.  
However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**  
The student can  
- describe the physical foundation of particle based simulation method (e.g. molecular dynamics)

**Prerequisites**  
None

**Content**  
See brick courses.

**Workload**  
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**  
Lectures, Tutorials
## 10.15 Module: Major Field: Advanced Mechatronics (SP 01) [M-MACH-102598]

**Responsible:** PD Dr.-Ing. Markus Reischl  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt (p))  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Production Technology (Schwerpunkt)  
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

### Election notes
In the core area of each Major Field at least 8 ECTS have to be chosen.

### Election block: Advanced Mechatronics (K) (at least 8 credits)

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<td>Introduction into Mechatronics</td>
<td>6 CR</td>
<td>Once</td>
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<td>T-MACH-105443</td>
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### Election block: Advanced Mechatronics (E) (at most 8 credits)

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<td>Actuators and Sensors in Nanotechnology</td>
<td>4 CR</td>
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**Election block: Advanced Mechatronics (P) (at most 4 credits)**

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<td>T-MACH-108878</td>
<td>Laboratory Production Metrology</td>
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**Election block: Advanced Mechatronics (Ü) ()**

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<td>T-INF-106257</td>
<td>Human-Machine-Interaction Pass</td>
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**Competence Certificate**

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**

Students of the major Advanced Mechatronics know the future-oriented procedures. They are able to creatively solve complex interdisciplinary questions, in particular by applying the latest computer-assisted mathematical methods.

**Prerequisites**

None

**Content**

The Advanced Mechatronics offers a broad, multidisciplinary body of knowledge. It qualifies graduates to solve essential mechatronic questions. In particular the following disciplines are covered by the major Advanced Mechatronics:

- Control theory
- Measurement technology and signal processing,
- Modelling and
- Mathematical methods.

**Workload**

The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**

The contents of this major field are taught in form of lectures, exercises and practical experiences.
10.16 Module: Major Field: Applied Mechanics (SP 30) [M-MACH-102646]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
Specialization / Specialization: Vehicle Technology (Schwerpunkt)
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
Specialization / Specialization: Production Technology (Schwerpunkt)
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt (p))
Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

Election block: Angewandte Mechanik (K) (at least 8 credits)

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<tr>
<td>T-MACH-105352</td>
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Election block: Angewandte Mechanik (E) (at most 8 credits)

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<td>Computational Homogenization on Digital Image Data</td>
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<td>T-MACH-105321</td>
<td>Introduction to Theory of Materials</td>
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<td>T-MACH-105439</td>
<td>Introduction to Nonlinear Vibrations</td>
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<td>Modelling of Microstructures</td>
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<td>Nonlinear Continuum Mechanics</td>
<td>5 CR</td>
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<td>T-MATH-102242</td>
<td>Numerical Mathematics for Students of Computer Science</td>
<td>6 CR</td>
<td>Rieder, Weiß, Wieners</td>
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<td>T-MACH-105348</td>
<td>Process Simulation in Forming Operations</td>
<td>4 CR</td>
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<td>T-MACH-105349</td>
<td>Computational Dynamics</td>
<td>4 CR</td>
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<td>T-MACH-105350</td>
<td>Computational Vehicle Dynamics</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105971</td>
<td>Simulation of the process chain of continuously fiber reinforced composite structure</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105372</td>
<td>Theory of Stability</td>
<td>6 CR</td>
<td>Fidlin</td>
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<tr>
<td>T-MACH-105970</td>
<td>Structural Analysis of Composite Laminates</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105290</td>
<td>Vibration Theory</td>
<td>5 CR</td>
<td>Fidlin, Seemann</td>
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<tr>
<td>T-MACH-105369</td>
<td>Materials Modelling: Dislocation Based Plasticity</td>
<td>4 CR</td>
<td>Weygand</td>
</tr>
<tr>
<td>T-MACH-100532</td>
<td>Scientific Computing for Engineers</td>
<td>5 CR</td>
<td>Gumbsch, Weygand</td>
</tr>
<tr>
<td>T-MACH-110431</td>
<td>Digital microstructure characterization and modeling</td>
<td>6 CR</td>
<td>Schneider</td>
</tr>
<tr>
<td>T-MACH-109302</td>
<td>Computational Homogenization on Digital Image Data</td>
<td>6 CR</td>
<td>Schneider</td>
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<tr>
<td>T-MACH-110378</td>
<td>Mathematical Methods in Micromechanics</td>
<td>5 CR</td>
<td>Böhlke</td>
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<tr>
<td>T-MACH-110380</td>
<td>Nonlinear optimization methods</td>
<td>6 CR</td>
<td>Schneider</td>
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<tr>
<td>T-MACH-110379</td>
<td>Tutorial Mathematical Methods in Micromechanics</td>
<td>1 CR</td>
<td>Böhlke</td>
</tr>
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</table>

Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
After having finished this major field the students can

- list important mathematical concepts that are applied in mechanics
- analyze, evaluate and assess models of mechanics according to their mathematical structure
- apply mathematical algorithms for solving special problems in mechanics
- select a mathematical description of a given problem in mechanics

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials, consultation hours
### Module: Major Field: Automation Technology (SP 04) [M-MACH-102601]

**Responsible:** Prof. Dr. Ralf Mikut  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt (p))  
- Specialization / Specialization: Production Technology (Schwerpunkt)  
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

**Credits:** 16  
**Recurrence:** Once  
**Language:** German/English  
**Level:** 4  
**Version:** 2

**Election notes:**  
In the core area of Major Field at least 8 ECTS have to be chosen.

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<tr>
<th>Election block: Automatisierungstechnik (K) (at least 8 credits)</th>
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<tbody>
<tr>
<td>T-MACH-105217 Automation Systems</td>
<td>4 CR Kaufmann</td>
</tr>
<tr>
<td>T-MACH-105314 Computational Intelligence</td>
<td>4 CR Jakob, Mikut, Reischl</td>
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<tr>
<td>T-MACH-105694 Data Analytics for Engineers</td>
<td>5 CR Ludwig, Mikut, Reischl</td>
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<tr>
<td>T-MACH-105317 Digital Control</td>
<td>4 CR Knoop</td>
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<tr>
<td>T-MACH-100535 Introduction into Mechatronics</td>
<td>6 CR Böhland, Lorch, Reischl</td>
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<tr>
<td>T-MACH-105539 Modern Control Concepts I</td>
<td>4 CR Groell, Matthes</td>
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<tbody>
<tr>
<td>T-MACH-108844 Automated Manufacturing Systems</td>
<td>8 CR Fleischer</td>
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<tr>
<td>T-MACH-105212 CAE-Workshop</td>
<td>4 CR Albers, Matthiesen</td>
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<tr>
<td>T-MACH-105156 Vehicle Mechatronics I</td>
<td>4 CR Ammon</td>
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<tr>
<td>T-MACH-105223 Machine Vision</td>
<td>8 CR Lauer, Stiller</td>
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<td>T-MACH-105335 Measurement II</td>
<td>4 CR Stiller</td>
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<tr>
<td>T-MACH-108809 Micro- and nanosystem integration for medical, fluidic and optical applications</td>
<td>4 CR Gengenbach, Hagenmeyer, Koker, Sieber</td>
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<tr>
<td>T-MACH-106691 Modern Control Concepts II</td>
<td>4 CR Groell</td>
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<td>T-MACH-106692 Modern Control Concepts III</td>
<td>4 CR Groell</td>
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<tr>
<td>T-MACH-105442 Intellectual Property Rights and Strategies in Industrial Companies</td>
<td>4 CR Albers, Matthiesen, Zacharias</td>
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<td>T-MACH-105990 Simulation of Optical Systems</td>
<td>4 CR Sieber</td>
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<td>T-MACH-105185 Control Technology</td>
<td>4 CR Gönnheimer</td>
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<td>T-MACH-105555 System Integration in Micro- and Nanotechnology</td>
<td>4 CR Gengenbach</td>
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<td>T-MACH-105367 Behaviour Generation for Vehicles</td>
<td>4 CR Stiller, Werling</td>
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<td>T-MACH-105443 Wave Propagation</td>
<td>4 CR Seemann</td>
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<td>T-MACH-109055 Machine Tools and Industrial Handling</td>
<td>8 CR Fleischer</td>
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<tr>
<td>T-MACH-105370 Laboratory Mechatronics</td>
<td>4 CR Lorch, Seemann, Stiller</td>
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<td>T-MACH-105341 Lab Computer-Aided Methods for Measurement and Control</td>
<td>4 CR Stiller</td>
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<td>T-MACH-108878 Laboratory Production Metrology</td>
<td>4 CR Häfner</td>
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<td>T-MACH-102149 Virtual Reality Practical Course</td>
<td>4 CR Ovtcharova</td>
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Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The Automation Engineering offers both theoretical foundations and practical knowledge in the field of automation. Students can select, apply and enhance existing methods. The main focus of the major is on

- Applied control engineering
- Automation
- Examples of field applications

Students of Automation Engineering are qualified to master complex challenges of the future. They are able to apply their profound knowledge and the future-oriented methods independent of a particular application field.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
10.18 Module: Major Field: Cognitive Technical Systems (SP 22) [M-MACH-102609]

**Responsible:** Prof. Dr.-Ing. Christoph Stiller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

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<td>T-MACH-105341</td>
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**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**
Students are able to

- explain fundamental components and processing steps of cognitive technical systems
- explain the interplay of individual components and the flow of information between them
- outline the major properties of cognitive functions at examples in emerging applications like vehicular technology or robotics
- determine the level of system function and safety for cognitive technical systems

**Prerequisites**
None
Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
Module: Major Field: Combustion Engines Based Powertrains (SP 58) [M-MACH-102650]

**Responsible:** Prof. Dr. Thomas Koch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt (p))
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

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**Mandatory**

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<tr>
<td>T-MACH-105564</td>
<td><strong>Energy Conversion and Increased Efficiency in Internal Combustion Engines</strong></td>
<td>4 CR</td>
<td>Koch, Kubach</td>
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<tr>
<td>T-MACH-102194</td>
<td><strong>Combustion Engines I</strong></td>
<td>4 CR</td>
<td>Koch, Kubach</td>
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**Election block: Verbrennungsmotorische Antriebssysteme (K) ()**

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<tr>
<td>T-MACH-105044</td>
<td><strong>Fundamentals of Catalytic Exhaust Gas Aftertreatment</strong></td>
<td>4 CR</td>
<td>Deutschmann, Grunwaldt, Kubach, Lox</td>
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<tr>
<td>T-MACH-105167</td>
<td><strong>Analysis Tools for Combustion Diagnostics</strong></td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105169</td>
<td><strong>Engine Measurement Techniques</strong></td>
<td>4 CR</td>
<td>Bernhardt</td>
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<tr>
<td>T-MACH-104609</td>
<td><strong>Combustion Engines II</strong></td>
<td>5 CR</td>
<td>Koch, Kubach</td>
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**Election block: Verbrennungsmotorische Antriebssysteme (E) ()**

<table>
<thead>
<tr>
<th>Code</th>
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<tbody>
<tr>
<td>T-MACH-105173</td>
<td><strong>Analysis of Exhaust Gas and Lubricating Oil in Combustion Engines</strong></td>
<td>4 CR</td>
<td>Gohl</td>
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<tr>
<td>T-MACH-105655</td>
<td><strong>Alternative Powertrain for Automobiles</strong></td>
<td>4 CR</td>
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<td>T-MACH-105451</td>
<td><strong>Drive Systems and Possibilities to Increase Efficiency</strong></td>
<td>2 CR</td>
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<tr>
<td>T-MACH-105649</td>
<td><strong>Boosting of Combustion Engines</strong></td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105310</td>
<td><strong>Design of Highly Stresses Components</strong></td>
<td>4 CR</td>
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<td>T-MACH-102162</td>
<td><strong>Automated Manufacturing Systems</strong></td>
<td>9 CR</td>
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<td>T-MACH-105184</td>
<td><strong>Fuels and Lubricants for Combustion Engines</strong></td>
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<td>Kehrwald, Kubach</td>
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<td><strong>Gasdynamics</strong></td>
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<td>Magagnato</td>
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<td>T-MACH-100092</td>
<td><strong>Automotive Engineering I</strong></td>
<td>8 CR</td>
<td>Gauterin, Unrau</td>
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<td>T-MACH-102117</td>
<td><strong>Automotive Engineering II</strong></td>
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<tr>
<td>T-MACH-105325</td>
<td><strong>Fundamentals of Combustion II</strong></td>
<td>4 CR</td>
<td>Maas</td>
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<td>T-MACH-105210</td>
<td><strong>Machine Dynamics</strong></td>
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<td>Proppe</td>
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<td>T-MACH-105224</td>
<td><strong>Machine Dynamics II</strong></td>
<td>4 CR</td>
<td>Proppe</td>
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<td>T-MACH-102199</td>
<td><strong>Model Based Application Methods</strong></td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105442</td>
<td><strong>Intellectual Property Rights and Strategies in Industrial Companies</strong></td>
<td>4 CR</td>
<td>Albers, Matthiesen, Zacharias</td>
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<td>T-MACH-105347</td>
<td><strong>Project Management in Global Product Engineering Structures</strong></td>
<td>4 CR</td>
<td>Albers, Gutzmer, Matthiesen</td>
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<td>T-MACH-105358</td>
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<td>4 CR</td>
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<td><strong>Tribology</strong></td>
<td>8 CR</td>
<td>Dienwiebel, Scherge</td>
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<tr>
<td>T-MACH-105985</td>
<td><strong>Ignition systems</strong></td>
<td>4 CR</td>
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**Election block: Verbrennungsmotorische Antriebssysteme (P) (at most 4 credits)**
Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
After completion of SP 48 students are able to:

- transfer fundamentals of thermodynamics and technical combustion to applications of combustion engines
- name and describe applications
- describe and explain the working principle of combustion engine and its application in vehicles
- analyze and evaluate propulsion systems

Prerequisites
None

Content
Energy converting machines are a key issue of technical engineering. Design and working principle are subject of the core area of SP 48. Fundamentals of thermodynamics are transferred to the application of internal combustion engines. In the supplementary area Measurement techniques to analyze and develop combustion engines as well as Fuels, Lubes and special engine concepts are addressed. The application of engines in drivetrains and production processes are continuative topics.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lecture, tutorial.
Module: Major Field: Computational Mechanics (SP 06) [M-MACH-102604]

**Responsible:** Prof. Dr.-Ing. Carsten Proppe  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt (p))

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**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

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**Election block: Computational Mechanics (K) (at least 8 credits)**

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<td>T-MACH-105349</td>
<td>Computational Dynamics</td>
<td>4 CR</td>
<td>Proppe</td>
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<td>T-MACH-105351</td>
<td>Computational Mechanics I</td>
<td>6 CR</td>
<td>Böhlke, Langhoff</td>
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**Election block: Computational Mechanics (E) (at most 8 credits)**

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<td>T-MACH-105390</td>
<td>Application of Advanced Programming Languages in Mechanical Engineering</td>
<td>4 CR</td>
<td>Weygand</td>
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<td>T-MACH-105308</td>
<td>Atomicistic Simulations and Molecular Dynamics</td>
<td>4 CR</td>
<td>Brandl, Gumbsch, Schneider</td>
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<td>T-MACH-105391</td>
<td>Finite Difference Methods for Numerical Solution of Thermal and Fluid Dynamical Problems</td>
<td>4 CR</td>
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<td>T-MACH-105394</td>
<td>Finite Volume Methods for Fluid Flow</td>
<td>4 CR</td>
<td>Günther</td>
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<td>T-MACH-105396</td>
<td>Modeling of Thermodynamical Processes</td>
<td>6 CR</td>
<td>Maas, Schießl</td>
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<td>T-MACH-105420</td>
<td>Numerical Simulation of Multi-Phase Flows</td>
<td>4 CR</td>
<td>Wörner</td>
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<td>Numerical Simulation of Reacting Two Phase Flows</td>
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<td>Numerical Simulation of Turbulent Flows</td>
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**Election block: Computational Mechanics (P) (at most 4 credits)**

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<td>FEM Workshop - Constitutive Laws</td>
<td>4 CR</td>
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**Competence Certificate**  
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

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**Competence Goal**  
The module offers a wide interdisciplinary education of the students in the areas which are summarized internationally under the concept 'Computational Mechanics':

* Continuum modelling (in structural mechanics, material theory, dynamics, fluid mechanics and thermodynamics)
* Numerical mathematics
* Informatics

Students know the procedures oriented to the future of modern engineering. They have the ability for individual, creative solutions of complicated problems with numerical means and take into account the interaction with neighboring fields.

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**Prerequisites**  
None
Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
# 10.21 Module: Major Field: Development of Innovative Appliances and Power Tools (SP 51) [M-MACH-102642]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt (p))  
Specialization / Specialization: Production Technology (Schwerpunkt)

## Credits
- **Credits:** 16  
- **Recurrence:** Once  
- **Language:** German/English  
- **Level:** 4  
- **Version:** 2

### Election regulations
Elections in this module require confirmation. Election is only possible until the lower bounds are reached.

### Mandatory
- **T-MACH-105229** Appliance and Power Tool Design  
  8 CR Albers, Matthiesen

### Election block: Entwicklung innovativer Geräte (E) (at most 8 credits)
- **T-MACH-105212** CAE-Workshop  
  4 CR Albers, Matthiesen  
- **T-MACH-105330** Design with Plastics  
  4 CR Liedel  
- **T-MACH-105221** Lightweight Engineering Design  
  4 CR Albers, Burkardt  
- **T-MACH-105231** Leadership and Management Development  
  4 CR Albers, Matthiesen, Ploch  
- **T-MACH-101910** Microactuators  
  4 CR Kohl  
- **T-MACH-102152** Novel Actuators and Sensors  
  4 CR Kohl, Sommer  
- **T-MACH-105442** Intellectual Property Rights and Strategies in Industrial Companies  
  4 CR Albers, Matthiesen, Zacharias  
- **T-MACH-105441** Development of Oil-Hydraulic Powertrain Systems  
  4 CR Ays, Geerling  
- **T-MACH-105347** Project Management in Global Product Engineering Structures  
  4 CR Albers, Gutzmer, Matthiesen  
- **T-MACH-102107** Quality Management  
  4 CR Lanza  
- **T-MACH-105696** Strategic product development - identification of potentials of innovative products  
  3 CR Albers, Matthiesen, Siebe  
- **T-MACH-110396** Strategic product development - identification of potentials of innovative products - Case Study  
  1 CR Albers, Matthiesen, Siebe

### Election block: Entwicklung innovativer Geräte (P) (at most 4 credits)
- **T-MACH-105370** Laboratory Mechatronics  
  4 CR Lorch, Seemann, Stiller

### Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal
Graduates are able to analyze and to synthesize complex technical products under consideration of customer, business and market demands. Specifically, they can address specific boundary conditions of devices and power tool manufacturers in power-tool development. They are able to take into account the resulting effects of complex product development projects: e.g. the production in large quantities, complexity of mechatronic solutions or workflow management of interdisciplinary and distributed development teams. The graduates are able to assess and optimize their work results in terms of quality, costs and user benefits. They have a holistic insight into the processes that are necessary for creating products in this specific context and thus are prepared for the technical and non-technical requirements of responsible positions in the team-oriented product development of devices and power tools.
Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lecture, exercise.
10.22 Module: Major Field: Energy Converting Engines (SP 24) [M-MACH-102627]

Responsibility: Prof. Dr. Thomas Koch
Organisation: KIT Department of Mechanical Engineering

Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

Credits: 16
Recurrence: Once
Language: German/English
Level: 4
Version: 2

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

Election block: Kraft- und Arbeitsmaschinen (K) (at least 8 credits)

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>T-MACH-105326</td>
<td>Hydraulic Fluid Machinery</td>
<td>8</td>
<td>Pritz</td>
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<tr>
<td>T-MACH-105363</td>
<td>Thermal Turbomachines I</td>
<td>6</td>
<td>Bauer</td>
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<tr>
<td>T-MACH-102194</td>
<td>Computation Engines I</td>
<td>4</td>
<td>Koch, Kubach</td>
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Election block: Kraft- und Arbeitsmaschinen (E) (at most 8 credits)

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<tr>
<td>T-MACH-105649</td>
<td>Boosting of Combustion Engines</td>
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<td>Kech, Kubach</td>
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<tr>
<td>T-CIWVT-105780</td>
<td>Design of a jet engine combustion chamber</td>
<td>6</td>
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<td>T-MACH-105184</td>
<td>Fuels and Lubricants for Combustion Engines</td>
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<td>Kahrwald, Kubach</td>
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<tr>
<td>T-MACH-105512</td>
<td>Experimental Fluid Mechanics</td>
<td>4</td>
<td>Kriegseis</td>
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<td>T-MACH-102093</td>
<td>Fluid Power Systems</td>
<td>4</td>
<td>Geimer, Pult</td>
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<td>T-MACH-105533</td>
<td>Gasdynamics</td>
<td>4</td>
<td>Magagnato</td>
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<td>T-MACH-105044</td>
<td>Fundamentals of Catalytic Exhaust Gas Aftertreatment</td>
<td>4</td>
<td>Deutschmann, Grunwaldt, Kubach, Lox</td>
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<td>T-MACH-105213</td>
<td>Fundamentals of Combustion I</td>
<td>4</td>
<td>Maas, Sommerer</td>
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<tr>
<td>T-MACH-105325</td>
<td>Fundamentals of Combustion II</td>
<td>4</td>
<td>Maas</td>
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<td>T-MACH-105338</td>
<td>Numerical Fluid Mechanics</td>
<td>4</td>
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<td>T-MACH-105441</td>
<td>Development of Oil-Hydraulic Powertrain Systems</td>
<td>4</td>
<td>Ays, Geering</td>
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<tr>
<td>T-MACH-107447</td>
<td>Reliability Engineering I</td>
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<td>Thermal Turbomachines II</td>
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<td>T-MACH-105365</td>
<td>Turbine and Compressor Design</td>
<td>4</td>
<td>Bauer</td>
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<td>T-MACH-105366</td>
<td>Turbo Jet Engines</td>
<td>4</td>
<td>Bauer</td>
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<tr>
<td>T-MACH-105234</td>
<td>Windpower</td>
<td>4</td>
<td>Lewald</td>
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<td>T-MACH-105784</td>
<td>Vortex Dynamics</td>
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<tr>
<td>T-MACH-105515</td>
<td>Introduction to Numerical Fluid Dynamics</td>
<td>4</td>
<td>Pritz</td>
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Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
Die Studierenden erwerben in den grundlagenorientierten Kernfächern des Schwerpunktes breite und fundierte Kenntnisse der wissenschaftlichen Theorien, Prinzipien und Methoden der Kraft- und Arbeitsmaschinen, um diese entwerfen, einsetzen und bewerten zu können.

Darauf aufbauend vertiefen die Studierenden in den Ergänzungsfächern ausgewählte Anwendungsfelder, sodass sie im Anschluss in der Lage sind, Probleme aus diesem Anwendungsfeld selbstständig zu analysieren, zu bewerten und hierauf aufbauend Lösungsansätze zu entwickeln.

Die Studierenden können nach Abschluss des Schwerpunkts insbesondere

- Funktion und Einsatz von Kraft- und Arbeitsmaschinen benennen,
- den Stand der Technik und daraus resultierende Anwendungsfelder der Kraft- und Arbeitsmaschinen beschreiben und am Beispiel anzuwenden,
- grundlegende Theorien, Methoden und Eigenschaften für die verschiedenen Anwendungsfelder der Kraft- und Arbeitsmaschinen benennen und diese einsetzen und bewerten.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lecture, tutorial.
Module: Major Field: Energy Technology for Buildings (SP 55) [M-MACH-102648]

### Responsible
Prof. Dr. Robert Stieglitz

### Organisation
KIT Department of Mechanical Engineering

### Credits
16

### Recurrence
Once

### Language
German/English

### Level
4

### Version
1

### Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

#### Mandatory
- T-MACH-105715 Energy demand of buildings – fundamentals and applications, with building simulation exercises 6 CR Schmidt

#### Election block: Gebäudeenergietechnik (K) (at least 4 credits)
- T-MACH-105952 Energy Storage and Network Integration 4 CR Jäger, Stieglitz
- T-ARCH-107406 Energy and Indoor Climate Concepts 4 CR Wagner
- T-ETIT-100724 Photovoltaic System Design 3 CR Grab
- T-MACH-105225 Thermal Solar Energy 4 CR Stieglitz
- T-MACH-106372 Thermal-Fluid-Dynamics 4 CR Ruck
- T-MACH-105430 Heatpumps 4 CR Maas, Wirbser
- T-MACH-105234 Windpower 4 CR Lewald

#### Election block: Gebäudeenergietechnik (E) (at most 8 credits)

### Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal
After completing the courses in SP 55 „Energy technology for buildings“ the students have achieved a comprehensive overview on the energy demand for air-conditioning of buildings (heating, cooling, humidification, dehumidification, ventilation) and the techniques for energy supply of buildings (heat, cold, locally generated electricity). They know the methods for evaluation of technologies regarding ecologic, criteria, primary energy and economic viability and they have the ability to apply these methods to concrete cases. They also have gained knowledge on all renewable energy technologies that are relevant for application in buildings, in particular solar thermal collectors and systems and photovoltaic systems as well as energy storage technologies that are applied in buildings (heat storage, batteries).

### Prerequisites
None

### Content
See brick courses.

### Workload
The work load is about 480 hours, corresponding to 16 credit points.

### Learning type
Lecture, exercise.
**10.24 Module: Major Field: Engineering Design (SP 10) [M-MACH-102605]**

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Production Technology (Schwerpunkt)

**Credits**  
16

**Recurrence**  
Once

**Language**  
German/English

**Level**  
4

**Version**  
2

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

### Election block: Entwicklung und Konstruktion (K) (at least 8 credits)

<table>
<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
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<tbody>
<tr>
<td>T-MACH-105233</td>
<td>Powertrain Systems Technology A: Automotive Systems</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ott</td>
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<tr>
<td>T-MACH-105216</td>
<td>Powertrain Systems Technology B: Stationary Machinery</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ott</td>
</tr>
<tr>
<td>T-MACH-105221</td>
<td>Lightweight Engineering Design</td>
<td>4 CR</td>
<td>Albers, Burkardt</td>
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### Election block: Entwicklung und Konstruktion (E) (at most 8 credits)

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<th>Code</th>
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<tbody>
<tr>
<td>T-MACH-105215</td>
<td>Applied Tribology in Industrial Product Development</td>
<td>4 CR</td>
<td>Albers, Lorentz, Matthiesen</td>
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<tr>
<td>T-MACH-105311</td>
<td>Design and Development of Mobile Machines</td>
<td>4 CR</td>
<td>Geimer, Siebert</td>
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<tr>
<td>T-MACH-105212</td>
<td>CAE-Workshop</td>
<td>4 CR</td>
<td>Albers, Matthiesen</td>
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<tr>
<td>T-MACH-108719</td>
<td>Designing with numerical methods in product development</td>
<td>4 CR</td>
<td>Schnack</td>
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<td>T-MACH-108374</td>
<td>Vehicle Ergonomics</td>
<td>4 CR</td>
<td>Heine</td>
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<tr>
<td>T-MACH-102105</td>
<td>Manufacturing Technology</td>
<td>8 CR</td>
<td>Schulze, Zanger</td>
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<td>T-MACH-100092</td>
<td>Automotive Engineering I</td>
<td>8 CR</td>
<td>Gauterze, Unrau</td>
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<tr>
<td>T-MACH-102116</td>
<td>Fundamentals for Design of Motor-Vehicle Bodies I</td>
<td>2 CR</td>
<td>Bardehle</td>
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<tr>
<td>T-MACH-102119</td>
<td>Fundamentals for Design of Motor-Vehicle Bodies II</td>
<td>2 CR</td>
<td>Bardehle</td>
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<tr>
<td>T-MACH-105160</td>
<td>Fundamentals in the Development of Commercial Vehicles I</td>
<td>2 CR</td>
<td>Zürn</td>
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<td>T-MACH-105161</td>
<td>Fundamentals in the Development of Commercial Vehicles II</td>
<td>2 CR</td>
<td>Zürn</td>
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<td>T-MACH-105162</td>
<td>Fundamentals of Automobile Development I</td>
<td>2 CR</td>
<td>Frech</td>
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<tr>
<td>T-MACH-105163</td>
<td>Fundamentals of Automobile Development II</td>
<td>2 CR</td>
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<tr>
<td>T-MACH-105188</td>
<td>Integrative Strategies in Production and Development of High Performance Cars</td>
<td>4 CR</td>
<td>Schlichtenmayer</td>
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<td>T-MACH-105330</td>
<td>Design with Plastics</td>
<td>4 CR</td>
<td>Liedel</td>
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<td>T-MACH-105231</td>
<td>Leadership and Management Development</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ploch</td>
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<td>T-MACH-105440</td>
<td>Leadership and Conflict Management</td>
<td>4 CR</td>
<td>Hatzl</td>
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<td>T-MACH-105441</td>
<td>Development of Oil-Hydraulic Powertrain Systems</td>
<td>4 CR</td>
<td>Ays, Geerling</td>
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<tr>
<td>T-MACH-105347</td>
<td>Project Management in Global Product Engineering Structures</td>
<td>4 CR</td>
<td>Albers, Gutzmer, Matthiesen</td>
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<tr>
<td>T-MACH-102107</td>
<td>Quality Management</td>
<td>4 CR</td>
<td>Lanza</td>
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<td>T-MACH-105171</td>
<td>Safety Engineering</td>
<td>4 CR</td>
<td>Kany</td>
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<td>T-MACH-105696</td>
<td>Strategic product development - identification of potentials of innovative products</td>
<td>3 CR</td>
<td>Albers, Matthiesen, Siebe</td>
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</table>
### Competence Certificate

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

The students are able to transfer their knowledge and abilities in product engineering to mechanical systems in research and industrial practice.

### Prerequisites

None

### Content

See brick courses.

### Workload

The work load is about 480 hours, corresponding to 16 credit points.

### Learning type

Lectures, Tutorials

<table>
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<th>Instructor(s)</th>
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<tr>
<td>T-MACH-110396</td>
<td>Strategic product development - identification of potentials of innovative products - Case Study</td>
<td>1 CR</td>
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<tr>
<td>T-MACH-105358</td>
<td>Sustainable Product Engineering</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ziegahn</td>
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<tr>
<td>T-MACH-105361</td>
<td>Technical Design in Product Development</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Schmid</td>
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<tr>
<td>T-MACH-109055</td>
<td>Machine Tools and Industrial Handling</td>
<td>8 CR</td>
<td>Fleischer</td>
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**Election block: Entwicklung und Konstruktion (P) (at most 4 credits)**

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<tr>
<td>T-MACH-105370</td>
<td>Laboratory Mechatronics</td>
<td>4 CR</td>
<td>Lorch, Seemann, Stiller</td>
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**Election block: Entwicklung und Konstruktion (Ü) ()**

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<tr>
<td>T-MACH-108887</td>
<td>Design and Development of Mobile Machines - Advance</td>
<td>0 CR</td>
<td>Geimer, Siebert</td>
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</table>
## 10.25 Module: Major Field: Engineering Thermodynamics (SP 45) [M-MACH-102635]

### Responsible
Prof. Dr. Ulrich Maas

### Organisation
KIT Department of Mechanical Engineering

### Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

### Credits
16

### Recurrence
Once

### Language
German/English

### Level
4

### Version
1

### Election notes
In the core area of each Major Field at least 8 ECTS have to be chosen.

### Election block: Technische Thermodynamik (K) (at least 8 credits)

<table>
<thead>
<tr>
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<th>Recurrence</th>
<th>Language</th>
<th>Instructor(s)</th>
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<tr>
<td>T-MACH-105213</td>
<td>Fundamentals of Combustion I</td>
<td>4 CR</td>
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<td>German/English</td>
<td>Maas, Sommerer</td>
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<tr>
<td>T-MACH-105325</td>
<td>Fundamentals of Combustion II</td>
<td>4 CR</td>
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<td>Maas</td>
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<td>T-MACH-105396</td>
<td>Modeling of Thermodynamical Processes</td>
<td>6 CR</td>
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<td>German/English</td>
<td>Maas, Schießl</td>
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<tr>
<td>T-MACH-105403</td>
<td>Flows and Heat Transfer in Energy Technology</td>
<td>4 CR</td>
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### Election block: Technische Thermodynamik (E) (at most 8 credits)

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<th>Recurrence</th>
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<tr>
<td>T-MACH-105428</td>
<td>Selected Chapters of the Combustion Fundamentals</td>
<td>4 CR</td>
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<td>German/English</td>
<td>Maas</td>
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<tr>
<td>T-MACH-106373</td>
<td>Experimental techniques in thermo- and fluid-dynamics</td>
<td>4 CR</td>
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<td>Cheng</td>
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<td>T-MACH-105533</td>
<td>Gasdynamics</td>
<td>4 CR</td>
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<td>T-MACH-105419</td>
<td>Mathematical Models and Methods in Combustion Theory</td>
<td>4 CR</td>
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<td>Bykov, Maas</td>
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<td>T-MACH-105167</td>
<td>Analysis Tools for Combustion Diagnostics</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105421</td>
<td>Reduction Methods for the Modeling and the Simulation of Vombustion Processes</td>
<td>4 CR</td>
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<td>German/English</td>
<td>Bykov, Maas</td>
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<tr>
<td>T-MACH-105422</td>
<td>Flows with Chemical Reactions</td>
<td>4 CR</td>
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<td>T-MACH-105363</td>
<td>Thermal Turbomachines I</td>
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<td>T-MACH-105364</td>
<td>Thermal Turbomachines II</td>
<td>6 CR</td>
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<tr>
<td>T-MACH-105429</td>
<td>Combustion Diagnostics</td>
<td>4 CR</td>
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### Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal
After completion of SP 45 students are able to:

- apply the thermodynamic fundamentals of irreversible processes.
- explain the governing processes in combustion.
- outline the fundamentals of modeling and simulation of reacting flows.
- understand the working principle of technical systems applying thermodynamic processes and combustion.

### Prerequisites
None
Content
Thermodynamics is considered to be the basis of all processes in nature and engineering. Combustion technology is still dominant as an energy conversion for power supply and for mobility applications. The major subject SP 45 extends the thermodynamic knowledge of the attendents in irreversible processes and provides insight into the fundamentals of reactive flows.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
## Module: Major Field: Fluid Mechanic (SP 41) [M-MACH-102634]

### Responsible:
Prof. Dr.-Ing. Bettina Frohnapfel

### Organisation:
KIT Department of Mechanical Engineering

### Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt (p))

### Credits
16

### Recurrence
Once

### Language
German/English

### Level
4

### Version
2

### Election block: Strömungsmechanik (K) (at least 8 credits)

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<td>Hydrodynamic Stability: From Order to Chaos</td>
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<td>T-MACH-105338</td>
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### Election block: Strömungsmechanik (P) (at most 4 credits)

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<td>CFD-Lab Using OpenFOAM</td>
<td>4 CR</td>
<td>Koch</td>
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<tr>
<td>T-MACH-105515</td>
<td>Introduction to Numerical Fluid Dynamics</td>
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<td>T-MACH-105453</td>
<td>Numerical Fluid Mechanics with MATLAB</td>
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<td>Flow Simulations</td>
<td>4 CR</td>
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### Competence Certificate

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

After having completed this module the student is capable of deriving the relevant fluid mechanical equations and interpret the governed physics. He/She can describe the characteristic properties of fluids and can analyze flow scenarios. According to the chosen lectures, the student can capture flow scenarios with analytical, numerical and/or experimental means and is capable to evaluate the acquired results thoroughly.
Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
# 10.27 Module: Major Field: Fundamentals of Energy Technology (SP 15) [M-MACH-102623]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Energy- and Environment Engineering (mandatory)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

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**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

### Mandatory

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### Election block: Grundlagen der Energietechnik (K) ()

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<td>Introduction to Nuclear Energy</td>
<td>4 CR</td>
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<td>T-MACH-105325</td>
<td>Fundamentals of Combustion II</td>
<td>4 CR</td>
<td>Maas</td>
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<tr>
<td>T-MACH-105326</td>
<td>Hydraulic Fluid Machinery</td>
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### Election block: Grundlagen der Energietechnik (E) (at most 8 credits)

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<td>T-MACH-105184</td>
<td>Fuels and Lubricants for Combustion Engines</td>
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<td>T-MACH-105151</td>
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<td>T-MACH-105952</td>
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<td>Microenergy Technologies</td>
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<td>Numerical Simulation of Reacting Two Phase Flows</td>
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<td>Magagnato</td>
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<td>Solar Thermal Energy Systems</td>
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### Election block: Grundlagen der Energietechnik (P) (at most 4 credits)

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<td>CFD-Lab Using OpenFOAM</td>
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<td>T-MACH-105515</td>
<td>Introduction to Numerical Fluid Dynamics</td>
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<td>T-MACH-105331</td>
<td>Laboratory Exercise in Energy Technology</td>
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<tr>
<td>T-MACH-106707</td>
<td>Workshop on computer-based flow measurement techniques</td>
<td>4 CR</td>
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</table>
Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
After completion of SP 15 students are able:

- to describe the elements of an energy system and their complex interactions,
- to list different conventional energy sources and assess their static range,
- to name the fluctuating supply of renewable energies such as wind, solar radiation, ocean currents and tides etc. and describe its effects on the energy system,
- to assess the effects of external and internal economic, ecological and technical boundary conditions of energy systems and to derive approaches for an optimal mix of different energy technologies,
- to explain the operational principle of well-established power plants as well as of power plants based on renewable energies.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, tutorials.
10.28 Module: Major Field: Fusion Technology (SP 53) [M-MACH-102643]

**Responsible:** Prof. Dr. Robert Stieglitz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

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**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

**Election block: Fusionstechnologie (K) (at least 8 credits)**
- T-MACH-105411 Fusion Technology A 4 CR Stieglitz
- T-MACH-105433 Fusion Technology B 4 CR Stieglitz
- T-ETIT-100663 Radiation Protection: Ionising Radiation 3 CR Dössel

**Election block: Fusionstechnologie (E) (at most 10 credits)**
- T-MACH-105310 Design of Highly Stresses Components 4 CR Aktaa
- T-MACH-105407 CFD in Power Engineering 4 CR Otic
- T-MACH-106698 A holistic approach to power plant management 4 CR Seidl, Stieglitz
- T-MACH-105434 Magnet Technology of Fusion Reactors 4 CR Fietz, Weiss
- T-MACH-105426 Magnetohydrodynamics 4 CR Bühler
- T-MACH-105435 Neutron Physics of Fusion Reactors 4 CR Fischer
- T-MACH-105456 Ten Lectures on Turbulence 4 CR Otic
- T-MACH-106372 Thermal-Fluid-Dynamics 4 CR Ruck
- T-MACH-105406 Two-Phase Flow and Heat Transfer 4 CR Schulenberg, Wörner
- T-MACH-108784 Vacuum and Tritium Technology in Nuclear Fusion 4 CR Bornschein, Day

**Competence Certificate**
Oral exam: Acceptance for the oral test only by certification of attendance of excercises (can be given in english)
Duration: approximately 30 minutes

No tools or reference materials may be used during the exam

**Competence Goal**
Graduate in fusion technology acquire a fundamental knowledge of the fusion process and are enabled to deduce based on the physical boundary conditions technological and scientific engineering solutions to individual problems. Since fusion technology is intrinsically of interdisciplinary nature consisting of physics, mechanics, thermal-hydraulics, material sciences and electrical engineering incorporates, the focus of this topic is mainly devoted to allow for the understanding of the underlying physics and moreover to enable the students of couple the different disciplines. Here, mainly methedologies and solution approaches are communicated to the graduates with the goal to capture critical issues within multi-physics problems, to identify central challenges within the given problem and to enable them to elaborate engineering solution concepts. Aside from the analysis of the relevance/importance of aspects within a complex multi-physics problem graduates are prepared to take decisions based on a solid physics basis and to formulate solution approaches.

The reliable handling of different physical phenomena from different disciplines and the methodological capability to tackle multi-physics questions and to extract from them central core issues qualifies the graduates for a competent and successful career not only in fusion technology but also in neighboring fields such energy energiering as well as process, chemical and environmental engineering both in the research and development context but also in the project management.

**Prerequisites**
None
Content
Actual energy situation and perspectives. Elementary particle physics, principles of nuclear fusion and nuclear fission. What is a plasma and how it can be confined? How stable is a plasma and conditions for an ignition, control of a plasma and transport in plasmas. Plasmas are confined contactless by means of magnetic fields. Hence fundamentals of the magnet technology, super-conductivity, materials in super-conductivity, fabrication and design of magnets are elaborated. A fusion reactor breeds its own fuel Tritium, which is radioactive. Tritium poses specific requirements regarding separation, conditioning and the fuel cycle, for which the physical and technological basis are outlined. Fusion plasmas are characterized by a small particle density and hence a vacuum is required. Simultaneously plasmas generate high temperatures and heat loads necessitating dedicated designs of plasma facing components at a considerable neutron irradiation. in both technology fields the tasks, requirements and challenges are formulated and how they translate to the current “state of the art” are illustrated. Moreover, an introduction into design criteria and calculation methods to select adequate vacuum pumps and to design plasma facing components is provided.

Recommendation
appreciated is knowledge in heat and mass transfer as well as in electrical engineering
Basic knowledge in fluid mechanics, material sciences and physics

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lecture, presentation (transparencies nearly exclusively in english) complemented by print-outs and exercises
### 10.29 Module: Major Field: Information Technology (SP 18) [M-MACH-102624]

**Responsible:** Prof. Dr.-Ing. Christoph Stiller  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

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**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

#### Election block: Informationstechnik (K) (at least 8 credits)

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#### Election block: Informationstechnik (E) (at most 6 credits)

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<td>German/English</td>
<td>Stiller, Werling</td>
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#### Election block: Informationstechnik (P) (at most 4 credits)

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<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Recurrence</th>
<th>Language</th>
<th>CR</th>
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<td>T-MACH-105370</td>
<td>Laboratory Mechatronics</td>
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<td>Lorch, Seemann, Stiller</td>
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<tr>
<td>T-MACH-105341</td>
<td>Lab Computer-Aided Methods for Measurement and Control</td>
<td>4</td>
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#### Election block: Informationstechnik (Ü) ()

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**Competence Certificate**

Oral exams: duration approx 5 min. per credit point.  
However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
Students are able to

- explain fundamentals of information technology for given problems in mechanical engineering and mechatronics.
- explain major methods for acquisition, processing and exploitation of information in technical systems.
- outline and to explain alternative methods to determine and to represent measurement uncertainties and their propagation in technical systems.
- explain information filters and fusion methods and understand their application to given problems.

Prerequisites
none

Content

- Techniques of information and data processing in mechanical engineering
- Techniques of sensor data processing
- Concepts of control theory
- Electronic devices for data processing

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, tutorials.
Module: Major Field: Information Technology of Logistic Systems (SP 19) [M-MACH-102625]

**Responsible:** Prof. Dr.-Ing. Kai Furmans  
**Organisation:** KIT Department of Mechanical Engineering

**Credits:** 16  
**Recurrence:** Once  
**Language:** German/English  
**Level:** 4  
**Version:** 1

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

**Election block: Informationstechnik für Logistiksysteme (K) (at least 8 credits)**

<table>
<thead>
<tr>
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<th>Course Title</th>
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<tbody>
<tr>
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<td>Information Systems and Supply Chain Management</td>
<td>3 CR</td>
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<tr>
<td>T-MACH-105187</td>
<td>IT-Fundamentals of Logistics</td>
<td>3 CR</td>
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<tr>
<td>T-MACH-102089</td>
<td>Logistics - Organisation, Design and Control of Logistic Systems</td>
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**Election block: Informationstechnik für Logistiksysteme (E) (at most 8 credits)**

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<tr>
<td>T-MACH-105218</td>
<td>Automotive Vision</td>
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<td>T-MACH-105174</td>
<td>Warehousing and Distribution Systems</td>
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<td>T-MACH-105175</td>
<td>Airport Logistics</td>
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<td>Supply Chain Management</td>
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**Competence Certificate**  
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**  
Students are able to:

- Describe and explain soft- and hardware for logistical systems including Supply-Chains,
- Choose control mechanisms and communication systems and describe their basic functions,
- Compare strength and weaknesses of different approaches and evaluate the fundamental suitability.

**Prerequisites**  
None

**Content**  
This emphasis module focuses on automation technology in material flow as well as the information technology that has a direct relationship with it. Information systems to support logistic processes are presented. It is shown how requirements of a supply chain can be identified and an appropriate information system can be choosen. Furthermore basic for the main topics of logistics are provided. To gain a deeper understanding, the courses are accompanied by exercises and partly by case studies.

**Workload**  
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**  
Lectures and practices; self-study
10.31 Module: Major Field: Innovation and Entrepreneurship (SP 59) [M-MACH-104323]

- **Responsible:** Prof. Dr. Andreas Class
- **Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

**Election block: Innovation und Entrepreneurship (K) (at least 8 credits)**

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**Election block: Innovation und Entrepreneurship (E) (at most 11,5 credits)**

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<tr>
<td>T-WIWI-102865</td>
<td>Business Planning</td>
<td>3 CR</td>
<td>English</td>
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</tbody>
</table>

**Competence Certificate**

Oral exams: duration approx. 5 minutes per credit point.

Amount, type and scope of the success control can vary according to individual choice.

**Competence Goal**

After completion of the module students

- know the principles of innovation and entrepreneurship
- can initiate patent research
- can name, compare and use the central methods and process models of product development within moderate complex technical systems.

**Prerequisites**

none

**Content**

The module introduces the basic concepts of entrepreneurship and illustrates the different stages of the dynamic development of a company.

The topics include:

- introduction to methods for generating innovative business ideas
- translating patents into business concepts
- general principles of financial planning
- the design and implementation of service-oriented information systems for Entrepreneurs
- Technology Management and Business Model Generation and “Lean Startup” methods for the implementation of business ideas by the way of controlled experiments in the market
- basics of product development.

**Workload**

The work load is about 480 hours, corresponding to 16 credit points. 1 LP = 30 working hours

**Learning type**

Seminar, lecture, project
Module: Major Field: Integrated Product Development [M-MACH-102626]

Responsible: Prof. Dr.-Ing. Albert Albers
Organisation: KIT Department of Mechanical Engineering

Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt (p))
- Specialization / Specialization: Production Technology (Schwerpunkt)

Credits
16

Recurrence
Once

Language
German

Level
4

Version
2

Mandatory

| T-MACH-105401 | Integrated Product Development | 16 CR | Albers, Albers Assistenten |

Competence Certificate
oral examination (60 minutes)

Competence Goal
By working practically in experience-based learning arrangements with industrial development tasks, graduates are able to succeed in new and unknown situations when developing innovative products by using methodological and systematic approaches. They can apply and adapt strategies of development and innovation management, technical system analysis and team leadership to the situation. As a result, they are able to foster the development of innovative products in industrial development teams in prominent positions, taking into account social, economic and ethical aspects.

Prerequisites
None

Content
Organizational integration: integrated product development model, core team management and simultaneous engineering, informational integration: innovation management, cost management, quality management and knowledge management
Personal integration: team development and leadership
Guest lectures from the industry

Annotation
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).
Due to organizational reasons, the number of participants is limited. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK homepage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
lecture
tutorial
product development project
Module: Major Field: Lifecycle Engineering (SP 28) [M-MACH-102613]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt (p))
- Specialization / Specialization: Production Technology (Schwerpunkt (p))

**Credits** 16  
**Recurrence** Once  
**Language** German/English  
**Level** 4  
**Version** 1

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

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<td>T-MACH-102123</td>
<td>Virtual Engineering I</td>
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<td>T-MACH-102124</td>
<td>Virtual Engineering II</td>
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**Election block: Lifecycle Engineering (E) (at most 11 credits)**

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<tr>
<td>T-MACH-109933</td>
<td>Business Administration for Engineers and IT professionals</td>
<td>4 CR</td>
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<td>T-MACH-105212</td>
<td>CAE-Workshop</td>
<td>4 CR</td>
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<td>CATIA Advanced</td>
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<td>T-MACH-108491</td>
<td>Digitalization of Products, Services &amp; Production</td>
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<td>T-MACH-106374</td>
<td>Human-oriented Productivity Management: Personnel Management</td>
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<td>Stock</td>
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<tr>
<td>T-MACH-105388</td>
<td>Introduction to Industrial Production Economics</td>
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<td>T-MACH-102209</td>
<td>Information Engineering</td>
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<td>IoT Platform for Engineering</td>
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<td>T-MACH-105189</td>
<td>Mathematical Models and Methods for Production Systems</td>
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<td>PLM for Product Development in Mechatronics</td>
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<td>T-MACH-105147</td>
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<td>T-MACH-105523</td>
<td>Productivity Management in Production Systems</td>
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<td>T-MACH-105457</td>
<td>Project Mikromanufacturing: Development and Manufacturing of Microsystems</td>
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<td>T-MACH-105171</td>
<td>Safety Engineering</td>
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<td>T-MACH-106740</td>
<td>Virtual Engineering Lab</td>
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<tr>
<td>T-MACH-102187</td>
<td>CAD-NX Training Course</td>
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**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point.

However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
Student gain a basic understanding of holistic development, validation and production of products, components and systems.
Students are able to appreciate the product and process complexity of today's products and manufacturing facilities. They know exemplary IT-Systems to support the complexity.
Students can describe the necessary information management for the product emergence process.
Students know the fundamental terms or virtual reality and are able to use a CAVE as tool to promote technical or management decisions.

Prerequisites
None

Content
Virtual Engineering, methods of product development and production, CAD, CAE, CAx, Virtual and Augmented Reality, digital twin.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, exercises, project work in teams, workshop, Learning by Doing
10.34 Module: Major Field: Lightweight Construction (SP 25) [M-MACH-102628]

**Responsible:** Prof. Dr.-Ing. Frank Henning  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Production Technology (Schwerpunkt)  
Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

**Mandatory**

<table>
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<tr>
<th>Code</th>
<th>Course</th>
<th>Credits</th>
<th>Level</th>
<th>Recurrence</th>
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<td>T-MACH-105535</td>
<td>Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies</td>
<td>4</td>
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**Election block: Leichtbau (E)**

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<td>T-MACH-105320</td>
<td>Introduction to the Finite Element Method</td>
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<td>T-MACH-105151</td>
<td>Energy Efficient Intralogistic Systems</td>
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<td>T-MACH-105157</td>
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<td>T-MACH-105330</td>
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<td>T-MACH-102139</td>
<td>Failure of Structural Materials: Fatigue and Creep</td>
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<td>T-MACH-102140</td>
<td>Failure of Structural Materials: Deformation and Fracture</td>
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<td>T-MACH-110318</td>
<td>Product- and Production-Concepts for modern Automobiles</td>
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**Competence Certificate**

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
Lightweight design is the realization of a development strategy, which aims at fulfilling a required function over the product life under specified boundary conditions by a system of minimal weight.

Therefore, lightweight design can always be described as an optimization problem, that must be solved as efficiently as possible by suitable measures. With regard to the automotive industry, this means reducing the total vehicle weight without negatively affecting important properties such as the bodywork stiffness or crash characteristics.

In order to solve the optimization problem of lightweight design technically and economically efficient, an interdisciplinary approach is required. This means that specific know-how is required in many areas of materials science and engineering, as well as interdisciplinary thinking.

Exploiting the full potential of lightweight design therefore requires the systematic development of materials, the development and adaption of suitable manufacturing and finishing processes, as well as the development of simulation tools and design methods for innovative lightweight constructions.

Students acquire the skill to name the basics of lightweight design and to apply them to problems in various areas of mechanical engineering, in particular materials, methods and production.

As an elementary component of the module, the students can explain and apply the materials relevant for lightweight design. The students are able to describe and compare the materials important for lightweight design and to select the corresponding methods for construction, design and dimensioning under consideration of suitable manufacturing technologies.

Based on examples, which are also used in industry, the students learn to select suitable materials, to describe them with suitable methods and to develop products under consideration of the manufacturing process. The students learn to analyze processes and to assess their efficiency.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
Module: Major Field: Logistics and Material Flow Theory (SP 29) [M-MACH-102629]

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
Specialization / Specialization: Production Technology (Schwerpunkt (p))

<table>
<thead>
<tr>
<th>Credits</th>
<th>Recurrence</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
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<tbody>
<tr>
<td>16</td>
<td>Once</td>
<td>German/English</td>
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</table>

**Mandatory**

- **T-MACH-102151** Material Flow in Logistic Systems 9 CR Furmans

**Election block: Logistik und Materialflusstechnik (E) ()**

- **T-MACH-105317** Digital Control 4 CR Knoop
- **T-MACH-105151** Energy Efficient Intralogistic Systems 4 CR Braun, Schöning
- **T-MACH-108848** Global Production and Logistics - Part 1: Global Production 4 CR Lanza
- **T-MACH-105159** Global Production and Logistics - Part 2: Global Logistics 4 CR Furmans
- **T-MACH-102128** Information Systems and Supply Chain Management 3 CR Kilger
- **T-MACH-105174** Warehousing and Distribution Systems 3 CR Furmans
- **T-MACH-105175** Airport Logistics 3 CR Richter
- **T-WIWI-103091** Production and Logistics Controlling 3 CR Rausch
- **T-MACH-105523** Productivity Management in Production Systems 4 CR Stowasser
- **T-MACH-105346** Production Techniques Laboratory 4 CR Deml, Fleischer, Furmans, Ovtcharova
- **T-MACH-105171** Safety Engineering 4 CR Kany

**Competence Certificate**

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**

Students

- acquire comprehensive and well-founded knowledge on the main topics of logistics, an overview of different logistic questions in practice and knows the functionality of material handling systems,
- are able to illustrate logistic systems with adequate accuracy by using simple models,
- are able to realize coherences within logistic systems,
- are able to evaluate logistic systems by using the learnt methods,
- are able to analyze and explain the phenomena of industrial material and value streams
- are able to plan logistic systems and evaluate their performance,
- can use approaches of Supply Chain Management within the operational practice,
- identify, analyse and evaluate risks within logistic systems.

**Prerequisites**

None

**Content**

The emphasis module Material Flow and Logistics provides comprehensive and well-founded basics for the main topics of logistics. Within the lectures, the interaction between several components of logistic systems will be shown. The module focuses on technical characteristics of material handling systems as well as on methods for illustrating and evaluating logistics systems. Furthermore the main topics of logistics and industrial material and value streams can be focused on by queuing methods to model production systems. Another focus can be set on basic methods for planning and running logistic systems or special issues like supply chain management. To gain a deeper understanding, the courses are accompanied by exercises and partly by case studies.
**Workload**
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**
Lectures and practices; self-study
10.36 Module: Major Field: Man - Technology - Organisation (SP 03) [M-MACH-102600]

Responsible: Prof. Dr.-Ing. Barbara Deml
Organisation: KIT Department of Mechanical Engineering

Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt (p))

Credits 16
Recurrence Once
Language German/English
Level 4
Version 1

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

<table>
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<tbody>
<tr>
<td>T-MACH-105518 Human Factors Engineering I</td>
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<tr>
<td>T-MACH-105519 Human Factors Engineering II</td>
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<th>Election block: Mensch - Technik - Organisation (E) (at most 8 credits)</th>
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<tr>
<td>T-MACH-105830 Human Factors Engineering III: Empirical research methods</td>
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<tr>
<td>T-MACH-108374 Vehicle Ergonomics</td>
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<td>T-MACH-106374 Human-oriented Productivity Management: Personnel Management</td>
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<td>T-MACH-105388 Introduction to Industrial Production Economics</td>
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<td>T-MACH-105386 Occupational Safety and Environmental Protection</td>
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<td>T-MACH-105231 Leadership and Management Development</td>
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<td>T-MACH-105440 Leadership and Conflict Management</td>
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<td>T-MACH-105387 Planning of Assembly Systems</td>
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<td>T-MACH-105470 Production Planning and Control</td>
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<td>T-MACH-105171 Safety Engineering</td>
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<td>T-MACH-105361 Technical Design in Product Development</td>
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Competence Certificate
In the core area of Major Field at least 8 ECTS have to be chosen.

Competence Goal
The students acquire a basic knowledge in the field of 1. ergonomics and 2. work organisation:

1. They are able to consider cognitive, physiological, anthropometric, and safety technical aspects in order to design workplaces ergonomically. Just as well they know physical and psycho-physical fundamentals (e. g. noise, lighting, climate) in the field of work-environmental design. Furthermore the students are able to evaluate workplaces by knowing and being able to apply essential methods of time studies and payment systems. Finally, they get a first, overall insight into the German labour law as well as into the organisation of advocacy groups beyond companies.

2. Within this module the students gain also a fundamental knowledge in the field of structural, process, and production organization. Besides, they get to know basic aspects of industrial teamwork and they know relevant theories in the field of interaction and communication, the management of employees as well as work satisfaction and motivation. Finally, the students get to know also methods in the field of personnel selection, development, and assessment.

Further on they get to know basic methods of behavioral-science data acquisition (e. g. eye-tracking, ECG, dual-task-paradigm) and they gain a first insight into empirical research methods (e. g. experimental design, statistical data evaluation). Selected complementary subjects deepen or extend the above mentioned learning outcomes.
Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
Module: Major Field: Materials Science and Engineering (SP 26) [M-MACH-102611]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)
- Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt (p))

**Credits:** 16

**Recurrence:** Once

**Language:** German/English

**Level:** 4

**Version:** 2

**Election notes**

In the core area of Major Field at least 8 ECTS have to be chosen.

**Mandatory**

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**Election block: Materialwissenschaft und Werkstofftechnik (E)**

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<td>T-MACH-102141</td>
<td>Constitution and Properties of Wearresistant Materials</td>
<td>4</td>
<td>Ulrich</td>
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<td>T-MACH-105150</td>
<td>Constitution and Properties of Protective Coatings</td>
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<td>T-MACH-105984</td>
<td>Fatigue of Welded Components and Structures</td>
<td>3</td>
<td>Farajian, Gumbsch</td>
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<td>T-MACH-105157</td>
<td>Foundry Technology</td>
<td>4</td>
<td>Wilhelm</td>
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<td>T-MACH-102111</td>
<td>Principles of Ceramic and Powder Metallurgy Processing</td>
<td>4</td>
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<td>Mechanics of Laminated Composites</td>
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<td>T-MACH-100287</td>
<td>Introduction to Ceramics</td>
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<td>Design with Plastics</td>
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<td>Laser in Automotive Engineering</td>
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<td>T-MACH-105333</td>
<td>Mechanics and Strength of Polymers</td>
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<td>von Bernstorff</td>
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<td>Modelling of Microstructures</td>
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<td>August, Nestler</td>
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<td>Nonlinear Continuum Mechanics</td>
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<td>T-MACH-105516</td>
<td>Multi-Scale Plasticity</td>
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<td>Polymer Engineering I</td>
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<td>High Performance Powder Metallurgy Materials</td>
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<td>T-MACH-105724</td>
<td>Failure Analysis</td>
<td>4</td>
<td>Greiner, Schneider</td>
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<td>T-MACH-105170</td>
<td>Welding Technology</td>
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<td>Farajian</td>
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<td>T-MACH-105354</td>
<td>Fatigue of Metallic Materials</td>
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<td>T-MACH-102179</td>
<td>Structural Ceramics</td>
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<td>T-MACH-105362</td>
<td>Technology of Steel Components</td>
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<td>Schulze</td>
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<td>T-MACH-108853</td>
<td>Hydrogen in Materials</td>
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<td>Pundt</td>
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<td>Failure of Structural Materials: Fatigue and Creep</td>
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<td>Failure of Structural Materials: Deformation and Fracture</td>
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<td>T-MACH-107684</td>
<td>Materials Characterization</td>
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<td>T-MACH-105211</td>
<td>Materials of Lightweight Construction</td>
<td>4</td>
<td>Liebig</td>
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<tr>
<td>T-MACH-107667</td>
<td>Solid State Reactions and Kinetics of Phase</td>
<td>4</td>
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</table>
### Competence Certificate

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

As part of a major field a specific subdomain of mechanical engineering is made accessible in breadth and depth. Students gain comprehensive knowledge in the core subjects and detailed knowledge in the supplementary subjects of the selected subdomain. They are able to generate new (scientific) solutions within this subdomain.

The specific learning outcomes are defined by the respective coordinator of the major field.

### Prerequisites

None

### Content

The comprehensive topic of the major field are the thermodynamical and kinetic basics of materials science that the students acquire within the core area (8 credit points). Moreover, there is a supplementary area of materials science and engineering which offers different subjects according to the students’ interests.

### Annotation

The module Materials Science and Engineering consists of 16 credit points in the master’s program. Within that module, the students have to take lectures from a core area (8 credit points) and can select from a broad variation of courses within the supplementary area. For the bachelor’s program, a reduced catalogue exists (see Studienplan).

### Workload

The work load is about 480 hours in the Master of Science program, whereof the presence time is 82 h.

### Learning type

In the core area of the major field Materials Science and Engineering the students choose from a small number of lectures and tutorials (obligatory).

Within the supplementary area students can choose not only lectures and tutorials but also lab courses and seminars.
**Module: Major Field: Mechatronics (SP 31) [M-MACH-102614]**

**Responsible:** Prof. Dr. Veit Hagenmeyer  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt (p))  
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
- Specialization / Specialization: Production Technology (Schwerpunkt)  
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

### Election block: Mechatronik (K) (at least 8 credits)

<table>
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<td>T-MACH-105314</td>
<td>Computational Intelligence</td>
<td>4 CR</td>
<td>Jakob, Mikut, Reischl</td>
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<td>T-MACH-105694</td>
<td>Data Analytics for Engineers</td>
<td>5 CR</td>
<td>Ludwig, Mikut, Reischl</td>
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<tr>
<td>T-MACH-100535</td>
<td>Introduction into Mechatronics</td>
<td>6 CR</td>
<td>Böhland, Lorch, Reischl</td>
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<tr>
<td>T-MACH-105209</td>
<td>Introduction into the Multi-Body Dynamics</td>
<td>5 CR</td>
<td>Seemann</td>
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<td>T-MACH-105218</td>
<td>Automotive Vision</td>
<td>6 CR</td>
<td>Lauer, Stiller</td>
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<td>T-MACH-105539</td>
<td>Modern Control Concepts I</td>
<td>4 CR</td>
<td>Groell, Matthes</td>
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<td>T-MACH-105367</td>
<td>Behaviour Generation for Vehicles</td>
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### Election block: Mechatronik (E) (at most 5 credits)

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<td>T-MACH-105217</td>
<td>Automation Systems</td>
<td>4 CR</td>
<td>Kaufmann</td>
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<tr>
<td>T-MACH-102150</td>
<td>BUS-Controls</td>
<td>4 CR</td>
<td>Becker, Geimer</td>
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<td>T-MACH-105212</td>
<td>CAE-Workshop</td>
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<td>Albers, Matthiesen</td>
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<td>T-MACH-105317</td>
<td>Digital Control</td>
<td>4 CR</td>
<td>Knoop</td>
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<td>T-MACH-105514</td>
<td>Experimental Dynamics</td>
<td>5 CR</td>
<td>Fidlin</td>
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<td>T-ETIT-100784</td>
<td>Hybrid and Electric Vehicles</td>
<td>4 CR</td>
<td>Becker</td>
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<td>T-MACH-105187</td>
<td>IT-Fundamentals of Logistics</td>
<td>3 CR</td>
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<td>T-MACH-108957</td>
<td>Mathematical Fundamentals of Numerical Mechanics</td>
<td>4 CR</td>
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<td>T-MACH-105294</td>
<td>Mathematical Methods of Vibration Theory</td>
<td>6 CR</td>
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<td>T-MACH-105210</td>
<td>Machine Dynamics</td>
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<td>Machine Dynamics II</td>
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<td>T-MACH-105335</td>
<td>Measurement II</td>
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<td>Microenergy Technologies</td>
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<td>T-MACH-108809</td>
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<td>4 CR</td>
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<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
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<td>T-MACH-105372</td>
<td>Theory of Stability</td>
<td>6 CR</td>
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### Competence Certificate

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

The topic mechatronics offers a broad, multidisciplinary body of knowledge. The graduates are qualified to solve essential mechatronic questions. In particular the following disciplines are covered by the major mechatronics:

- § Mechanics and fluidics
- § Electronics
- § Information processing
- § Automation.

Students of the topic mechatronics know the future-oriented procedures. They are able to individually and creatively solve interdisciplinary questions and learn to effectively combine tools from the individual disciplines.

### Prerequisites

none

### Content

See brick courses.

### Workload

The work load is about 480 hours, corresponding to 16 credit points.

### Learning type

Lecture, tutorial.
Module: Major Field: Medical Technology (SP 32) [M-MACH-102615]

Responsible: Prof. Dr. Christian Pylatiuk
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

Credits 16
Recurrence Once
Language German/English
Level 4
Version 1

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

**Mandatory**

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<td>Introduction into Mechatronics</td>
<td>6 CR</td>
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**Election block: Medizintechnik (K) (at least 2 credits)**

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<td>T-MACH-100966</td>
<td>BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I</td>
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<td>T-MACH-100967</td>
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<td>Computational Intelligence</td>
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<td>Principles of Medicine for Engineers</td>
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**Election block: Medizintechnik (E) (at most 8 credits)**

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<td>T-ETIT-101930</td>
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<td>Biomedical Measurement Techniques II</td>
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<td>T-MACH-102172</td>
<td>Bionics for Engineers and Natural Scientists</td>
<td>4 CR</td>
<td>Hölscher</td>
</tr>
<tr>
<td>T-MACH-105228</td>
<td>Organ Support Systems</td>
<td>4 CR</td>
<td>Pylatiuk</td>
</tr>
<tr>
<td>T-MACH-105221</td>
<td>Lightweight Engineering Design</td>
<td>4 CR</td>
<td>Albers, Burkardt</td>
</tr>
<tr>
<td>T-MACH-105334</td>
<td>Mechanics in Microtechnology</td>
<td>4 CR</td>
<td>Greiner, Gruber</td>
</tr>
<tr>
<td>T-ETIT-101937</td>
<td>Measurement</td>
<td>5 CR</td>
<td>Puente León</td>
</tr>
<tr>
<td>T-MACH-108809</td>
<td>Micro- and nanosystem integration for medical, fluidic and optical applications</td>
<td>4 CR</td>
<td>Gengenbach, Hagenmeyer, Koker, Sieber</td>
</tr>
<tr>
<td>T-ETIT-100664</td>
<td>Nuclear Medicine and Measuring Techniques I</td>
<td>1 CR</td>
<td>Dössel</td>
</tr>
<tr>
<td>T-MACH-105442</td>
<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Zacharias</td>
</tr>
<tr>
<td>T-MACH-105457</td>
<td>Project Mikromanufacturing: Development and Manufacturing of Microsystems</td>
<td>5 CR</td>
<td>Schulze</td>
</tr>
<tr>
<td>T-MACH-105347</td>
<td>Project Management in Global Product Engineering Structures</td>
<td>4 CR</td>
<td>Albers, Gutzmer, Matthiesen</td>
</tr>
<tr>
<td>T-INFO-108014</td>
<td>Robotics I - Introduction to Robotics</td>
<td>6 CR</td>
<td>Asfour</td>
</tr>
</tbody>
</table>
Competence Certificate
In the core area of Major Field at least 8 ECTS have to be chosen.

Competence Goal
The Medical Engineering qualifies students to solve challenges in the field of complex medical and biomedical systems supporting human-centred diagnostics and therapy. Based on the specific requirements for medical products the following topics are taught within the major Medical Engineering:

- Broad basis of relevant medical and biological knowledge
- Measuring technology and signal processing
- Development and Manufacturing of medical products

Graduates of this major know all relevant methods to design modern medical devices and have the ability to efficiently and creatively develop solutions for leading edge medical applications.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
10.40 Module: Major Field: Microactuators and Microsensors (SP 54) [M-MACH-102647]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)

Credits: 16
Recurrence: Once
Language: German/English
Level: 4
Version: 1

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

| Election block: Mikroaktoren und Mikrosensoren (K) (at least 8 credits) |
| T-MACH-101910 | Microactuators | 4 CR | Kohl |
| T-MACH-102152 | Novel Actuators and Sensors | 4 CR | Kohl, Sommer |

| Election block: Mikroaktoren und Mikrosensoren (E) (at most 11 credits) |
| T-MACH-105238 | Actuators and Sensors in Nanotechnology | 4 CR | Kohl |
| T-MACH-100966 | BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I | 4 CR | Guber |
| T-MACH-105321 | Introduction to Theory of Materials | 4 CR | Kamlah |
| T-MACH-102166 | Fabrication Processes in Microsystem Technology | 4 CR | Bade |
| T-MACH-105182 | Introduction to Microsystem Technology I | 4 CR | Badilta, Jouda, Korvink |
| T-MACH-105183 | Introduction to Microsystem Technology II | 4 CR | Jouda, Korvink |
| T-MACH-105334 | Mechanics in Microtechnology | 4 CR | Greiner, Gruber |
| T-MACH-105557 | Microenergy Technologies | 4 CR | Kohl |
| T-MACH-105303 | Modelling of Microstructures | 5 CR | August, Nestler |
| T-MACH-105180 | Nanotechnology for Engineers and Natural Scientists | 4 CR | Dienwiebel, Hölscher, Walheim |
| T-INFO-108014 | Robotics I - Introduction to Robotics | 6 CR | Asfour |
| T-MACH-105555 | System Integration in Micro- and Nanotechnology | 4 CR | Gengenbach |
| T-MACH-105782 | Micro Magnetic Resonance | 4 CR | Korvink, Mackinnon |

Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
- Knowledge of the principles of actuation and sensing including pros and cons
- Knowledge of the underlying concepts of materials science and technology on different lengths scales
- Explanation of layout and function of important actuators and sensors
- Calculation of important properties (time constants, forces, displacements, sensitivity, etc.)
- Development of a layout based on specifications
Prerequisites
none

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lecture, exercise.
M 10.41 Module: Major Field: Microsystem Technology (SP 33) [M-MACH-102616]

Responsible: Dr. Arndt Last
Organisation: KIT Department of Mechanical Engineering

Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt (p))
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

<table>
<thead>
<tr>
<th>Credits</th>
<th>Recurrence</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Once</td>
<td>German/English</td>
<td>4</td>
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</tr>
</tbody>
</table>

### Mandatory

- **T-MACH-105182** Introduction to Microsystem Technology I 4 CR Badilita, Jouda, Korvink
- **T-MACH-105183** Introduction to Microsystem Technology II 4 CR Jouda, Korvink

### Election block: Mikrosystemtechnik (E) (at most 10 credits)

- **T-MACH-105238** Actuators and Sensors in Nanotechnology 4 CR Kohl
- **T-MACH-102176** Current Topics on BioMEMS 4 CR Guber
- **T-MACH-100966** BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I 4 CR Guber
- **T-MACH-100967** BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II 4 CR Guber
- **T-MACH-100968** BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III 4 CR Guber
- **T-MACH-102172** Bionics for Engineers and Natural Scientists 4 CR Hölscher
- **T-MACH-102166** Fabrication Processes in Microsystem Technology 4 CR Bade
- **T-MACH-105334** Mechanics in Microtechnology 4 CR Greiner, Gruber
- **T-MACH-105557** Microenergy Technologies 4 CR Kohl
- **T-MACH-101910** Microactuators 4 CR Kohl
- **T-MACH-108383** Microsystem Simulation 4 CR Korvink
- **T-MACH-105814** Microsystem product design for young entrepreneurs 6 CR Korvink
- **T-MACH-108613** Miniaturized Heat Exchangers 4 CR Brandner
- **T-MACH-105180** Nanotechnology for Engineers and Natural Scientists 4 CR Dienwiebel, Hölscher, Walheim
- **T-MACH-102152** Novel Actuators and Sensors 4 CR Kohl, Sommer
- **T-MACH-105442** Intellectual Property Rights and Strategies in Industrial Companies 4 CR Albers, Matthiesen, Zacharias
- **T-MACH-102192** Polymers in MEMS A: Chemistry, Synthesis and Applications 4 CR Rapp
- **T-MACH-102191** Polymers in MEMS B: Physics, Microstructuring and Applications 4 CR Worgull
- **T-MACH-102200** Polymers in MEMS C: Biopolymers and Bioplastics 4 CR Rapp, Worgull
- **T-MACH-109122** X-ray Optics 4 CR Last

### Election block: Mikrosystemtechnik (P) (at most 4 credits)

- **T-MACH-108407** NMR micro probe hardware conception and construction 4 CR Korvink
- **T-MACH-105556** Practical Course Polymers in MEMS 2 CR Rapp, Worgull
- **T-MACH-102164** Practical Training in Basics of Microsystem Technology 4 CR Last
- **T-MACH-105782** Micro Magnetic Resonance 4 CR Korvink, MacKinnon
**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**
In this key area, attendees gain competence in the design, construction, production, and application of micro and nano systems. Microsystems comprise the smallest human-made components. These include sensors, actuators, and system components working together for form a more powerful whole. Micro and nano systems are the basis for numerous smart products, such as smart dust, smart buildings, the internet of things, smart consumer-ware, smart mobility, and smart production via industry 4.0 concepts.

The increasing control over morphology at the nano and microscale is enabling the bottom up construction of passive and active materials with ideal and unheard-of properties, embedded in the devices that can make use of these, and are therefore revolutionising the world of products and scientific instrumentation.

**Prerequisites**
none

**Content**
See brick courses.

**Workload**
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**
Lectures, Tutorials
10 MODULES

Module: Major Field: Mobile Machines (SP 34) [M-MACH-102630]

10.42 Module: Major Field: Mobile Machines (SP 34) [M-MACH-102630]

Responsible: Prof. Dr.-Ing. Marcus Geimer
Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
    Specialization / Specialization: Vehicle Technology (Schwerpunkt (p))
    Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
    Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
    Specialization / Specialization: Production Technology (Schwerpunkt)

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

<table>
<thead>
<tr>
<th>Credits</th>
<th>Recurrence</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>Once</td>
<td>German/English</td>
<td>4</td>
<td>1</td>
</tr>
</tbody>
</table>

Mandatory
T-MACH-105168 Mobile Machines 8 CR Geimer

Election block: Mobile Arbeitsmaschinen (E) ()
T-MACH-105307 Drive Train of Mobile Machines 4 CR Geimer, Wydra
T-MACH-105311 Design and Development of Mobile Machines 4 CR Geimer, Siebert
T-MACH-102150 BUS-Controls 4 CR Becker, Geimer
T-MACH-105151 Energy Efficient Intralogistic Systems 4 CR Braun, Schönung
T-MACH-108374 Vehicle Ergonomics 4 CR Heine
T-MACH-105218 Automotive Vision 6 CR Lauer, Stiller
T-MACH-105160 Fundamentals in the Development of Commercial Vehicles I 2 CR Zürn
T-MACH-105161 Fundamentals in the Development of Commercial Vehicles II 2 CR Zürn
T-MACH-102093 Fluid Power Systems 4 CR Geimer, Pult
T-MACH-105441 Development of Oil-Hydraulic Powertrain Systems 4 CR Ays, Geerling
T-MACH-105347 Project Management in Global Product Engineering Structures 4 CR Albers, Gutzmer, Matthiesen
T-MACH-105172 Simulation of Coupled Systems 4 CR Geimer, Xiang
T-MACH-105423 Tractors 4 CR Becker, Geimer, Kremmer
T-MACH-102194 Combustion Engines I 4 CR Koch, Kubach
T-MACH-105367 Behaviour Generation for Vehicles 4 CR Stiller, Werling

Election block: Mobile Arbeitsmaschinen (Ü) ()
T-MACH-108889 BUS-Controls - Advance 0 CR Daiß, Geimer
T-MACH-108888 Simulation of Coupled Systems - Advance 0 CR Geimer, Xiang
T-MACH-108887 Design and Development of Mobile Machines - Advance 0 CR Geimer, Siebert

Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The student

- knows and understands the basic structure of the machines,
- masters the basic skills to develop the selected machines

Prerequisites
None

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Content

- Introduction of the required components and machines
- Basics of the structure of the whole system
- Practical insight in the development techniques

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type

- Research-oriented teaching
- lectures
- exercises
10.43 Module: Major Field: Modeling and Simulation in Dynamics (SP 61) [M-MACH-104434]

**Responsible:** Prof. Dr.-Ing. Wolfgang Seemann  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Production Technology (Schwerpunkt)  
Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt (p))

<table>
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<tr>
<th>Credits</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
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<tbody>
<tr>
<td>16</td>
<td>German/English</td>
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<td>2</td>
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</table>

**Election notes**  
In the core area of each Major Field at least 8 ECTS have to be chosen.

**Election block: Modellbildung und Simulation in der Dynamik (K) (at least 8 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Responsible</th>
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</thead>
<tbody>
<tr>
<td>T-MACH-105209</td>
<td>Introduction into the Multi-Body Dynamics</td>
<td>5</td>
<td>Seemann</td>
</tr>
<tr>
<td>T-MACH-105210</td>
<td>Machine Dynamics</td>
<td>5</td>
<td>Proppe</td>
</tr>
<tr>
<td>T-MACH-105293</td>
<td>Mathematical Methods in Dynamics</td>
<td>6</td>
<td>Proppe</td>
</tr>
<tr>
<td>T-MACH-105226</td>
<td>Dynamics of the Automotive Drive Train</td>
<td>5</td>
<td>Fidlin</td>
</tr>
<tr>
<td>T-MACH-105290</td>
<td>Vibration Theory</td>
<td>5</td>
<td>Fidlin, Seemann</td>
</tr>
</tbody>
</table>

**Election block: Modellbildung und Simulation in der Dynamik (E) (at most 9 credits)**

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-105308</td>
<td>Atomicistic Simulations and Molecular Dynamics</td>
<td>4</td>
<td>Brandl, Gumbsch, Schneider</td>
</tr>
<tr>
<td>T-MACH-105294</td>
<td>Mathematical Methods of Vibration Theory</td>
<td>6</td>
<td>Seemann</td>
</tr>
<tr>
<td>T-MACH-105172</td>
<td>Simulation of Coupled Systems</td>
<td>4</td>
<td>Geimer, Xiang</td>
</tr>
<tr>
<td>T-MACH-105514</td>
<td>Experimental Dynamics</td>
<td>5</td>
<td>Fidlin</td>
</tr>
<tr>
<td>T-MACH-105349</td>
<td>Computational Dynamics</td>
<td>4</td>
<td>Proppe</td>
</tr>
<tr>
<td>T-MACH-105384</td>
<td>Computerized Multibody Dynamics</td>
<td>4</td>
<td>Seemann</td>
</tr>
<tr>
<td>T-MACH-105224</td>
<td>Machine Dynamics II</td>
<td>4</td>
<td>Proppe</td>
</tr>
<tr>
<td>T-MACH-105350</td>
<td>Computational Vehicle Dynamics</td>
<td>4</td>
<td>Proppe</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
Oral exams: duration approx. 5 minutes per credit point.  
Amount, type and scope of the success control can vary according to individual choice.

**Competence Goal**  
The module provides modeling competences and continues thus the compulsory courses in dynamics. To this end analytical methods for the modeling and examination of dynamical systems are presented. The simulation of the systems enables the students to do simulation studies in typical applications in dynamical systems of mechanical engineering to be able to evaluate and interpret the results.

**Prerequisites**  
none

**Content**  
See brick courses.
**Workload**
The work load is about 480 hours, corresponding to 16 credit points. 1 LP = 30 working hours.

**Learning type**
Lectures, Tutorials
Module: Major Field: Modeling and Simulation in Energy- and Fluid Engineering (SP 27) [M-MACH-102612]

**Responsible:** Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

**Credits:** 16

**Recurrence:** Once

**Language:** German/English

**Level:** 4

**Version:** 1

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

### Election block: Modellierung und Simulation in der Energie- und Strömungstechnik (K) (at least 8 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course</th>
<th>CR</th>
<th>Lecturer(s)</th>
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<tbody>
<tr>
<td>T-MACH-105396</td>
<td>Modeling of Thermodynamical Processes</td>
<td>6 CR</td>
<td>Maas, Schießl</td>
</tr>
<tr>
<td>T-MACH-105339</td>
<td>Numerical Simulation of Reacting Two Phase Flows</td>
<td>4 CR</td>
<td>Koch</td>
</tr>
<tr>
<td>T-MACH-105338</td>
<td>Numerical Fluid Mechanics</td>
<td>4 CR</td>
<td>Magagnato</td>
</tr>
</tbody>
</table>

### Election block: Modellierung und Simulation in der Energie- und Strömungstechnik (E) (at most 8 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course</th>
<th>CR</th>
<th>Lecturer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-105407</td>
<td>CFD in Power Engineering</td>
<td>4 CR</td>
<td>Otic</td>
</tr>
<tr>
<td>T-MACH-105533</td>
<td>Gasdynamics</td>
<td>4 CR</td>
<td>Magagnato</td>
</tr>
<tr>
<td>T-MACH-105419</td>
<td>Mathematical Models and Methods in Combustion Theory</td>
<td>4 CR</td>
<td>Bykov, Maas</td>
</tr>
<tr>
<td>T-MACH-105167</td>
<td>Analysis Tools for Combustion Diagnostics</td>
<td>4 CR</td>
<td>Pfeil</td>
</tr>
<tr>
<td>T-MACH-105420</td>
<td>Numerical Simulation of Multi-Phase Flows</td>
<td>4 CR</td>
<td>Wörner</td>
</tr>
<tr>
<td>T-MACH-105397</td>
<td>Numerical Simulation of Turbulent Flows</td>
<td>4 CR</td>
<td>Grötzbach</td>
</tr>
<tr>
<td>T-MACH-105421</td>
<td>Reduction Methods for the Modeling and the Simulation of Vombustion Processes</td>
<td>4 CR</td>
<td>Bykov, Maas</td>
</tr>
<tr>
<td>T-MACH-105422</td>
<td>Flows with Chemical Reactions</td>
<td>4 CR</td>
<td>Class</td>
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<tr>
<td>T-MACH-105403</td>
<td>Flows and Heat Transfer in Energy Technology</td>
<td>4 CR</td>
<td>Cheng</td>
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<tr>
<td>T-MACH-105456</td>
<td>Ten Lectures on Turbulence</td>
<td>4 CR</td>
<td>Otic</td>
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<tr>
<td>T-MACH-106372</td>
<td>Thermal-Fluid-Dynamics</td>
<td>4 CR</td>
<td>Ruck</td>
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<tr>
<td>T-MACH-102149</td>
<td>Virtual Reality Practical Course</td>
<td>4 CR</td>
<td>Ovtcharova</td>
</tr>
</tbody>
</table>

**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**
After completing the students can:
- formulate the governing equations for specific systems in energy and fluid mechanics.
- explain the different numerical schemes applied to solve the system of equations.
- use frequently applied simulation tools in a more efficient and successful way.

**Prerequisites**
None

**Content**
See brick courses.

**Workload**
The work load is about 480 hours, corresponding to 16 credit points.
Learning type
Lectures, Tutorials
**Module: Major Field: Nuclear Energy (SP 21) [M-MACH-102608]**

**Responsible:** Prof. Dr.-Ing. Xu Cheng

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

**Credits:** 16  
**Recurrence:** Once  
**Language:** German/English  
**Level:** 4  
**Version:** 2

### Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

#### Election block: Kerntechnik (K) (at least 8 credits)

<table>
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<tr>
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<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>T-MACH-105525</td>
<td>Introduction to Nuclear Energy</td>
<td>4 CR</td>
<td>Cheng</td>
</tr>
<tr>
<td>T-MACH-105402</td>
<td>Nuclear Power Plant Technology</td>
<td>4 CR</td>
<td>Badea, Cheng, Schulenberg</td>
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</tbody>
</table>

#### Election block: Kerntechnik (E) (at most 8 credits)

<table>
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<th>Course Title</th>
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<tr>
<td>T-MACH-105310</td>
<td>Design of Highly Stresses Components</td>
<td>4 CR</td>
<td>Aktaa</td>
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<tr>
<td>T-MACH-105407</td>
<td>CFD in Power Engineering</td>
<td>4 CR</td>
<td>Otic</td>
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<td>T-MACH-105530</td>
<td>Fundamentals of reactor safety for the operation and dismantling of nuclear power plants</td>
<td>4 CR</td>
<td>Sanchez-Espinoza</td>
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<tr>
<td>T-MACH-105550</td>
<td>Energy systems II: Reactor Physics</td>
<td>4 CR</td>
<td>Badea</td>
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<tr>
<td>T-MACH-105404</td>
<td>Innovative Nuclear Systems</td>
<td>4 CR</td>
<td>Cheng</td>
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<tr>
<td>T-MACH-105466</td>
<td>Introduction to Neutron Cross Section Theory and Nuclear Data Generation</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105405</td>
<td>Reactor Safety I: Fundamentals</td>
<td>4 CR</td>
<td>Sanchez-Espinoza</td>
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<tr>
<td>T-MACH-105403</td>
<td>Flows and Heat Transfer in Energy Technology</td>
<td>4 CR</td>
<td>Cheng</td>
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<td>T-MACH-105456</td>
<td>Ten Lectures on Turbulence</td>
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<td>T-MACH-105406</td>
<td>Two-Phase Flow and Heat Transfer</td>
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<td>Schulenberg, Wörner</td>
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<td>Nuclear Fusion Technology</td>
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<td>Badea</td>
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<tr>
<td>T-MACH-110332</td>
<td>Nuclear Power and Reactor Technology</td>
<td>4 CR</td>
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**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**
Students acquire the basic and advanced knowledge of nuclear technology and are able to apply the assimilated knowledge in practice and to analyze and solve by themselves important questions in the nuclear energy field.

The courses of this module are built on three levels. With the overview lecture "Introduction into Nuclear Power", the students acquire broad basic knowledge of nuclear energy and are able to further study in-depth courses in various disciplines, namely thermal-hydraulics, reactor physics and materials science. As a result, students will understand the important processes of nuclear technology, such as control, heat transport and material behavior in a nuclear reactor. The properties of various nuclear systems, especially nuclear power plants, are available for study on the third level of the lectures. The students will possess then the ability to compare and analyze different nuclear systems.

**Prerequisites**
None

**Content**
See brick courses.
**Workload**
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**
Lectures, Tutorials
Responsibility: Prof. Dr.-Ing. Peter Elsner
Organization: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
Specialization / Specialization: Vehicle Technology (Schwerpunkt)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
Specialization / Specialization: Production Technology (Schwerpunkt)
Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

Credits 16
Recurrence Once
Language German/English
Level 4
Version 1

Election notes
In the core area of each Major Field at least 8 ECTS have to be chosen.

Election block: Polymerengineering (K) (at least 8 credits)
T-MACH-102137 Polymer Engineering I  4 CR  Elsner
T-MACH-102138 Polymer Engineering II  4 CR  Elsner

Election block: Polymerengineering (E) (at most 8 credits)
T-MACH-105237 Vehicle Lightweight Design - Strategies, Concepts, Materials  4 CR  Henning
T-MACH-105535 Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies  4 CR  Henning
T-MACH-105330 Design with Plastics  4 CR  Liedel
T-MACH-105333 Mechanics and Strength of Polymers  4 CR  von Bernstorff
T-MACH-105971 Simulation of the process chain of continuously fiber reinforced composite structure  4 CR  Kärger
T-MACH-105970 Structural Analysis of Composite Laminates  4 CR  Kärger

Competence Certificate
Oral exams: duration approx. 5 min. per credit point.
However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The students...

- are able to choose polymers for applications in mechanical engineering in target-oriented way and are able to justify their selection.
- are able to describe and compare production processes for polymers and PMCs exemplarily.
- are able to describe the mechanical behaviour of polymers and PMC based on scientific theories, principles and methods.
- are able to solve tasks in the field of polymer engineering and proceed adequate to the situation.
- are able to integrate intra-modular knowledge at the solution of given problems.
- have the ability to develop polymer parts in a constructive way under consideration of technical and economic conditions.

Prerequisites
None

Content
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, that the students gather knowledge and technical skills to use the material “polymer” meeting its requirements in an economical and ecological way.

Workload
The work load is about 480 hours, corresponding to 16 credit points.
Learning type
Lectures, Tutorials
## 10.47 Module: Major Field: Power Plant Technology (SP 23) [M-MACH-102610]

### Responsible:
Prof. Dr.-Ing. Hans-Jörg Bauer

### Organisation:
KIT Department of Mechanical Engineering

### Part of:
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

### Credits
16

### Recurrence
Once

### Language
German/English

### Level
4

### Version
2

### Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

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<tr>
<td>T-MACH-105410 Coal Fired Power Plants 4 CR</td>
<td>Schulenberg</td>
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<tr>
<td>T-MACH-105444 Combined Cycle Power Plants 4 CR</td>
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<tr>
<td>T-MACH-105326 Hydraulic Fluid Machinery 8 CR</td>
<td>Pritz</td>
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<tr>
<td>T-MACH-105402 Nuclear Power Plant Technology 4 CR</td>
<td>Badea, Cheng, Schulenberg</td>
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<tr>
<td>T-MACH-105363 Thermal Turbomachines I 6 CR</td>
<td>Bauer</td>
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<td>T-MACH-105364 Thermal Turbomachines II 6 CR</td>
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<td>T-MACH-105310 Design of Highly Stresses Components 4 CR</td>
<td>Aktaa</td>
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<td>T-MACH-105525 Introduction to Nuclear Energy 4 CR</td>
<td>Cheng</td>
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<td>T-MACH-105952 Energy Storage and Network Integration 4 CR</td>
<td>Jäger, Stieglitz</td>
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<td>T-MACH-105411 Fusion Technology A 4 CR</td>
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<td>T-MACH-105213 Fundamentals of Combustion I 4 CR</td>
<td>Maas, Sommerer</td>
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<td>T-MACH-105386 Occupational Safety and Environmental Protection 4 CR</td>
<td>von Kiparski</td>
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<td>T-MACH-105404 Innovative Nuclear Systems 4 CR</td>
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<td>T-MACH-105414 Cooling of Thermally High Loaded Gas Turbine Components 4 CR</td>
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<td>T-MACH-105338 Numerical Fluid Mechanics 4 CR</td>
<td>Magagnato</td>
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<td>T-MACH-105442 Intellectual Property Rights and Strategies in Industrial Companies 4 CR</td>
<td>Albers, Matthiesen, Zacharias</td>
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<td>T-MACH-105347 Project Management in Global Product Engineering Structures 4 CR</td>
<td>Albers, Gutzmer, Matthiesen</td>
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<td>T-MACH-107447 Reliability Engineering 1 3 CR</td>
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<td>T-MACH-105354 Fatigue of Metallic Materials 4 CR</td>
<td>Guth, Lang</td>
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<td>T-MACH-105445 Simulator Exercises Combined Cycle Power Plants 2 CR</td>
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<td>T-MACH-105225 Thermal Solar Energy 4 CR</td>
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<td>T-MACH-106372 Thermal-Fluid-Dynamics 4 CR</td>
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<td>T-MACH-105365 Turbine and Compressor Design 4 CR</td>
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<td>T-MACH-105416 Hydrogen Technologies 4 CR</td>
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<td>T-MACH-105234 Windpower 4 CR</td>
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<td>T-MACH-105406 Two-Phase Flow and Heat Transfer 4 CR</td>
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<td>T-MACH-105515 Introduction to Numerical Fluid Dynamics 4 CR</td>
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<td>T-MACH-105331 Laboratory Exercise in Energy Technology 4 CR</td>
<td>Bauer, Maas, Wirbser</td>
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<tr>
<td>T-MACH-106707 Workshop on computer-based flow measurement techniques 4 CR</td>
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**Competence Certificate**
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**
After completion of SP 23 students are able:

- to name the different types of centralized and distributed power plants,
- to explain the operational principle of well-established power plants as well as of power plants based on renewable energies,
- to predict the electric, respectively thermal efficiency of power plants,
- to assess the economics of power plants,
- to highlight the environmental impact of conventional power plants and of renewable energies,
- to assess the availability, operational safety and flexibility of different types of power plants,
- to develop advanced power plants based on thermodynamic, fluid mechanical and other basics.

**Prerequisites**
None

**Content**
See brick courses.

**Workload**
The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**
Lectures, tutorials.
## 10.48 Module: Major Field: Powertrain Systems (SP 02) [M-MACH-102599]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
Specialization / Specialization: Production Technology (Schwerpunkt)

### Credits  
16  

### Recurrence  
Once

### Language  
German/English

### Level  
4

### Version  
2

**Election notes**  
In the core area of each Major Field at least 8 ECTS have to be chosen.

#### Election block: Antriebssysteme (K) (at least 8 credits)

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<th>Course Title</th>
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#### Election block: Antriebssysteme (E) (at most 8 credits)

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<td>Albers, Matthiesen, Zacharias</td>
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<td>Strategic product development - identification of potentials of innovative products - Case Study</td>
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<td>Combustion Engines I</td>
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<td>Failure of Structural Materials: Deformation and Fracture</td>
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Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The students know and understand the technical and physical basics and systematic connections of drive systems. The lecture deals vehicle drive systems as well as drive systems for stationary and mobile work machines. They are able to choose, describe and use complex dimensioning- and design methods for drive systems under consideration of the interactions of the system.

Prerequisites
none

Content
See brick courses

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
**10.49 Module: Major Field: Production Technology (SP 39) [M-MACH-102618]**

**Responsible:** Prof. Dr.-Ing. Volker Schulze  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
- Specialization / Specialization: Production Technology (Schwerpunkt (p))

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**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

**Election block: Produktionstechnik (K) (at least 8 credits)**

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<td>T-MACH-108844</td>
<td>Automated Manufacturing Systems</td>
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<td>T-MACH-102105</td>
<td>Manufacturing Technology</td>
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<td>Schulze, Zanger</td>
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<td>T-MACH-110337</td>
<td>Global Production and Logistics</td>
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<td>T-MACH-108849</td>
<td>Integrated Production Planning in the Age of Industry 4.0</td>
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<td>T-MACH-109055</td>
<td>Machine Tools and Industrial Handling</td>
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**Election block: Produktionstechnik (E) (at most 8 credits)**

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<td>Digitalization from Production to the Customer in the Optical Industry</td>
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<td>T-MACH-102159</td>
<td>Elements and Systems of Technical Logistics</td>
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<td>T-MACH-108946</td>
<td>Elements and Systems of Technical Logistics - Project</td>
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<td>Energy Efficient Intralogistic Systems</td>
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<td>T-MACH-105157</td>
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<td>T-MACH-105158</td>
<td>Global Production and Logistics - Part 1: Global Production</td>
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<td>Global Production and Logistics - Part 2: Global Logistics</td>
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<td>T-MACH-102163</td>
<td>Basics of Technical Logistics</td>
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<td>T-MACH-106374</td>
<td>Human-oriented Productivity Management: Personnel Management</td>
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<td>T-MACH-105388</td>
<td>Introduction to Industrial Production Economics</td>
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<td>T-MACH-105188</td>
<td>Integrative Strategies in Production and Development of High Performance Cars</td>
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<td>T-MACH-110334</td>
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<td>T-MACH-105174</td>
<td>Warehousing and Distribution Systems</td>
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<td>T-MACH-105783</td>
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<td>T-MACH-105189</td>
<td>Mathematical Models and Methods for Production Systems</td>
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<td>Planning of Assembly Systems</td>
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<td>PLM in the Manufacturing Industry</td>
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<td>T-MACH-110318</td>
<td>Product- and Production-Concepts for modern Automobiles</td>
<td>4</td>
<td>Kienzle, Steegmüller</td>
</tr>
<tr>
<td>T-MACH-105470</td>
<td>Production Planning and Control</td>
<td>4</td>
<td>Rinn</td>
</tr>
<tr>
<td>T-MACH-105523</td>
<td>Productivity Management in Production Systems</td>
<td>4</td>
<td>Stowasser</td>
</tr>
</tbody>
</table>
### Competence Certificate

Oral exams: duration approx. 5 min per credit point

Written exams: duration approx. 20 - 25 min per credit point

Amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

The students ...  

- are able to analyze new situations and choose methods of production science target-oriented based on the analyses, as well as justifying their selection.
- are able to describe and compare complex production processes exemplarily.
- are able to generate new solutions in the field of production science under consideration of scientific theories, principles and methods.
- are able to solve tasks in the field of production science team oriented and proceed responsible and adequate to the situation.
- are able to integrate the results of others at the solution of given problems.
- have the ability to state results in written form developed in a team, and are able to interpret and present them with self-chosen methods.
- are able to identify, dissect and develop further systems and processes and apply given sets of criteria under consideration of technical, economic and social conditions.

### Prerequisites

None

### Content

Within this module the students will get to know and learn about production science. Manifold lectures and excursions as part of several lectures provide specific insights into the field of production science.

### Workload

The work load is about 480 hours, corresponding to 16 credit points.

### Learning type

Lectures, seminars, workshops, excursions
**Module: Major Field: Rail System Technology (SP 50) [M-MACH-102641]**

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt (p))  
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

### Mandatory

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Responsible</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-106424</td>
<td>Rail System Technology</td>
<td>4 CR</td>
<td>Gratzfeld</td>
</tr>
<tr>
<td>T-MACH-105353</td>
<td>Rail Vehicle Technology</td>
<td>4 CR</td>
<td>Gratzfeld</td>
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</table>

### Election block: Bahnsystemtechnik (E) (at most 10 credits)

<table>
<thead>
<tr>
<th>Code</th>
<th>Course Title</th>
<th>Credits</th>
<th>Responsible</th>
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<tbody>
<tr>
<td>T-MACH-105540</td>
<td>Railways in the Transportation Market</td>
<td>4 CR</td>
<td>Gratzfeld</td>
</tr>
<tr>
<td>T-MACH-102121</td>
<td>Electric Rail Vehicles</td>
<td>4 CR</td>
<td>Gratzfeld</td>
</tr>
<tr>
<td>T-MACH-105237</td>
<td>Vehicle Lightweight Design - Strategies, Concepts, Materials</td>
<td>4 CR</td>
<td>Henning</td>
</tr>
<tr>
<td>T-MACH-105218</td>
<td>Automotive Vision</td>
<td>6 CR</td>
<td>Lauer, Stiller</td>
</tr>
<tr>
<td>T-MACH-105535</td>
<td>Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies</td>
<td>4 CR</td>
<td>Henning</td>
</tr>
<tr>
<td>T-MACH-104599</td>
<td>Project Management in Rail Industry</td>
<td>4 CR</td>
<td>Gratzfeld</td>
</tr>
<tr>
<td>T-MACH-105350</td>
<td>Computational Vehicle Dynamics</td>
<td>4 CR</td>
<td>Proppe</td>
</tr>
<tr>
<td>T-MACH-108692</td>
<td>Seminar for Rail System Technology</td>
<td>3 CR</td>
<td>Gratzfeld</td>
</tr>
</tbody>
</table>

### Competence Certificate

Oral exams: duration approx. 5 min. per credit point.  
However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

- The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.  
- Based on operating requirements and legal framework they derive the requirements concerning a capable infrastructure and suitable concepts of rail vehicles.  
- They recognize the impact of alignment, understand the important function of the wheel-rail-contact and estimate the impact of driving dynamics on the operating program.  
- They evaluate the impact of operating concepts on safety and capacity of a rail system.  
- They know the infrastructure to provide power supply to rail vehicles with different drive systems.  
- The students learn the role of rail vehicles and understand their classification. They understand the basic structure and know the functions of the main systems. They understand the overall tasks of vehicle system technology. They learn functions and requirements of car bodies and judge advantages and disadvantages of design principles. They know the functions of the car body's interfaces.  
- They know about the basics of running dynamics and bogies.  
- The students learn about advantages and disadvantages of different types of traction drives and judge, which one fits best for each application.  
- They understand brakes from a vehicular and an operational point of view. They assess the fitness of different brake systems.  
- They know the basic setup of train control management system and understand the most important functions.  
- They specify and define suitable vehicle concepts based on requirements for modern rail vehicles.  
- Supplementary lectures present further major aspects of a rail system.
Prerequisites
None

Content
1. Railway System: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
3. Infrastructure: rail facilities, track alignment, railway stations, clearance diagram
4. Wheel-rail-contact: carrying of vehicle mass, adhesion, wheel guidance, current return
5. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles
6. Signaling and Control: operating procedure, succession of trains, European Train Control System, blocking period, automatic train control
7. Traction power supply: power supply of rail vehicles, power networks, filling stations
8. Vehicle system technology: structure and main systems of rail vehicles
9. Car body: functions, requirements, design principles, crash elements, interfaces
10. Bogies: forces, running gears, axle configuration
11. Drives: vehicle with/without contact wire, dual-mode vehicle
12. Brakes: tasks, basics, principles, blending, brake control
13. Train control management system: definitions, networks, bus systems, components, examples
15. History (optional)
16. Further contents in supplementary lectures

Annotation
A bibliography is available for download (Ilias-platform).

Workload
- Total effort at 16 ECTS (M.Sc.): about 480 hours
- Regular attendance: 84 hours
- Self-study: 84 hours
- Exam and preparation: 312 hours

Learning type
Lectures in the core part.
Lectures and seminars are offered in the supplementary part.
### 10.51 Module: Major Field: Reliability in Mechanical Engineering (SP 49) [M-MACH-102602]

**Responsible:** Prof. Dr. Peter Gumbsch  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)
- Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt (p))

**Credits** 16  
**Recurrence** Once  
**Language** German/English  
**Level** 4  
**Version** 2

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

<table>
<thead>
<tr>
<th>Mandatory</th>
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<tbody>
<tr>
<td>T-MACH-102139</td>
<td>Failure of Structural Materials: Fatigue and Creep</td>
<td>4 CR</td>
<td>Gruber, Gumbsch</td>
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<tr>
<td>T-MACH-102140</td>
<td>Failure of Structural Materials: Deformation and Fracture</td>
<td>4 CR</td>
<td>Gumbsch, Weygand</td>
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</tbody>
</table>

| Election block: Zuverlässigkeit im Maschinenbau (E) () |
|---|---|---|---|---|
| T-MACH-105390 | Application of Advanced Programming Languages in Mechanical Engineering | 4 CR | Weygand |
| T-MACH-105308 | Atomistic Simulations and Molecular Dynamics | 4 CR | Brandl, Gumbsch, Schneider |
| T-MACH-105310 | Design of Highly Stresses Components | 4 CR | Aktaa |
| T-MACH-105320 | Introduction to the Finite Element Method | 4 CR | Böhlke, Langhoff |
| T-MACH-105321 | Introduction to Theory of Materials | 4 CR | Kamlah |
| T-MACH-105984 | Fatigue of Welded Components and Structures | 3 CR | Farajian, Gumbsch |
| T-MACH-105324 | Foundations of Nonlinear Continuum Mechanics | 4 CR | Kamlah |
| T-MACH-105221 | Lightweight Engineering Design | 4 CR | Albers, Burkardt |
| T-MACH-105334 | Mechanics in Microtechnology | 4 CR | Greiner, Gruber |
| T-MACH-105303 | Modelling of Microstructures | 5 CR | August, Nestler |
| T-MACH-105516 | Multi-Scale Plasticity | 4 CR | Greiner, Schulz |
| T-MACH-102107 | Quality Management | 4 CR | Lanza |
| T-MACH-105724 | Failure Analysis | 4 CR | Greiner, Schneider |
| T-MACH-105354 | Fatigue of Metallic Materials | 4 CR | Guth, Lang |
| T-MACH-105171 | Safety Engineering | 4 CR | Kany |
| T-MACH-105369 | Materials Modelling: Dislocation Based Plasticity | 4 CR | Weygand |
| T-MACH-100532 | Scientific Computing for Engineers | 5 CR | Gumbsch, Weygand |
| T-MACH-110375 | Mathematical Methods in Continuum Mechanics | 4 CR | Böhlke |
| T-MACH-110377 | Advanced Methods in Strength of Materials | 4 CR | Böhlke, Frohnapfel |
| T-MACH-110378 | Mathematical Methods in Micromechanics | 5 CR | Böhlke |

**Election block: Zuverlässigkeit im Maschinenbau (P) (at most 4 credits)**

| T-MACH-105392 | FEM Workshop - Constitutive Laws | 4 CR | Schulz, Weygand |
| T-MACH-105417 | Finite Element Workshop | 4 CR | Mattheck, Weygand |

**Election block: Zuverlässigkeit im Maschinenbau (Ü) ()**

| T-MACH-109304 | Excercises - Fatigue of Welded Components and Structures | 1 CR | Farajian, Gumbsch |
Competence Certificate
Oral exams: duration approx. 5 min. per credit point.
However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
After attending the core subjects “failure of structural materials: fatigue and creep” (T-MACH-102139) and “failure of structural materials: deformation and fracture” (T-MACH-102140) the students will gain the following skills:

- They have the basic understanding of mechanical processes to explain the relationship between externally applied load and materials strength.
- They can explain the foundation of linear elastic fracture mechanics and is able to determine if this concept can be applied to a failure by fracture.
- They can describe the main empirical materials models for fatigue and creep as well as for deformation and fracture and can apply them.
- They have the physical understanding to describe and explain phenomena of failure.
- They can use statistical approaches for reliability predictions.
- They can use its acquired skills, to select and develop materials for specific applications.

The additional learning outcomes depend on which further lectures are selected and are explicitly described there.

Prerequisites
None

Content
In addition to the core subjects “failure of structural materials: fatigue and creep” (T-MACH-102139) and “failure of structural materials: deformation and fracture” (T-MACH-102140), the student has to choose two more lectures, which deal with specific problems of reliability of components and systems in mechanical engineering.

For detailed information see the description of the different courses of the module.

Recommendation
preliminary knowledge in mathematics, mechanics and materials science

Annotation
The module Reliability in Mechanical Engineering consists of 16 credit points in the master’s program. Within that module, the students have to pass bricks T-MACH-105531 and T-MACH-109303 from the core area (8 credit points) and can select from a broad variation of courses within the supplementary area.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
In the core area of the major field Materials Science and Engineering the students have to pass bricks T-MACH-102139 and T-MACH-102140 (obligatory).

Within the supplementary area students can choose not only lectures and tutorials but also lab courses and seminars.
10.52 Module: Major Field: Robotics (SP 40) [M-MACH-102633]

**Responsible:** Prof. Dr. Ralf Mikut

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt (p))
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

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<thead>
<tr>
<th>Credits</th>
<th>Recurrence</th>
<th>Language</th>
<th>Level</th>
<th>Version</th>
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<tr>
<td>16</td>
<td>Once</td>
<td>German/English</td>
<td>4</td>
<td>2</td>
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</table>

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

### Election block: Robotik (K) (at least 8 credits)

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Credits</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-105314</td>
<td>Computational Intelligence</td>
<td>4 CR</td>
<td>Jakob, Mikut, Reischl</td>
</tr>
<tr>
<td>T-MACH-105694</td>
<td>Data Analytics for Engineers</td>
<td>5 CR</td>
<td>Ludwig, Mikut, Reischl</td>
</tr>
<tr>
<td>T-MACH-100535</td>
<td>Introduction into Mechatronics</td>
<td>6 CR</td>
<td>Böhland, Lorch, Reischl</td>
</tr>
<tr>
<td>T-MACH-105218</td>
<td>Automotive Vision</td>
<td>6 CR</td>
<td>Lauer, Stiller</td>
</tr>
<tr>
<td>T-INFO-108014</td>
<td>Robotics I - Introduction to Robotics</td>
<td>6 CR</td>
<td>Asfour</td>
</tr>
<tr>
<td>T-INFO-105723</td>
<td>Robotics II: Humanoid Robotics</td>
<td>3 CR</td>
<td>Asfour</td>
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<tr>
<td>T-MACH-105367</td>
<td>Behaviour Generation for Vehicles</td>
<td>4 CR</td>
<td>Stiller, Werling</td>
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</table>

### Election block: Robotik (E) (at most 8 credits)

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Credits</th>
<th>Lecturers</th>
</tr>
</thead>
<tbody>
<tr>
<td>T-MACH-105216</td>
<td>Powertrain Systems Technology B: Stationary Machinery</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ott</td>
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<tr>
<td>T-MACH-108844</td>
<td>Automated Manufacturing Systems</td>
<td>8 CR</td>
<td>Fleischer</td>
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<tr>
<td>T-MACH-105317</td>
<td>Digital Control</td>
<td>4 CR</td>
<td>Knoop</td>
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<tr>
<td>T-MACH-105378</td>
<td>Cognitive Automobiles - Laboratory</td>
<td>6 CR</td>
<td>Kitt, Lauer, Stiller</td>
</tr>
<tr>
<td>T-MACH-105221</td>
<td>Lightweight Engineering Design</td>
<td>4 CR</td>
<td>Albers, Burkardt</td>
</tr>
<tr>
<td>T-INFO-101377</td>
<td>Localization of Mobile Agents</td>
<td>6 CR</td>
<td>Hanebeck</td>
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<tr>
<td>T-MACH-105223</td>
<td>Machine Vision</td>
<td>8 CR</td>
<td>Lauer, Stiller</td>
</tr>
<tr>
<td>T-MACH-105189</td>
<td>Mathematical Models and Methods for Production Systems</td>
<td>6 CR</td>
<td>Baumann, Furmans</td>
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<tr>
<td>T-MACH-105335</td>
<td>Measurement II</td>
<td>4 CR</td>
<td>Stiller</td>
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<tr>
<td>T-MACH-108809</td>
<td>Micro- and nanosystem integration for medical, fluidic and optical applications</td>
<td>4 CR</td>
<td>Gengenbach, Hagenmeyer, Koker, Sieber</td>
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<tr>
<td>T-MACH-105539</td>
<td>Modern Control Concepts I</td>
<td>4 CR</td>
<td>Groell, Matthies</td>
</tr>
<tr>
<td>T-MACH-102152</td>
<td>Novel Actuators and Sensors</td>
<td>4 CR</td>
<td>Kohl, Sommer</td>
</tr>
<tr>
<td>T-MACH-105442</td>
<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Zacharias</td>
</tr>
<tr>
<td>T-MACH-105384</td>
<td>Computerized Multibody Dynamics</td>
<td>4 CR</td>
<td>Seemann</td>
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<tr>
<td>T-INFO-101352</td>
<td>Robotics III - Sensors in Robotics</td>
<td>3 CR</td>
<td>Asfour</td>
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<tr>
<td>T-MACH-105185</td>
<td>Control Technology</td>
<td>4 CR</td>
<td>Gönnheimer</td>
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<tr>
<td>T-MACH-105358</td>
<td>Sustainable Product Engineering</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ziegahn</td>
</tr>
<tr>
<td>T-MACH-105555</td>
<td>System Integration in Micro- and Nanotechnology</td>
<td>4 CR</td>
<td>Gengenbach</td>
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<tr>
<td>T-MACH-105360</td>
<td>Computer Engineering</td>
<td>6 CR</td>
<td>Keller, Lorch</td>
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</table>

### Election block: Robotik (P) (at most 4 credits)

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Module Name</th>
<th>Credits</th>
<th>Lecturers</th>
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<tbody>
<tr>
<td>T-MACH-105539</td>
<td>Modern Control Concepts I</td>
<td>4 CR</td>
<td>Groell, Matthies</td>
</tr>
<tr>
<td>T-MACH-102152</td>
<td>Novel Actuators and Sensors</td>
<td>4 CR</td>
<td>Kohl, Sommer</td>
</tr>
<tr>
<td>T-MACH-105442</td>
<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Zacharias</td>
</tr>
<tr>
<td>T-MACH-105384</td>
<td>Computerized Multibody Dynamics</td>
<td>4 CR</td>
<td>Seemann</td>
</tr>
<tr>
<td>T-INFO-101352</td>
<td>Robotics III - Sensors in Robotics</td>
<td>3 CR</td>
<td>Asfour</td>
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<tr>
<td>T-MACH-105185</td>
<td>Control Technology</td>
<td>4 CR</td>
<td>Gönnheimer</td>
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<tr>
<td>T-MACH-105358</td>
<td>Sustainable Product Engineering</td>
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<td>Albers, Matthiesen, Ziegahn</td>
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<td>System Integration in Micro- and Nanotechnology</td>
<td>4 CR</td>
<td>Gengenbach</td>
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<tr>
<td>T-MACH-105360</td>
<td>Computer Engineering</td>
<td>6 CR</td>
<td>Keller, Lorch</td>
</tr>
</tbody>
</table>
### Competence Certificate

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

### Competence Goal

The Robotics offers extensive knowledge to develop, design and manufacture future intelligent robots. The following scientific disciplines are covered during the major Robotics:

- Control systems and control theory
- Actuators and sensors
- Mathematical and descriptive methods

The students of the major Robotics have the essential skills necessary to develop future robotic systems for modern applications.

### Prerequisites

None

### Content

See brick courses.

### Workload

The work load is about 480 hours, corresponding to 16 credit points.

### Learning type

Lecture, tutorial.
10.53 Module: Major Field: Technical Ceramics and Powder Materials (SP 43) [M-MACH-102619]

Responsibility: Prof. Dr. Michael Hoffmann

Organisation: KIT Department of Mechanical Engineering

Part of: Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
Specialization / Specialization: Vehicle Technology (Schwerpunkt)
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

Credits: 16
Recurrence: Once
Language: German/English
Level: 4
Version: 1

Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

Election block: Technische Keramik und Pulverwerkstoffe (K) (at least 8 credits)

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Course Title</th>
<th>CR</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>T-MACH-102111</td>
<td>Principles of Ceramic and Powder Metallurgy Processing</td>
<td>4</td>
<td>Schell</td>
</tr>
<tr>
<td>T-MACH-100287</td>
<td>Introduction to Ceramics</td>
<td>6</td>
<td>Hoffmann</td>
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<tr>
<td>T-MACH-106722</td>
<td>Ceramic Matrix Composites</td>
<td>4</td>
<td>Koch</td>
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<tr>
<td>T-MACH-102179</td>
<td>Structural Ceramics</td>
<td>4</td>
<td>Hoffmann</td>
</tr>
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</table>

Election block: Technische Keramik und Pulverwerkstoffe (E) (at most 8 credits)

<table>
<thead>
<tr>
<th>Module Code</th>
<th>Course Title</th>
<th>CR</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>T-MACH-106723</td>
<td>Bionic Inspired Reinforced Composites</td>
<td>4</td>
<td>Koch</td>
</tr>
<tr>
<td>T-MACH-102182</td>
<td>Ceramic Processing Technology</td>
<td>4</td>
<td>Binder</td>
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<td>T-MACH-102157</td>
<td>High Performance Powder Metallurgy Materials</td>
<td>4</td>
<td>Schell</td>
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<tr>
<td>T-MACH-102170</td>
<td>Structural and Phase Analysis</td>
<td>4</td>
<td>Wagner</td>
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<tr>
<td>T-MACH-102140</td>
<td>Failure of Structural Materials: Deformation and Fracture</td>
<td>4</td>
<td>Gumbsch, Weygand</td>
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</table>

Election block: Technische Keramik und Pulverwerkstoffe (P) (at most 4 credits)

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<tr>
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<td>T-MACH-105178</td>
<td>Practical Course Technical Ceramics</td>
<td>1</td>
<td>Schell</td>
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</table>

Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The students acquire comprehensive and fundamental knowledge of preparation, processing and characterization of technical powders, their consolidation by various shaping techniques and the densification by sintering. They know the manifold possibilities of microstructural design of powdermetallurgical parts and are able to discuss the microstructure property relationships.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
**10.54 Module: Major Field: Technical Logistics (SP 44) [M-MACH-102640]**

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)

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**Mandatory**

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<tbody>
<tr>
<td>T-MACH-109919</td>
<td>Basics of Technical Logistics I</td>
<td>4 CR</td>
<td>Mittwollen, Oellerich</td>
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<tr>
<td>T-MACH-109920</td>
<td>Basics of Technical Logistics II</td>
<td>5 CR</td>
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**Election block: Technische Logistik (E) (at least 7 credits)**

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<td>T-MACH-102160</td>
<td>Selected Applications of Technical Logistics</td>
<td>4 CR</td>
<td>Milushev, Mittwollen</td>
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<tr>
<td>T-MACH-108945</td>
<td>Selected Applications of Technical Logistics - Project</td>
<td>2 CR</td>
<td>Milushev, Mittwollen</td>
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<tr>
<td>T-MACH-108844</td>
<td>Automated Manufacturing Systems</td>
<td>8 CR</td>
<td>Fleischer</td>
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<tr>
<td>T-MACH-102159</td>
<td>Elements and Systems of Technical Logistics</td>
<td>4 CR</td>
<td>Fischer, Mittwollen</td>
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<tr>
<td>T-MACH-105151</td>
<td>Energy Efficient Intralogistic Systems</td>
<td>4 CR</td>
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<td>T-MACH-105159</td>
<td>Global Production and Logistics - Part 2: Global Logistics</td>
<td>4 CR</td>
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<td>IT-Fundamentals of Logistics</td>
<td>3 CR</td>
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<tr>
<td>T-MACH-105175</td>
<td>Airport Logistics</td>
<td>3 CR</td>
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<td>T-MACH-105174</td>
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<td>3 CR</td>
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<td>T-MACH-102107</td>
<td>Quality Management</td>
<td>4 CR</td>
<td>Lanza</td>
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<td>T-MACH-105171</td>
<td>Safety Engineering</td>
<td>4 CR</td>
<td>Kany</td>
</tr>
<tr>
<td>T-MACH-105367</td>
<td>Behaviour Generation for Vehicles</td>
<td>4 CR</td>
<td>Stiller, Werling</td>
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</table>

**Competence Certificate**

see brick courses

**Competence Goal**

Students are able to:

- Describe main functional elements of technical logistics,
- Determine the main parameters necessary for functionality,
- Combine those functional elements to solve material handling tasks appropriate, and
- Evaluate resulting material handling installations.

**Prerequisites**

None

**Content**

The emphasis module Technical Logistics provides in-depth basics on the main topics of technical logistics. The module focuses on technical characteristics of material handling technology. To gain a deeper understanding, the course is accompanied by exercises.

**Workload**

The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**

Lectures and practices; self-study
# 10.55 Module: Major Field: Thermal Turbomachines (SP 46) [M-MACH-102636]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)  
- Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

### Credits  
16

### Recurrence  
Once

### Language  
German/English

### Level  
4

### Version  
1

**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

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<thead>
<tr>
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<th>Title</th>
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<td>4</td>
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<td>Cooling of Thermally High Loaded Gas Turbine Components</td>
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<td>Machine Dynamics</td>
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<td>Numerical Simulation of Reacting Two Phase Flows</td>
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<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
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<td>Fatigue of Metallic Materials</td>
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<td>Guth, Lang</td>
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<td>Failure of Structural Materials: Fatigue and Creep</td>
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**Election block: Thermische Turbomaschinen (P) (at most 4 credits)**

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<td>T-MACH-105445</td>
<td>Simulator Exercises Combined Cycle Power Plants</td>
<td>2</td>
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</table>

**Competence Certificate**

Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.
Competence Goal
After completion of SP 46 students are able to:

- identify and quantify the specific requirements of different applications in the fields of energy technology, aeronautics, car and motor technology and process technology on thermal turbo machines,
- apply the basics of thermodynamics, fluid mechanics and of other generic disciplines to analyse and design turbo machines and their components,
- explain the governing processes in turbo machines such as compression, combustion and expansion,
- Recognise and exploit the potentials to further improve the economics and environmental friendliness of turbo machines, their components and in their interaction with the overarching systems, like power plant or airplane,
- Explain the operational principle of turbo machines and the related generics.

Prerequisites
None

Content
Thermal turbo machines are driving generators of power plants to generate electric energy. In aeronautics turbofan, turboprop and turboshaft engines are the dominating propulsion systems for airplanes and helicopters due to their high specific power-to-weight ratio and efficiency. Turbochargers are providing increased power and efficiency to internal combustion engines. Turbocompressors are used in multiple applications in chemical and process industry. In the major subject “Thermal Turbo Machines” students learn to apply their basic knowledge in thermodynamics, fluid mechanics, technical mechanics and other generic disciplines to analyse and develop challenging applications.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
10.56 Module: Major Field: Tribology (SP 47) [M-MACH-102637]

**Responsible:** Prof. Dr. Martin Dienwiebel

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)
- Specialization / Specialization: Materials and Structures for High Performance Systems (Schwerpunkt)

**Credits**
- 16

**Recurrence**
- Once

**Language**
- German/English

**Level**
- 4

**Version**
- 1

**Election notes**
In the core area of Major Field at least 8 ECTS have to be chosen.

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**Election block: Tribologie (E) ()**

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<th>T-MACH-105215 Applied Tribology in Industrial Product Development</th>
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<td>4 CR</td>
<td>Albers, Matthiesen</td>
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<td>T-MACH-105308 Atomicistic Simulations and Molecular Dynamics</td>
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<td>T-MACH-102141 Constitution and Properties of Wearresistant Materials</td>
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<td>T-MACH-105786 Contact Mechanics</td>
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<td>T-MACH-105180 Nanotechnology for Engineers and Natural Scientists</td>
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<td>T-MACH-102167 Nanotribology and -Mechanics</td>
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<td>T-MACH-105724 Failure Analysis</td>
<td>4 CR</td>
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<td>T-MACH-102103 Superhard Thin Film Materials</td>
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</table>

**Election block: Tribologie (P) (at most 4 credits)**

| T-MACH-105813 Practical Course “Tribology”                         | 4 CR    | Dienwiebel, Schneider |

**Competence Certificate**
- Oral exams: duration approx. 5 min. per credit point.
- However, amount, type and scope of the success control can vary according to the individually choice.
**Competence Goal**

After attending the core subject “tribology” (2181114) the students have the following skills:

- They can describe the fundamental friction and wear mechanisms, which occur in tribologically stressed systems.
- They can evaluate the friction and wear behavior of tribological systems.
- They can explain the effects of lubricants and their most important additives.
- They can identify suitable approaches to optimize tribological systems.
- They explain the most important experimental methods for the measurement of friction and wear, and is able to use them for the characterisation of tribo pairs.
- They can choose suitable methods for the evaluation of roughness and topography from the nm-scale to the mm-scale and is able to interpret the determined values in respect to their effect on the tribological behavior.
- They can describe the most important surface-analytical methods and their physical principles for the characterization of tribologically stressed sliding surfaces.

The additional learning outcomes depend on which further lectures are selected and are explicitly described there.

**Prerequisites**

None

**Content**

In addition to the core subject "tribology" (bricks T-MACH-105531 and T-MACH-109303), the student has to choose two more lectures, which deal with specific problems of tribology, e.g. in the field of product development, simulation or materials selection.

For detailed information see the description of the different courses of the module.

**Annotation**

The module Tribology consists of 16 credit points in the master’s program. Within that module, the students have to pass bricks T-MACH-105531 and T-MACH-109303 from the core area (8 credit points) and can select from a broad variation of courses within the supplementary area.

**Workload**

The work load is about 480 hours, corresponding to 16 credit points.

**Learning type**

In the core area of the major field Materials Science and Engineering the students have to pass bricks T-MACH-105531 and T-MACH-109303 (obligatory).

Within the supplementary area students can choose not only lectures and tutorials but also lab courses and seminars.
Module: Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics (SP 11) [M-MACH-102606]

**Responsible:** Prof. Dr. Frank Gauterin  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
- Specialization / Specialization: Vehicle Technology (Schwerpunkt)  
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)  
- Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)  
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt)

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**Election notes**  
In the core area of Major Field at least 8 ECTS have to be chosen.

**Election block: Fahrdynamik, Fahrzeugkomfort und -akustik (K) (at least 8 credits)**

<table>
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<td>Vehicle Comfort and Acoustics I</td>
<td>4 CR</td>
<td>Gauterin</td>
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<tr>
<td>T-MACH-105155</td>
<td>Vehicle Comfort and Acoustics II</td>
<td>4 CR</td>
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**Election block: Fahrdynamik, Fahrzeugkomfort und -akustik (E) (at most 11 credits)**

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<th>Course Title</th>
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<td>Powertrain Systems Technology A: Automotive Systems</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ott</td>
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<tr>
<td>T-MACH-105226</td>
<td>Dynamics of the Automotive Drive Train</td>
<td>5 CR</td>
<td>Fidlin</td>
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<td>T-MACH-105152</td>
<td>Handling Characteristics of Motor Vehicles I</td>
<td>4 CR</td>
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<tr>
<td>T-MACH-105153</td>
<td>Handling Characteristics of Motor Vehicles II</td>
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<td>Vehicle Ergonomics</td>
<td>4 CR</td>
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<td>Automotive Vision</td>
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<td>Automotive Engineering II</td>
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<td>Breitling, Frohnapfel</td>
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<td>Albers, Burkardt</td>
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<td>Modern Control Concepts I</td>
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<td>T-MACH-105367</td>
<td>Behaviour Generation for Vehicles</td>
<td>4 CR</td>
<td>Stiller, Werling</td>
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<td>T-MACH-105443</td>
<td>Wave Propagation</td>
<td>4 CR</td>
<td>Seemann</td>
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**Competence Certificate**  
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

**Competence Goal**  
The student
- knows and understands the dynamic characteristics of vehicles, owing to the construction and design tokens,
- knows and understands especially the factors being relevant for comfort and acoustics,
- is capable of fundamentally evaluating and rating handling characteristics.

**Prerequisites**  
None
Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, Tutorials
### 10.58 Module: Major Field: Vehicle Technology (SP 12) [M-MACH-102607]

**Responsible:** Prof. Dr. Frank Gauterin  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)  
Specialization / Specialization: Vehicle Technology (Schwerpunkt (p))  
Specialization / Specialization: Product Development and Engineering Design (Schwerpunkt)

**Credits:** 16  
**Recurrence:** Once  
**Language:** German/English  
**Level:** 4  
**Version:** 4

#### Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

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**Election block: Kraftfahrzeugtechnik (E) (at most 8 credits)**

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<td>T-MACH-105233 Powertrain Systems Technology A: Automotive Systems</td>
<td>4 CR</td>
<td>Albers, Matthiesen, Ott</td>
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<td>T-MACH-105536 Dimensioning and Optimization of Power Train System</td>
<td>4 CR</td>
<td>Albers, Faust, Kirchner, Matthiesen</td>
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<td>4 CR</td>
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</table>
Competence Certificate
Oral exams: duration approx. 5 min. per credit point. However, amount, type and scope of the success control can vary according to the individually choice.

Competence Goal
The student
- knows the most important components of a vehicle,
- knows and understands the functioning and the interaction of the individual components,
- knows the basics of dimensioning the components,
- knows and understands the procedures in automobile development,
- knows and understands the technical specifications at the development procedures,
- is aware of notable boundaries like legislation,
- is ready to analyze and judge vehicle concepts and to participate competently in the development of vehicles.

Prerequisites
None

Content
See brick courses.

Workload
The work load is about 480 hours, corresponding to 16 credit points.

Learning type
Lectures, tutorials.
10.59 Module: Major Field: Vibration Theory (SP 60) [M-MACH-104443]

**Responsible:** Prof. Dr.-Ing. Alexander Fidlin

**Organisation:** KIT Department of Mechanical Engineering

### Part of:
- Specialization / Specialization: General Mechanical Engineering (Schwerpunkte)
- Specialization / Specialization: Energy- and Environment Engineering (Schwerpunkt)
- Specialization / Specialization: Mechatronics and Microsystems Technology (Schwerpunkt)
- Specialization / Specialization: Production Technology (Schwerpunkt)
- Specialization / Specialization: Theoretical Mechanical Engineering (Schwerpunkt (p))

### Election notes
In the core area of Major Field at least 8 ECTS have to be chosen.

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<th>Election block: Schwingungslehre (K) (at least 8 credits)</th>
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<td>T-MACH-105290 Vibration Theory</td>
<td>5</td>
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<tr>
<td>T-MACH-105210 Machine Dynamics</td>
<td>5</td>
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<td>T-MACH-105294 Mathematical Methods of Vibration Theory</td>
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<td>T-MACH-105372 Theory of Stability</td>
<td>6</td>
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<td>T-MACH-105443 Wave Propagation</td>
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<td>T-MACH-105439 Introduction to Nonlinear Vibrations</td>
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<td>T-MACH-105154 Vehicle Comfort and Acoustics I</td>
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<td>T-MACH-105349 Computational Dynamics</td>
<td>4</td>
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<td>T-MACH-105373 Practical Training in Measurement of Vibrations</td>
<td>4</td>
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**Competence Certificate**
Oral exams: duration approx. 5 minutes per credit point.
Amount, type and scope of the success control can vary according to individual choice.

**Competence Goal**
The students know different methods which may be applied for the analysis of investigation of vibrations problems. They are able to treat one or multiple degrees of freedom systems as well as vibrating continua. The goal is to establish a chain from physical modeling via mathematical solution to an interpretation of the results. Based on the courses which are chosen the knowledge has emphasis on theoretical investigations, approximation methods or experimental methods and applications in automotive engineering.

**Prerequisites**
one

**Workload**
The work load is about 480 hours, corresponding to 16 credit points. 1 LP = 30 working hours

**Learning type**
Lectures, Tutorials
Module: Master's Thesis [M-MACH-102858]

10.60 Module: Master's Thesis [M-MACH-102858]

Responsible: Prof. Dr.-Ing. Martin Heilmann
Organisation: KIT Department of Mechanical Engineering

Part of: Master Thesis

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Mandatory

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<tr>
<td>T-MACH-105299</td>
<td>Master's Thesis</td>
<td>30 CR</td>
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Competence Certificate
The module Master Thesis consists of a written master thesis and an oral presentation of a scientific subject chosen by the student himself/herself or given by the supervisor. The master thesis is designed to show that the student is able to deal with a problem of his/her subject area in an independent manner and within the given period of time using scientific methods.

The maximal processing time of the master thesis takes six months. With consent of the examiner the thesis can be written in another language than German as well. The date of issue of the subject has to be fixed by the supervisor and the student and to be put on record at the examination board. The subject of the master thesis may be only returned once and only within the first month of processing time.

On a reasoned request of the student, the examination board can extend the processing time by up to one month. If the master thesis is not completed in time, this examination is “failed” (5,0), unless the student is not responsible.

The master thesis is to be evaluated by not less than a professor or a senior scientist according to § 14 Abs. 3 Ziff. 1 KITGor habilitated members of the KIT Faculty of Mechanical Engineering and another examiner. Generally, one of the two examiners is the person who has assigned the thesis. If the examiners do not agree, the master thesis is graded by the examination board within this assessment; another expert can be appointed too. The master thesis has to be graded within a period of six weeks after the submission.

The colloquium presentation must be held within 6 weeks after the submission of the master thesis. The presentation should last around 30 minutes and is followed by a scientific discussion with the present expert audience.

Competence Goal
The student is able to work independently on a defined, subject-relevant theme based on scientific criteria within a given period of time. The student is able to do research independently, to analyze information, to abstract as well as collect and recognize basic principles and regularities on the basis of less structured information. He/she overviews the given scientific question, is able to choose sophisticated scientific methods and techniques, and use them to solve this question and to identify further potentials, respectively. In addition, this will be carried out in consideration of social and/or ethical aspects.

The student can interpret, evaluate, and if needed plot the results obtained in a more sophisticated way. He/she is able to clearly structure his scientific work and (a) to communicate it in written form using state-of-the-art technical terminology as well as (b) to present it in oral form and discuss it with experts.

Prerequisites
The requirement for admission to the master thesis module are 74 ECTS. As to exceptions, the examination board decides on a request of the student (see § 14 (1) SPO).

Modeled Conditions
The following conditions have to be fulfilled:

1. You need to earn at least 74 credits in the following fields:
   - Advanced Engineering Fundamentals
   - Specialization

Content
The student shall be allowed to make suggestions for the topic of his/her master thesis. The topic is set by the supervisor of the thesis in accordance with § 14 (3) SPO.

Workload
The workload for the preparation and presentation of the master thesis is about 900 hours.
Module: Mathematical Methods (MSc-Modul 08, MM) [M-MACH-102594]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Advanced Engineering Fundamentals

**Credits:** 6

**Recurrence:** Once

**Language:** German/English

**Level:** 4

**Version:** 2

### Election block: Mathematische Methoden (1 item)

- **T-MACH-105293** Mathematical Methods in Dynamics 6 CR Proppe
- **T-MACH-105294** Mathematical Methods of Vibration Theory 6 CR Seemann
- **T-MACH-105295** Mathematical Methods in Fluid Mechanics 6 CR Frohnepfel
- **T-MACH-105189** Mathematical Models and Methods for Production Systems 6 CR Baumann, Furmans
- **T-MATH-102242** Numerical Mathematics for Students of Computer Science 6 CR Rieder, Weiß, Wiener
- **T-MATH-109620** Probability Theory and Statistics 6 CR Hug
- **T-MACH-110375** Mathematical Methods in Continuum Mechanics 4 CR Böhlke
- **T-MACH-110378** Mathematical Methods in Micromechanics 5 CR Böhlke

### Election block: Übungen zu Mathematische Methoden (1 item)

- **T-MACH-110376** Tutorial Mathematical Methods in Continuum Mechanics 1 CR Böhlke
- **T-MACH-110379** Tutorial Mathematical Methods in Micromechanics 1 CR Böhlke

**Competence Certificate**

written exam, duration 3 h

**Competence Goal**

Students will deepen and explain mathematical methods and transfer them to a variety of engineering problems. They are able to select suitable methods and transfer them to new problems.

**Prerequisites**

none

**Content**

see chosen brick course.

**Workload**

The work load is about 180 hours, corresponding to 6 credit points.

**Learning type**

Lectures, Tutorials
Module: Modeling and Simulation (MSc-Modul 05, MS) [M-MACH-102592]

**M 10.62 Module: Modeling and Simulation (MSc-Modul 05, MS) [M-MACH-102592]**

**Responsible:** Prof. Dr.-Ing. Kai Furmans  
Prof. Dr.-Ing. Marcus Geimer  
Dr. Balazs Pritz  
Prof. Dr.-Ing. Carsten Proppe  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** Advanced Engineering Fundamentals

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**Mandatory**

| T-MACH-105297 | Modeling and Simulation | 7 CR | Furmans, Geimer, Pritz, Proppe |

**Competence Certificate**

written exam, 3 hours

**Competence Goal**

Students are able to explain models and simulations as part of many disciplines of mechanical engineering. They are able to reproduce the interdisciplinary aspects of typical modeling and simulation techniques in mechanical engineering. The students are proficient in simulation studies from problem formulation to modeling, simulation, verification and validation, i.e:

- They are able to formulate the steps necessary to resolve problems arising in engineering, to create appropriate conceptual and mathematical models and to analyze them.

- They are able to develop and implement algorithms for the solution of mathematical models.

- They are able to perform comprehensive and interdisciplinary simulation studies to assess the simulation results and to critically evaluate the quality of the simulation results.

**Prerequisites**

none

**Content**

Introduction: Overview, concept formulation, simulation studies.  
Time/event-discrete models, event-orientated/process orientated/transaction orientated view, typical model classes (operation/maintenance, storekeeping, loss-susceptible systems).


Time-continuous models with distributed parameters, description of systems by means of partial differential equations, model reduction, numerical solution procedures for partial differential equations.

**Workload**

Regular attendance: 42 hours  
Self-study: 168 hours

**Learning type**

Lecture and Tutorials
### Module: Product Development - Dimensioning of Components (MSc-Modul 06, PE-B) [M-MACH-102593]

**Responsible:** Prof. Dr.-Ing. Volker Schulze  
**Organisation:** KIT Department of Mechanical Engineering

#### Part of: Advanced Engineering Fundamentals

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#### Mandatory

| T-MACH-105383 | Product Development - Dimensioning of Components | 7 CR | Dietrich, Schulze |

#### Competence Certificate

The assessment is carried out as a written exam (2 hours).

#### Competence Goal

The students...

- are capable to design and dimension components according to their load.  
- can include mechanical material properties from the mechanical material test in the dimensioning process.  
- can identify superimposed total loads and critical loads on simple components and to compute them.  
- acquire the skill to select materials based on the application area of the components and respective loads.

#### Prerequisites

none

#### Content

The aim of the lecture is to present the topics of the dimensioning and the material science in their connection and to learn how to deal with corresponding methods and the combination thereof.  

For the prospective engineer the most important educational objective is to understand the interaction of these topics while the interplay of the individual material stresses in the component are clarified.

The topics in detail are

- Structural dimensioning: basic stresses, superimposed stresses, notch influence, fatigue limit, fatigue strength, assessment of cracked components, operational strength, residual stresses, high temperature stress and corrosion  
- Material selection: Basics, material indices, material selection diagrams, Ashby procedure, multiple boundary conditions, target conflicts, shape and efficiency.

#### Workload

The workload for the lecture “Product Development - Dimensioning of Components” is 210 h per semester and consists of the presence during the lectures (50 h) including tutorials, preparation and rework time at home (80 h) and preparation time for the oral exam (80 h).

#### Learning type

Lectures  
Tutorials
Module: Product Development - Methods of Product Development [M-MACH-102718]

Responsible: Prof. Dr.-Ing. Albert Albers
Norbert Burkardt
Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: Advanced Engineering Fundamentals

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Mandatory

| T-MACH-109192 | Methods and Processes of PGE - Product Generation Development | 6 CR | Albers, Burkardt, Matthiesen |

Competence Certificate

Written examination (processing time: 120 min + 10 min reading time)

Competence Goal

The students are able to ...

- classify product development in companies and differentiate between different types of product development.
- name the relevant influencing factors of a market for product development.
- name, compare and use the central methods and process models of product development within moderate complex technical systems.
- explain problem solving techniques and associated development methods.
- explain product profiles and to differentiate and choose suitable creative techniques of solution/idea generation finding on this basis.
- use design guidelines to create simple technical systems and to explain these guidelines.
- name and compare quality assurance methods; to choose and use suitable methods for particular applications.
- explain the different methods of design of experiment.
- explain the costs in development process.

Prerequisites

None

Content

Basics of Product Development: Basic Terms, Classification of the Product
Development into the industrial environment, generation of costs / responsibility for costs
Concept Development: List of demands / Abstraction of the Problem Definition / Creativity Techniques / Evaluation and selection of solutions
Drafting: Prevailing basic rules of Design / Design Principles as a problem oriented accessory
Rationalization within the Product Development: Basics of Development
Management/ Simultaneous Engineering and Integrated Product Development/Development of Product Lines and Modular Construction Systems
Quality Assurance in early Development Phases: Methods of Quality Assurance in an overview/QFD/FMEA

Workload

regular attendance: 31.5 h
self-study: 148.5 h

Learning type

Lecture
Tutorial
Literature
Lecture documents
Pahl, Beitz: Konstruktionslehre, Springer-Verlag 1997
Hering, Triemel, Blank: Qualitätssicherung für Ingenieure; VDI-Verlag, 1993
11 Courses

### 11.1 Course: A holistic approach to power plant management [T-MACH-106698]

**Responsible:** Dr. Marcus Seidl  
Prof. Dr. Robert Stieglitz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102643 - Major Field: Fusion Technology

<table>
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<tr>
<td>WS 19/20</td>
<td>4</td>
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**Competence Certificate**
oral exam of about 30 minutes

**Prerequisites**
none

**Annotation**
none

Below you will find excerpts from events related to this course:

**A holistic approach to power plant management**  
2189404, WS 19/20, 2 SWS, Language: English, Open in study portal

**Description**
Main Contents:
The structure of electricity markets  
Requirements from network operators  
The basics of commodity markets  
The impact of regulation on power plant operation  
The role of behavioral economics in power plant decision making  
Integration of renewable energy sources into the electricity market  
Calibration of power plant operation and maintenance to market requirements  
Asset management for power plant fleets  
Applying financial engineering to optimize asset utilization  
Day-to-day decision making for power plant operation
Notes
Main Contents:
The structure of electricity markets
Requirements from network operators
The basics of commodity markets
The impact of regulation on power plant operation
The role of behavioral economics in power plant decision making
Integration of renewable energy sources into the electricity market
Calibration of power plant operation and maintenance to market requirements
Asset management for power plant fleets
Applying financial engineering to optimize asset utilization
Day-to-day decision making for power plant operation
The lecture provides an overview of the many practical aspects of power plant operation. For this purpose, the knowledge of the energy and commodity markets, the regulatory boundary conditions, the energy trading instruments, the principles of fleet management and the requirements of power plant maintenance are required.
For the purpose of an efficient management of a power plant fleet it is explained how a variety of statistical models can be used to determine the optimal combination of resource purchases, outage management, load availability and ask prices.
Each credit point equals to 25-30 h working time of a student. Thereby, the time is based on an average student finishing with and average score. The working time can be split into: 1 attendance of the lectures, 2. pre- and post-processing of the lecture, 3 preparations for examination.
Students understand the many aspects of power plant operation: the structure of the energy and commodity markets, the regulatory boundary conditions, the energy trading instruments, the principles of fleet management and the requirements of power plant maintenance.
Furthermore, students can develop on their own a suitable strategy for the management of a power plant fleet.
Oral exam of about 25 min.

Learning Content
The lecture provides an overview of the many practical aspects of power plant operation. For this purpose, the knowledge of the energy and commodity markets, the regulatory boundary conditions, the energy trading instruments, the principles of fleet management and the requirements of power plant maintenance are required.
For the purpose of an efficient management of a power plant fleet it is explained how a variety of statistical models can be used to determine the optimal combination of resource purchases, outage management, load availability and ask prices.

Workload
Each credit point equals to 25-30 h working time of a student. Thereby, the time is based on an average student finishing with and average score. The working time can be split into: 1 attendance of the lectures, 2. pre- and post-processing of the lecture, 3 preparations for examination.

Literature
G. Balzer, C. Schorn, Asset Management für Infrastrukturanlagen - Energie und Wasser, VDI
R. Weron, Modeling and Forecasting Electricity Loads and Prices: A Statistical Approach, Wiley
11.2 Course: Actuators and Sensors in Nanotechnology [T-MACH-105238]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102647 - Major Field: Microactuators and Microsensors

Type
Oral examination
Credits 4
Recurrence Each winter term
Version 1

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</table>

Actuators and sensors in nanotechnology

Competence Certificate
oral exam

Prerequisites
none

Below you will find excerpts from events related to this course:

Actuators and sensors in nanotechnology
2141866, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
- Physical principles of actuation and sensing
- Scaling and size effects
- Fabrication technologies
- Selected developments
- Applications

The lecture includes amongst others the following topics:
- Nano technologies
- Nano electro mechanical systems (NEMS)
- Nano magneto mechanical and multiferroic systems
- Polymer-based nano actuators
- Nano motors, molecular systems
- Adaptive nano optical systems
- Nanosensors: concepts, materials, fabrication
- Examples on different categories of materials and applications:
  - C-based, MeOx-based nano sensors
  - Physical, chemical, biological nano sensors
- Multivariant data analysis / interpretation

Workload
time of attendance: 1.5 hours/week
Self-study: 8.5 hours/week
Literature
- Lecture notes
11.3 Course: Advanced Methods in Strength of Materials [T-MACH-110377]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Bettina Frohnapfel

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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<th><strong>Expansion</strong></th>
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<td>Continuum mechanics of solids and fluids</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Böhlke, Frohnapfel</td>
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</table>

**Competence Certificate**

Written examination (90 min). Additives as announced
prerequisites to the exam: passing the corresponding Tutorial Continuum Mechanics of Solids and Fluids (T-MACH-110333)

**Prerequisites**

passing the corresponding Tutorial Continuum Mechanics of Solids and Fluids (T-MACH-110333)

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-110333 - Tutorial Continuum Mechanics of solids and fluids must have been passed.

Below you will find excerpts from events related to this course:

**Continuum mechanics of solids and fluids**

2161252, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**

**Notes**

- introduction into tensor calculus
- kinematics
- balance laws of mechanics and thermodynamics
- material theory of solids and fluids
- field equations for solids and fluids
- thermomechanical couplings
- dimensional analysis

**Workload**

regular attendance: 21 hours
self-study: 99 hours

**Literature**

lecture notes (in German)
Greve, R: Kontinuumsmechanik, Springer 2003
Joseph Spurk, J.; Aksel, N.: Strömungslehre, Springe 2010
Schade, H: Strömungslehre, de Gruyter 2013

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
11.4 Course: Aerodynamics [T-MACH-105528]

**Responsible:** Prof. Dr.-Ing. Bettina Frohnapfel
Frank Ohle

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102634 - Major Field: Fluid Mechanic

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**Exams**

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<td>Aerodynamics</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**

oral exam 30 minutes

**Prerequisites**

none

Below you will find excerpts from events related to this course:

Aerodynamics

2154420, SS 2019, 2 SWS, Language: German, Open in study portal

**Learning Content**

- Basics of aerodynamics
- Basic properties of flowing gas
- Potential Theory
- Airfoils (2-D wing)
- The finite (3-D) wing
- Airplane performance
- CFD
- Experimental verification

**Annotation**

Block course with limited number of participants, registration in the secretary's office required.
See details at www.istm.kit.edu.

**Workload**

regular attendance: 20h
self study: 100h

**Literature**

J.D. Anderson, jr.. Fundamentals of Aerodynamics, McGraw-Hill
Schlichting, Gersten. Grenzschichttheorie, Springer
11.5 Course: Aerothermodynamics [T-MACH-105437]

**Responsible:** Prof. Dr.-Ing. Bettina Frohnapfel
Prof. Dr.-Ing. Friedrich Seiler

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102634 - Major Field: Fluid Mechanic

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**Competence Certificate**

oral exam 30 minutes

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Aerothermodynamics**

2154436, SS 2019, 2 SWS, Language: German, Open in study portal

**Learning Content**

- Nature of a hypersonic flow
- Fundamentals of aerothermodynamics
- Problems during re-entry
- Flow regimes during re-entry
- Applied hypersonic research

**Annotation**

Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

**Workload**

regular attendance: 21
self-study: 99h

**Literature**

H. Oertel jun.: Aerothermodynamik, Springer-Verlag, Berlin Heidelberg New York, 1994
F. Seiler: Skript zur Vorlesung über Aerothermodynamik
Course: Airport Logistics [T-MACH-105175]

**Responsible:** André Richter  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems  
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory  
- M-MACH-102640 - Major Field: Technical Logistics

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<td>Airport logistics</td>
<td>Lecture (V)</td>
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**Competence Certificate**  
The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Airport logistics**

2117056, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)  

**Description**  
**Media:**  
presentations
Notes
Media
Presentations

Learning content

• Introduction
• Airport installations
• Luggage transport
• Passenger transport
• Security on the airport
• Legal bases of the air traffic
• Freight on the airport

Learning goals
The students are able to:

• Describe material handling and informations technology activities on airports,
• Evaluate processes and systems on airports as the law stands, and
• Choose appropriate processes and material handling systems for airports.

Recommendations
None

Workload
Regular attendance: 21 hours
Self-study: 99 hours

Note
Limited number of participants: allocation of places in sequence of registration (first come first served). Registration via "ILIAS" mandatory.
Personal presence during lectures mandatory.

Learning Content
Introduction
airport installations
luggage transport
passenger transport
security on the airport
legal bases of the air traffic
freight on the airport

Annotation
Limited number of participants: allocation of places in sequence of application (first come first served)
Application via "ILIAS" mandatory
personal presence during lectures mandatory

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
## 11.7 Course: Alternative Powertrain for Automobiles [T-MACH-105655]

### Responsible:
Prof. Dipl.-Ing. Karl Ernst Noreikat

### Organisation:
KIT Department of Mechanical Engineering

### Part of:
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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<td>WS 19/20</td>
<td>Alternative Powertrain for Automobiles</td>
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### Competence Certificate
written exam

Below you will find excerpts from events related to this course:

### Alternative Powertrains for Automobiles

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<tr>
<td>2133132, WS 19/20, 2 SWS, <a href="#">Open in study portal</a></td>
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</table>

### Notes
- History
- Infrastructure
- Market Situation
- Legislation
- Alternative Fuels
- Innovative Drivetrains
- Hybrids
- Plug-In Hybrids
- BEV
- Fuel Cells
11.8 Course: Analysis of Exhaust Gas and Lubricating Oil in Combustion Engines [T-MACH-105173]

Responsible: Dr.-Ing. Marcus Gohl
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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Competence Certificate
Letter of attendance or oral exam (25 minutes, no auxillary means)

Prerequisites
none

Below you will find excerpts from events related to this course:

Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines
2134150, SS 2019, 2 SWS, Language: German, Open in study portal

Description
Media:
Lecture with Powerpoint slides

Learning Content
The students get involved in the application of different measurement techniques in the field of exhaust gas and lubricating oil analysis. The functional principles of the systems as well as the application areas of the latter are discussed. In addition to a general overview of standard applications, current specific development and research activities are introduced.

Workload
regular attendance: 24 hrs
self study: 96 hrs

Literature
The lecture documents are distributed during the courses.
11.9 Course: Analysis Tools for Combustion Diagnostics [T-MACH-105167]

**Responsible:** Jürgen Pfeil  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102635 - Major Field: Engineering Thermodynamics  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**

oral examination, Duration: 25 min., no auxiliary means

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Analysis tools for combustion diagnostics**

2134134, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- energy balance at the engine  
- energy conversion in the combustion chamber  
- thermodynamics of the combustion process  
- flow velocities  
- flame propagation  
- special measurement techniques

**Workload**

- regular attendance: 24 hours  
- self-study: 96 hours

**Literature**

Lecture notes available in the lectures
11.10 Course: Appliance and Power Tool Design [T-MACH-105229]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

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**Competence Certificate**  
Oral examination

**Prerequisites**  
The participation in “Appliance and power tool design” requires the concurrent project work. Due to organizational reasons, the number of participants is limited. At the beginning of August, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous.

Below you will find excerpts from events related to this course:

**Appliance and Power Tool Design**  
2145164, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Learning Content**  
Operation system, system of objects and system of objectives of mechatronic appliances and power tool designs.  
Mode of operation as enabler of design, components of mechatronic systems, application oriented design, guidelines for appliance and power tool design.  
Part of the lecture is a project work, in which theory will be reprocessed and presented in a practical way. In such exercises the students also will present their results developed in project teams.  
The interaction of analysis and synthesis will be acquired in student teams at the example of different appliances and power tools.

**Workload**  
regular attendance: 73.5 h  
self-study: 148 h

**Appliance and Power Tool Design Project Work**  
2145165, SS 2019, 1 SWS, [Open in study portal](#)
Description

Media

- Beamer
- Touchscreen
- Models

Learning Content
The interaction of analysis and synthesis will be acquired in student teams at the example of different appliances and power tools.

Workload
lectures: 42 h
preparation to exam: 18 h
11 Course: Application of Advanced Programming Languages in Mechanical Engineering [T-MACH-105390]

Responsible: Dr. Daniel Weygand
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
M-MACH-102604 - Major Field: Computational Mechanics

Type: Oral examination
Credits: 4
Recurrence: Each summer term
Version: 2

Events

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Exams

| Exams | SS 2019 | 76-T-MACH-105390 | Application of Advanced Programming Languages in Mechanical Engineering | Prüfung (PR) | Weygand |

Competence Certificate
oral exam ca. 30 minutes

Prerequisites
It is not possible, to combine this brick with brick Scientific computing for Engineers [T-MACH-100532].

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-100532 - Scientific Computing for Engineers must not have been started.

Below you will find excerpts from events related to this course:

Application of advanced programming languages in mechanical engineering
2182735, SS 2019, 2 SWS, Language: German, Open in study portal
Notes
This lecture gives an introduction to advances programming and scripting languages and numerical methods under UNIX/Linux:

* Fortran 95/2003
  - structure of source code
  - programing
  - compiling
  - debugging
  - parallelization with OpenMP
* numerical methods
* script languages: Python, awk
* visualisation

The student can
  - utilise the programming language Fortran 95 and Fortran 2003 to implement simple numerical simulations
  - apply a script languages awk resp. python for data treatment

regular attendance: 22,5 hours
Lab: 22,5 hours
self-study: 75 hours
oral exam ca. 30 minutes

Learning Content
This lecture gives an introduction to advances programming and scripting languages and numerical methods under UNIX/Linux:

* Fortran 95/2003
  - structure of source code
  - programing
  - compiling
  - debugging
  - parallelization with OpenMP
* numerical methods
* script languages: Python, awk
* visualisation

Workload
regular attendance: 22,5 hours
Lab: 22,5 hours
self-study: 75 hours

Literature
2. Intel Fortran compiler handbook.
Learning Content
* Working under Unix/Linux:
  - login
  - organization of files
  - file system
  - shell commands
  - administration of jobs
  - editor

* visualisation of data unter Linux
programming exercises

Workload
see lecture

Literature
siehe Vorlesung
Course: Applied Materials Modelling [T-MACH-105527]

**Responsible:** Prof. Dr. Peter Gumbsch  
Dr. Katrin Schulz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<tbody>
<tr>
<td>Oral examination</td>
<td>4</td>
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**Events**

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<tr>
<td>SS 2019</td>
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<td>4 SWS</td>
<td>Lecture / Practice (VÜ)</td>
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**Exams**

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<td>Applied Materials Modelling</td>
<td>4 SWS</td>
<td>Prüfung (PR)</td>
<td>Gumbsch, Schulz</td>
</tr>
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</table>

**Competence Certificate**
oral exam ca. 30 minutes  
no tools or reference materials

**Prerequisites**
The successful participation in Exercises for Applied Materials Modelling is the condition for the admittance to the oral exam in Applied Materials Modelling.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-107671 - Exercises for Applied Materials Simulation must have been passed.

*Below you will find excerpts from events related to this course:*

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<tr>
<th>Applied Materials Modelling</th>
<th>Lecture / Practice (VÜ)</th>
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<tbody>
<tr>
<td>2182614, SS 2019, 4 SWS, Language: German, Open in study portal</td>
<td></td>
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</tbody>
</table>

**Description**

**Media:**
black board, beamer, script, computer exercise
Notes
This lecture should give the students an overview of different simulation methods in the field of materials science and engineering. Numerical methods are presented and their use in different fields of application and size scales shown and discussed. On the basis of theoretical as well as practical aspects, a critical examination of the opportunities and challenges of numerical material simulation shall be carried out.

The student can

- define different numerical methods and distinguish their range of application
- approach issues by applying the finite element method and discuss the processes and results
- understand complex processes of metal forming and crash simulation and discuss the structural and material behavior
- define and apply the physical fundamentals of particle-based simulation techniques to applications of materials science
- illustrate the range of application of atomistic simulation methods and distinguish between different models

preliminary knowledge in mathematics, physics and materials science recommended

regular attendance: 34 hours
exercise: 11 hours
self-study: 165 hours
oral exam ca. 35 minutes
no tools or reference materials
admission to the exam only with successful completion of the exercises

Learning Content
This lecture should give the students an overview of different simulation methods in the field of materials science and engineering. Numerical methods are presented and their use in different fields of application and size scales shown and discussed. On the basis of theoretical as well as practical aspects, a critical examination of the opportunities and challenges of numerical material simulation shall be carried out.

Workload
regular attendance: 34 hours
exercise: 11 hours
self-study: 165 hours

Literature
### 11.13 Course: Applied Mathematics in Natural Science: Flows with chemical reactions [T-MACH-108847]

**Responsible:** Prof. Dr. Andreas Class  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering

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<td>Completed coursework (oral)</td>
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<td>Each winter term</td>
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**Events**

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<tbody>
<tr>
<td>WS 19/20</td>
<td>2153406</td>
<td>Flows with chemical reactions</td>
<td>2 SWS</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
The study performance is considered to have been passed if all exercise assignments have been successfull processed and the final colloquium (30 minutes) has been successfully passed.

**no auxiliary mean**

**Prerequisites**  
none

**Recommendation**  
Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

Below you will find excerpts from events related to this course:

### Flows with chemical reactions  
2153406, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Description**  
**Media:** Black board

**Notes**

The students can describe flow scenarios, where a chemical reaction is confined to a thin layer. They can choose simplifying approaches for the underlying chemistry and discuss the problems with focus on the fluid mechanic aspects. The students are able to solve simple problems analytically. Furthermore, they are qualified to discuss simplifications as relevant for an efficient numerical solution of complex problems.

In the lecture we mainly consider problems, where chemical reaction is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficient numerical solution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

**Learning Content**

In the lecture we mainly consider problems, where chemical reaction is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficient numerical solution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

**Workload**

- regulare attendance: 22.5h
- self-study: 99h
Literature
Lecture

Buckmaster, J.D.; Ludford, G.S.S.: Lectures on Mathematical Combustion, SIAM 1983

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Dr.-Ing. Benoit Lorentz  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** 
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102637 - Major Field: Tribology

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<tbody>
<tr>
<td>Oral exam</td>
<td>4</td>
<td>Each winter term</td>
<td>2</td>
</tr>
</tbody>
</table>

| Events | 2019/20 | 2145181 | Applied Tribology in Industrial Product Development | 2 SWS | Lecture (V) | Lorentz |

**Competence Certificate**
oral exam (20 min)

**Prerequisites**
None

Below you will find excerpts from events related to this course:

**Notes**
The aim of the lecture is to discuss tribological problems, tribological features and the tribological variety on examples of the industry.

The students are able to

- define a tribological system,
- design a tribological system,
- discuss wear and damage impacts,
- explain measurement techniques to investigate tribological systems and
- show the limits of a tribological system.

Further content:

- Friction, Wear, Wear Measurement
- Lubricant (Oil, Grease, etc.)
- Hydrodynamic and elastohydrodynamic Lubrication
- Design of Tribologic Working Surface Pairs
- Technique of Measurement in Lubricated Contacts
- Prevention of Maschine Failure
- Protective Surface Layers
- Journal Bearings, Roller Bearings
- Gear Wheels and Transmissions
Learning Content
Friction, Wear, Wear Measurement
Lubricant (Oil, Grease, etc.)
Hydrodynamic and elastohydrodynamic Lubrication
Design of Tribologic Working Surface Pairs
Technique of Measurement in Lubricated Contacts
Prevention of Machine Failure
Protective Surface Layers
Journal Bearings, Roller Bearings
Gear Wheels and Transmissions

Workload
regular attendance: 21 h
self-study: 99 h

Literature
The lecture script will be allocated at Ilias.
11.15 Course: Atomistic Simulations and Molecular Dynamics [T-MACH-105308]

**Responsible:**
Dr. Christian Brandl  
Prof. Dr. Peter Gumbsch  
Dr.-Ing. Johannes Schneider

**Organisation:**
KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102604 - Major Field: Computational Mechanics  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102637 - Major Field: Tribology  
- M-MACH-102649 - Major Field: Advanced Materials Modelling  
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

**Type**  
Oral examination

**Credits**  
4

**Recurrence**  
Each summer term

**Version**  
2

**Events**

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<td>2181740</td>
<td>Atomistic simulations and molecular dynamics</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Gumbsch</td>
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<td>SS 2019</td>
<td>2181741</td>
<td>Lab for 'Atomistic simulations and molecular dynamics'</td>
<td>2</td>
<td>Practice (Ü)</td>
<td>Gumbsch</td>
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</table>

**Competence Certificate**
oral exam ca. 30 minutes

**Prerequisites**
none

**Recommendation**
preliminary knowledge in mathematics, physics and materials science

Below you will find excerpts from events related to this course:

**Atomistic simulations and molecular dynamics**

2181740, SS 2019, 2 SWS, Language: English, [Open in study portal](#)
Notes
The lecture introduces the foundation of particle based simulation methods focussing on molecular dynamics:

1. Introduction
2. Physics of Materials
3. MD Basics, Atom-Billard
   * particle, position, energy, forces, pair potentials
   * initial and boundary conditions
   * time integration
4. algorithms
5. statics, dynamics, thermodynamics
6. MD output
7. interaction between particles
   * pair potential -- many body potentials
   * principles of quantum mechanics
   * tight binding methods
   * dissipative particle dynamics
8. application of particle based methods

Exercises (2181741, 2 SWS) are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students.

The student can

- describe the physical foundation of particle based simulation method (e.g. molecular dynamics)
- apply particle based simulation methods to problems in materials science

preliminary knowlegde in mathematics, physics and materials science recommended

regular attendance: 22.5 hours
exercise: 22.5 hours
self-study: 75 hours
oral exam ca. 30 minutes

Learning Content
The lecture introduces the foundation of particle based simulation methods focussing on molecular dynamics:

1. Introduction
2. Physics of Materials
3. MD Basics, Atom-Billard
   * particle, position, energy, forces, pair potentials
   * initial and boundary conditions
   * time integration
4. algorithms
5. statics, dynamics, thermodynamics
6. MD output
7. interaction between particles
   * pair potential -- many body potentials
   * principles of quantum mechanics
   * tight binding methods
   * dissipative particle dynamics
8. application of particle based methods

Exercises (2181741, 2 SWS) are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students.

Workload
regular attendance: 22.5 hours
exercise: 22.5 hours
self-study: 75 hours

Literature
Notes
Introduction to the basic usage of the MD software package IMD:

* generating initial structures
* energy calculations
* defects in lattices
* visualization of MD structures

The students will be able to use a standard molecular dynamics software package.

Learning Content
Introduction to the basic usage of the MD software package IMD:

* generating initial structures
* energy calculations
* defects in lattices
* visualization of MD structures

Workload
see lecture

Literature
see lecture
11.16 Course: Automated Manufacturing Systems [T-MACH-108844]

**Responsibility:** Prof. Dr.-Ing. Jürgen Fleischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102633 - Major Field: Robotics
- M-MACH-102640 - Major Field: Technical Logistics

**Type:** Oral examination

**Credits:** 8

**Recurrence:** Each summer term

**Version:** 1

**Events**

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<tr>
<th>Event</th>
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<th>Credits</th>
<th>Recurrence</th>
<th>Instructors</th>
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<td>SS 2019</td>
<td>2150904</td>
<td>Automated Manufacturing Systems</td>
<td>6 SWS</td>
<td>Lecture / Practice (VÜ)</td>
<td>Fleischer</td>
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**Exams**

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<thead>
<tr>
<th>Event</th>
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<th>Type</th>
<th>Credits</th>
<th>Recurrence</th>
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<td>Automated Manufacturing Systems</td>
<td>Prüfung (PR)</td>
<td>Fleischer</td>
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**Competence Certificate**

oral exam (40 minutes)

**Prerequisites**

"T-MACH-102162 - Automatisierte Produktionsanlagen" must not be commenced.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-102162 - Automated Manufacturing Systems must not have been started.

Below you will find excerpts from events related to this course:

**Automated Manufacturing Systems**

2150904, SS 2019, 6 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
- planning of automated manufacturing systems

An interdisciplinary view of these subareas enables Industry 4.0 solutions.
In the second part of the lecture, the basics are illustrated using implemented manufacturing processes for the production of automotive components (chassis and drive technology). The analysis of automated manufacturing systems for manufacturing of defined components is also included.
In the field of vehicle power train both, the automated manufacturing process for the production of the conventional internal-combustion engine and the automated manufacturing process for the production of the prospective electric power train (electric motor and battery) are considered. In the field of car body, the focus is on the analysis of the process chain for the automated manufacturing of conventional sheet metal body parts, as well as for automated manufacturing of body components made out of fiber-reinforced plastics.
Within tutorials, the contents from the lecture are advanced and applied to specific problems and tasks.

Learning Outcomes:
The students …

- are able to analyze implemented automated manufacturing systems and describe their components.
- are capable to assess the implemented examples of implemented automated manufacturing systems and apply them to new problems.
- are able to name automation tasks in manufacturing plants and name the components which are necessary for the implementation of each automation task.
- are capable with respect to a given task to plan the configuration of an automated manufacturing system and to determine the necessary components to its realization.
- are able to design and select components for a given use case of the categories: "Handling Technology", "Industrial Robotics", "Sensory" and "Controls".
- are capable to compare different concepts for multi-machine systems and select a suitable concept for a given use case.

Workload:
MACH:
regular attendance: 63 hours
self-study: 177 hours

WING:
regular attendance: 63 hours
self-study: 207 hours
Learning Content
The lecture provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
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Within tutorials, the contents from the lecture are advanced and applied to specific problems and tasks.

Annotation
None

Workload
MACH:
regular attendance: 63 hours
self-study: 177 hours

WING/TVWL:
regular attendance: 63 hours
self-study: 207 hours

Literature
Lecture Notes
Course: Automated Manufacturing Systems [T-MACH-102162]

**Responsible:** Prof. Dr.-Ing. Jürgen Fleischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

### Events

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<tr>
<td>Type</td>
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<td>Each summer term</td>
<td>2</td>
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<tr>
<td>Written examination</td>
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<tr>
<td>SS 2019</td>
<td>6 SWS</td>
<td>Lecture / Practice (VÜ)</td>
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<tr>
<td>2150904</td>
<td>Automated Manufacturing Systems</td>
<td>Fleischer</td>
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<th>Exams</th>
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<th>Recurrence</th>
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<td>SS 2019</td>
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<td>SS 2019</td>
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<td>76-T-MACH-102162-MIT</td>
<td>Automated Manufacturing Systems</td>
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**Competence Certificate**

written exam (120 minutes)

**Prerequisites**

"T-MACH-108844 - Automatisierte Produktionsanlagen" must not be commenced.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-108844 - Automated Manufacturing Systems must not have been started.

**Below you will find excerpts from events related to this course:**

**Automated Manufacturing Systems**

2150904, SS 2019, 6 SWS, Language: German, Open in study portal

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
- planning of automated manufacturing systems

An interdisciplinary view of these subareas enables Industry 4.0 solutions.
In the second part of the lecture, the basics are illustrated using implemented manufacturing processes for the production of automotive components (chassis and drive technology). The analysis of automated manufacturing systems for manufacturing of defined components is also included.
In the field of vehicle power train both, the automated manufacturing process for the production of the conventional internal-combustion engine and the automated manufacturing process for the production of the prospective electric power train (electric motor and battery) are considered. In the field of car body, the focus is on the analysis of the process chain for the automated manufacturing of conventional sheet metal body parts, as well as for automated manufacturing of body components made out of fiber-reinforced plastics.
Within tutorials, the contents from the lecture are advanced and applied to specific problems and tasks.

Learning Outcomes:
The students ...

- are able to analyze implemented automated manufacturing systems and describe their components.
- are capable to assess the implemented examples of implemented automated manufacturing systems and apply them to new problems.
- are able to name automation tasks in manufacturing plants and name the components which are necessary for the implementation of each automation task.
- are capable with respect to a given task to plan the configuration of an automated manufacturing system and to determine the necessary components to its realization.
- are able to design and select components for a given use case of the categories: "Handling Technology", "Industrial Robotics", "Sensory" and "Controls".
- are capable to compare different concepts for multi-machine systems and select a suitable concept for a given use case.

Workload:
MACH:
regular attendance: 63 hours
self-study: 177 hours

WING:
regular attendance: 63 hours
self-study: 207 hours
Learning Content
The lecture provides an overview of the structure and functioning of automated manufacturing systems. In the introduction chapter the basic elements for the realization of automated manufacturing systems are given. This includes:

- Drive and control technology
- Handling technology for handling work pieces and tools
- Industrial Robotics
- Quality assurance in automated manufacturing
- automatic machines, cells, centers and systems for manufacturing and assembly
- structures of multi-machine systems
- planning of automated manufacturing systems

An interdisciplinary view of these subareas enables Industry 4.0 solutions. In the second part of the lecture, the basics are illustrated using implemented manufacturing processes for the production of automotive components (chassis and drive technology). The analysis of automated manufacturing systems for manufacturing of defined components is also included.

In the field of vehicle power train both, the automated manufacturing process for the production of the conventional internal-combustion engine and the automated manufacturing process for the production of the prospective electric power train (electric motor and battery) are considered. In the field of car body, the focus is on the analysis of the process chain for the automated manufacturing of conventional sheet metal body parts, as well as for automated manufacturing of body components made out of fiber-reinforced plastics.

Within tutorials, the contents from the lecture are advanced and applied to specific problems and tasks.

Annotation
None

Workload
MACH:
regular attendance: 63 hours
self-study: 177 hours

WING/TVWL:
regular attendance: 63 hours
self-study: 207 hours

Literature
Lecture Notes
11.18 Course: Automation Systems [T-MACH-105217]

Responsibility: Prof. Dr.-Ing. Michael Kaufmann
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102614 - Major Field: Mechatronics

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<th>Recurrence</th>
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<tbody>
<tr>
<td>Written exam</td>
<td>4</td>
<td>Each summer term</td>
<td>2</td>
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Events
SS 2019 | 2106005 | Automation Systems | 2 SWS | Lecture (V) | Kaufmann

Competence Certificate
Written exam (Duration: 1 h)

Prerequisites
none

Below you will find excerpts from events related to this course:

Automation Systems
2106005, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content

- Introduction: Terms and definitions, examples, requirements
- Industrial processes: classification, process conditions
- Automation tasks
- Components of industrial automation systems: control functions, data acquisition, data output equipment, Programmable Logic Controllers, PC-based control
- Industrial communication, classification, topology, protocols, bus systems for automation systems
- Engineering: plant engineering, composition of control systems, programming
- Requirements on equipment, documentation, identification
- Dependability and safety
- Diagnosis
- Application examples

Workload
general attendance: 21 h
self-study: 99 h

Literature

11.19 Course: Automotive Engineering I [T-MACH-100092]

**Responsible:** Prof. Dr. Frank Gauterin  
Dr.-Ing. Hans-Joachim Unrau

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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<th>Language</th>
<th>Version</th>
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<tr>
<td>Written examination</td>
<td>8</td>
<td>Each winter term</td>
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**Events**

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<th>Period</th>
<th>Code</th>
<th>Event</th>
<th>Type</th>
<th>SWS</th>
<th>Time</th>
<th>Instructor(s)</th>
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<tbody>
<tr>
<td>WS 19/20</td>
<td>2113805</td>
<td>Automotive Engineering I</td>
<td>Lecture (V)</td>
<td>4</td>
<td></td>
<td>Gauterin, Unrau</td>
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<tr>
<td>WS 19/20</td>
<td>2113809</td>
<td>Automotive Engineering I</td>
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**Exams**

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**Competence Certificate**

Written examination

Duration: 120 minutes

Auxiliary means: none

**Prerequisites**

The brick "T-MACH-102203 - Automotive Engineering I" is not started or finished. The bricks "T-MACH-100092 - Grundlagen der Fahrzeugtechnik I" and "T-MACH-102203 - Automotive Engineering I" can not be combined.

Below you will find excerpts from events related to this course:

**V Automotive Engineering I**

2113805, WS 19/20, 4 SWS, Language: German, Open in study portal

**Learning Content**

1. History and future of the automobile
2. Driving mechanics: driving resistances and driving performance, mechanics of longitudinal and lateral forces, active and passive safety
3. Drive systems: combustion engine, hybrid and electric drive systems
4. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)
5. Power transmission and distribution: drive shafts, cardon joints, differentials

**Workload**

regular attendance: 45 hours  
self-study: 195 hours
Literature

Notes
In English language.

Learning Content
1. History and future of the automobile
2. Driving mechanics: driving resistances and driving performances, mechanics of longitudinal and lateral forces, active and passive safety
3. Drive systems: combustion engine, hybrid and electric drive systems
4. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)
5. Power transmission and distribution: drive shafts, cardon joints, differentials

Workload
regular attendance: 45 hours
self-study: 195 hours

Literature
11.20 Course: Automotive Engineering II [T-MACH-102117]

Responsible: Prof. Dr. Frank Gauterin  
Dr.-Ing. Hans-Joachim Unrau

Organisation: KIT Department of Mechanical Engineering

Part of:  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

Events

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Competence Certificate

Written Examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites

none

Below you will find excerpts from events related to this course:

Automotive Engineering II  
2114835, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content

1. Chassis: Wheel suspensions (rear axles, front axles, kinematics of axles), tyres, springs, damping devices
2. Steering elements: Manual steering, servo steering, steer by wire
3. Brakes: Disc brake, drum brake, comparison of designs

Workload

regular attendance: 22,5 hours  
self-study: 97,5 hours

Literature

Automotive Engineering II
2114855, SS 2019, 2 SWS, Language: English, Open in study portal

Notes
In English language.

Learning Content
1. Chassis: Wheel suspensions (rear axles, front axles, kinematics of axles), tyres, springs, damping devices
2. Steering elements: Manual steering, servo steering, steer by wire
3. Brakes: Disc brake, drum brake, comparison of the designs

Literature
Elective literature:
11.21 Course: Automotive Logistics [T-MACH-105165]

Responsible: Prof. Dr.-Ing. Kai Furmans
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102618 - Major Field: Production Technology

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Competition Certificate
The assessment consists of a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

Prerequisites
none

Below you will find excerpts from events related to this course:

**Automotive Logistics**

2118085, SS 2019, 2 SWS, Language: German, [Open in study portal]

Description

Media:
presentations, black board

Notes

The event will be offered for the last time in the summer semester 2019.

Learning Content

- Logistic questions within the automobile industry
- Basic model of automobile production and distribution
- Relation with the suppliers
- Disposition and physical execution
- Vehicle production in the interaction of shell, paint shop and assembly
- Sequence planning
- Assembly supply
- Vehicle distribution and linkage with selling processes
- Physical execution, planning and control

Annotation

none

Workload

Regular attendance: 21 hours
Self-study: 99 hours

Literature

None.
## 11.22 Course: Automotive Vision [T-MACH-105218]

**Responsible:** Dr. Martin Lauer  
Prof. Dr.-Ing. Christoph Stiller  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems  
- M-MACH-102630 - Major Field: Mobile Machines  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102641 - Major Field: Rail System Technology

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### Exams

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### Competence Certificate

Type of Examination: written exam  
Duration of Examination: 60 minutes

**Prerequisites**

none

Below you will find excerpts from events related to this course:

### Automotive Vision

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Notes
Lernziele (EN):
Machine perception and interpretation of the environment for the basis for the generation of intelligent behaviour. Especially visual perception opens the door to novel automotive applications. First driver assistance systems can already improve safety, comfort and efficiency in vehicles. Yet, several decades of research will be required to achieve an automated behaviour with a performance equivalent to a human operator. The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision, vehicle kinematics and advanced information processing techniques are presented to provide a broad overview on seeing vehicles'. Application examples from cutting-edge and future driver assistance systems illustrate the discussed subjects.

Lehrinhalt (EN):
1. Driver assistance systems
2. Binocular vision
3. Feature point methods
4. Optical flow/tracking in images
5. Tracking and state estimation
6. Self-localization and mapping
7. Lane recognition
8. Behavior recognition

Arbeitsaufwand (EN): 120 hours

Learning Content
1. Driver assistance systems
2. Binocular vision
3. Feature point methods
4. Optical flow/tracking in images
5. Tracking and state estimation
6. Self-localization and mapping
7. Lane recognition
8. Behavior recognition

Workload
120 hours
11.23 Course: Basics of Technical Logistics [T-MACH-102163]

Responsible: Dr.-Ing. Martin Mittwollen
Jan Oellerich

Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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Exams

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Competence Certificate
The assessment consists of a written exam (60 min.).

Prerequisites
none

Below you will find excerpts from events related to this course:

Basics of Technical Logistics
2117095, WS 19/20, 6 SWS, Language: German, Open in study portal

Description
Media:
supplementary sheets, presentations, blackboard

Notes
lectures and practice; practice dates: look up ILIAS
Learning Content

- effect model of conveyor machines
- elements for the change of position and orientation
- conveyor processes
- identification systems
- drives
- mechanical behaviour of conveyors
- structure and function of conveyor machines
- elements of intralogistics
- sample applications and calculations in addition to the lectures inside practical lectures

Annotation
Basics knowledge of technical mechanics is preconditioned

Workload
presence: 48h
rework: 132h

Literature
Recommendations during lessons
11.24 Course: Basics of Technical Logistics I [T-MACH-109919]

**Responsible:** Dr.-Ing. Martin Mittwollen
Jan Oellerich

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102640 - Major Field: Technical Logistics

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**Competence Certificate**
The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation.

**Prerequisites**
none
### 11.25 Course: Basics of Technical Logistics II [T-MACH-109920]

**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102640 - Major Field: Technical Logistics

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**Competence Certificate**  
The assessment consists of a written exam (60 min.) according to § 4 paragraph 2 Nr. 1 of the examination regulation.

**Prerequisites**  
none
Course: Behaviour Generation for Vehicles [T-MACH-105367]

**Responsible:** Prof. Dr.-Ing. Christoph Stiller  
Dr. Moritz Werling

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102630 - Major Field: Mobile Machines  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102640 - Major Field: Technical Logistics

**Type**  
Written examination

**Credits**  
4

**Recurrence**  
Each summer term

**Version**  
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**Competence Certificate**

written examination

60 min.

Simple calculators are allowed, programmable or graphical ones are prohibited.

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Notes**

Lernziele (EN):

Modern vehicle control systems like ABS or ESP transform the intention of the driver into a corresponding behaviour of the vehicle. This is achieved by compensating disturbances like a varying traction for example. Within the recent years, vehicles have been increasingly equipped with sensors that gather information about the environment (Radar, Lidar and Video for example). This enables the vehicles to generate an 'intelligent' behaviour and transform this behaviour into control signals for actors. Several so called 'driver assistance systems' have already achieved remarkable improvements as far as comfort, safety and efficiency are concerned. But nevertheless, several decades of research will be required to achieve an automated behaviour with a performance equivalent to a human operator ('the driver'). The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Information technology, control theory and kinematic aspects are treated to provide a broad overview over vehicle guidance. Application examples from cutting-edge and future driver assistance systems illustrate the discussed subjects.
Workload
120 hours
11.27 Course: Bioelectric Signals [T-ETIT-101956]

| Responsible:   | Dr.-Ing. Axel Loewe |
| Organisation:  | KIT Department of Electrical Engineering and Information Technology |
| Part of:       | M-MACH-102615 - Major Field: Medical Technology |

**Type**: Written examination  
**Credits**: 3  
**Recurrence**: Each summer term  
**Version**: 2

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**Competence Certificate**
The examination is a written examination with a duration of 90 minutes.
11.28 Course: Biomechanics: design in nature and inspired by nature [T-MACH-105651]

**Responsible:** Prof. Dr. Claus Mattheck  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

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**Competence Certificate**  
Colloquium, ungraded.

**Prerequisites**  
The number of participants is limited. Prior registration through ILIAS is necessary. In case of too many registrations, a selection (in accordance with SPO) will take place. Before the registration in SP 26 (ME) or SP 01 (MSMT) the participation at the seminar must be confirmed.

*Below you will find excerpts from events related to this course:*

**Biomechanics: Design in Nature and Inspired by Nature**  
2181708, WS 19/20, 3 SWS, Language: German, [Open in study portal]

**Notes**
- mechanics and growth laws of trees  
- failure criteria and safety factors  
- computer simulation of adaptive growth  
- notches and damage case studies  
- optimization inspired by nature  
- structural shape optimization without computers  
- universal shapes of nature  
- fibre reinforces materials  
- failure of trees, hillsides, dikes, walls and pipes

**Learning Content**
- mechanics and growth laws of trees  
- failure criteria and safety factors  
- computer simulation of adaptive growth  
- notches and damage case studies  
- optimization inspired by nature  
- structural shape optimization without computers  
- universal shapes of nature  
- fibre reinforces materials  
- failure of trees, hillsides, dikes, walls and pipes

**Workload**
regular attendance: 30 hours  
self-study: 90 hours
11.29 Course: Biomedical Measurement Techniques I [T-ETIT-106492]

**Responsible:** Prof. Dr. Werner Nahm

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:** M-MACH-102615 - Major Field: Medical Technology

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**Prerequisites**

T-ETIT-101928 - Biomedizinische Messtechnik I darf weder begonnen noch abgeschlossen sein.
## Course: Biomedical Measurement Techniques II [T-ETIT-106973]

| Responsible: | Prof. Dr. Werner Nahm |
| Organisation: | KIT Department of Electrical Engineering and Information Technology |
| Part of: | M-MACH-102615 - Major Field: Medical Technology |

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11.31 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I [T-MACH-100966]

**Responsible:** Prof. Dr. Andreas Guber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Competence Certificate**
- written exam (75 Min.)

**Prerequisites**
- none

Below you will find excerpts from events related to this course:

**BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I**

**Description**

**Media:**
- Lecture script

**Learning Content**

Introduction into various microtechnical manufacturing methods: LIGA, Micro milling, Silicon Micromachining, Laser Microstructuring, µEDM, Metal-Etching

Biomaterials, Sterilisation.

Examples of use in the life science sector: basic micro fluidic structures: micro channels, micro filters, micromixers, micropumps, microvalves, Micro and nanotiter plates, Microanalysis systems (µTAS), Lab-on-chip applications.

**Annotation**

The exam is held during the semester break. The date will be announced at the beginning of the semester.

**Workload**

- Literature: 20 h
- Lessons: 21 h
- Preparation and Review: 50 h
- Exam preparation: 30 h
Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005
M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011
### 11.32 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [T-MACH-100967]

**Responsible:** Prof. Dr. Andreas Guber  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102616 - Major Field: Microsystem Technology

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#### Competence Certificate

Written exam (75 Min.)

#### Prerequisites

none

*Below you will find excerpts from events related to this course:*

### BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II

2142883, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

#### Description

**Media:**
Lecture script

#### Learning Content

Examples of use in Life-Sciences and biomedicine: Microfluidic Systems:  
LabCD, Protein Crystallisation  
Microarrays  
Tissue Engineering  
Cell Chip Systems  
Drug Delivery Systems  
Micro reaction technology  
Microfluidic Cells for FTIR-Spectroscopy  
Microsystem Technology for Anesthesia, Intensive Care and Infusion  
Analysis Systems of Person’s Breath  
Neurobionics and Neuroprosthesis  
Nano Surgery

#### Workload

- Literature: 20 h  
- Lessons: 21 h  
- Preparation and Review: 50 h  
- Exam preparation: 30 h
**Literature**

Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II; Springer-Verlag, 1994

M. Madou
Fundamentals of Microfabrication
11.33 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [T-MACH-100968]

**Responsible:** Prof. Dr. Andreas Guber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology

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**Exams**

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**Competence Certificate**

Written exam (75 Min.)

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III**

2142879, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Description**

**Media:**

Lecture script

**Learning Content**

Examples of use in minimally invasive therapy
Minimally invasive surgery (MIS)
Endoscopic neurosurgery
Interventional cardiology
NOTES
OP-robots and Endosystems
License of Medical Products and Quality Management

**Workload**

Literature: 20 h
Lessons: 21 h
Preparation and Review: 50 h
Exam preparation: 30 h
**Literature**
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2005
Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II; Springer-Verlag, 1994
M. Madou
Fundamentals of Microfabrication
11.34 Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine IV [T-MACH-106877]

Responsible: Prof. Dr. Andreas Guber
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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Competence Certificate

Oral examination (45 Min.)

Prerequisites

none
### 11.35 Course: Bionic Inspired Reinforced Composites [T-MACH-106723]

**Responsible:** Prof. Dr.-Ing. Dietmar Koch  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Competence Certificate**  
oral exam
11.36 Course: Bionics for Engineers and Natural Scientists [T-MACH-102172]

**Responsible:** PD Dr. Hendrik Hölscher

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology

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**Exams**

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<td>Hölscher</td>
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**Competence Certificate**

written or oral exam

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Bionics for Engineers and Natural Scientists**

2142140, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Description**

**Media:**

Slides of the lectures

**Notes**

Bionics focuses on the design of technical products following the example of nature. For this purpose we have to learn from nature and to understand its basic design rules. Therefore, the lecture focuses on the analysis of the fascinating effects used by many plants and animals. Possible implementations into technical products are discussed in the end.

The students should be able analyze, judge, plan and develop biomimetic strategies and products.

Basic knowledge in physics and chemistry

lectures 30 h

self study 30 h

preparation for examination 30 h

The successfull attendance of the lecture is controlled by a written examination.

**Learning Content**

Bionics focuses on the design of technical products following the example of nature. For this purpose we have to learn from nature and to understand its basic design rules. Therefore, the lecture focuses on the analysis of the fascinating effects used by many plants and animals. Possible implementations into technical products are discussed in the end.

**Workload**

lectures 30 h

self study 30 h

preparation for examination 30 h
Literature
Course: Boosting of Combustion Engines [T-MACH-105649]

Responsible: Dr.-Ing. Johannes Kech
Dr.-Ing. Heiko Kubach

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102627 - Major Field: Energy Converting Engines
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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Competence Certificate
oral exam, 20 min

Prerequisites
none
### 11.38 Course: BUS-Controls [T-MACH-102150]

**Responsible:** Simon Becker  
Prof. Dr.-Ing. Marcus Geimer  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102630 - Major Field: Mobile Machines

**Type**  
Oral examination

**Credits**  
4

**Recurrence**  
Each summer term

**Version**  
2

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**Competence Certificate**  
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**  
Required for the participation in the examination is the preparation of a report during the semester. The partial service with the code T-MACH-108889 must have been passed.

**Modeled Conditions**  
The following conditions have to be fulfilled:

1. The course T-MACH-108889 - BUS-Controls - Advance must have been passed.

**Recommendation**  
Basic knowledge of electrical engineering is recommended. Programming skills are also helpful.

The number of participants is limited. A registration is mandatory, the details will be announced on the webpages of the Institute of Vehicle System Technology / Institute of Mobile Machines. In case of too many applications, attendance will be granted based on pre-qualification.

**Annotation**  
The students will get an overview of the theoretic and practical functioning of different bus systems.

After the practical oriented lessons the students will be able to visualize the communication structure of different applications, design basic systems and evaluate the complexity of programming of the complete system.

Hereunto the students program in the practical orientated lessons IFM-controllers using the programming environment CoDeSys.

**Content:**  
- Knowledge of the basics of data communication in networks  
- Overview of the operating mode of current field buses  
- Explicit observation of the operating mode and application areas of CAN buses  
- Practical programming of an example application (hardware is provided)

**Literature:**  
Below you will find excerpts from events related to this course:

**BUS-Controls**

2114092, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- Knowledge of the basics of data communication in networks
- Overview of the operating mode of current field buses
- Explicit observation of the operating mode and application areas of CAN buses
- Practical programming of an example application (hardware is provided)

**Annotation**

The course will be replenished by interesting lectures of professionals.

**Workload**

- regular attendance: 21 hours
- self-study: 92 hours

**Literature**

**Elective literature:**

11.39 Course: BUS-Controls - Advance [T-MACH-108889]

**Responsible:** Kevin Daß
Prof. Dr.-Ing. Marcus Geimer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102630 - Major Field: Mobile Machines

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**Exams**

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**Competence Certificate**
Creation of control program

**Prerequisites**
none
11.40 Course: Business Administration for Engineers and IT professionals [T-MACH-109933]

Responsible: Peter Sebregondi  
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102613 - Major Field: Lifecycle Engineering

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Competence Certificate
Assessment of another type. Two presentations and six written compositions in team work. Grading: each composition 1/8 and each presentation 1/8.

Prerequisites
None

Below you will find excerpts from events related to this course:

Business Administration for Engineers and IT professionals

2122303, SS 2019, 2 SWS, Open in study portal

Notes
Number of participants limited to 30 people.

Business Administration for Engineers and IT professionals

2122303, WS 19/20, 2 SWS, Language: German, Open in study portal

Notes
Number of participants limited to 30 people.
**11.41 Course: Business Planning [T-WIWI-102865]**

**Responsible:** Prof. Dr. Orestis Terzidis  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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**Competence Certificate**  

**Prerequisites**  
None

**Recommendation**  
None

Below you will find excerpts from events related to this course:

**Geschäftsplanung für Gründer (Track 1)**  
2545005, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Description**

This seminar introduces basic concepts of business planning for entrepreneurs to the participants. It focuses on practical concepts and hands-on-methods on how to turn business ideas into solid businesses (e.g. Business Modelling, Market Potential, Planning of Ressources, and further more) and on the creation of a realistic and viable Business Plan (with or without Venture Capital).

**Business Planning for Founders (EUCOR Edition)**  
2545020, WS 19/20, 2 SWS, Language: English, [Open in study portal](#)

**Description**

This seminar introduces basic concepts of business planning for entrepreneurs to the participants. It focuses on practical concepts and hands-on-methods on how to turn business ideas into solid businesses (e.g. Business Modelling, Market Potential, Planning of Ressources, and further more) and on the creation of a realistic and viable Business Plan (with or without Venture Capital).

**Annotation**

Please register on the seminar website.  
WARNING: creditability in Seminar Module  
The EnTechnon seminars are NOT accepted in the seminar module! The credit is only possible in MODULE ENTREPRENEURSHIP. OneException is the seminar “Entrepreneurship Research”.

Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019  
245
11.42 Course: CAD-NX Training Course [T-MACH-102187]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102613 - Major Field: Lifecycle Engineering

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Exams

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<td>SS 2019 76-T-MACH-102187</td>
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Competence Certificate
Practical examination on CAD computer, duration: 60 min.

Prerequisites
None

Recommendation
Dealing with technical drawings is required.

Annotation
For the practical course compulsory attendance exists.

Below you will find excerpts from events related to this course:

Learning Content
The participant will learn the following knowledge:

- Overview of the functional range
- Introduction to the work environment of NX
- Basics of 3D-CAD modelling
- Feature-based modelling
- Freeform modelling
- Generation of technical drawings
- Assembly modelling
- Finite element method (FEM) and multi-body simulation (MBS) with NX

Annotation
For the practical course compulsory attendance exists.

Workload
Regular attendance: 35 hours,
Self-study: 12 hours

Literature
Practical course skript
CAD-NX training course
2123357, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
The participant will learn the following knowledge:

- Overview of the functional range
- Introduction to the work environment of NX
- Basics of 3D-CAD modelling
- Feature-based modelling
- Freeform modelling
- Generation of technical drawings
- Assembly modelling
- Finite element method (FEM) and multi-body simulation (MBS) with NX

Annotation
For the practical course compulsory attendance exists.

Workload
Regular attendance: 35 hours,
Self-study: 12 hours

Literature
Practical course skript
11.43 Course: CAE-Workshop [T-MACH-105212]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102613 - Major Field: Lifecycle Engineering  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102628 - Major Field: Lightweight Construction  
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology  
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

### Type
- **Examination of another type**

### Credits
- **4**

### Recurrence
- **Each term**

### Version
- **2**

**Events**

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</table>

**Competence Certificate**

Written test (with practical part on the computer), duration 60 min.

**Prerequisites**

None

**Annotation**

For a successful participation in the examination a continuous attendance at the workshop days is necessary. Limited number of participants. Selection is made according to a selection procedure.

Below you will find excerpts from events related to this course:

**CAE-Workshop**

2147175, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Notes**

- introduction to the finite element analysis (FEA)
- stress and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to topology and shape optimization
- creation and calculation of various optimization models with the Abaqus optimization package
Workload
regular attendance: 31.5 h
self-study: 58 h
independent work with different software tools (supported by tutors and faculty stuff)
discussing and presenting results in small groups

Notes
- introduction to the finite element analysis (FEA)
- stress and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to topology and shape optimization
- creation and calculation of various optimization models with the Abaqus optimization package

Workload
regular attendance: 31.5 h
self-study: 58 h
independent work with different software tools (supported by tutors and faculty stuff)
discussing and presenting results in small groups
### 11.44 Course: CATIA Advanced [T-MACH-105312]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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<td>Each term</td>
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</table>

**Competence Certificate**  
Assessment of another type. Design project and written documentation in team work and final presentation. Grading: Project work 3/5, documentation 1/5 and presentation 1/5.

**Prerequisites**  
none

**Below you will find excerpts from events related to this course:**

**CATIA advanced**  
2123380, SS 2019, 3 SWS, Language: German, [Open in study portal]

**Learning Content**

- Use of advanced CAD techniques and CATIA functionalities  
- Management of data using the PLM system SmarTeam  
- Design engineering with CAD  
- Integration of partial solutions into the overall solution  
- Ensuring the reusability of CAD models through parameterization and cataloging  
- Validation, strength tests (FEM analysis)  
- Kinematic simulation with the digital mockup (DMU Kinematics)  
- Production with integrated CAM tool  
- Animations  
- Presentation of results at the end of the semester

**Annotation**  
For the workshop compulsory attendance exists.

**Workload**  
regular attendance: 21 hours, self-study: 35 hours
11.45 Course: Ceramic Matrix Composites [T-MACH-106722]

**Responsibility:** Prof. Dr.-Ing. Dietmar Koch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Exams**

| SS 2019 | 76-T-MACH-106722 | Ceramic Matrix Composites | Prüfung (PR) | Koch |

**Competence Certificate**

oral exam
### Course: Ceramic Processing Technology [T-MACH-102182]

**Responsibility:** Dr. Joachim Binder

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Competence Certificate**
The assessment consists of an oral exam (approx. 20 min) taking place at the agreed date.

Auxiliary means: none

The re-examination is offered upon agreement.

**Prerequisites**
none

Below you will find excerpts from events related to this course:

#### Ceramics Processing

2126730, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**
The course imparts technological basics for processing of engineering ceramics. The course is arranged in the following units:

- Synthesis methods
- Powder conditioning and mixing methods
- Forming of ceramics
- Sintering
- Finishing processes
- Ceramic films and multi-layer systems
- Effects of processing on properties

**Workload**
- Regular attendance: 21 hours
- Self-study: 99 hours

**Literature**
11.47 Course: CFD in Power Engineering [T-MACH-105407]

**Responsible:** Dr. Ivan Otic

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102608 - Major Field: Nuclear Energy
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102643 - Major Field: Fusion Technology

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<td>CFD for Power Engineering</td>
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**Exams**

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**Competence Certificate**

Oral exam, 30 min

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**CFD for Power Engineering**

2130910, SS 2019, 2 SWS, Language: English, [Open in study portal](#)

**Lecture (V)**

**Notes**

This course is specified for both Bachelor and Master students, Mechanical, Power and Nuclear Engineering.

The course is aimed of giving the fundamental of Computational Fluid Dynamics (CFD) for energy technologies. Computational techniques for solving Navier-Stokes and Energy equations with emphasis on turbulent heat and mass transfer are introduced. Finite volume method and solution of systems of linear algebraic equations are discussed. Error control, accuracy and stability are discussed and demonstrated. Reynolds-Averaged-Navier-Stokes (RANS) equations and computation of turbulent flows are discussed and demonstrated. Explicit vs. implicit time stepping methods. The course consists of both, a theoretical and a practical component. The former will deal with the derivations and properties of the methods and models for CFD. The practical part will make use of open source CFD computer program OpenFOAM to give a "hands on" insight into the simulation of turbulent flows.
Learning Content
The course is aimed at giving the fundamental of Computational Fluid Dynamics (CFD) for energy technologies. Starting from the basic physical phenomena equations an overview on computational methods and turbulence modeling is given. The course consists of both, a theoretical and a numerical component. The former will deal with the derivations and properties of the methods and models for CFD. The numerical part will make use of open source CFD computer program OpenFOAM to give a "hands on" insight into the simulation of turbulent flows. After completing the course you should be able to establish a connection between theory and CFD modeling and simulation for energy applications.

Tentative Course Outline:
The weekly coverage might change as it depends on the progress of the class.
Content
1 Introduction: What is Computational Fluid Dynamics?
2 Governing Equations
3 Numerical Methods: Introduction
4 Numerical Methods: Finite Volume
5 Numerical Methods: Solution of ordinary differential equations
6 Numerical Methods: Convergence and numerical stability
7 Turbulence and Turbulence Modelling
8 Reynolds Averaged Navier-Stokes Simulation Approach
9 Heat Transfer

Annotation
CFD Project:
- Part of this class is performing CFD simulations of turbulent heat and mass transfer using open-source CFD software OpenFOAM
- After CFD analysis is completed students have to write a technical report
- Projects are to be performed individually or in teams of two but every student writes his own report
- The CFD analysis technical report is part of the final examination.

Workload
- regular attendance: 20 h
- tutorials: 20 h
- self-study: 80 h

Literature
Course note packet
Project package
Course: CFD-Lab Using OpenFOAM [T-MACH-105313]

**Responsible:** Dr.-Ing. Rainer Koch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102634 - Major Field: Fluid Mechanic

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</table>

**Competence Certificate**

Successful solution of problems

**Prerequisites**

none

*Below you will find excerpts from events related to this course:

CFD-Lab using OpenFOAM

2169459, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**

- A CD containing the course material will be handed out to the students

**Learning Content**

- Introduction to using Open Foam
- Grid generation
- Boundary conditions
- Numerical errors
- Discretization schemes
- Turbulence models
- Two phase flow - spray
- Two Phase flow - Volume of Fluid method

**Annotation**

- Number of participants is limited
- Priority for students of the lecture "Numerische Simulation reagierender Zweiphasenströmungen" (Vorl.-Nr. 2169458)

**Workload**

- 5 days of 8 h = 40 h

**Literature**

- Documentation of Open Foam
- [www.open foam.com/docs](#)
11.49 Course: Coal Fired Power Plants [T-MACH-105410]

**Responsible:** Prof. Dr.-Ing. Thomas Schulenberg

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology

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<td>Schulenberg</td>
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</table>

**Competence Certificate**

Oral examination, Duration approximately 30 Minutes

no tools or reference materials may be used during the exam

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Coal fired power plants**

2169461, WS 19/20, 2 SWS, Language: English, Open in study portal

**Notes**

This lecture will be omitted until further
11.50 Course: Cognitive Automobiles - Laboratory [T-MACH-105378]

**Responsible:** Bernd Kitt  
Dr. Martin Lauer  
Prof. Dr.-Ing. Christoph Stiller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102640 - Major Field: Technical Logistics

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**Events**  
SS 2019 | 2138341 | Cognitive Automobiles - Laboratory | 3 SWS | Stiller, Lauer, Kamran

**Competence Certificate**  
oral exam  
30 minutes

**Prerequisites**  
none

**Annotation**  
The number of participants is limited. A registration is mandatory, the details are announced on the webpages of the institute of measurement and control systems (mrt). In case of too many interested students a subset will be selected (see website).

*Below you will find excerpts from events related to this course:*

**Cognitive Automobiles - Laboratory**  
2138341, SS 2019, 3 SWS, Language: German, Open in study portal

**Notes**  
**Lehrinhalt (EN):**  
1. Lane recognition  
2. Object detection  
3. Vehicle lateral control  
4. Vehicle longitudinal control  
5. Collision avoidance

**Lernziele (EN):**  
The laboratory accompanies the lectures "Automotive Vision" and "Behaviour Generation for Vehicles". It will provide the opportunity of turning theoretical skills taught in the lecture to practice. The laboratory is divided into four groups with a maximum number of five students in each group. During the lessons you will be supervised by scientific staff. The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision, vehicle kinematics and advanced information processing techniques are presented to provide a broad overview on "seeing vehicles". Each group is given the task to extract lane markings from video images and generate a suitable trajectory which the vehicle should follow. Apart from technical aspects in a highly innovative field of automotive technology, participants have the opportunity of gathering important qualifications as i.e. implementation skills, acquisition and comprehension of suitable literature, project and team work.
Learning Content
1. Lane recognition
2. Object detection
3. Vehicle lateral control
4. Vehicle longitudinal control
5. Collision avoidance

Workload
120 hours
11.51 Course: Cognitive Systems [T-INFO-101356]

**Responsible:** Prof. Dr.-Ing. Rüdiger Dillmann
Prof. Dr. Alexander Waibel

**Organisation:** KIT Department of Informatics

**Part of:** M-MACH-102609 - Major Field: Cognitive Technical Systems

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**Exams**

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</table>
11.52 Course: Combined Cycle Power Plants [T-MACH-105444]

Responsible: Prof. Dr.-Ing. Thomas Schulenberg
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102610 - Major Field: Power Plant Technology
M-MACH-102636 - Major Field: Thermal Turbomachines

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Events

SS 2019 2170490 Combined Cycle Power Plants 2 SWS Lecture (V) Schulenberg

Exams

SS 2019 76-T-MACH-105444 Combined Cycle Power Plants Prüfung (PR) Schulenberg

Competence Certificate

oral exam ca. 30 min

Prerequisites

none

Recommendation

We recommend to combine the lecture with the Simulator Exercises for Combined Cycle Power Plants (T-MACH-105445).

Below you will find excerpts from events related to this course:

Combined Cycle Power Plants 2170490, SS 2019, 2 SWS, Language: English, Open in study portal

Description

Media:
Lecture with English Power Point Presentation

Notes

The training objective of the course is the qualification for a research-related professional activity in power plant engineering. The participants can name the most important components of the combined cycle power plant and describe their function. They can design or modify combined cycle power plants independently and creatively. They have acquired a broad knowledge of this power plant technology, including specific knowledge of gas turbine design, steam turbine design and boiler design. On this basis, they can describe and analyze the specific behavior of the power plant components as well as the entire power plant in the grid. Participants in the lecture have a trained analytical thinking and judgment in power plant design.

Layout of a combined cycle power plant, design and operation of gas turbines, of the heat recovery steam generator, of the feedwater system and cooling systems. Design and operation of steam turbines, of the generator and its electrical systems. System response to challenging grids, protection systems, water make-up and water chemistry. Design concepts of different power plant manufacturers, innovative power plant concepts.

Learning Content

Layout of a combined cycle power plant, design and operation of gas turbines, of the heat recovery steam generator, of the feedwater system and cooling systems. Design and operation of steam turbines, of the generator and its electrical systems. System response to challenging grids, protection systems, water make-up and water chemistry. Design concepts of different power plant manufacturers, innovative power plant concepts.
Annotation
Recommendations: Knowledge in thermodynamics, heat and mass transfer, instrumentation and control, and turbomachines is presumed.
We recommend to combine the lecture with the Simulator Exercises for Combined Cycle Power Plants (2170491)

Workload
Regular attendance: 32 hours
Self study: 88 hours

Literature
Power point slides and other lecture material will be provided.
Recommended additional literature:
11 COURSES

11.53 Course: Combustion Diagnostics [T-MACH-105429]

Responsibility: Prof. Dr. Ulrich Maas
Dr.-Ing. Robert Schießl

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102635 - Major Field: Engineering Thermodynamics

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Competence Certificate
Oral exam (20 min)

Prerequisites
none

Below you will find excerpts from events related to this course:

Combustion diagnostics
2167048, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
Diagnostical methods: Laser induced fluorescence, Rayleigh-scattering, Raman-scattering Chemoluminescence.
Reduced description of combustion processes and measurements.
Discussion of the potential and limits of specific strategies in different combustion systems.

Workload
Regular attendance: 22 hours
Self-study, exam preparation: 100,0 hours

Literature
Lecture notes
Learning Content
Diagnostical methods: Laser induced fluorescence, Rayleigh-scattering, Raman-scattering Chemoluminescence.
Reduced description of combustion processes and measurements.
Discussion of the potential and limits of specific strategies in different combustion systems.

Workload
Regular attendance: 22.5 h
Self-study, exam preparation: 97.5 h

Literature
Lecture notes
11.54 Course: Combustion Engines I [T-MACH-102194]

**Responsible:** Prof. Dr. Thomas Koch  
Dr.-Ing. Heiko Kubach

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102627 - Major Field: Energy Converting Engines  
- M-MACH-102630 - Major Field: Mobile Machines  
- M-MACH-102635 - Major Field: Engineering Thermodynamics  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

**Type** | **Credits** | **Recurrence** | **Version**
---|---|---|---
Oral examination | 4 | Each winter term | 1

**Events**

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**Competence Certificate**

oral examination, Duration: 25 min., no auxiliary means

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Combustion Engines I**

2133113, WS 19/20, 4 SWS, Language: German, Open in study portal

**Notes**

Introduction, History, Concepts  
Working Principle and Applications  
Characteristic Parameters  
Engine Parts  
Drive Train  
Fuels  
Gasoline Engines  
Diesel Engines  
Exhaust Gas Aftertreatment
Learning Content
Introduction, History, Concepts
Working Principle and Applications
Characteristic Parameters
Engine Parts
Drive Train
Fuels
Gasoline Engines
Diesel Engines
Exhaust Gas Aftertreatment

Workload
regular attendance: 32 hours
self-study: 88 hours
### Course: Combustion Engines II [T-MACH-104609]

**Responsible:** Dr.-Ing. Rainer Koch  
Dr.-Ing. Heiko Kubach  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**  
oral examination, duration: 25 minutes, no auxiliary means

**Prerequisites**  
none

**Recommendation**  
Fundamentals of Combustion Engines I helpful

Below you will find excerpts from events related to this course:

#### Combustion Engines II

2134151, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- Emissions
- Fuels
- Drive Train Dynamics
- Engine Parts
- Boosting
- Alternative Powertrain Concepts
- Special Engine Concepts
- Power Transmission

**Workload**

regular attendance: 31.5 hours  
self-study: 90 hours
### 11.56 Course: Composite Manufacturing - Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies [T-MACH-105535]

**Responsible:** Prof. Dr.-Ing. Frank Henning  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102628 - Major Field: Lightweight Construction  
- M-MACH-102632 - Major Field: Polymer Engineering  
- M-MACH-102641 - Major Field: Rail System Technology

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**Competence Certificate**

- written exam 90 minutes

**Prerequisites**

- none

*Below you will find excerpts from events related to this course:*

**Composite Manufacturing – Polymers, Fibers, Semi-Finished Products, Manufacturing Technologies**

- Lecture (V)  
- 2114053, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Learning Content
Physical connections of fiber reinforcement
Use and examples
automotive construction
transport
Energy and construction
sport and recreation
resins
thermoplastics
duromeres
mechanisms of reinforcements
glas fibers
carbon fibers
aramid fibers
natural fibers
semi-finished products - textiles
process technologies - prepregs
recycling of composites

Workload
lectures: 21h, preparation of examination: 79h
11.57 Course: Computational Dynamics [T-MACH-105349]

**Responsibility:** Prof. Dr.-Ing. Carsten Proppe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102604 - Major Field: Computational Mechanics
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

**Type:** Oral examination

**Credits:** 4

**Recurrence:** Each summer term

**Version:** 1

**Events**

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**Competence Certificate**
oral exam, 30 min.

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Computational Dynamics**
2162246, SS 2019, 2 SWS, Open in study portal

**Learning Content**
1. Fundamentals of elasto-kinetics (Equations of motion, principle of Hamilton and principle of Hellinger-Reissner)
2. Differential equations for the vibration of structure elements (bars, plates)
3. Numerical solutions of the equations of motion
4. Numerical algorithms
5. Stability analyses

**Annotation**
The course takes place every two years (in pair years).

**Workload**
Lectures: 20 h
Self-studies: 100 h

**Literature**
1. Lecture notes (in German) will be provided!
Course: Computational Homogenization on Digital Image Data [T-MACH-109302]

**Responsible:** Prof. Dr. Matti Schneider

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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**Competence Certificate**
oral exam, 30 min

**Prerequisites**
nein

**Below you will find excerpts from events related to this course:**

**Computational homogenization on digital image data (Lecture)**

2161123, WS 19/20, 2 SWS, Language: English, Open in study portal

**Description**
Contents of the lectures "Continuum Mechanics of Solids and Fluids" or "Mathematical Methods in Continuum Mechanics" are required

**Notes**
* Basic equations for computing effective elastic material properties
* Moulinec-Suquet's FFT-based computational homogenization method
* Schemes for treating highly contrasted/porous/defected media
* Treating non-linear and time dependent mechanical problems

**Learning Content**
Contents:
* basic equations for computing effective elastic material properties
* Moulinec-Suquet's FFT-based computational homogenization method
* schemes for treating highly contrasted/porous/defected media
* treating non-linear and time dependent mechanical problems

**Workload**
regular attendance: 42 hours (together with tutorial No 2161124)
self-study: 138 hours

**Literature**
Notes
Please refer to the lecture "Computational homogenization on digital image data".
### Course: Computational Intelligence [T-MACH-105314]

**Responsible:** Dr. Wilfried Jakob  
Prof. Dr. Ralf Mikut  
PD Dr.-Ing. Markus Reischl

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102633 - Major Field: Robotics

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**Competence Certificate**

Written exam (Duration: 1h)

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Notes**

The students are able to apply the fundamental methods of computational intelligence (fuzzy logic, artificial neural networks, evolutionary algorithms) efficiently. They know the basic mathematical foundations and are able to transfer these methods to practical applications.

**Content:**

- Terms and definitions Computational Intelligence, application fields and examples
- Fuzzy logic: fuzzy sets; fuzzification and membership functions; inference: T-norms and -conorms, operators, aggregation, activation, accumulation; defuzzification methods, structures for fuzzy control
- Artificial Neural Nets: biology of neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps, training strategies (Backpropagation, Levenberg-Marquardt)
- Evolutionary Algorithms: Basic algorithm, Genetic Algorithms and Evolution Strategies, Evolutionary Algorithm GLEAM, integration of local search strategies, memetic algorithms, application examples

**Learning objectives:**

The students are able to apply the fundamental methods of computational intelligence (fuzzy logic, artificial neural networks, evolutionary algorithms) efficiently. They know the basic mathematical foundations and are able to transfer these methods to practical applications.
Learning Content

- Terms and definitions Computational Intelligence, application fields and examples
- Fuzzy logic: fuzzy sets; fuzzification and membership functions; inference: T-norms and \( -\)conorms, operators, aggregation, activation, accumulation; defuzzification methods, structures for fuzzy control
- Artificial Neural Nets: biology of neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps, training strategies (Backpropagation, Levenberg-Marquardt)
- Evolutionary Algorithms: Basic algorithm, Genetic Algorithms and Evolution Strategies, Evolutionary Algorithm GLEAM, integration of local search strategies, memetic algorithms, application examples

Workload

regular attendance: 21 hours
self-study: 99 hours

Literature

Lecture notes (ILIAS)
Kroll, A. Computational Intelligence: Eine Einführung in Probleme, Methoden und technische Anwendungen Oldenbourg Verlag, 2013
Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe; 2008 (PDF frei im Internet)
11.60 Course: Computational Mechanics I [T-MACH-105351]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke
Dr.-Ing. Tom-Alexander Langhoff

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102604 - Major Field: Computational Mechanics
- M-MACH-102646 - Major Field: Applied Mechanics

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**Competence Certificate**
oral examination, 30 min.

**Prerequisites**
none

**Recommendation**
The contents of the lectures "Mathematical Methods in Strength of Materials" and "Introduction to the Finite Element Method" are assumed to be known.
This course is geared to MSc students.

Below you will find excerpts from events related to this course:

**Notes**
Please refer to the lecture "Computational Mechanics I".

**Learning Content**
- numerical solution of linear systems
- basics of boundary value problems of linear elasticity
- solution methods of boundary value problem of linear elasticity;
- matrix displacement method
- variational principles of linear elasticity
- finite-element-technology for linear static problems

**Workload**
regular attendance: 42 hours
self-study: 138 hours
Literature
### Course: Computational Mechanics II [T-MACH-105352]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke  
Dr.-Ing. Tom-Alexander Langhoff  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102604 - Major Field: Computational Mechanics  
M-MACH-102646 - Major Field: Applied Mechanics  

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**Competence Certificate**

oral examination, 30 min.

**Prerequisites**

none  

Below you will find excerpts from events related to this course:

**Computational Mechanics II**

2162296, SS 2019, 2 SWS, Language: German, [Open in study portal](#)  

**Learning Content**

- overview quasistatic nonlinear phenomena  
- numerics of nonlinear systems  
- foundations of nonlinear continuum mechanics  
- balance equations of geometrically nonlinear solid mechanics  
- finite elasticity  
- infinitesimal plasticity  
- linear and geometrically nonlinear thermoelasticity

**Workload**

regular attendance: 42 hours  
self-study: 138 hours

**Literature**

11.62 Course: Computational Vehicle Dynamics [T-MACH-105350]

**Responsible:** Prof. Dr.-Ing. Carsten Proppe  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102604 - Major Field: Computational Mechanics  
M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102609 - Major Field: Cognitive Technical Systems  
M-MACH-102641 - Major Field: Rail System Technology  
M-MACH-102646 - Major Field: Applied Mechanics  
M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

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**Events**

| SS 2019  | 2162256 | Computational Vehicle Dynamics | 2 SWS | Lecture (V) | Proppe |

**Competence Certificate**  
oral exam, 30 min.

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Computational Vehicle Dynamics**  
2162256, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Learning Content**

1. Introduction  
2. Models of load bearing systems  
3. Contact forces between wheels and roadway  
4. Simulation of roadways  
5. Vehicle models  
6. Methods of calculation  
7. Performance indicators

**Annotation**  
The course takes place every two years (impair years only).

**Workload**

Lectures: 20 h  
Self-studies: 100 h

**Literature**

11.63 Course: Computer Engineering [T-MACH-105360]

**Responsible:** Dr. Hubert Keller  
Dr.-Ing. Maik Lorch  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102633 - Major Field: Robotics  

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**Events**

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<td>Prüfung (PR)</td>
<td>Keller, Lorch</td>
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**Competence Certificate**

written exam (Duration: 2 hours)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Notes**

**Content:**

Introduction: definitions, basic concepts, introductory examples  
Information coding on finite automata: numbers, characters, commands, examples  
Algorithm design: definitions, complexity of algorithms, complexity classes P and NP, examples  
Sorting algorithms: relevance, algorithms, simplifications, examples  
Software quality assurance: terms and measures, errors, phases of quality assurance, constructive measures, analytical measures, certification

Lectures are complemented by an exercise course.

**Learning objectives:**

The students possess essential knowledge about information processing in digital computers. Based on information representation and calculations of complexity, students are capable to design algorithms efficiently. The students are able to apply the knowledge about efficient algorithm design to important numerical computation methods in mechanical engineering. Students have basic knowledge of real-time systems and their development. Students can use the knowledge to develop real-time systems for reliable automation of technological systems in mechanical engineering.
Learning Content
Introduction: definitions, basic concepts, introductory examples

Information coding on finite automata: numbers, characters, commands, examples

Algorithm design: definitions, complexity of algorithms, complexity classes P and NP, examples

Sorting algorithms: relevance, algorithms, simplifications, examples

Software quality assurance: terms and measures, errors, phases of quality assurance, constructive measures, analytical measures, certification

Lectures are complemented by an exercise course.

Workload
regular attendance: 31.5 hours
self-study: 73.5 hours

Literature
Lecture Notes (Ilias)


Course: Computerized Multibody Dynamics [T-MACH-105384]

**Responsible:** Prof. Dr.-Ing. Wolfgang Seemann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- **M-MACH-102597** - Compulsory Elective Module Mechanical Engineering
- **M-MACH-102598** - Major Field: Advanced Mechatronics
- **M-MACH-102606** - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- **M-MACH-102633** - Major Field: Robotics
- **M-MACH-104434** - Major Field: Modeling and Simulation in Dynamics

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**Competence Certificate**
Oral exam, 30 min.

**Prerequisites**
none

**Recommendation**
Knowledge of EM III/IV
11.65 Course: Constitution and Properties of Protective Coatings [T-MACH-105150]

**Responsible:** Prof. Dr. Sven Ulrich  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering

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**Exams**

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**Competence Certificate**
oral examination (about 30 min)
no tools or reference materials

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Constitution and Properties of Protective Coatings**
2177601, WS 19/20, 2 SWS, Language: German, [Open in study portal]

Notes
oral examination (about 30 min); no tools or reference materials
Teaching Content:
introduction and overview
concepts of surface modification
coating concepts
coating materials
methods of surface modification
coating methods
characterization methods
state of the art of industrial coating of tools and components
new developments of coating technology
regular attendance: 22 hours
self-study: 98 hours
Transfer of the basic knowledge of surface engineering, of the relations between constitution, properties and performance, of the manifold methods of modification, coating and characterization of surfaces.
Learning Content
introduction and overview

concepts of surface modification
coating concepts
coating materials
methods of surface modification
coating methods
characterization methods
state of the art of industrial coating of tools and components
new developments of coating technology

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature

Copies with figures and tables will be distributed
11.66 Course: Constitution and Properties of Wearresistant Materials [T-MACH-102141]

**Responsible:** Prof. Dr. Sven Ulrich  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102637 - Major Field: Tribology

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**Events**

| SS 2019 | 2194643 | Constitution and Properties of Wear resistant materials | 2 SWS | Lecture (V) | Ulrich |

**Exams**

| SS 2019 | 76-T-MACH-102141 | Constitution and Properties of Wearresistant Materials | Prüfung (PR) | Ulrich |

** Competence Certificate**

oral examination (about 30 min)

no tools or reference materials

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Constitution and Properties of Wear resistant materials**

2194643, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Notes
The assessment consists of an oral exam (ca. 30 min) taking place at the agreed date (according to Section 4(2), 2 of the examination regulation). The re-examination is offered upon agreement.

Teaching Content:
introduction
materials and wear
unalloyed and alloyed tool steels
high speed steels
stellites and hard alloys
hard materials
hard metals
ceramic tool materials
superhard materials
new developments
regular attendance: 22 hours
self-study: 98 hours
Basic understanding of constitution of wear-resistant materials, of the relations between constitution, properties and performance, of principles of increasing of hardness and toughness of materials as well as of the characteristics of the various groups of wear-resistant materials.

Learning Content
introduction
materials and wear
unalloyed and alloyed tool steels
high speed steels
stellites and hard alloys
hard materials
hard metals
ceramic tool materials
superhard materials
new developments

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature
Schneider, J.: Schneidkeramik, Verlag moderne Industrie, Landsberg am Lech, 1995
Copies with figures and tables will be distributed
11.67 Course: Contact Mechanics [T-MACH-105786]

**Responsible:** Dr. Christian Greiner  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102637 - Major Field: Tribology

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| Events | SS 2019 | 2181220 | Contact Mechanics | 2 SWS | Lecture (V) | Greiner |

**Competence Certificate**  
oral exam ca. 30 minutes

**Prerequisites**  
none

**Recommendation**  
preliminary knowledge in mathematics, physics and materials science

*Below you will find excerpts from events related to this course:*

**Contact Mechanics**  
2181220, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Notes**  
The course introduces contact mechanics of smooth and rough surface for non-adhesive and adhesive interfacial conditions. There will be a computer lab held in parallel to the lecture that teaches numerical approaches to contact mechanical problems.

1. Introduction: contact area and stiffness  
2. Theory of the elastic half-space  
3. Contact of nonadhesive spheres: Hertz theory  
4. Physics and chemistry of adhesive interactions at interfaces  
5. Contact of adhesive spheres: theories of Johnson-Kendall-Roberts, Derjaguin-Muller-Toporov and Maugis-Dugdale  
6. Surface roughness: topography, power spectral density, structure of real surfaces, fractal surfaces as a model, metrology  
8. Contact of adhesive rough surface: theories of Fuller-Tabor, Persson and recent numerical results  
9. Contact of rough spheres: theory of Greenwood-Tripp and recent numerical results  
10. Lateral and sliding contact: theories of Cattaneo-Mindlin, Savkoor, Persson  
11. Applications of contact mechanics

The student  
- knows models for smooth and rough surfaces under non-adhesive and adhesive conditions and understands their strengths and limits  
- knows fundamental scaling relations for the functional dependency between contact area, stiffness and normal force  
- can apply numerical methods to study questions from materials science

Preliminary knowledge in mathematics, physics and materials science recommended.

Regular attendance: 22.5 hours  
Self-study: 97.5 hours  
Oral exam ca. 30 minutes
**Learning Content**
The course introduces contact mechanics of smooth and rough surface for non-adhesive and adhesive interfacial conditions. There will a computer lab held in parallel to the lecture that teaches numerical approaches to contact mechanical problems.

1. Introduction: contact area and stiffness
2. Theory of the elastic half-space
3. Contact of nonadhesive spheres: Hertz theory
4. Physics and chemistry of adhesive interactions at interfaces
5. Contact of adhesive spheres: theories of Johnson-Kendall-Roberts, Derjaguin-Muller-Toporov and Maugis-Dugdale
6. Surface roughness: topography, power spectral density, structure of real surfaces, fractal surfaces as a model, metrology
8. Contact of adhesive rough surface: theories of Fuller-Tabor, Persson and recent numerical results
9. Contact of rough spheres: theory of Greenwood-Tripp and recent numerical results
10. Lateral and sliding contact: theories of Cattaneo-Mindlin, Savkoor, Persson
11. Applications of contact mechanics

**Workload**
regular attendance: 22.5 hours
self-study: 97.5 hours

**Literature**
K. L. Johnson, Contact Mechanics (Cambridge University Press, 1985)
D. Maugis, Contact, Adhesion and Rupture of Elastic Solids (Springer-Verlag, 2000)
### 11.68 Course: Control Technology [T-MACH-105185]

**Responsible:** Christoph Gönnheimer  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102616 - Major Field: Production Technology  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102633 - Major Field: Robotics

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**Events**

| SS 2019 | 2150683 | Control Technology | 2 SWS | Lecture (V) | Gönnheimer |

**Exams**

| SS 2019 | 76-T-MACH-105185 | Control Technology | Prüfung (PR) | Fleischer |

**Competence Certificate**

Written Exam (60 min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

#### Control Technology

**2150683, SS 2019, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)**

**Description**

**Media:**

Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).
Notes
The lecture control technology gives an integral overview of available control components within the field of industrial production systems. The first part of the lecture deals with the fundamentals of signal processing and with control peripherals in the form of sensors and actors which are used in production systems for the detection and manipulation of process states. The second part handles with the function of electric control systems in the production environment. The main focus in this chapter is laid on programmable logic controls, computerized numerical controls and robot controls. Finally the course ends with the topic of cross-linking and decentralization with the help of bus systems. The lecture is very practice-oriented and illustrated with numerous examples from different branches.

The following topics will be covered:

- Signal processing
- Control peripherals
- Programmable logic controls
- Numerical controls
- Controls for industrial robots
- Distributed control systems
- Field bus
- Trends in the area of control technology

Learning Outcomes:
The students ...

- are able to name the electrical controls which occur in the industrial environment and explain their function.
- can explain fundamental methods of signal processing. This involves in particular several coding methods, error protection methods and analog to digital conversion.
- are able to choose and to dimension control components, including sensors and actors, for an industrial application, particularly in the field of plant engineering and machine tools. Thereby, they can consider both, technical and economical issues.
- can describe the approach for projecting and writing software programs for a programmable logic control named Simatic S7 from Siemens. Thereby they can name several programming languages of the IEC 1131.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
The lecture control technology gives an integral overview of available control components within the field of industrial production systems. The first part of the lecture deals with the fundamentals of signal processing and with control peripherals in the form of sensors and actors which are used in production systems for the detection and manipulation of process states. The second part handles with the function of electric control systems in the production environment. The main focus in this chapter is laid on programmable logic controls, computerized numerical controls and robot controls. Finally the course ends with the topic of cross-linking and decentralization with the help of bus systems. The lecture is very practice-oriented and illustrated with numerous examples from different branches.

The following topics will be covered:

- Signal processing
- Control peripherals
- Programmable logic controls
- Numerical controls
- Controls for industrial robots
- Distributed control systems
- Field bus
- Trends in the area of control technology

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours
Course: Cooling of Thermally High Loaded Gas Turbine Components [T-MACH-105414]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
Dr.-Ing. Achmed Schulz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102636 - Major Field: Thermal Turbomachines

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**Competence Certificate**

oral exam, 30 min.

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**V Cooling of thermally high loaded gas turbine components**

2170463, SS 2019, 2 SWS, Language: German, Open in study portal

**Learning Content**

Hot gas temperatures of modern gas turbine engines exceed the maximum tolerable material temperatures by several hundreds of K. To ensure reliability of lifetime, complex cooling technology must be applied. Various cooling methods will be introduced in this lesson. Specific pros and cons will be identified and new concepts for further improvement of cooling will be discussed. Furthermore, the fundamentals of forced convection heat transfer and film cooling will be imparted and a simplified design process of a cooled gas turbine components will be demonstrated. Finally, experimental and numerical methods for the characterization of heat transfer will be presented.

**Workload**

regular attendance: 21 h  
self-study: 42 h
11.70 Course: Current Topics on BioMEMS [T-MACH-102176]

**Responsible:** Prof. Dr. Andreas Guber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102616 - Major Field: Microsystem Technology

### Type
Examination of another type

### Credits
4

### Recurrence
Each term

### Version
2

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<td>Guber</td>
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| Exams | SS 2019 | 76-T-MACH-102176 | Current Topics on BioMEMS | | | Guber |

**Competence Certificate**
active participation and own presentation (30 Min.)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Actual topics of BioMEMS**
2143873, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**
Media:
Written preparations from the participants.

**Workload**
Active participation on the seminar and preparation of an own presentation of a topic in BioMEMS.
Lecture time: 21 h
Preparation: 40 h
Preparation of own preparation: 60 h

**Actual topics of BioMEMS**
2143873, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**
Media:
Written preparations from the participants.

**Workload**
Active participation on the seminar and preparation of an own presentation of a topic in BioMEMS.
Lecture time: 21 h
Preparation: 40 h
Preparation of own preparation: 60 h
11.71 Course: Data Analytics for Engineers [T-MACH-105694]

Responsible: Nicole Ludwig
Prof. Dr. Ralf Mikut
PD Dr.-Ing. Markus Reischl

Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102609 - Major Field: Cognitive Technical Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102633 - Major Field: Robotics

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Events

SS 2019 2106014 Data Analytics for Engineers
3 SWS Lecture / Practice (VÜ)
Mikut, Reischl, Ludwig

Exams

SS 2019 76-T-MACH-105694 Datenanalyse für Ingenieure
Prüfung (PR)
Mikut, Reischl, Hagenmeyer

Competence Certificate
Written exam (Duration: 1h)

Prerequisites
none

Below you will find excerpts from events related to this course:

Data Analytics for Engineers
2106014, SS 2019, 3 SWS, Language: German, [Open in study portal]

Lecture / Practice (VÜ)

Notes
Content:

- Introduction and motivation
- Terms and definitions (types of multidimensional features - time series and images, problem classes)
- Scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation
- Biweekly computer exercises (Software practice with Gait-CAD): Data import, benchmark datasets, control of hand prostheses, energy prediction
- 2 hours per week lectures, 1 hour per week computer training

Learning objectives:
The students are able to apply the methods of data analysis efficiently. They know the basic mathematical data mining foundations for the analysis of single features and time series using classifiers, clustering and regression approaches. They are able to use various relevant methods as Bayes classifiers, Support Vector Machines, decision trees, fuzzy rulebases and they can adapt application scenarios (with data preprocessing and validation techniques) to real-world applications.
Learning Content

- Introduction and motivation
- Terms and definitions (types of multidimensional features - time series and images, problem classes)
- Scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation
- Biweekly computer exercises (Software practice with Gait-CAD): Data import, benchmark datasets, control of hand prostheses, energy prediction
- 2 hours per week lectures, 1 hour per week computer training

Workload
regular attendance: 32 hours
self-study: 118 hours

Literature
Lecture notes (ILIAS)
Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe. 2008 (free PDF in the Internet)
11.72 Course: Decentrally Controlled Intralogistic Systems [T-MACH-105230]

**Responsible:** Prof. Dr.-Ing. Kai Furmans
Maximilian Hochstein

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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<td>2</td>
<td>Practical course (P)</td>
<td>Furmans, Hochstein</td>
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<tr>
<td>SS 2019</td>
<td>76-T-MACH-105230</td>
<td>Decentrally Controlled Intralogistic Systems</td>
<td>Furmans</td>
</tr>
</tbody>
</table>

**Competence Certificate**
Certificate by colloquium with presentation

**Prerequisites**
None

Below you will find excerpts from events related to this course:

**Decentrally controlled intralogistic systems**

2117084, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**
Lego Mindstorms, PC

**Learning Content**

- Introduction to material handling systems
- Construction of a model for decentralized logistic systems
- object-oriented programming with LabView
- Implementation of the model with Mindstorms

Presentation of the results

**Annotation**

number of participants limited
participants will be selected
One course during summer semester in english

**Workload**

regular attendance: 10 hours
self-study: 80 hours (workplace is provided)

**Literature**

none
Decentrally controlled intralogistic systems
2117084, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
Media:
Lego Mindstorms, PC

Learning Content
- Introduction to material handling systems
- Construction of a model for decentralized logistic systems
- Object-oriented programming with LabView
- Implementation of the model with Mindstorms

Presentation of the results

Annotation
number of participants limited
participants will be selected
One course during summer semester in English

Workload
regular attendance: 10 hours
self-study: 80 hours (workplace is provided)

Literature
none
### Course: Design and Development of Mobile Machines [T-MACH-105311]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer  
Jan Siebert  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102630 - Major Field: Mobile Machines

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<tr>
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**Events**

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<tr>
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<th>2113079</th>
<th>Design and Development of Mobile Machines</th>
<th>2 SWS</th>
<th>Lecture (V)</th>
<th>Geimer, Siebert, Lehr, Geiger</th>
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**Exams**

<table>
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<tr>
<th>SS 2019</th>
<th>76-T-MACH-105311</th>
<th>Design and Development of Mobile Machines</th>
<th>Prüfung (PR)</th>
<th>Geimer</th>
</tr>
</thead>
</table>

**WS 19/20 | 76-T-MACH-105311 | Design and Development of Mobile Machines | Prüfung (PR) | Geimer |

**Competence Certificate**

The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

A registration is mandatory, the details will be announced on the webpages of the Institute of Vehicle System Technology / Institute of Mobile Machines. In case of too many applications, attendance will be granted based on pre-qualification.

The course will be replenished by interesting lectures of professionals from leading hydraulic companies.

**Prerequisites**

Required for the participation in the examination is the preparation of a report during the semester. The partial service with the code T-MACH-108887 must have been passed.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-108887 - Design and Development of Mobile Machines - Advance must have been passed.

**Recommendation**

Knowledge in Fluid Power Systems (LV 2114093)
Annotation
After completion of the lecture, students can:

- design working and travel drive train hydraulics of mobile machines and can derive characteristic key factors.
- choose and apply suitable state of the art designing methods successfully
- analyse a mobile machines and break its structure down from a complex system to subsystems with reduced complexity
- identify and describe interactions and links between subsystems of a mobile machine
- present and document solutions of a technical problem according to R&D standards

The number of participants is limited.

Content:
The working scenario of a mobile machine depends strongly on the machine itself. Highly specialised machines, e.g. pavers are also as common as universal machines with a wide range of applications, e.g. hydraulic excavators. In general, all mobile machines are required to do their intended work in an optimal way and satisfy various criteria at the same time. This makes designing mobile machines to a great and interesting challenge. Nevertheless, usually key factors can be derived for every mobile machine, which affect all other machine parameters. During this lecture, these key factors and designing mobile machines accordingly will be addressed. To do so, an exemplary mobile machine will be discussed and designed in the lecture as a semester project.

Literature:
See German recommendations

Below you will find excerpts from events related to this course:

Design and Development of Mobile Machines
2113079, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
Wheel loaders and excavators are highly specialized mobile machines. Their function is to detach, pick up and deposit materials near by. Significant size for dimensioning of the machines is the content of their standard shovel. In this lecture the main steps in dimensioning a wheel loader or excavator are being thought. This includes among others:

- Defining the size and dimensions,
- the dimensioning of the drive train,
- Determining the kinematics of the equipment,
- the dimension of the working hydraulics and
- Calculations of strength

The entire design process of these machines is strongly influenced by the use of standards and guidelines (ISO/DIN-EN). Even this aspect is dealt with.

The lecture is based on the knowledge from the fields of mechanics, strength of materials, machine elements, propulsion and fluid technique. The lecture requires active participation and continued collaboration.

Workload
- regular attendance: 21 hours
- self-study: 99 hours

Literature
None.
## 11.74 Course: Design and Development of Mobile Machines - Advance [T-MACH-108887]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer  
Jan Siebert  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102630 - Major Field: Mobile Machines

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### Exams

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<td>Design and Development of Mobile Machines - Advance</td>
<td>Prüfung (PR)</td>
<td>Geimer</td>
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<tr>
<td>WS 19/20</td>
<td>76-T-MACH-108887</td>
<td>Design and Development of Mobile Machines - Advance</td>
<td>Prüfung (PR)</td>
<td>Geimer</td>
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</table>

**Competence Certificate**  
Preparation of semester report

**Prerequisites**  
none
Course: Design of a jet engine combustion chamber [T-CIWVT-105780]

**Responsible:** Prof. Dr.-Ing. Nikolaos Zarzalis  
**Organisation:** KIT Department of Chemical and Process Engineering  
**Part of:** M-MACH-102627 - Major Field: Energy Converting Engines

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<th>Lecture</th>
<th>Title</th>
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<tr>
<td>WS 19/20</td>
<td>22527</td>
<td>Design of a Jet Engine Combustion Chamber</td>
<td>SWS</td>
<td>Zarzalis</td>
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</table>

**Competence Certificate**
The examination is an oral examination on lecture 22527 with a duration of 20 minutes.

**Prerequisites**
None
11 COURSES

Course: Design of Highly Stresses Components [T-MACH-105310]

11.76 Course: Design of Highly Stresses Components [T-MACH-105310]

Responsible: Prof. Dr.-Ing. Jarir Aktaa
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102608 - Major Field: Nuclear Energy
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102643 - Major Field: Fusion Technology
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

<table>
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Events

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<td>2181745</td>
<td>Design of highly stresses components</td>
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<td>Aktaa</td>
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Exams

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<th>Code</th>
<th>Title</th>
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<td>SS 2019</td>
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<td>Design of Highly Stresses Components</td>
<td>Prüfung (PR)</td>
<td>Aktaa</td>
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</tbody>
</table>

Competence Certificate
oral exam

Below you will find excerpts from events related to this course:

**Design of highly stresses components**

2181745, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

Contents of the lecture:

- rules of common design codes
- classical models for elasto-plasticity and creep
- lifetime rules for creep, fatigue and creep-fatigue interaction
- unified constitutive models for thermo-elasto-viscoplasticity
- continuum mechanical models for damage at high temperatures
- application of advanced material models in FE-codes

**Workload**

regular attendance: 22,5 hours
self-study: 97,5 hours

**Literature**

11.77 Course: Design Thinking [T-WIWI-102866]

**Responsible:** Prof. Dr. Orestis Terzidis

**Organisation:** KIT Department of Economics and Management

**Part of:** M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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<th>Design Thinking (Track 1)</th>
<th>2 SWS</th>
<th>Seminar (S)</th>
<th>Terzidis, Jochem, Lau</th>
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<tbody>
<tr>
<td>WS 19/20</td>
<td>2545008</td>
<td>Design Thinking (Track 1)</td>
<td>2 SWS</td>
<td>Seminar (S)</td>
<td>Jochem, Terzidis, Lau</td>
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</tbody>
</table>

**Exams**

| SS 2019  | 7900053 | Design Thinking (Track 1) | Prüfung (PR) | Terzidis |

**Competence Certificate**
Alternative exam assessments (§4(2), 3 SPO).

**Prerequisites**
None

**Recommendation**
None

**Annotation**
The seminar content will be published on the website of the institute.
11.78 Course: Design with Plastics [T-MACH-105330]

**Responsible:** Markus Liedel

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102632 - Major Field: Polymer Engineering
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

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**Events**

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<th>2174571</th>
<th>Design with Plastics</th>
<th>2 SWS</th>
<th>Lecture (V)</th>
<th>Liedel</th>
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**Exams**

<table>
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<th>76-T-MACH-105330</th>
<th>Design with Plastics</th>
<th>Prüfung (PR)</th>
<th>Liedel</th>
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</table>

**Competence Certificate**

Oral exam, about 20 minutes

**Prerequisites**

none

**Recommendation**

Poly I

Below you will find excerpts from events related to this course:

**Design with Plastics**

2174571, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)
Notes
Structure and properties of plastics materials,
Processing of plastics,
Behavior of plastics under environmental impacts,
Classic strength dimensioning,
Geometric dimensioning,
Plastic appropriate design,
Failure examples,
Joining of plastic parts,
Supporting simulation tools,
Structural foams,
Plastics Technology trends.

learning objectives:
Students will be able to

- distinguish polymer compounds from other construction materials regarding chemical differences, thermal behavior and solid conditions.
- discuss main plastics processes regarding advantages and disadvantages of materials selection and part geometry design and to make appropriate selections.
- analyze complex application requirements concerning material impacts on strength and to use the classic dimensioning method specific to the application to evaluate the lifetime part strength limit.
- evaluate part tolerances and geometry by appropriate methods considering molding shrinkage, production tolerances, post shrinkage, heat expansion, swelling, elastic and creep deformation.
- design plastic specific joining geometries like snap fits, screw bosses, weld seams and film hinges.
- detect classic molding failures and understand potential causes as well as to reduce the probability of molding failures by defining an optimized design.
- understand benefits and limits of selected simulation tools in the plastic technology discipline (strength, deformation, filling, warpage).
- assess polymer classes and plastic part designs with respect to suitable recycling concepts and ecological consequences.

requirements:
none,
recommendation: Polymerengineering I

workload:
The workload for the lecture Design with Plastics is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Learning Content
Structure and properties of plastics materials,
Processing of plastics,
Behavior of plastics under environmental impacts,
Classic strength dimensioning,
Geometric dimensioning,
Plastic appropriate design,
Failure examples,
Joining of plastic parts,
Supporting simulation tools,
Structural foams,
Plastics Technology trends.

Workload
The workload for the lecture Design with Plastics is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Literature
Scriptum will be handed out during the lecture.
Recommended literature are provided in the lecture.
11.79 Course: Designing with Composites [T-MACH-108721]

Responsible: Prof. Dr. Eckart Schnack
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
        M-MACH-102628 - Major Field: Lightweight Construction

<table>
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</table>

Exams

| SS 2019 | 76-T-MACH-108721 | Designing with Composites | Prüfung (PR) |

Competence Certificate
Oral exam, 20 minutes

Prerequisites
None

Annotation
The lecture notes are made available via ILIAS.
11.80 Course: Designing with numerical methods in product development [T-MACH-108719]

**Responsible:** Prof. Dr. Eckart Schnack  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102605 - Major Field: Engineering Design

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<th>Recurrence</th>
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**Events**

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<td>Oral examination</td>
<td>4</td>
<td>Each winter term</td>
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**Exams**

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<tr>
<td>SS 2019</td>
<td>Oral examination</td>
<td>4</td>
<td>Each winter term</td>
<td>1</td>
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</table>

**Competence Certificate**  
Oral examination (duration: 20 min)

**Prerequisites**  
None

**Annotation**  
The lecture notes are made available via ILIAS.

Below you will find excerpts from events related to this course:

**Learning Content**  

**Workload**  
Contact time: 22.5 hrs; Self-study: 97.5 hrs

**Literature**  
Lecture notes (available in the administration office, building 10.91, rm. 310)
11.81 Course: Development of Oil-Hydraulic Powertrain Systems [T-MACH-105441]

**Responsible:** Isabelle Ays  
Dr.-Ing. Gerhard Geerling

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102618 - Major Field: Production Technology  
- M-MACH-102627 - Major Field: Energy Converting Engines  
- M-MACH-102630 - Major Field: Mobile Machines  
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

**Type**  
Oral examination

**Credits**  
4

**Recurrence**  
Each winter term

**Version**  
1

**Events**

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<td>Development of Oil-Hydraulic Powertrain Systems</td>
<td>2</td>
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<td>Geerling, Becker</td>
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**Exams**

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<td>Development of Oil-Hydraulic Powertrain Systems</td>
<td>Prüfung (PR)</td>
<td>Geimer</td>
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</table>

**Competence Certificate**  
oral exam (20 min)

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Development of Oil-Hydraulic Powertrain Systems**

2113072, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Block (B)**

**Notes**  
Place and time see institute homepage

**Learning Content**

The bloc course offered by the Chair of Mobile Machines (Mobima) conveys the basics of planning and development of mobile and industrial hydrostatic systems. The lecturer works for a market leading company producing fluid power drives and controls and gives a deep view into the process of planning and development using real life examples. The contents of the course are:

- marketing, project planning  
- hydrostatic circuits  
- heat balance, hydraulic accumulators  
- filtration, noise lowering  
- development exercises + laboratory tutorial

**Workload**

- regular attendance: 19 hours  
- self-study: 90 hours
Course: Digital Control [T-MACH-105317]

**Responsibility:** Dr.-Ing. Michael Knoop

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102609 - Major Field: Cognitive Technical Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory
- M-MACH-102633 - Major Field: Robotics

**Events**

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**Type**
- Written examination

**Credits**
- 4

**Recurrence**
- Each winter term

**Version**
- 1

**Events**

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**Exams**

- SS 2019: 76-T-MACH-105317, Digital Control, Prüfung (PR), Stiller
- WS 19/20: 76-T-MACH-105317, Digital Control, Prüfung (PR), Stiller

**Competence Certificate**

- written exam
- 60 min.

**Prerequisites**

- none

**Below you will find excerpts from events related to this course:**

**Notes**

**Lehrinhalt (EN):**
1. Introduction into digital control:
   - Motivation for digital implementation of controllers
   - Structure of digital feedback control loops
   - Sample and hold units
2. State space analysis and design:
   - Discretisation of continuous-time systems
   - Discrete-time state space equations
   - Stability - definition and criteria
   - State feedback design by eigenvalue assignment
   - PI state feedback controller
   - Luenberger observer, separation theorem
   - Systems with dead-time
   - Deadbeat design
3. Analysis and design based on z-transform:
   - z-transform - definition and theorems
   - Control loop description in the z domain
   - Stability criteria
   - Root locus controller design
   - Transfer of continuous-time controllers into discrete-time controllers

**Voraussetzungen (EN):**
- Basic studies and preliminary examination; basic lectures in automatic control

**Lernziele (EN):**
- The lecture introduces key methods for the analysis and design of digital feedback control systems. Starting point is the discretisation of linear, continuous-time models. State space based and z-transform based controller design techniques are presented for discrete-time, single-input single-output systems. Furthermore, plants with dead-time and deadbeat design are covered.
Learning Content
1. Introduction into digital control:
   Motivation for digital implementation of controllers Structure of digital feedback control loops Sample and hold units
2. State space analysis and design:
   Discretisation of continuous-time systems Discrete-time state space equations Stability - definition and criteria State feedback design by eigenvalue assignment PI state feedback controller Luenberger observer, separation theorem Systems with dead-time Deadbeat design
3. Analysis and design based on z-transform: z-transform - definition and theorems Control loop description in the z domain Stability criteria Root locus controller design Transfer of continuous-time controllers into discrete-time controllers

Workload
120 hours

Literature

### 11.83 Course: Digital microstructure characterization and modeling [T-MACH-110431]

- **Responsible:** Prof. Dr. Matti Schneider
- **Organisation:** KIT Department of Mechanical Engineering
- **Part of:**
  - M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
  - M-MACH-102646 - Major Field: Applied Mechanics

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<td>Each winter term</td>
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**Competence Certificate**
oral examination
### Course: Digitalization from Production to the Customer in the Optical Industry [T-MACH-110176]

**Responsible:** Dr. Marc Wawerla  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102618 - Major Field: Production Technology

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**Events**

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**Competence Certificate**

Alternative test achievement (graded):
- Processing and presentation (ca. 15 min) of a case study with weighting 20%
- Oral exam (ca. 20 min) with weighting 80%

**Prerequisites**

none

---

Below you will find excerpts from events related to this course:

### Digitalization from Production to the Customer in the Optical Industry

**2149701, WS 19/20, 2 SWS, Language: English, Open in study portal**

**Lecture (V)**

**Description**

The lecture deals with Digitalization along the entire value chain end-to-end, with a focus on production and supply chain. Within this context, concepts, tools, methods, technologies and concrete applications in the industry are presented. Furthermore, the students get the opportunity to get first-hand insights into the digitalization journey of a German technology company.

Main topics of the lecture:

- Concepts and methods such as disruptive innovation and agile project management
- Overview on technologies at disposal
- Practical approaches in innovation
- Applications in industry
- Field trip to ZEISS
Notes
The lecture deals with Digitalization along the entire value chain end-to-end, with a focus on production and supply chain. Within this context, concepts, tools, methods, technologies and concrete applications in the industry are presented. Furthermore, the students get the opportunity to get first-hand insights into the digitalization journey of a German technology company.

Main topics of the lecture:
- Concepts and methods such as disruptive innovation and agile project management
- Overview on technologies at disposal
- Practical approaches in innovation
- Applications in industry
- Field trip to ZEISS

Learning Outcomes:
The students ...
- are capable to comment on the content covered by the lecture.
- are able to analyze and evaluate the suitability of digitalization technologies in the optical industry.
- are able to assess the applicability of methods such as disruptive innovation and agile project management.
- are able to appreciate the practical challenges to digitalization in industry.

Workload:
regular attendance: 21 hours
self-study: 99 hours
## 11.85 Course: Digitalization of Products, Services & Production [T-MACH-108491]

**Responsible:** Dr.-Ing. Bernd Pätzold  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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### Competence Certificate

Assessment of another type. Two presentations in team work and two written compositions. Grading: each composition 1/6 and each presentation 2/3.

### Prerequisites

none

Below you will find excerpts from events related to this course:

**Digitalization of Products, Services & Production**  
2122310, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- Digitalization of products, services and production in the context of Industry 4.0 .
- Key drivers for ongoing digitalization and their impact on future product development and manufacturing.
- Methods and procedures to design the according transformation process.
- Intensive group discussions of use-case scenarios using practical examples from the industry.

**Digitalization of Products, Services & Production**  
2122310, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- Digitalization of products, services and production in the context of Industry 4.0 .
- Key drivers for ongoing digitalization and their impact on future product development and manufacturing.
- Methods and procedures to design the according transformation process.
- Intensive group discussions of use-case scenarios using practical examples from the industry.
11.86 Course: Dimensioning and Optimization of Power Train System [T-MACH-105536]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Dr.-Ing. Hartmut Faust  
Dr. Eckhard Kirchner  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102607 - Major Field: Vehicle Technology

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**Exams**

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**Competence Certificate**

oral exam (20 min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Dimensioning and Optimization of Power Train System**

Lecture (V)

2146208, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

1. Architectures: conventional, hybrid and electrical transmissions  
2. The gear as system in a vehicle  
3. Components and power flow of synchromesh gears  
4. Spur gears  
5. Synchronization  
6. Switching systems for vehicles with manual transmission  
7. Actuators  
8. Comfort aspects for manual transmissions  
9. Torque converter  
10. Planetary sets  
11. Power conversion in automatic transmissions  
12. Continuously variable transmission systems  
13. Differentials and components for power split  
14. Drive train for commercial vehicles  
15. Gears and electrical machines for electro mobility

**Workload**

regular attendance: 21 h  
self-study: 99 h
Course: Do it! – Service-Learning for prospective mechanical engineers [T-MACH-106700]

**Responsible:** Prof. Dr.-Ing. Barbara Deml  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102824 - Key Competences

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**Competence Certificate**  
Active and regular participation (compulsory attendance) in all appointments; no marking.

**Prerequisites**  
Timely enrollment in ILIAS; limited number of participants.

Below you will find excerpts from events related to this course:

Do it! – Service-Learning for prospective mechanical engineers  
2109039, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Notes**  
The course combines university learning with social engagement. The students leave the well-known academic working conditions and apply engineering skills (such as the ergonomic workplace design) within a social institution.

The course will take place every two weeks with each session lasting three hours. A part of the course will not be held at KIT, but at a workshop for persons with disabilities.

1) Introductory session
   Technical and generic preparation of the work assignment
2) Work assignment (3 sessions)
   Getting to know the working conditions in a workshop for persons with disabilities and conducting a work analysis in small groups
3) Interim review session
   Sharing about the experiences
4) Implementation phase (2 sessions)
   Implementing improvement measures concerning workplace/-process design in small groups
5) Evaluation session
   Evaluating and reflecting as well as transferring and integrating the new experiences in their student and working life

**Learning target:**  
The aim of this course is to enable students to get to know different social living and working conditions (such as a workshop for persons with disabilities), to engage in society as prospective mechanical engineers, and in doing so to develop their personality.

The overall goal is to learn by service for people, which again is an important factor for client-oriented behavior. This kind of experience and action oriented learning by social engagement is also called “service-learning”. This is supposed to encourage students’ willingness to change their perspective and to achieve some level of understanding for other living and working conditions in order to enhance their social skills such as empathy, communication skills, individual initiative, and conflict management as well as to support self-organized learning.

This course is carried out in cooperation with external partners; the concept also exists at other universities (http://www.agentur-mehrwert.de/de/hochschulen/do-it-studierendenprojekte.html).
**Literature**

Course material will be provided in ILIAS.
11.88 Course: Drive Systems and Possibilities to Increase Efficiency [T-MACH-105451]

**Responsible:** Dr.-Ing. Hans-Peter Kollmeier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**
Oral examination, time duration 30 min., no aids

**Prerequisites**
none
11.89 Course: Drive Train of Mobile Machines [T-MACH-105307]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer
Marco Wydra

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102630 - Major Field: Mobile Machines

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<td>1 SWS</td>
<td>Practice (Ü)</td>
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**Exam:**
- SS 2019 | 76-T-MACH-105307 | Drive Train of Mobile Machines | Prüfung (PR) | Geimer |

**Competence Certificate**
The final assessment will be an oral examination (20 min) taking place during the recess period. The examination will be offered in every semester and can be repeated at any regular examination date.

**Prerequisites**
- none

**Recommendation**
- General principles of mechanicals engineering
- Basic knowledge of hydraulics
- Interest in mobile machinery

**Annotation**
At the end of the lecture, participants can explain the structure and function of all discussed drive trains of mobile machines. They can analyze complex gearbox schematics and synthesize simple transmission functions using rough calculations.

**Content:**
In this course the different drive trains of mobile machinery will be discussed. The focus of this course is:
- mechanical gears
- torque converter
- hydrostatic drives
- power split drives
- electrical drives
- hybrid drives
- axles
- terra mechanics

**Media:** projector presentation

**Literature:** Download of lecture slides from IILIAS. Further literature recommendations during lectures.

*Below you will find excerpts from events related to this course:*
Drive Train of Mobile Machines
2113077, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
Media:
projector presentation

Learning Content
In this course will be discussed the different drive train of mobile machineries. The fokus of this course is:
- improve knowledge of fundamentals
- mechanical gears
- torque converter
- hydrostatic drives
- continuous variable transmission
- electrical drives
- hybrid drives
- axles
- terra mechanic

Workload
- regular attendance: 21 hours
- self-study: 89 hours

Literature
download of scriptum via ILIAS
11.90 Course: Dynamics of the Automotive Drive Train [T-MACH-105226]

Responsible: Prof. Dr.-Ing. Alexander Fidlin
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

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Events

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<td>2163112</td>
<td>Übungen zu Dynamik des Kfz-Antriebsstrangs</td>
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Competence Certificate
Oral examination, 30 min.

Prerequisites
none

Recommendation

Below you will find excerpts from events related to this course:

Dynamics of the Automotive Drive Train
2163111, WS 19/20, 2 SWS, Language: German, [Open in study portal]

Learning Content
- Main components of the vehicle powertrain and their modelling
- Typical driving situations
- Problem-oriented models for particular driving situations
- System analysis and optimization with respect to dynamic behavior

Workload
- time of attendance: 39 h
- self-study: 201 h

Literature
- Pfeiffer F., Mechanical System Dynamics, Springer, 2008
11.91 Course: Electric Rail Vehicles [T-MACH-102121]

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102641 - Major Field: Rail System Technology

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**Events**

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**Exams**

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**Competence Certificate**  
Oral examination  
Duration: ca. 20 minutes  
No tools or reference materials may be used during the exam.

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Electric Rail Vehicles**  
2114346, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**  
**Media:**  
All slides are available for download (Ilias-platform).

**Notes**

1. Introduction: history of electric traction in railway vehicles, economic impact  
2. Wheel-rail-contact: carrying of vehicle mass, adhesion, current return  
3. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles  
4. Electric drives: purpose of electric drive and basic configurations, traction motors (induction machine, synchronous machine with permanent magnets), drives for vehicles at dc and ac lines, drives for vehicle without contact wire, hybrids, conventional drives for existing vehicles  
5. Train control management system: definitions, networks, bus systems, components, examples  
6. Vehicle concepts: modern vehicle concepts for mass transit and electric main line  
7. Traction power supply: dc and ac networks, energy management, design aspects
Learning Content

1. Introduction: history of electric traction in railway vehicles, economic impact
2. Wheel-rail-contact: carrying of vehicle mass, adhesion, current return
3. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles
4. Electric drives: traction motors, power conversion, drives for vehicles at dc and ac lines, diecaselectric vehicles, multi system vehicles, axle drives, transmission of tractive effort to the rails
5. Train control management system: definitions, networks, bus systems, components, examples
6. Vehicle concepts: modern vehicle concepts for mass transit and electric main line
7. Traction power supply: networks, substations, inductive power supply, energy management

Workload

Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature

A bibliography is available for download (Ilias-platform).
### 11.92 Course: Electrical Engineering for Business Engineers, Part II [T-ETIT-100534]

**Responsible:** Dr. Wolfgang Menesklo

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:** M-MACH-102739 - Fundamentals and Methods of Automotive Engineering

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11.93 Course: Elements and Systems of Technical Logistics [T-MACH-102159]

Responsible: Georg Fischer
Dr.-Ing. Martin Mittwollen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102618 - Major Field: Production Technology
M-MACH-102640 - Major Field: Technical Logistics

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Exams

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<td>76-T-MACH-102159</td>
<td>Elements and Systems of Technical Logistics</td>
<td>Prüfung (PR)</td>
<td>Mittwollen</td>
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</tbody>
</table>

Competence Certificate

The assessment consists of an oral exam (20min) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

Prerequisites

none

Recommendation

Knowledge out of Basics of Technical Logistics (T-MACH-102163) preconditioned

Below you will find excerpts from events related to this course:

Elements and systems of Technical Logistics

2117096, WS 19/20, 3 SWS, Language: German, Open in study portal

Learning Content

- material flow systems and their (conveying) technical components
- mechanical behaviour of conveyors;
- structure and function of conveyor machines; elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)
- sample applications and calculations in addition to the lectures inside practical lectures

Annotation

Knowledge out of Basics of Technical Logistics preconditioned

Workload

presence: 36h
rework: 84h

Literature

recommendations during lectures
11.94 Course: Elements and Systems of Technical Logistics - Project [T-MACH-108946]

Responsible: Georg Fischer
Dr.-Ing. Martin Mittwollen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102618 - Major Field: Production Technology

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<td>SWS</td>
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<td>Elements and Systems of Technical Logistics - Project</td>
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Exams

Competence Certificate
Presentation of performed project and defense (30min) according to §4 (2), No. 3 of the examination regulation

Prerequisites
T-MACH-102159 (Elements and Systems of Technical Logistics) must have been started

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-102159 - Elements and Systems of Technical Logistics must have been started.

Recommendation
Knowledge out of Basics of Technical Logistics (T-MACH-102163) preconditioned

Below you will find excerpts from events related to this course:

Elements and systems of Technical Logistics - project
2117097, WS 19/20, SWS, Language: German, Open in study portal

Description
Media:
supplementary sheets, presentations, blackboard

Learning Content

- mechanical behaviour of conveyors;
- structure and function of conveyor machines;
- elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)
- sample applications and calculations in addition to the lectures inside practical lectures
- Self manufacturing of a project report to recesses the topic.

Annotation
Knowledge out of Basics of Technical Logistics (LV 2117095) preconditioned
11.95 Course: Energy and Indoor Climate Concepts [T-ARCH-107406]

**Responsible:** Prof. Andreas Wagner

**Organisation:** KIT Department of Architecture

**Part of:** M-MACH-102648 - Major Field: Energy Technology for Buildings

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<th>3 SWS</th>
<th>Lecture (V)</th>
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**Exams**

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<th>7000764</th>
<th>Energy and Indoor Climate Concepts</th>
<th>Prüfung (PR)</th>
<th>Wagner</th>
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</thead>
</table>

Below you will find excerpts from events related to this course:

**Energy and Indoor Climate Concepts**

1720970, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**

**Notes**

The students will become familiar with concepts and technologies of energy-efficient building. Topics like heat protection, passive solar energy use, ventilation systems and passive cooling are addressed. New ways of renewable energy supply show the path towards climate-neutral buildings. On the basis of examples from practice, energy and indoor climate concepts for different buildings types are investigated in detail and analyzed with regard to presented performance criteria. In addition, an excursion is offered. In terms of project work, individual design projects are examined with regard to their energy performance. For qualification targets see module handbook.

**Appointment:** Tue 9:45 - 11:15, 20.40, R 240

**First Meeting:** 23.04.2019, 11:15, 20 40, R 240

**Examination:** 14.08.2019

**Number of Participants:** 10
**11 COURSES**

Course: Energy Conversion and Increased Efficiency in Internal Combustion Engines [T-MACH-105564]

**11.96 Course: Energy Conversion and Increased Efficiency in Internal Combustion Engines [T-MACH-105564]**

**Responsible:** Prof. Dr. Thomas Koch  
Dr.-Ing. Heiko Kubach

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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<td>Koch, Kubach</td>
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<td>Koch</td>
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**Competence Certificate**

oral exam, 25 minutes, no auxiliary means

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Energy Conversion and Increased Efficiency in Internal Combustion Engines**

2133121, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**

1. Introduction
2. Thermodynamics of combustion engines
3. Fundamentals
4. gas exchange
5. Flow field
6. Wall heat losses
7. Combustion in gasoline engines
8. Pressure Trace Analysis
9. Combustion in Diesel engines
10. Waste heat recovery
Learning Content
1. Introduction
2. Thermodynamics of combustion engines
3. Fundamentals
4. gas exchange
5. Flow field
6. Wall heat losses
7. Combustion in gasoline engines
8. Pressure Trace Analysis
9. Combustion in Diesel engines
10. Waste heat recovery

Workload
regular attendance: 24 hours, self-study: 96 hours
**Course: Energy demand of buildings – fundamentals and applications, with building simulation exercises [T-MACH-105715]**

**Responsible:** Dr. Ferdinand Schmidt  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102648 - Major Field: Energy Technology for Buildings

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<td>2158203</td>
<td><strong>Energy demand of buildings – fundamentals and applications, with building simulation exercises</strong></td>
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<td>Lecture / Practice (VÜ)</td>
<td>Schmidt</td>
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**Exams**

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<th>Type / Practice</th>
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<td><strong>Energy demand of buildings – fundamentals and applications, with building simulation exercises</strong></td>
<td>Prüfung (PR)</td>
<td>Schmidt</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
oral exam, 30 minutes

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:
Notes

- Selected topics of building physics regarding energy demand of buildings for heating and cooling
- Occupants' comfort in buildings
- Ventilation demand and ventilation concepts
- The passive house concept
- Passive use of solar energy in buildings
- Passive systems / concepts for cooling of buildings
- Exergetic evaluation of building systems
- Heat transfer systems to rooms for heating and cooling, "low-ex" systems
- Numerical methods in building simulation
- Generation of load series, simulation of technical building equipment

Learning outcomes:
The students know the influencing factors on the energy demand of buildings. They know the requirements and prerequisites for low energy and passive houses. They are familiar with methods for setting up energy balances for buildings and the relevant technical building equipment. Students are able to judge under which circumstances zero-energy or plus-energy buildings (with respect to the annual primary energy balance) are attainable. They know the requirements and criteria for occupants' comfort in buildings and they are able to estimate the influence of different renovation and retrofit measures on the energy demand and occupants' comfort. They know use cases and limits of different heat transfer systems for heating and cooling of rooms and are familiar with low exergy concepts for building energy systems. Through integrated computer exercises, students learn to set up energy models of buildings, perform simulations and sensitivity analysis using these models and to evaluate and present their results.

Exam conditions:
- Project work as prerequisite for oral exam (solution of assigned building simulation task, including presentation in front of class)
- Mode of examination: oral (30 min.)
- Conditions: Cannot be combined with the following courses:
  - Building Simulation [2157109]

Learning Content

- Selected topics of building physics regarding energy demand of buildings for heating and cooling
- Occupants' comfort in buildings
- Ventilation demand and ventilation concepts
- The passive house concept
- Passive use of solar energy in buildings
- Passive systems / concepts for cooling of buildings
- Exergetic evaluation of building systems
- Heat transfer systems to rooms for heating and cooling, "low-ex" systems
- Numerical methods in building simulation
- Generation of load series, simulation of technical building equipment

Literature

same as in German, no English version of book by Pehnt (ed.) available
11.8 Course: Energy Efficient Intralogistic Systems [T-MACH-105151]

**Responsible:**
Dr.-Ing. Meike Braun  
Dr.-Ing. Frank Schönung

**Organisation:**
KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory
- M-MACH-102630 - Major Field: Mobile Machines
- M-MACH-102640 - Major Field: Technical Logistics

**Type**  
Oral examination

**Credits**  
4

**Recurrence**  
Each winter term

**Version**  
1

**Events**

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<td>WS 19/20</td>
<td>2117500</td>
<td>Energy efficient intralogistic systems</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Braun, Schönung</td>
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**Exams**

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<td>SS 2019</td>
<td>76-T-MACH-105151</td>
<td>Energy Efficient Intralogistic Systems</td>
<td>Prüfung (PR)</td>
<td>Braun</td>
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</table>

**Competence Certificate**
Oral, 30 min. examination dates after the end of each lesson period.

**Prerequisites**
none

**Recommendation**
The content of course “Basics of Technical Logistics" should be known.

**Annotation**
Visit the IFL homepage of the course for the course dates and/or possible limitations of course participation.

*Below you will find excerpts from events related to this course:*

**Energy efficient intralogistic systems**
2117500, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**
presentations, black board

**Notes**
The content of course “Basics of Technical Logistics" should be knownn.
Learning Content
The main focuses of the course are:

- green supply chain
- processes in Intralogistic systems
- evaluation of energy consumption of conveyors
- modeling of conveying systems
- methods for energy savings
- approaches for energy efficiency increasing of continuous and discontinuous conveyors
- dimensioning energy efficient drives
- new approaches for resource efficient conveying systems.

Annotation
Visit the IFL homepage of the course for the course dates and/or possible limitations of course participation

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
None.
### 11.99 Course: Energy Market Engineering [T-WIWI-107501]

**Responsible:** Prof. Dr. Christof Weinhardt

**Organisation:** KIT Department of Economics and Management

**Part of:** M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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<td>Weinhardt, Staudt</td>
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<td>79852</td>
<td>Energy Market Engineering</td>
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**Compeience Certificate**
The assessment consists of a written exam (60 min) (according to §4(2), 1 of the examination regulations). By successful completion of the exercises (§4 (2), 3 SPO 2007 respectively §4 (3) SPO 2015) a bonus can be obtained. If the grade of the written exam is at least 4.0 and at most 1.3, the bonus will improve it by one grade level (i.e. by 0.3 or 0.4).

**Prerequisites**
None

**Recommendation**
None

**Annotation**
Former course title until summer term 2017: T-WIWI-102794 “eEnergy: Markets, Services, Systems”.
The lecture has also been added in the IIP Module Basics of Liberalised Energy Markets.

**Below you will find excerpts from events related to this course:**

### Energy Market Engineering

**2540464, SS 2019, 2 SWS, Language: German, Open in study portal**

**Learning Content**
This lecture discusses different design options for electricity markets. We will focus on different approaches of nodal and zonal pricing as well as single price mechanisms and capacity markets. After a short recap of German and European market designs, the different design options will be discussed scientifically and with the help of examples. Furthermore, we will evaluate alternative market design options like microgrids. Besides the fundamental functioning of those markets, we will introduce and discuss methodological knowledge to evaluate market design options.

**Annotation**
The lecture has also been added in the IIP Module Basics of Liberalised Energy Markets.

**Workload**
The total workload for this course is approximately 135.0 hours. For further information see German version.
Literature

11.100 Course: Energy Storage and Network Integration [T-MACH-105952]

**Responsible:** Dr.-Ing. Wadim Jäger  
Prof. Dr. Robert Stieglitz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
M-MACH-102648 - Major Field: Energy Technology for Buildings

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<td>WS 19/20</td>
<td>2189487</td>
<td>Energy Storage and Grid Integration</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Jäger, Stieglitz</td>
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<td>Energiespeicher und Netzintegration</td>
<td>Prüfung (PR)</td>
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<td>Energiespeicher und Netzintegration</td>
<td>Prüfung (PR)</td>
<td>Jäger, Stieglitz</td>
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**Competence Certificate**

oral exam, about 30 minutes

**Prerequisites**

The courses T-MACH-105952 Energiespeicher und Netzintegration and T-ETIT-104644 - Energy Storage and Network Integration can not be combined.

Below you will find excerpts from events related to this course:

**Energy Storage and Grid Integration**  
2189487, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**

The lecture provides an overview of the different storage types and their fundamental integration into the power supply grid.  
Thereby, within the scope of this lecture, the necessity and the motivation for converting and storing energy will be given. Starting from the definition of fundamental terms different physical and chemical storage types along with their theoretical and practical basis are described. In particular, the decoupling of energy production and energy consumption, and the provision of different energy scales (time, power, density) will be discussed. Furthermore, the challenge of energy transport and re-integration into the different grid types is considered.  
Students understand the different types of energy storage and apply their knowledge for the selection and principal dimensioning of relevant energy storage tasks.  
Furthermore, students can reflect the state-of-the-art of most important energy storage types, their fundamental characteristics and viability at given boundary conditions and they are enabled to elaborate and apply basic integration issues dependent on the grid structure for the different network types.  
Oral exam, duration approximately 30 min, tools: non
Learning Content

The lecture provides an overview of the different storage types and their fundamental integration into the power supply grid.

Thereby, within the scope of this lecture, the necessity and the motivation for converting and storing energy will be given. Starting from the definition of fundamental terms different physical and chemical storage types along with their theoretical and practical basis are described. In particular, the decoupling of energy production and energy consumption, and the provision of different energy scales (time, power, density) will be discussed. Furthermore, the challenge of energy transport and re-integration into the different grid types is considered.
**11.01 Course: Energy Systems I: Renewable Energy [T-MACH-105408]**

**Responsible:** Dr. Ron Dagan  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102643 - Major Field: Fusion Technology  
- M-MACH-102648 - Major Field: Energy Technology for Buildings

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<td>Lecture (V)</td>
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<td>Dagan</td>
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**Competence Certificate**

oral exam, 1/2 hour

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Energy Systems I - Renewable Energy**  
2129901, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)

**Notes**

The course deals with fundamental aspects of renewable energies.

1. The first part deals with the basic concepts of absorbing solar beams, in an efficient manner accounting for the minimization of heat losses. In this context, selective topics on thermodynamics as well as fluid dynamics are introduced. In the second part few applications are discussed and optimizations techniques of solar collectors construction and their heat transfer are presented.
2. The use of solar energy as a source for heat generation is followed by the idea of electricity generation. Introductive aspects of Photovoltaic technologies are illuminated.
3. The last part presents additional regenerative energy sources such as wind and geothermal energy.

The student knows the principles of the feasibility of energy gain by means of renewable energies, in particular the solar energy.

- regular attendance: 34 hours
- self-study: 146 hours

Oral examination – as an elective course 30 minutes, in combination with Energiesysteme-II or other courses within the energy courses, as a major course 1 hour
Learning Content
The course deals with fundamental aspects of renewable energies.

1. The first part deals with the basic concepts of absorbing solar beans, in an efficient manner accounting for the minimization of heat losses. In this context, selective topics on thermodynamics as well as fluid dynamics are introduced. In the second part few applications are discussed and optimizations techniques of solar collectors construction and their heat transfer are presented.
2. The use of solar energy as a source for heat generation is followed by the idea of electricity generation. Introductive aspects of Photovoltaic technologies are illuminated.
3. The last part presents additional regenerative energy sources such as wind and geothermal energy.

Workload
regular attendance: 34 hours
self-study: 146 hours
11.02 Course: Energy systems II: Reactor Physics [T-MACH-105550]

**Responsible:** Dr. Aurelian Florin Badea  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102608 - Major Field: Nuclear Energy

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**Events**

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**Exams**

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**Competence Certificate**
oral exam, 20 min

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Energy systems II: Reactor Physics**
2130929, SS 2019, 2 SWS, Language: German, Open in study portal

**Learning Content**
nuclear fission & fusion,
radioactive decay, neutron excess, fission, fast and thermal neutrons, fissile and fertile nuclei,
neutron flux, cross section, reaction rate, mean free path,
chain reaction, critical size, moderation,
reactor dynamics,
transport- and diffusion-equation for the neutron flux distribution,
power distributions in reactor,
one-group and two-group theories,
light-water reactors,
reactor safety,
design of nuclear reactors,
breeding processes,
nuclear power systems of generation IV

**Literature**
Dieter Schmidt, Reaktortechnik, Band 1: Grundlagen, ISBN 3 7650 2003 6
### 11.103 Course: Engine Laboratory [T-MACH-105337]

**Responsible:** Dr.-Ing. Uwe Wagner  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
- M-MACH-102591 - Laboratory Course  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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</table>

#### Competence Certificate

Written documentation of every experiment, certificate of successful attendance, no grading

#### Prerequisites

None

Below you will find excerpts from events related to this course:

**Engine Laboratory**

2134001, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

#### Learning Content

5 engine experiments in up-to-date development projects

#### Workload

- Regular attendance: 40 hours
- Self-study: 80 hours

#### Literature

Description of experiments
11.04 Course: Engine Measurement Techniques [T-MACH-105169]

Responsible: Dr.-Ing. Sören Bernhardt
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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Competence Certificate
oral examination, Duration: 0,5 hours, no auxiliary means

Prerequisites
none

Recommendation
T-MACH-102194 Combustion Engines I

Below you will find excerpts from events related to this course:

V Engine measurement techniques
2134137, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
Students get to know state-of-the-art measurement techniques for combustion engines. In particular basic techniques for measuring engine operating parameters such as torque, speed, power and temperature.

Possible measurement errors and aberrations are discussed.

Furthermore techniques for measuring exhaust emissions, air/fuel ratio, fuel consumption as well as pressure indication for thermodynamic analysis are covered.

Workload
regular attendance: 21 hours
self-study: 100 hours

Literature
1. Grohe, H.: Messen an Verbrennungsmotoren
2. Bosch: Handbuch Kraftfahrzeugtechnik
3. Veröffentlichungen von Firmen aus der Messtechnik
4. Hoffmann, Handbuch der Messtechnik
5. Klingenberg, Automobil-Messtechnik, Band C
11.105 Course: Engineer's Field of Work [T-MACH-105721]

Responsible: Prof. Dr. Martin Doppelbauer
Prof. Dr.-Ing. Peter Gratzfeld

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102824 - Key Competences

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Exams

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<td>Gratzfeld, Doppelbauer</td>
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Competence Certificate
written test
Duration: 30 minutes
result: passed / not passed
No tools or reference materials may be used during the exam.

Prerequisites
none

Below you will find excerpts from events related to this course:

V Engineer's Field of Work
2114917, SS 2019, 2 SWS, Language: German, Open in study portal
Notes
AFI1: Organization of Companies (Peter Gratzfeld)
organizational structure, organizational units, managerial structure, organization charts, project organization, relation between superior and staff, board of managing directors, management of the company, supervisory board, advisory board

AFI2: Project Management (Peter Gratzfeld)
definition of project, project manager, project team, primary processes, supporting processes

AFI3: Personnel Development (Martin Doppelbauer)
applications, trainee programs, management career, professional career, career paths in companies, individual career planning, tasks of HR, manpower requirements planning, training, training-on-the-job, tools for human resource management, annual personnel talk, objective agreement

AFI4: Scheduling (Peter Gratzfeld)
Methods for detailed scheduling, network plans, critical path, Gantt-diagram, milestones

AFI5a/b: Development Processes (Martin Doppelbauer)
research, advance development, series development, product marketing, V-model, SPALTEN-model, technical specifications, requirement specifications, clarification, concept, draft, elaboration, validation, verification, documentation, FMEA

AFI6: Standards and Laws (Martin Doppelbauer)
importance of standards, German and international standardization systems, committees, certification

AFI7: Commercial Law (Martin Doppelbauer)
health protection, safety at work, environment protection, product liability, patents

AFI8: Calculation, Financial Statement (Peter Gratzfeld)
contract award estimate, project costing, unit cost, target costs, cost center accounting, cost recording, hourly rates, asset accounting, profit and loss statement

AFI9: Governance (Peter Gratzfeld)
principles of governance (accountability, responsibility, transparency, fairness), leadership (technical, commercial), reviews, boards, audits, codetermination, compliance

Learning Content
AFI1: Organization of Companies (Peter Gratzfeld)
organizational structure, organizational units, managerial structure, organization charts, project organization, relation between superior and staff, board of managing directors, management of the company, supervisory board, advisory board

AFI2: Project Management (Peter Gratzfeld)
definition of project, project manager, project team, primary processes, supporting processes

AFI3: Personnel Development (Martin Doppelbauer)
applications, trainee programs, management career, professional career, career paths in companies, individual career planning, tasks of HR, manpower requirements planning, training, training-on-the-job, tools for human resource management, annual personnel talk, objective agreement

AFI4: Scheduling (Peter Gratzfeld)
Methods for detailed scheduling, network plans, critical path, Gantt-diagram, milestones

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importance of standards, German and international standardization systems, committees, certification

AFI7: Commercial Law (Martin Doppelbauer)
health protection, safety at work, environment protection, product liability, patents

AFI8: Calculation, Financial Statement (Peter Gratzfeld)
contract award estimate, project costing, unit cost, target costs, cost center accounting, cost recording, hourly rates, asset accounting, profit and loss statement

AFI9: Governance (Peter Gratzfeld)
principles of governance (accountability, responsibility, transparency, fairness), leadership (technical, commercial), reviews, boards, audits, codetermination, compliance

Workload
Regular attendance: 15 hours
Self-study: 15 hours
Test and preparation: 30 hours

Literature
All slides are available for download (Ilias-platform).
Course: Entrepreneurship [T-WIWI-102864]

Responsible: Prof. Dr. Orestis Terzidis
Organisation: KIT Department of Economics and Management
Part of: M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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Competence Certificate
The assessment consists of a written exam (60 minutes) (following §4(2), 1 of the examination regulation).

Prerequisites
None

Recommendation
None

Below you will find excerpts from events related to this course:

Entrepreneurship
2545001, SS 2019, 2 SWS, Language: English, Open in study portal

Description
This lecture, as an obligatory part of the module “Entrepreneurship”, introduces basic concepts of entrepreneurship. It approaches the individual steps of dynamic corporate development. The focus here is the introduction to methods for generating innovative business ideas, the translation of patents into business concepts and general principles of business planning.
Other topics are the design and use of service-oriented information systems for founders, technology management, business model generation and lean startup methods for the implementation of business ideas in the way of controlled experiments in the market.

Learning Content
This lecture, as an obligatory part of the module "Entrepreneurship", introduces basic concepts of entrepreneurship. It approaches the individual steps of dynamic corporate development. The focus here is the introduction to methods for generating innovative business ideas, the translation of patents into business concepts and general principles of business planning.
Other topics are the design and use of service-oriented information systems for founders, technology management, business model generation and lean startup methods for the implementation of business ideas in the way of controlled experiments in the market.

Workload
The total workload for this course is approximately 90 hours. For further information see German version.
11.07 Course: Exercises - Fatigue of Welded Components and Structures [T-MACH-109304]

**Responsible:** Dr. Majid Farajian  
Prof. Dr. Peter Gumbsch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering

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**Notes**

The lecture gives an introduction to the following topics:
- weld quality
- typical damages of welded joints
- evaluation of notches, defects and residual stresses
- strength concepts: nominal, structural and notch stress concepts, fracture mechanics
- life cycle analysis
- post-treatment methods for an extended lifetime
- maintenance, reconditioning and repair

The student can

- describe the influence of welding induced notches, defects and residual stresses on component behavior
- explain the basics of numerical and experimental methods for the evaluation of statically or cyclically loaded welds
- explain and apply them
- derive measures in order to increase the lifetime of structures with welded joints under cyclical load

preliminary knowledge materials science and mechanics recommended

regular attendance: 22,5 hours  
self-study: 97,5 hours

Exercise sheets are handed out regularly.  
oral examination (ca. 30 min)  
no tools or reference materials
Learning Content
The lecture gives an introduction to the following topics:
- weld quality
- typical damages of welded joints
- evaluation of notches, defects and residual stresses
- strength concepts: nominal, structural and notch stress concepts, fracture mechanics
- life cycle analysis
- post-treatment methods for an extented lifetime
- maintenance, reconditioning and repair

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Literature
2. FKM-Richtlinie, Bruchmechanischer Festigkeitsnachweis, Forschungskuratorium Maschinenbau, VDMA Verlag, 2009
**11.08 Course: Exercices - Tribology [T-MACH-109303]**

**Responsible:** Prof. Dr. Martin Dienwiebel  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102637 - Major Field: Tribology  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**  
successful solving of all exercises

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

**Tribology**

2181114, WS 19/20, 5 SWS, Language: German, [Open in study portal](#)
Notes

• Chapter 1: Friction
  adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing,
  environmental influences, tribological age, contact models, Simulation of contacts, roughness.

• Chapter 2: Wear
  plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-
  in, running- in dynamics, shear stress.

• Chapter 3: Lubrication
  base oils, Stribeck plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid
  lubrication.

• Chapter 4: Measurement Techniques
  friction measurement, tribometer, dissipated frictional power, conventional wear measurement, continuous wear
  measurement(RNT)

• Chapter 5: Roughness
  profilometry, surface roughness parameters, evaluation length and filters, bearing ratio curve, measurement error

• Chapter 6: Accompanying Analysis
  multi-scale topography measurement, chemical surface analysis, structural analysis, mechanical analysis

Exercises are used for complementing and deepening the contents of the lecture as well as for answering more extensive
questions raised by the students.

The student can

• describe the fundamental friction and wear mechanisms, which occur in tribologically stressed systems

• evaluate the friction and wear behavior of tribological systems

• explain the effects of lubricants and their most important additives

• identify suitable approaches to optimize tribological systems

• explain the most important experimental methods for the measurement of friction and wear, and is able to use
  them for the characterisation of tribo pairs

• choose suitable methods for the evaluation of roughness and topography from the nm-scale to the mm-scale
  and is able to interpret the determined values in respect to their effect on the tribological behavior

• describe the most important surface-analytical methods and their physical principles for the characterization
  of tribologically stressed sliding surfaces

Preliminary knowledge in mathematics, mechanics and materials science recommended

Regular attendance: 45 hours
Self-study: 195 hours

Oral examination (ca. 40 min)
No tools or reference materials

Admission to the exam only with successful completion of the exercises

Learning Content

• Chapter 1: Friction
  adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing,
  environmental influences, tribological age, contact models, Simulation of contacts, roughness.

• Chapter 2: Wear
  plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-
  in, running- in dynamics, shear stress.

• Chapter 3: Lubrication
  base oils, Stribeck plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid
  lubrication.

• Chapter 4: Measurement Techniques
  friction measurement, tribometer, dissipated frictional power, conventional wear measurement, continuous wear
  measurement(RNT)

• Chapter 5: Roughness
  profilometry, surface roughness parameters, evaluation length and filters, bearing ratio curve, measurement error

• Chapter 6: Accompanying Analysis
  multi-scale topography measurement, chemical surface analysis, structural analysis, mechanical analysis

Exercises are used for complementing and deepening the contents of the lecture as well as for answering more extensive
questions raised by the students.

Workload

Regular attendance: 45 hours
Self-study: 195 hours
Literature

11.09 Course: Exercises for Applied Materials Simulation [T-MACH-107671]

Responsible: Prof. Dr. Peter Gumbsch
Dr. Katrin Schulz

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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Competence Certificate

successful solving of all exercises

Prerequisites

none

Below you will find excerpts from events related to this course:

Applied Materials Modelling

2182614, SS 2019, 4 SWS, Language: German, Open in study portal

Description

Media:
blackboard, beamer, script, computer exercise

Notes

This lecture should give the students an overview of different simulation methods in the field of materials science and engineering. Numerical methods are presented and their use in different fields of application and size scales shown and discussed. On the basis of theoretical as well as practical aspects, a critical examination of the opportunities and challenges of numerical material simulation shall be carried out.

The student can

- define different numerical methods and distinguish their range of application
- approach issues by applying the finite element method and discuss the processes and results
- understand complex processes of metal forming and crash simulation and discuss the structural and material behavior
- define and apply the physical fundamentals of particle-based simulation techniques to applications of materials science
- illustrate the range of application of atomistic simulation methods and distinguish between different models

preliminary knowledge in mathematics, physics and materials science recommended

regular attendance: 34 hours
exercise: 11 hours
self-study: 165 hours
oral exam ca. 35 minutes
no tools or reference materials
admission to the exam only with successful completion of the exercises
Learning Content
This lecture should give the students an overview of different simulation methods in the field of materials science and engineering. Numerical methods are presented and their use in different fields of application and size scales shown and discussed. On the basis of theoretical as well as practical aspects, a critical examination of the opportunities and challenges of numerical material simulation shall be carried out.

Workload
regular attendance: 34 hours
exercise: 11 hours
self-study: 165 hours

Literature
11 COURSES

**11.110 Course: Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria [T-MACH-107669]**

**Responsible:** Prof. Dr. Hans Jürgen Seifert

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<tr>
<td>WS 19/20</td>
<td>Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria</td>
<td>1 SWS</td>
<td>Practice (Ü)</td>
<td>Seifert, Smyrek, Ziebert</td>
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<tr>
<td>SS 2019</td>
<td>Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria</td>
<td>Prüfung (PR)</td>
<td>Seifert</td>
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</table>

**Competence Certificate**

successful solving of all exercises

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria**

2193005, WS 19/20, 1 SWS, Language: German, [Open in study portal]

**Notes**

1. Ternary phase diagrams
   - Complete solubility
   - Eutectic systems
2. Thermodynamics of solution phases
3. Materials reactions involving pure condensed phases and a gaseous phase
4. Reaction equilibria in systems containing components in condensed solutions

This exercise deals with the construction of isothermal sections and isopleths in ternary materials systems. The thermodynamic properties of multiphase engineering materials are calculated.

**Learning Content**

1. Ternary phase diagrams
   - Complete solubility
   - Eutectic systems
2. Thermodynamics of solution phases
3. Materials reactions involving pure condensed phases and a gaseous phase
4. Reaction equilibria in systems containing components in condensed solutions

**Workload**

regular attendance: 14 hours

self-study: 46 hours
Literature
11.111 Course: Exercises for Materials Characterization [T-MACH-107685]

**Responsible:** Dr.-Ing. Jens Gibmeier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

**Type**
- Completed coursework

**Credits**
- 2

**Recurrence**
- Each winter term

**Version**
- 3

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<tr>
<td>WS 19/20</td>
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<td>Prüfung (PR)</td>
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**Events**
- WS 19/20 2174586 materials characterization 2 SWS Lecture (V) Schneider, Gibmeier
- SS 2019 76-T-MACH-107685 Exercises for Materials Characterization Prüfung (PR) Heilmaier, Gibmeier
- WS 19/20 76-T-MACH-107685 Exercises for Materials Characterization Prüfung (PR) Heilmaier, Gibmeier

**Competence Certificate**
- Regular attendance

**Prerequisites**
- none

**Below you will find excerpts from events related to this course:**

**materials characterization**
- 2174586, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Notes**
- The following methods will be introduced within this lecture:
  - microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy
  - material and microstructure analyses by means of X-ray, neutron and electron beams
  - analysis methods at SEM/TEM (e.g. EELS)
  - spectroscopic methods (e.g. EDS / WDS)

**Learning objectives:**
- The students have fundamental knowledge about methods of material analysis. They have a basic understanding to transfer this fundamental knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure.

**requirements:**
- none

**workload:**
- The workload for the module “Materials Characterization” is 180 h per semester and consists of the presence during the lectures (21 h) and tutorials (12 h) as well as self-study for the lecture (99 h) and for the tutorials (48 h).

**Learning Content**
- The following methods will be introduced within this lecture:
  - microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy
  - material and microstructure analyses by means of X-ray, neutron and electron beams
  - analysis methods at SEM/TEM (e.g. EELS)
  - spectroscopic methods (e.g. EDS / WDS)

**Workload**
- The workload for the module “Materials Characterization” is 180 h per semester and consists of the presence during the lectures (21 h) and tutorials (12 h) as well as self-study for the lecture (99 h) and for the tutorials (48 h).
**Literature**
Lecture notes (will be provided at the beginning of the lecture).
Literature will be announced at the beginning of the lecture.
11.12 Course: Exercises for Solid State Reactions and Kinetics of Phase Transformations [T-MACH-107632]

**Responsible:** Dr. Peter Franke  
Prof. Dr. Hans Jürgen Seifert

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering

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**Competence Certificate**

successful processing of exercises

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Notes**

1. Fick's laws of diffusion  
2. Calculation of diffusion coefficients  
3. Diffusion and solidification

**Recommendations:** Lecture in Solid State Reactions and Kinetics of Phase Transformations; Basic course in materials science and engineering; physical chemistry  
Reinforcement of the lecture by the solution of practical and lecture-relevant exercises

**Learning Content**

1. Fick's laws of diffusion  
2. Calculation of diffusion coefficients  
3. Diffusion and solidification

**Workload**

regular attendance: 14 hours  
self-study: 46 hours

**Literature**

Lecture notes
11.113 Course: Experimental Dynamics [T-MACH-105514]

Responsible: Prof. Dr.-Ing. Alexander Fidlin
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102598 - Major Field: Advanced Mechatronics
M-MACH-102614 - Major Field: Mechatronics
M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
M-MACH-104443 - Major Field: Vibration Theory

Type | Credits | Recurrence | Version
--- | --- | --- | ---
Oral examination | 5 | Each summer term | 1

Events
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<td>2162228</td>
<td>Übungen zu Experimentelle Dynamik</td>
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<td>Practice (Ü)</td>
<td>Fidlin, Aramendiz Fuentes</td>
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Competence Certificate
oral exam, 30 min.

Prerequisites
Can not be combined with Practical Training in Measurement of Vibrations (T-MACH-105373).

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-105373 - Practical Training in Measurement of Vibrations must not have been started.

Below you will find excerpts from events related to this course:

Experimental Dynamics
2162225, SS 2019, 3 SWS, Language: German, Open in study portal

Learning Content
1. Introduction
2. Measurement principles
3. Sensors as coupled multi-physical systems
4. Digital signal processing, measurements in frequency domain
5. Forced non-linear vibrations
6. Stability problems (Mathieu oscillator, friction induces vibrations)
7. Elementary rotor dynamics
8. Modal analysis

Annotation
The lectures will be accompanied by the laboratory experiments

Workload
time of attendance: 29 h
self-study: 121 h
11.114 Course: Experimental Fluid Mechanics [T-MACH-105512]

**Responsible:** Dr. Jochen Kriegseis  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102627 - Major Field: Energy Converting Engines  
- M-MACH-102634 - Major Field: Fluid Mechanics  
- M-MACH-102636 - Major Field: Thermal Turbomachines

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<td>2153530</td>
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**Exams**

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<td>Kriegseis</td>
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**Competence Certificate**
oral exam - 30 minutes

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**Experimental Fluid Mechanics**

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<thead>
<tr>
<th>Course Code</th>
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<td>2 SWS</td>
<td>Kriegseis</td>
<td>German</td>
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</table>

**Description**

**Media:**
Slides, chalk board, overhead

**Learning Content**

This lecture focuses on experimental methods of fluid mechanics and their application to solve flow problems of practical relevance. In addition, measurement signals and data, obtained with the discussed measuring techniques, are evaluated, presented and discussed.

The lecture covers a selection of the following topics:

- measuring techniques and measureable quantities
- measurements in turbulent flows
- pressure measurements
- hot wire measurements
- optical measuring techniques
- error analysis
- scaling laws
- signal and data evaluation

**Workload**

regular attendance: 19,5 hours  
self-study: 100,5 hours
Literature

Experimental Fluid Mechanics
2153530, WS 19/20, 2 SWS, Language: English, Open in study portal

Description
Media:
Slides, chalk board, overhead

Notes
The students can describe the relevant physical principles of experimental fluid mechanics. They are qualified to comparatively discuss the introduced measurement techniques. Furthermore, they are able to distinguish (dis-)advantages of the respective approaches. The students can evaluate and discuss measurement signal and data obtained with the common fluid mechanical measuring techniques.

This lecture focuses on experimental methods of fluid mechanics and their application to solve flow problems of practical relevance. In addition, measurement signals and data, obtained with the discussed measuring techniques, are evaluated, presented and discussed.

The lecture covers a selection of the following topics:

- measuring techniques and measureable quantities
- measurements in turbulent flows
- pressure measurements
- hot wire measurements
- optical measuring techniques
- error analysis
- scaling laws
- signal and data evaluation

Learning Content
This lecture focuses on experimental methods of fluid mechanics and their application to solve flow problems of practical relevance. In addition, measurement signals and data, obtained with the discussed measuring techniques, are evaluated, presented and discussed.

The lecture covers a selection of the following topics:

- measuring techniques and measureable quantities
- measurements in turbulent flows
- pressure measurements
- hot wire measurements
- optical measuring techniques
- error analysis
- scaling laws
- signal and data evaluation

Workload
regular attendance: 19,5 hours
self-study: 100,5 hours

Literature
11.115 Course: Experimental Lab Class in Welding Technology, in Groups [T-MACH-102099]

Responsible: Dr.-Ing. Stefan Dietrich
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102618 - Major Field: Production Technology

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Events

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<th>Number</th>
<th>Welding Lab Course, in groupes</th>
<th>WS 19/20</th>
<th>3 SWS</th>
<th>Practical course (P)</th>
<th>Dietrich, Schulze</th>
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</table>

Competence Certificate
Certificate to be issued after evaluation of the lab class report.

Prerequisites
Certificate of attendance for Welding technique (The participation in the course Welding Technology I/II is assumed.).

Annotation
The lab takes place at the beginning of the winter semester break once a year. The registration is possible during the lecture period in the secretariat of the Institute of Applied Materials (IAM – WK). The lab is carried out in the Handwerkskammer Karlsruhe.

You need sturdy shoes and long clothes!

Below you will find excerpts from events related to this course:

Welding Lab Course, in groupes
2173560, WS 19/20, 3 SWS, Language: German, Open in study portal
Practical course (P)

Notes
The lab takes place at the beginning of the winter semester break once a year. The registration is possible during the lecture period in the secretariat of the Institute of Applied Materials (IAM – WK). The lab is carried out in the Handwerkskammer Karlsruhe.

learning objectives: The students are capable to name a survey of current welding processes and their suitability for joining different metals. The students can evaluate the advantages and disadvantages of the individual procedures. The students have weld with different welding processes.

requirements:
Certificate to be issued after evaluation of the lab class report
You need sturdy shoes and long clothes!

workload:
regular attendance: 31,5 hours
preparation: 8,5 hours
lab report: 80 hours
Learning Content
Gas welding of steels with different weld geometries
Gas welding of cast iron, nonferrous metals
Brazing of aluminum
Electric arc welding with different weld geometries
Gas welding according to the TIG, MIG and MAG procedures

Annotation
The lab takes place at the beginning of the winter semester break once a year. The registration is possible during the lecture period in the secretariat of the Institute of Applied Materials (IAM – WK). The lab is carried out in the Handwerkskammer Karlsruhe.
You need sturdy shoes and long clothes!

Workload
regular attendance: 31.5 hours
preparation: 8.5 hours
lab report: 80 hours

Literature
distributed during the lab attendance
Course: Experimental techniques in thermo- and fluid-dynamics [T-MACH-106373]

**Responsible:** Prof. Dr.-Ing. Xu Cheng  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102635 - Major Field: Engineering Thermodynamics

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### Events

| SS 2019 | 2190920 | Experimental Techniques in thermo- and fluid-dynamics | 2 SWS | Lecture (V) | Cheng |

### Exams

| SS 2019 | 76-T-MACH-106373 | Experimental techniques in thermo- and fluid-dynamics | Prüfung (PR) | Cheng |

**Competence Certificate**  
oral exam, duration 20 min

**Prerequisites**  
none
11.117 Course: Fabrication Processes in Microsystem Technology [T-MACH-102166]

**Responsible:** Dr. Klaus Bade  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102616 - Major Field: Microsystem Technology  
M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Exams**

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<td>76-T-MACH-102166</td>
<td>Fabrication Processes in Microsystem Technology</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**

Oral examination, 20 minutes

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Fabrication Processes in Microsystem Technology**  
2143882, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**
pdf files of presentation sheets

**Learning Content**

The lecture offers an advanced understanding of manufacturing processes in microsystem technology. Basic aspects of microtechnological processing will be introduced. With examples from semiconductor microfabrication and microsystem technology the base processing steps for conditioning and finishing, patterning, removal are imparted. Nano-patterning is covered is also included and the micro-nano interface is discussed. By the help of typical processing steps elementary mechanisms, process execution, and equipment are explained. Additionally quality control, process control and environmental topics are included

**Literature**

M. Madou  
Fundamentals of Microfabrication  
CRC Press, Boca Raton, 1997  
W. Menz, J. Mohr, O. Paul  
Mikrosystemtechnik für Ingenieure  
Dritte Auflage, Wiley-VCH, Weinheim 2005  
L.F. Thompson, C.G. Willson, A.J. Bowden  
Introduction to Microlithography  
Fabrication Processes in Microsystem Technology
2143882, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
Media:
pdf files of presentation sheets

Learning Content
The lecture offers an advanced understanding of manufacturing processes in microsystem technology. Basic aspects of microtechnological processing will be introduced. With examples from semiconductor microfabrication and microsystem technology the base processing steps for conditioning and finishing, patterning, removal are imparted. Nano-patterning is covered is also included and the micro-nano interface is discussed. By the help of typical processing steps elementary mechanisms, process execution, and equipment are explained. Additionally quality control, process control and environmental topics are included

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M. Madou
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W. Menz, J. Mohr, O. Paul
Mikrosystemtechnik für Ingenieure
Dritte Auflage, Wiley-VCH, Weinheim 2005

L.F. Thompson, C.G. Willson, A.J. Bowden
Introduction to Microlithography
**11.118 Course: Failure Analysis [T-MACH-105724]**

**Responsible:** Dr. Christian Greiner  
Dr.-Ing. Johannes Schneider

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102637 - Major Field: Tribology

**Events**

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**Exams**

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**Competence Certificate**

oral examination, ca. 30 min

**Prerequisites**

none

**Recommendation**

basic knowledge in materials science (e.g. lecture materials science I and II)

**Notes**

Aim, procedure and content of examining failure

Examination methods

Types of failure:
- Failure due to mechanical loads
- Failure due to corrosion in electrolytes
- Failure due to thermal loads
- Failure due to tribological loads

Damage systematics

The students are able to discuss damage evaluation and to perform damage investigations. They know the common necessary investigation methods and can regard failures considering load and material resistance. Furthermore they can describe and discuss the most important types of failure and damage appearance.

basic knowledge in materials science (e.g. lecture materials science I and II) recommended

regular attendance: 21 hours

self-study: 99 hours

oral exam, duration: ca. 30 minutes

no notes
Learning Content
Aim, procedure and content of examining failure

Examination methods

Types of failure:
- Failure due to mechanical loads
- Failure due to corrosion in electrolytes
- Failure due to thermal loads
- Failure due to tribological loads

Damage systematics

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature

11.119 Course: Failure of Structural Materials: Deformation and Fracture [T-MACH-102140]

**Responsible:** Prof. Dr. Peter Gumbsch  
Dr. Daniel Weygand  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102599 - Major Field: Powertrain Systems  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering  
M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials  
M-MACH-102628 - Major Field: Lightweight Construction  
M-MACH-102636 - Major Field: Thermal Turbomachines

**Type**  
Oral examination

**Credits**  
4

**Recurrence**  
Each winter term

**Version**  
1

**Events**

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<td>Gumbsch, Weygand</td>
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**Competence Certificate**

oral exam ca. 30 minutes  
no tools or reference materials

**Prerequisites**

none

**Recommendation**

preliminary knowledge in mathematics, mechanics and materials science

*Below you will find excerpts from events related to this course:*
Notes

1. Introduction
2. Linear elasticity
3. Classification of stresses
4. Failure due to plasticity
   - Tensile test
   - Dislocations
   - Hardening mechanisms
   - Guidelines for dimensioning
5. Composite materials
6. Fracture mechanics
   - Hypothese for failure
   - Linear elastic fracture mechanics
   - Crack resistance
   - Experimental measurement of fracture toughness
   - Defect measurement
   - Crack propagation
   - Application of fracture mechanics
   - Atomistics of fracture

The student

- Has the basic understanding of mechanical processes to explain the relationship between externally applied load and materials strength.
- Can explain the foundation of linear elastic fracture mechanics and is able to determine if this concept can be applied to a failure by fracture.
- Can describe the main empirical materials models for deformation and fracture and can apply them.
- Has the physical understanding to describe and explain phenomena of failure.

Preliminary knowledge in mathematics, mechanics and materials science recommended.
Regular attendance: 22.5 hours
Self-study: 97.5 hours

The assessment consists of an oral examination (ca. 30 min) according to Section 4(2), 2 of the examination regulation.

Learning Content

1. Introduction
2. Linear elasticity
3. Classification of stresses
4. Failure due to plasticity
   - Tensile test
   - Dislocations
   - Hardening mechanisms
   - Guidelines for dimensioning
5. Composite materials
6. Fracture mechanics
   - Hypotheses for failure
   - Linear elastic fracture mechanics
   - Crack resistance
   - Experimental measurement of fracture toughness
   - Defect measurement
   - Crack propagation
   - Application of fracture mechanics
   - Atomistics of fracture

Workload
Regular attendance: 22.5 hours
Self-study: 97.5 hours

Literature

- Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relatively simple but yet comprehensive overview of metallic materials
11.120 Course: Failure of Structural Materials: Fatigue and Creep [T-MACH-102139]

**Responsible:** Dr. Patric Gruber  
Prof. Dr. Peter Gumbsch  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering  
M-MACH-102628 - Major Field: Lightweight Construction  
M-MACH-102636 - Major Field: Thermal Turbomachines

**Type**  
Oral examination  

**Credits**  
4  

**Recurrence**  
Each winter term  

**Version**  
1

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**Competence Certificate**  
oral exam ca. 30 minutes  
no tools or reference materials

**Prerequisites**  
none

**Recommendation**  
preliminary knowledge in mathematics, mechanics and materials science

*Below you will find excerpts from events related to this course:*

**Failure of Structural Materials: Fatigue and Creep**  
2181715, WS 19/20, 2 SWS, Language: German, Open in study portal
Notes
1 Fatigue
1.1 Introduction
1.2 Statistical Aspects
1.3 Lifetime
1.4 Fatigue Mechanisms
1.5 Material Selection
1.6 Thermomechanical Loading
1.7 Notches and Shape Optimization
1.8 Case Study: ICE-Desaster

2 Creep
2.1 Introduction
2.2 High Temperature Plasticity
2.3 Phänomenological DEsciption of Creep
2.4 Creep Mechanisms
2.5 Alloying Effects

The student
• has the basic understanding of mechanical processes to explain the relationships between externally applied load and materials strength.
• can describe the main empirical materials models for fatigue and creep and can apply them.
• has the physical understanding to describe and explain phenomena of failure.
• can use statistical approaches for reliability predictions.
• can use its acquired skills, to select and develop materials for specific applications.

preliminary knowlegde in mathematics, mechanics and materials science recommended

regular attendance: 22,5 hours
self-study: 97,5 hours

The assessment consists of an oral examination (ca. 30 min) according to Section 4(2), 2 of the examination regulation.

Learning Content
1 Fatigue
1.1 Introduction
1.2 Statistical Aspects
1.3 Lifetime
1.4 Fatigue Mechanisms
1.5 Material Selection
1.6 Thermomechanical Loading
1.7 Notches and Shape Optimization
1.8 Case Study: ICE-Desaster

2 Creep
2.1 Introduction
2.2 High Temperature Plasticity
2.3 Phänomenological DEsciption of Creep
2.4 Creep Mechanisms
2.5 Alloying Effects

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Literature
• Mechanical Behavior of Materials, Thomas H. Courtney (2nd Edition, McGraw Hill, Singapur); classic on the mechanical behavior of materials, extensive and good
• Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relatively simple but yet comprehensive overview of metallic materials
• Fatigue of Materials, Subra Suresh (2nd Edition, Cambridge University Press); standard work on fatigue, all classes of materials, extensive, for beginners and advanced student
# 11.121 Course: Fatigue of Metallic Materials [T-MACH-105354]

**Responsible:** Dr.-Ing. Stefan Guth
Dr. Karl-Heinz Lang

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102636 - Major Field: Thermal Turbomachines

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**Competence Certificate**
Oral exam, about 20 minutes

**Prerequisites**
none

**Recommendation**
Basic knowledge in Materials Science will be helpful.

Below you will find excerpts from events related to this course:

**Fatigue of Metallic Materials**
2173585, WS 19/20, 2 SWS, Language: German, [Open in study portal]
Notes
Introduction: some interesting cases of damage
Cyclic Stress Strain Behaviour
Crack Initiation
Crack Propagation
Lifetime Behaviour under Cyclic Loading
Fatigue of Notched Components
Influence of Residual Stresses
Structural Durability

learning objectives:
The students are able to recognise the deformation and the failure behaviour of metallic materials under cyclic loading and to assign it to the basic microstructural processes. They know the sequence and the development of fatigue damages and can evaluate the initiation and the growth of fatigue cracks.

The students can assess the cyclic strength behaviour of metallic materials and components both qualitatively and quantitatively and know the procedures for the assessment of single-stage, multistage and stochastic cyclical loadings. Furthermore, they can take into account the influence of residual stresses.

requirements:
none, basic knowledge in Material Science will be helpful

workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
Introduction: some interesting cases of damage
Cyclic Stress Strain Behaviour
Crack Initiation
Crack Propagation
Lifetime Behaviour under Cyclic Loading
Fatigue of Notched Components
Influence of Residual Stresses
Structural Durability

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Lecture notes that include a list of current literature will be distributed.
11.122 Course: Fatigue of Welded Components and Structures [T-MACH-105984]

**Responsible:** Dr. Majid Farajian  
Prof. Dr. Peter Gumbsch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering

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<td>Fatigue of Welded Components and Structures</td>
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<td>Farajian, Gumbsch</td>
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**Competence Certificate**
oral examination (ca. 30 min)
no tools or reference materials

**Prerequisites**
admission to the exam only with successful completion of the exercises [T-MACH-109304]

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-109304 - Exercices - Fatigue of Welded Components and Structures must have been passed.

**Recommendation**
preliminary knowledge materials science and mechanics

Below you will find excerpts from events related to this course:
Notes
The lecture gives an introduction to the following topics:
- weld quality
- typical damages of welded joints
- evaluation of notches, defects and residual stresses
- strength concepts: nominal, structural and notch stress concepts, fracture mechanics
- life cycle analysis
- post-treatment methods for an extended lifetime
- maintenance, reconditioning and repair

The student can
- describe the influence of welding induced notches, defects and residual stresses on component behavior
- explain the basics of numerical and experimental methods for the evaluation of statically or cyclically loaded welds
- explain and can apply them
- derive measures in order to increase the lifetime of structures with welded joints under cyclical load

Preliminary knowledge: Materials science and mechanics recommended

Regular attendance: 22.5 hours
Self-study: 97.5 hours

Exercise sheets are handed out regularly.
Oral examination (ca. 30 min)
No tools or reference materials

Learning Content
The lecture gives an introduction to the following topics:
- weld quality
- typical damages of welded joints
- evaluation of notches, defects and residual stresses
- strength concepts: nominal, structural and notch stress concepts, fracture mechanics
- life cycle analysis
- post-treatment methods for an extended lifetime
- maintenance, reconditioning and repair

Workload
Regular attendance: 22.5 hours
Self-study: 97.5 hours

Literature
2. FKM-Richtlinie, Bruchmechanischer Festigkeitsnachweis, Forschungskuratorium Maschinenbau, VDMA Verlag, 2009
11.123 Course: FEM Workshop - Constitutive Laws [T-MACH-105392]

**Responsible:** Dr. Katrin Schulz  
Dr. Daniel Weygand

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102604 - Major Field: Computational Mechanics

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<td>Schulz, Weygand</td>
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**Competence Certificate**

- solving of a FEM problem
- preparation of a report
- preparation of a short presentation

**Prerequisites**

- none

**Recommendation**

Engineering Mechanics; Advanced Mathematics; Introduction to Theory of Materials

**Notes**

The course repeats the fundamentals of the theory of materials. It leads to the characterization and classification of material behavior as well as the specification by adequate material models. Here we focus on elastic, viscoelastic, plastic, and viscoplastic deformation behavior. Introducing the finite element program ABAQUS, the students learn how to analyze the material models numerically. Therefore ABAQUS-own and continuative constitutive equations are chosen.

The student

- has the basic understanding of the materials theory and the classification of materials
- is able to independently generate numerical models using ABAQUS and can choose and apply adequate constitutive equations

Engineering Mechanics; Advanced Mathematics; Introduction to Theory of Materials recommended

- regular attendance: 28 hours
- self-study: 92 hours

Oral examination in the elective module MSc, otherwise no grading

- solving of a FEM problem
- preparation of a report
- preparation of a short presentation

**Responsible:** Prof. Dr. Claus Günther

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102604 - Major Field: Computational Mechanics

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<td>Finite Difference Methods for numerical solution of thermal and fluid dynamical problems</td>
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<td>SS 2019</td>
<td>76-T-MACH-105391</td>
<td>Finite Difference Methods for Numerical Solution of Thermal and Fluid Dynamical Problems</td>
<td>Prüfung (PR)</td>
<td>Günther</td>
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**Competence Certificate**
oral exam, Duration: 30 minutes
no auxiliary means

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Finite Difference Methods for numerical solution of thermal and fluid dynamical problems**

2153405, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Notes**

This lecture will be omitted until further.

The students can apply the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. They are able to discuss the most relevant properties of difference schemes such as consistency, stability and convergence. Furthermore, they can estimate the order of the numerical error and non-appearance of numerical oscillations.

The students get a basic knowledge of relevant numerical algorithms and the use of them in commercial and open fluid flow codes.

The lecture initially presents an overview and then the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. The most relevant properties of difference schemes at one side as consistency, stability and convergence, at the other side the order of the numerical error and non-appearance of numerical oscillations are described. Algorithms for the solution of coupled systems of equations, characteristic for fluid flow and thermal problems, are reviewed.

- Spatial and temporal discretization
- Properties of difference schemes
- Numerical stability, consistency, convergence
- Nonhomogeneous meshes
- Coupled and noninteracting calculation methods
Learning Content
The lecture initially presents an overview and then the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. The most relevant properties of difference schemes at one side as consistency, stability and convergence, at the other side the order of the numerical error and non-appearance of numerical oscillations are described. Algorithms for the solution of coupled systems of equations, characteristic for fluid flow and thermal problems, are reviewed.

- Spatial and temporal discretization
- Properties of difference schemes
- Numerical stability, consistency, convergence
- Nonhomogeneous meshes
- Coupled and noninteracting calculation methods

Workload
regulare attendance: 21h
self-study: 100h
11.125 Course: Finite Element Workshop [T-MACH-105417]

**Responsible:** Prof. Dr. Claus Mattheck
Dr. Daniel Weygand

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102602 - Major Field: Reliability in Mechanical Engineering

### Type
- Completed coursework

### Credits
- 4

### Recurrence
- Each summer term

### Version
- 1

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**Competence Certificate**
- attendance certificate for participation in all course dates

**Prerequisites**
- none

**Recommendation**
- Continuum Mechanics

*Below you will find excerpts from events related to this course:*

**Finite Element Workshop**
- 2182731, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Notes**
The students will learn the foundations of the FEM stress analysis and the optimization method 'Zugdreiecke'.
The student can

- perform stress analysis for simple components using the commercial software package ANSYS
- utilise the method of the tensile triangle to optimize the shape of components with respect to stress distribution

Fundamentals of Continuum Mechanics are required.
- regular attendance: 22,5 hours
- certificate in case of regular attendance

**Learning Content**
The students will learn the foundations of the FEM stress analysis and the optimization method 'Zugdreiecke'.

**Workload**
The students will learn the foundations of the FEM stress analysis and the optimization method 'Zugdreiecke'.

- regular attendance: 22,5 hours
### Course: Finite Volume Methods for Fluid Flow [T-MACH-105394]

**Responsible:** Prof. Dr. Claus Günther  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102604 - Major Field: Computational Mechanics

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**Competence Certificate**  
oral exam, Duration: 30 minutes  
no auxiliary means

**Prerequisites**  
none

**Below you will find excerpts from events related to this course:**

#### Notes

Students can describe all fundamental aspects of the finite volume methods, which form the basis for a number of different commercial CFD codes. Students become familiar with the basics of the generation of unstructured meshes. The Finite Volume Method (=FVM) is nowadays of great interest, as it guarantees conservation of all relevant variables and as it can be used on nearly arbitrary meshes. By this it is a fundamental tool for numerical simulation of flows, which plays an ever growing role for construction and engineering and is the basis of several commercial or research codes as CFX, STAR-CCM+, FLUENT or OpenFOAM. The lecture is concerned with all aspects of FVM, mesh generation is also included. Newer developments as CVFEM (control volume based FEM) are described.

- Introduction
- Conservative schemes
- Finite volume method
- Analysis of FVM
- CVFEM as conservative FEM
- FVM for Navier-Stokes Equations
- Basics of mesh generation

Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019
Learning Content
The Finite Volume Method (=FVM) is nowadays of great interest, as it guarantees conservation of all relevant variables and as it can be used on nearly arbitrary meshes. By this it is a fundamental tool for numerical simulation of flows, which plays an ever growing role for construction and engineering and is the basis of several commercial or research codes as CFX, STAR-CCM+, FLUENT or OpenFOAM. The lecture is concerned with all aspects of FVM, mesh generation is also included. Newer developments as CVFEM (control volume based FEM) are described.

- Introduction
- Conservative schemes
- Finite volume method
- Analysis of FVM
- CVFEM as conservative FEM
- FVM for Navier-Stokes Equations
- Basics of mesh generation

Annotation
The lecture is recommended for students of mechanical, chemical or electrical engineering and is also of interest for people which are interested in FVM in a context other than fluid flow problems.

Workload
regulare attendance: 32 h
self-study: 88 h
11.127 Course: Flow Measurement Techniques [T-MACH-108796]

Responsible: Dr. Jochen Kriegseis
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102591 - Laboratory Course

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Competence Certificate
Participation in at least 7 out of 9 events, successful initial colloquium prior to the respective measurements and submission of a significant report after every experiment

Prerequisites
none

Recommendation
The content of lecture "Experimental Fluid Mechanics" (T-MACH-105512)

Below you will find excerpts from events related to this course:

Notes
The following flow measurement techniques are considered:
- wind tunnel techniques and estimation of turbulence intensity
- hot wire calibration an measurement
- pressure measurements in air (around bodies)
- pressure measurements in water (Nikuradse diagram)
- Schlieren techniques
- Mach-Zehnder interferometry
- laser Doppler anemometry
- particle image velocimetry
- uncertainty estimation

The students can apply various flow measurements. They are capable to obtain, (post-)process and analyze flow data. Furthermore, the students can contrast advantages and disadvantages of the respective experimental approaches.

regular attendance: 30 hours
self-study: 90 hours
11.28 Course: Flow Simulations [T-MACH-105458]

Responsibility: Prof. Dr.-Ing. Bettina Frohnapfel
Organisation: KIT Department of Mechanical Engineering
Part of: M-MACH-102634 - Major Field: Fluid Mechanics

Type: Completed coursework
Credits: 4
Recurrence: Each winter term
Version: 1

Events

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Competence Certificate
ungraded homework and colloquium

Prerequisites
none

Below you will find excerpts from events related to this course:

Flow Simulations
2154447, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
Practical exercises

Notes
Flow Simulations with OpenFOAM(R)

- Basic elements of a simulation with OpenFOAM(R)
- Simulation of 'classic' incompressible, stationary/unstationary, laminar/turbulent (in RANS context) flows (special types of flows, e.g. reactive flows, multi-phase flows, magnetohydrodynamics, ... are not covered)
- Visualization of results
- Evaluation and interpretation of results
- Necessary basics of turbulence modelling with RANS models in OpenFOAM(R)
- Basics of the structure and the numerics of OpenFOAM(R) and possibilities for extending the software

(This offering is not approved or endorsed by OpenCFD Limited, producer and distributor of the OpenFOAM software via www.openfoam.com, and owner of the OPENFOAM(R) and OpenCFD(R) trade marks. OPENFOAM(R) is a registered trade mark of OpenCFD Limited, producer and distributor of the OpenFOAM software via www.openfoam.com.)

Learning Content
Flow Simulations with OpenFOAM(R)

- Basic elements of a simulation with OpenFOAM(R)
- Simulation of 'classic' incompressible, stationary/unstationary, laminar/turbulent (in RANS context) flows (special types of flows, e.g. reactive flows, multi-phase flows, magnetohydrodynamics, ... are not covered)
- Visualization of results
- Evaluation and interpretation of results
- Necessary basics of turbulence modelling with RANS models in OpenFOAM(R)
- Basics of the structure and the numerics of OpenFOAM(R) and possibilities for extending the software

Students are able to use the basic functionality of the open source software OpenFOAM(R) for simulating laminar and turbulent flows (in RANS context). They know the setup and the process of a fluid mechanical simulation with OpenFOAM(R). The students are able to visualize the results and to question the plausibility of the results. They are able to build simple block-structured meshes and meshes of more complex three-dimensional domains. The students are aware of the sensitivity of the results of a flow simulation (meshing, numerical settings, turbulence model).
Annotation
Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu
(This offering is not approved or endorsed by OpenCFD Limited, producer and distributor of the OpenFOAM software via www.openfoam.com, and owner of the OPENFOAM(R) and OpenCFD(R) trade marks. OPENFOAM(R) is a registered trade mark of OpenCFD Limited, producer and distributor of the OpenFOAM software via www.openfoam.com.)

Workload
regular attendance: 30h
self-study: 90h

Literature
### 11.129 Course: Flows and Heat Transfer in Energy Technology [T-MACH-105403]

**Responsible:** Prof. Dr.-Ing. Xu Cheng  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102608 - Major Field: Nuclear Energy  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102635 - Major Field: Engineering Thermodynamics

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**Events**

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**Exams**

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**Competence Certificate**

oral exam, 20 min

**Prerequisites**

none
11.130 Course: Flows with Chemical Reactions [T-MACH-105422]

**Responsible:** Prof. Dr. Andreas Class  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanic  
- M-MACH-102635 - Major Field: Engineering Thermodynamics

### Events

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**Competence Certificate**  
oral exam, duration 30 minutes  
Auxiliary none

**Prerequisites**  
one

**Recommendation**  
Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

Below you will find excerpts from events related to this course:

**Flows with chemical reactions**  
2153406, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Description**

**Media:**  
Black board

**Notes**

The students can describe flow scenarios, where a chemical reaction is confined to a thin layer. They can choose simplifying approaches for the underlying chemistry and discuss the problems with focus on the fluid mechanic aspects. The students are able to solve simple problems analytically. Furthermore, they are qualified to discuss simplifications as relevant for an efficient numerical solution of complex problems.

In the lecture we mainly consider problems, where chemical reaction is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficient numerical solution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

**Learning Content**

In the lecture we mainly consider problems, where chemical reaction is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficient numerical solution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

**Workload**

regular attendance: 22.5h  
self-study: 99h
Literature

Lecture

Buckmaster, J.D.; Ludford, G.S.S.: Lectures on Mathematical Combustion, SIAM 1983

- **Responsible:** Prof. Dr.-Ing. Markus Uhlmann
- **Organisation:** KIT Department of Civil Engineering, Geo- and Environmental Sciences
- **Part of:** M-MACH-102634 - Major Field: Fluid Mechanic

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**Competence Certificate**
oral exam, appr. 30 min.

**Prerequisites**
none

**Recommendation**
none

**Annotation**
none
11.132 Course: Fluid Power Systems [T-MACH-102093]

Responsible: Prof. Dr.-Ing. Marcus Geimer  
Felix Pult

Organisation: KIT Department of Mechanical Engineering

Part of:  
M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102627 - Major Field: Energy Converting Engines  
M-MACH-102630 - Major Field: Mobile Machines  
M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
M-MACH-102742 - Fundamentals and Methods of Production Technology  
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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Exams

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Competence Certificate

The assessment consists of a written exam (90 minutes) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Prerequisites

none

Below you will find excerpts from events related to this course:

Fluid Technology

2114093, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

Learning Content

In the range of hydrostatics the following topics will be introduced:

- Hydraulic fluids
- Pumps and motors
- Valves
- Accessories
- Hydraulic circuits.

In the range of pneumatics the following topics will be introduced:

- Compressors
- Motors
- Valves
- Pneumatic circuits.

Workload

- regular attendance: 21 hours
- self-study: 92 hours
**Literature**
Scritum for the lecture *Fluidtechnik*
Institute of Vehicle System Technology
downloadable
11.133 Course: Fluid-Structure-Interaction [T-MACH-105474]

**Responsible:** Prof. Dr.-Ing. Bettina Frohnapfel  
Dr.-Ing. Mark-Patrick Mühlhausen  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanic  

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<td>SS 2019 2154401 Fluid-Structure-Interaction 2 SWS Mühlhausen</td>
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**Competence Certificate**  
oral exam 30 minutes

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Fluid-Structure-Interaction**  
2154401, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**  
The lecture first introduces/recalls the fundamental governing equations that describe fluids and structures. After the characterization of the problem, the relevant equations are discussed and geometry and grid generation are treated. The resulting partial differential equations are transformed into an algebraic set of equations using different DFG and CSD methods and discretization schemes. Different methods for fluid structure coupling are introduced, where the resulting stability problem is treated in detail. Finally, the obtained result is critically examined in terms of errors and inaccuracy and verification and validation procedures are introduced.

The lecture includes an introduction to function of CFG-Programs and Matlab routines that are related to the theoretically discussed approaches.

**Annotation**  
Block course with limited number of participants, registration in the secretary's office required.  
See details at [www.istm.kit.edu](http://www.istm.kit.edu)

**Workload**  
regular attendance: 21.5h  
self-studie: 99h

**Literature**  
will be introduced during the lecture
11.134 Course: Foundations of Nonlinear Continuum Mechanics [T-MACH-105324]

**Responsible:** Prof. Dr. Marc Kamlah
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102646 - Major Field: Applied Mechanics

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**Competence Certificate**
oral exam

Below you will find excerpts from events related to this course:

**Foundations of nonlinear continuum mechanics**
2181720, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Learning Content**
The lecture is organized in three parts. In the first part, the mathematical foundations of tensor algebra and tensor analysis are introduced, usually in cartesian representation. In the second part of the lecture, the kinematics, i.e. the geometry of deformation is presented. Besides finite deformation, geometric linearization is discussed. The third part of the lecture deals with the physical balance laws of thermomechanics. It is shown, how a special classical theory of continuum mechanics can be derived by adding a corresponding constitutive model. For the illustration of the theory, elementary examples are discussed repeatedly.

**Workload**
regular attendance: 22,5 hours
self-study: 97,5 hours

**Literature**
lecture notes
## 11.135 Course: Foundry Technology [T-MACH-105157]  

**Responsible:** Dr.-Ing. Christian Wilhelm  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102618 - Major Field: Production Technology  
- M-MACH-102628 - Major Field: Lightweight Construction

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### Competence Certificate

oral exam; about 25 minutes

### Prerequisites

Materials Science I & II must be passed.

*Below you will find excerpts from events related to this course:*

### Foundry Technology

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<td>2174575</td>
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Notes
Moulding and casting processes
Solidifying of melts
Castability
Fe-Alloys
Non-Fe-Alloys
Moulding and additive materials
Core production
Sand reclamation
Design in casting technology
Casting simulation
Foundry Processes

learning objectives:
The students know the specific moulding and casting techniques and are able to describe them in detail. The students know the application of moulding and casting techniques concerning castings and metals, their advantages and disadvantages in comparison, their application limits and are able to describe these in detail.

The students know the applied metals and are able to describe advantages and disadvantages as well as the specific range of use.

The students are able, to describe detailed mould and core materials, technologies, their application focus and mould-affected casting defects.

The students know the basics of casting process of any casting parts concerning the above mentioned criteria and are able to describe detailed.

requirements:
Required: Material Science and Engineering I and II

workload:
The workload for the lecture Foundry Technology is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Learning Content
Moulding and casting processes
Solidifying of melts
Castability
Fe-Alloys
Non-Fe-Alloys
Moulding and additive materials
Core production
Sand reclamation
Design in casting technology
Casting simulation
Foundry Processes

Workload
The workload for the lecture Foundry Technology is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Literature
Reference to literature, documentation and partial lecture notes given in lecture
11.136 Course: Fuels and Lubricants for Combustion Engines [T-MACH-105184]

**Responsible:** Dr.-Ing. Bernhard Ulrich Kehrwald  
Dr.-Ing. Heiko Kubach  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
M-MACH-102627 - Major Field: Energy Converting Engines  
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**

oral examination, Duration: ca. 25 min., no auxiliary means

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Fuels and Lubricants for Combustion Engines**

2133108, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**

Introduction and basics

Fuels for Gasoline and Diesel engines

Hydrogen

Lubricants for Gasoline and Diesel engines

Coolants for combustion engines

**Learning Content**

Introduction and basics

Fuels for Gasoline and Diesel engines

Hydrogen

Lubricants for Gasoline and Diesel engines

Coolants for combustion engines
Workload
regular attendance: 24 hours
self-study: 96 hours

Literature
Lecturer notes
11.137 Course: Fundamentals for Design of Motor-Vehicle Bodies I [T-MACH-102116]

**Responsible:** Horst Dietmar Bardehle  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102607 - Major Field: Vehicle Technology

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**Competence Certificate**

Oral group examination  
Duration: 30 minutes  
Auxiliary means: none

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Fundamentals for Design of Motor-Vehicles Bodies I**

2113814, WS 19/20, 1 SWS, Language: German, [Open in study portal]

**Notes**

Anticipated dates: 23 October 2019, 30 October 2019, 6 November 2019, 20 November 2019, 27 November 2019 (alternate date), and 4 December 2019 (alternate date). Further information will be published on the homepage of the institute

**Learning Content**

1. History and design  
2. Aerodynamics  
3. Design methods (CAD/CAM, FEM)  
4. Manufacturing methods of body parts  
5. Fastening technology  
6. Body in white / body production, body surface

**Workload**

regular attendance: 10,5 hours  
self-study: 49,5 hours
Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH, Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg
**11.138 Course: Fundamentals for Design of Motor-Vehicle Bodies II [T-MACH-102119]**

**Responsible:** Horst Dietmar Bardehle

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102607 - Major Field: Vehicle Technology

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**Events**

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**Exams**

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**Competence Certificate**

Oral group examination

Duration: 30 minutes

Auxiliary means: none

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Fundamentals for Design of Motor-Vehicles Bodies II**

2114840, SS 2019, 1 SWS, Language: German, [Open in study portal](#)

**Notes**

Scheduled dates:

see homepage of the institute.

Further information and possible changes of date: see homepage of the institute.

**Learning Content**

1. Body properties/testing procedures
2. External body-parts
3. Interior trim
4. Compartment air conditioning
5. Electric and electronic features
6. Crash tests
7. Project management aspects, future prospects

**Workload**

regular attendance: 10,5 hours
self-study: 49,5 hours
Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH, Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg
11.139 Course: Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria [T-MACH-107670]

**Responsible:** Dr. Peter Franke  
Prof. Dr. Hans Jürgen Seifert

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering

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**Competence Certificate**

Oral examination (about 30 min)

**Prerequisites**

The successful participation in Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria is the condition for the admittance to the oral exam in Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-107669 - Exercises for Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria must have been passed.

**Recommendation**

Basic course in materials science and engineering  
Basic course in mathematics  
Physics or physical chemistry

*Below you will find excerpts from events related to this course:*

**Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria (with exercises)**

<table>
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Notes
Oral examination (about 30 min)

Teaching Content:
1. Binary phase diagrams
2. Ternary phase diagrams
   - Complete solubility
   - Eutectic systems
   - Peritectic systems
   - Systems with transition reactions
   - Systems with intermetallic phases
3. Thermodynamics of solution phases
4. Materials reactions involving pure condensed phases and a gaseous phase
5. Reaction equilibria in systems containing components in condensed solutions
6. Thermodynamics of multicomponent multiphase materials systems
7. Calculation of Phase Diagrams (CALPHAD)

Recommendations:
Knowledge of the course "Solid State Reactions and Kinetics of Phase Transformations" (Franke); basic course in materials science and Engineering; basic course in mathematics; physics or physical chemistry

regular attendance: 22 hours
self-study: 98 hours

The students know the heterogeneous phase equilibria of binary, ternary and multicomponent materials systems. They can analyze the thermodynamic properties of multiphase engineering materials and their reactions with gas and liquid phases.

Learning Content
1. Binary phase diagrams
2. Ternary phase diagrams
   - Complete solubility
   - Eutectic systems
   - Peritectic systems
   - Systems with transition reactions
   - Systems with intermetallic phases
3. Thermodynamics of solution phases
4. Materials reactions involving pure condensed phases and a gaseous phase
5. Reaction equilibria in systems containing components in condensed solutions
6. Thermodynamics of multicomponent multiphase materials systems
7. Calculation of Phase Diagrams (CALPHAD)

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature
11 COURSES

Course: Fundamentals in the Development of Commercial Vehicles I [T-MACH-105160]

**11.140 Course: Fundamentals in the Development of Commercial Vehicles I [T-MACH-105160]**

**Responsible:** Prof. Dr. Jörg Zürn

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102630 - Major Field: Mobile Machines

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<th>1 SWS</th>
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**Exams**

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<th>Prüfung (PR)</th>
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</table>

**Competence Certificate**

Oral group examination

Duration: 30 minutes

Auxiliary means: none

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Fundamentals in the Development of Commercial Vehicles I**

2113812, WS 19/20, 1 SWS, Language: German, [Open in study portal]

**Notes**


**Learning Content**

1. Introduction, definitions, history
2. Development tools
3. Complete vehicle
4. Cab, bodyshell work
5. Cab, interior fitting
6. Alternative drive systems
7. Drive train
8. Drive system diesel engine
9. Intercooled diesel engines

**Workload**

Regular attendance: 10.5 hours
Self-study: 49.5 hours

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Literature
### 11.141 Course: Fundamentals in the Development of Commercial Vehicles II [T-MACH-105161]

**Responsible:** Prof. Dr. Jörg Zürn  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102630 - Major Field: Mobile Machines

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<th>Fundamentals in the Development of Commercial Vehicles II</th>
<th>Prüfung (PR)</th>
<th>Zürn</th>
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**Competence Certificate**

**Oral group examination**

**Duration:** 30 minutes  
**Auxiliary means:** none

**Prerequisites**

none

Below you will find excerpts from events related to this course:

### Fundamentals in the Development of Commercial Vehicles II

**2114844, SS 2019, 1 SWS, Language: German, Open in study portal**

**Learning Content**

1. Gear boxes of commercial vehicles  
2. Intermediate elements of the drive train  
3. Axle systems  
4. Front axles and driving dynamics  
5. Chassis and axle suspension  
6. Braking System  
7. Systems  
8. Excursion

**Workload**

regular attendance: 10,5 hours  
self-study: 49,5 hours
Literature


11 COURSES
Course: Fundamentals of Automobile Development I [T-MACH-105162]

11.142 Course: Fundamentals of Automobile Development I [T-MACH-105162]

Responsibility: Dipl.-Ing. Rolf Frech
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102605 - Major Field: Engineering Design
M-MACH-102607 - Major Field: Vehicle Technology

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Exams

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Competence Certificate
Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites
none

Below you will find excerpts from events related to this course:

Fundamentals of Automobile Development I

2113810, WS 19/20, 1 SWS, Language: German, [Open in study portal]

Notes
Block lecture in room 219 in building 70.04 (Campus East).
Date: 21 October 2019, 28 October 2019 and 4 November 2019 from 8:00 to 11:00 a.m.
Further information will be published on the homepage of the institute.

Learning Content
1. Process of automobile development
2. Conceptual dimensioning and design of an automobile
3. Laws and regulations – National and international boundary conditions
4. Aero dynamical dimensioning and design of an automobile I
5. Aero dynamical dimensioning and design of an automobile II
6. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines I
7. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines II

Workload
regular attendance: 10,5 hours
self-study: 49,5 hours

Literature
The scriptum will be provided during the first lessons.
Notes
Block lecture in room 219 in building 70.04 (Campus East), in English.
Date: 21 October 2019, 28 October 2019 and 4 November 2019 from 11:00 a.m. to 2:00 p.m.
Further information will be published on the homepage of the institute.

Learning Content
1. Process of automobile development
2. Conceptual dimensioning and design of an automobile
3. Laws and regulations – National and international boundary conditions
4. Aero dynamical dimensioning and design of an automobile I
5. Aero dynamical dimensioning and design of an automobile II
6. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines I
7. Thermo-management in the conflict of objectives between styling, aerodynamic and packaging guidelines II

Workload
regular attendance: 10.5 hours
self-study: 49.5 hours

Literature
The scriptum will be provided during the first lessons
11.143 Course: Fundamentals of Automobile Development II [T-MACH-105163]

Responsible: Dipl.-Ing. Rolf Frech
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102605 - Major Field: Engineering Design
          M-MACH-102607 - Major Field: Vehicle Technology

Events

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Competence Certificate

Written examination

Duration: 90 minutes

Auxiliary means: none

Prerequisites

none

Below you will find excerpts from events related to this course:

Fundamentals of Automobile Development II
2114842, SS 2019, 1 SWS, Language: German, Open in study portal

Learning Content
1. Application-oriented material and production technology I
2. Application-oriented material and production technology II
3. Overall vehicle acoustics in the automobile development
4. Drive train acoustics in the automobile development
5. Testing of the complete vehicle
6. Properties of the complete automobile

Workload
regular attendance: 10,5 hours
self-study: 49,5 hours

Literature
The scriptum will be provided during the first lessons.

Principles of Whole Vehicle Engineering II
2114860, SS 2019, 1 SWS, Language: English, Open in study portal
Notes
In English language.

Learning Content
1. Application-oriented material and production technology I
2. Application-oriented material and production technology II
3. Overall vehicle acoustics in the automobile development
4. Drive train acoustics in the automobile development
5. Testing of the complete vehicle
6. Properties of the complete automobile

Workload
regular attendance: 10,5 hours
self-study: 49,5 hours

Literature
The scriptum will be provided during the first lessons.
11.144 Course: Fundamentals of Catalytic Exhaust Gas Aftertreatment [T-MACH-105044]

**Responsible:** Prof. Dr. Olaf Deutschmann  
Prof. Dr. Jan-Dierk Grunwaldt  
Dr.-Ing. Heiko Kubach  
Prof. Dr.-Ing. Egbert Lox

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102627 - Major Field: Energy Converting Engines  
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**  
oral examination, Duration: 25 min., no auxiliary means

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

**Fundamentals of catalytic exhaust gas aftertreatment**  
2134138, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

1. kind and source of emissions
2. emission legislation
3. principal of catalytic exhaust gas aftertreatment (EGA)  
4. EGA at stoichiometric gasoline engines  
5. EGA at gasoline engines with lean mixtures  
6. EGA at diesel engines  
7. economical basic conditions for catalytic EGA

**Workload**

regular attendance: 36 hours  
self-study: 84 hours
Literature
Lecture notes available in the lectures.

11.145 Course: Fundamentals of Combustion Engine Technology [T-MACH-105652]

**Responsible:** Dr.-Ing. Sören Bernhardt  
Dr.-Ing. Heiko Kubach  
Jürgen Pfeil  
Dr.-Ing. Olaf Toedter  
Dr.-Ing. Uwe Wagner

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction

**Type:** Oral examination  
**Credits:** 5  
**Recurrence:** Each winter term  
**Version:** 1

**Events**

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**Exams**

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**Competence Certificate**  
oral exam, 30 min

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Fundamentals of Combustion Engine Technology**  
2133123, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**  
Fundamentals of engine processes  
Components of combustion engines  
Mixture formation systems  
Gas exchange systems  
Injection systems  
Exhaust Gas Aftertreatment Systems  
Cooling systems  
Ignition Systems
Learning Content
Fundamentals of engine processes
Components of combustion engines
Mixture formation systems
Gas exchange systems
Injection systems
Exhaust Gas Aftertreatment Systems
Cooling systems
Ignition Systems

Workload
regular attendance 25 h
self-study 125 h
11.146 Course: Fundamentals of Combustion I [T-MACH-105213]

**Responsible:** Prof. Dr. Ulrich Maas  
Dr. Jörg Sommerer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102627 - Major Field: Energy Converting Engines  
M-MACH-102635 - Major Field: Engineering Thermodynamics  
M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

**Type**  
Written examination

**Credits**  
4

**Recurrence**  
Each winter term

**Version**  
1

### Events

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**Competence Certificate**  
Written exam, 3 h

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

**Fundamentals of Combustion I**  
2165515, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**  
Media:  
Blackboard and Powerpoint presentation

**Learning Content**

- Fundamental concepts ans phenomena
- Experimental analysis of flames
- Conservation equations for laminar flat flames
- Chemical reactions
- Chemical kinetics mechanisms
- Laminar premixed flames
- Laminar diffusion flames
- Ignition processes
- Pollutant formation
Annotation
Compulsory elective subject: 2+1 SWS and 5 LP.

Workload
Regular attendance: 22.5 h
Self-study: 97.5 h

Literature
Lecture notes,

Fundamentals of Combustion I (Tutorial)
2165517, WS 19/20, 1 SWS, Open in study portal

Literature
- Lecture Notes
11.147 Course: Fundamentals of Combustion II [T-MACH-105325]

Responsible: Prof. Dr. Ulrich Maas
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102623 - Major Field: Fundamentals of Energy Technology
M-MACH-102627 - Major Field: Energy Converting Engines
M-MACH-102635 - Major Field: Engineering Thermodynamics
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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Competence Certificate
oral exam, 20 min

Prerequisites
none

Below you will find excerpts from events related to this course:

V Fundamentals of combustion II
2166538, SS 2019, 2 SWS, Language: German, Open in study portal

Description
Media:
Blackboard and Powerpoint presentation

Learning Content

- Three dimensional Navier-Stokes equations for reacting flows
- Tubulent reactive flows
- Turbulent non-premixed flames
- Turbulent premixed flames
- Combustion of liquid and solid fuels
- Engine knock
- NOx formation
- Formation of hydrocarbons and soot
- Thermodynamics of combustion processes
- Transport phenomena

Workload
Regular attendance: 35 hours
Self-study: 95 hours

Literature
Lecture notes;
Übung zu Grundlagen der technischen Verbrennung II
2166539, SS 2019, 1 SWS, Language: German, Open in study portal

Learning Content
Calculation and Simulation of combustion processes

Workload
regular attendance: 21 hours

Literature
Lecture notes
### 11.148 Course: Fundamentals of Energy Technology [T-MACH-105220]

**Responsible:** Dr. Aurelian Florin Badea  
Prof. Dr.-Ing. Xu Cheng

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Competence Certificate**

Written examination, 90 min

**Prerequisites**

none

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**Below you will find excerpts from events related to this course:**

**Fundamentals of Energy Technology**

2130927, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**

**Learning Content**

The following relevant fields of the energy industry are covered:
- Energy demand and energy situation
- Energy types and energy mix
- Basics. Thermodynamics relevant to the energy sector
- Conventional fossil-fired power plants
- Combined Cycle Power Plants
- Cogeneration
- Nuclear energy
- Regenerative energies: hydropower, wind energy, solar energy, other energy systems
- Energy storage
- Transport of energy
- Power generation and environment. Future of the energy industry
Workload
lectures: 45 h
preparation to exam: 195 h

Fundamentals of Energy Technology
3190923, SS 2019, 3 SWS, Language: English, Open in study portal

Learning Content
The following relevant fields of the energy industry are covered:
- Energy forms
- Thermodynamics relevant to energy industry
- Energy sources: fossil fuels, nuclear energy, renewable sources
- Energy industry in Germany, Europe and worldwide
- Power generation and environment
- Evaluation of energy conversion processes
- Thermal/electrical power plants and processes
- Transport of energy / energy carriers
- Energy storage
- Systems utilizing renewable energy sources
- Basics of economic efficiency and calculus / Optimisation
- Future of the energy industry

Workload
lectures: 45 h
preparation to exam: 195 h
Course: Fundamentals of reactor safety for the operation and dismantling of nuclear power plants [T-MACH-105530]

Responsible: Dr. Victor Hugo Sanchez-Espinoza
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102608 - Major Field: Nuclear Energy

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Competence Certificate
oral exam about 30 minutes

Prerequisites
none

Below you will find excerpts from events related to this course:

Fundamentals of reactor safety for the operation and dismantling of nuclear power plants
2190465, WS 19/20, 2 SWS, Language: English, Open in study portal

Notes
This lecture describes the fundamentals of reactor safety for both the operation and the decommissioning of nuclear power plants. The first part will be focused on reactor safety issues important for the operation of a NPP:

- Safety fundamentals as defense in depth, multi-barrier concepts
- Operational modes of nuclear power plants
- Main components for heat removal, safety systems of selected NPP designs
- Thermal characterization of the core and plant under normal operation conditions
- Accident analysis in nuclear power plants- initiation, methods of evaluations and safety implications

The second part of this lecture will be devoted to explain the neutron physical, radiation protection and safety aspects to be considered for the safe and economical decommissioning of nuclear power plants:

- Life cycle of a nuclear power plant and main strategies and challenges in the NPP decommissioning
- Physical processes responsible for the activation of reactor components during the operation of a nuclear power plant
- Radioactive waste generation in the core, classification and radiological relevance
- Waste classification, minimization methods and intermediate and final disposal
- Risk analysis and prevention, radiation protection issues and the regulatory framework for decommissioning
- Computational methods for the estimation of nuclei inventories, activation and dose rates of reactor components

Knowledge in energy technology, nuclear power plants, reactor physics, radiation protection is welcomed

Time of attendance: 30 hours
Self-study: 90 hours
oral examination; duration: about 30 minutes
Learning Content
This lecture describes the fundamentals of reactor safety for both the operation and the decommissioning of nuclear power plants. The first part will be focused on reactor safety issues important for the operation of a NPP:

- Safety fundamentals as defense in depth, multi-barrier concepts
- Operational modes of nuclear power plants
- Main components for heat removal, safety systems of selected NPP designs
- Thermal characterization of the core and plant under normal operation conditions
- Accident analysis in nuclear power plants—initiation, methods of evaluations and safety implications

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- Waste classification, minimization methods and intermediate and final disposal
- Risk analysis and prevention, radiation protection issues and the regulatory framework for decommissioning
- Computational methods for the estimation of nuclei inventories, activation and dose rates of reactor components

Workload
Time of attendance: 30 hours
Self-study: 90 hours

Literature
Bibliography related to the Block Course “Fundamentals of Reactor Safety for the Operation and Dismantling of NPPs”

7. “Safe and effective nuclear power plant life cycle management towards decommissioning”, IAEA-TECDOC-1305.
Course: Fusion Technology A [T-MACH-105411]

**Responsible:** Prof. Dr. Robert Stieglitz  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102643 - Major Field: Fusion Technology

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**Competence Certificate**
oral exam of about 30 minutes

**Prerequisites**
none

**Recommendation**
appreciated is knowledge in heat and mass transfer as well as in electrical engineering, basic knowledge in fluid mechanics, material sciences and physics

Below you will find excerpts from events related to this course:
Notes
To transfer the basic physical concepts of particle physics, fusion and nuclear fission; this includes fundamental questions such as how: What is a plasma? How can it be ignited? What is the difference between magnetic and inertial fusion? Based on this, aspects of the stability of plasmas, their control and particle transport are discussed. After characterizing the plasma, the “fire” of fusion, the confinement in magnetic fields is sketched, which are built up with the help of magnetic technology. Here, knowledge of superconductivity, production and design of magnets is imparted. A reactor operation with a plasma as energy source requires a continuous operation of a tritium and fuel cycle, which is generated by the fusion reactor itself. Since fusion plasmas require small material densities, vacuum technology plays a central role. Finally, the heat generated in the fusion power plant must be converted into a power plant process and the reaction products removed. The functional basics and the structure of these fusion-typical in-vessel components are presented and the current challenges and the state of the art are demonstrated.

The course describes the essential functional principles of a fusion reactor, beginning with plasma, magnet technology, the tritium and fuel cycle, vacuum technology and the associated material sciences. The physical basics will be taught and the engineering laws of scaling will be demonstrated. Special importance is attached to the understanding of the interfaces between the different subject areas, which essentially determine the engineering technical interpretations. Methods for identifying and evaluating the central parameters will be demonstrated. Based on the acquired perception skills, methods for the design of solution strategies will be taught and technical solutions will be identified, their weak points discussed and evaluated.

Recommendations/Pre-knowledge:
Basic knowledge of fluid mechanics, materials engineering and physics. Knowledge of heat and mass transfer and electrical engineering is helpful.
Presence time: 21 h
Self-study: 90 h
Oral examination:
Duration: approx. 30 minutes, aids: none

Workload
regular attendance: 21 h
self-study: 90 h

Literature
Within each subblock an adequate selection of literature is given. Additionally the students get the lecture materials in printed and electronic version.
11.151 Course: Fusion Technology B [T-MACH-105433]

**Responsible:** Prof. Dr. Robert Stieglitz  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102643 - Major Field: Fusion Technology

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**Competence Certificate**

oral exam of about 30 minutes

**Prerequisites**

none

**Recommendation**

attendance of fusion technology A lecture  
reliable capability to use fundamental knowledge communicated in the bachelor study in physics, material sciences, electrical engineering and engineering design

**Annotation**

none

Below you will find excerpts from events related to this course:

**Fusion Technology B**

2190492, SS 2019, 2 SWS, Language: German, Open in study portal
Notes
Fusion Technology B is a continuation of Fusion Technology A lecture and includes the following topics:
Fusion neutronics, materials science of thermally and neutronically highly loaded components, reactor scaling and safety as well as plasma heating and current drive. The section fusion neutronics develops the basics of fusion neutronics and its calculation methods, the nuclear physical design of a fusion reactor and the corresponding components (blankets, shielding, activation, tritium breeding ratio and dose rate). Since both neutron fluxes and area power density in a fusion power plant are significantly higher than those of other power plants, they require special materials. After an extension of existing material knowledge by fundamentals and methods for the calculation of radiation damage in materials, strategies for the material selection of functional and structural materials are shown and deepened by examples. The arrangement of components close to the plasma in a fusion power plant means changed requirements for system integration and energy conversion; these questions are the subject of the block reactor scaling and safety. In addition to the explanation of the safety objectives, the methods for achieving the objectives and the computational tools required to achieve them are dealt with in particular. To ignite the plasma, extreme temperatures of several million degrees are required. Special plasma heating methods are used for this purpose, such as electron cyclotron resonance heating (ECRH), ion cyclotron resonance heating (ICRH), current drive at the lower hybrid frequency and neutral particle injection. Their basic mode of action, design criteria, transmission options and performance are presented and discussed. In addition, the heating processes can also be used for plasma stabilization. Some considerations and limitations are presented.

The lecture, which runs over 2 semesters, is aimed at students of engineering sciences and physics after the bachelor. The aim is an introduction to the current research and development on fusion and its long-term goal of a promising energy source. After a short insight into fusion physics, the lecture focuses on key technologies for a future fusion reactor. The lecture will be accompanied by exercises at Campus Nord (block event, 2-3 afternoons per topic).

Recommendations/Prerequisites:
Knowledge of physics, heat and mass transfer, and design theory taught in the bachelor's degree. Attendance of the lecture Fusion technology A

Presence time: 21 h
Self-study: 49 h
Oral proof of participation in the exercises
Duration: approx. 25 minutes, aids: none

Learning Content
Die Fusionstechnologie B beinhaltet
Fusion neutronics, plasma facing components and plasma heating-and current drive methods. The section fusion neutronics scopes the fundamentals and calculation methods, which allows for a physical design of a nuclear fusion reactor and the corresponding components (such as blankets, divertors, shielding, activation and dose rate). Fusion reactors produce fuel their "self". The necessary blankets are complex structures whose foundations and concept options, design criteria and methods are discussed. Also the divertor is a plasma facing component. Its tasks, constraints, and design concepts are explained. The arrangement of the plasma facing components in a fusion power plant means changing demands on the system integration and energy conversion. To ignite the plasma extreme temperatures of several million degrees are required. For this purpose, special plasma heating techniques are used such as electron cyclotron resonance heating (ECRH), ion-cyclotron resonance heating (ICRH), the current drive at the lower hybrid frequency, and the neutral particle injection. Their basic mode of action, the design criteria, the transmission options and performance are presented and discussed. Additionally the heating method used also for plasma stabilization. Here are some considerations and limitations are presented.

Workload
regular attendance: 21 h
self-study: 49 h

Literature
Lecture notes

11.152 Course: Gasdynamics [T-MACH-105533]

**Responsible:** Dr.-Ing. Franco Magagnato

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102634 - Major Field: Fluid Mechanic
- M-MACH-102635 - Major Field: Engineering Thermodynamics
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each winter term

**Version**
- 1

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**Competence Certificate**
- Oral exam - 30 minutes

**Prerequisites**
- None

*Below you will find excerpts from events related to this course:*

**Gasdynamics**

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**Description**

Powerpoint presentation
Notes
The student can describe the governing equations of Gas Dynamics and the associated basics in Thermodynamics. He will know different flow phenomena of applied Gas Dynamics. He can calculate compressible flows analytically. He is familiar with the Rankine-Hugoniot curve. They can derive the continuity-, the momentum- and the energy equations in differential form. With the help of the stationary flow filament theory they can calculate the normal shock wave and the associated increase of the entropy along past the shock wave. They are able to calculate the stagnation values of the Gas Dynamical variables and to determine their critical values. The students can apply the flow filament theory for variable cross-sectional areas and can distinguish between the different flow fields inside the Laval nozzle that forms with different boundary conditions. He can calculate the values behind an oblique shock wave and can distinguish between detached and attached shock waves. The student can calculate the Prandtl-Meyer expansion wave.

This lecture covers the following topics:

• Introduction to gas dynamics
• Numerical and experimental examples
• Governing equations of gas dynamics
• The transport equations in differential and integral form
• Stationary flow filament theory with and without normal shock waves
• Discussion of the energy equation: Stagnation and critical values
• Flow filament theory at variable cross-sectional area. Flow inside a Laval nozzle
• Oblique shock waves, detached shock waves
• Prandtl-Meyer expansion wave
• Viscous flows (Fanno flow)

Learning Content
This lecture covers the following topics:

• Introduction, basics of Thermodynamics
• Governing equations of gas dynamics
• Application of the conservation equations
• The transport equations in differential form
• Stationary flow filament theory with and without shock waves
• Discussion of the energy equation: Stagnation and critical values

Flow filament theory for variable cross-sectional areas. Flow inside a Laval nozzle

Workload
regular attendance: 21 hours
self-study: 84 hours

Literature
11.153 Course: Gear Cutting Technology [T-MACH-102148]

**Responsible:** Dr. Markus Klaiber  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102618 - Major Field: Production Technology

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**Events**

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<tr>
<th>Semester</th>
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<th>Course Title</th>
<th>SWS</th>
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<tr>
<td>WS 19/20</td>
<td>2149655</td>
<td>Gear Technology</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Klaiber</td>
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<tr>
<td>SS 2019</td>
<td>76-T-MACH-102148</td>
<td>Gear Cutting Technology</td>
<td></td>
<td>Prüfung (PR)</td>
<td>Schulze</td>
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**Competence Certificate**  
Oral Exam (20 min)

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

**Gear Technology**  
2149655, WS 19/20, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**  
**Media:**  
Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
Based on the gearing theory, manufacturing processes and machine technologies for producing gearings, the needs of modern gear manufacturing will be discussed in the lecture. For this purpose, various processes for various gear types are taught which represent the state of the art in practice today. A classification in soft and hard machining and furthermore in cutting and non-cutting technologies will be made. For comprehensive understanding the processes, machine technologies, tools and applications of the manufacturing of gearings will be introduced and the current developments presented. For assessment and classification of the applications and the performance of the technologies, the methods of mass production and manufacturing defects will be discussed. Sample parts, reports from current developments in the field of research and an excursion to a gear manufacturing company round out the lecture.

Learning Outcomes:
The students ...
- can describe the basic terms of gearings and are able to explain the imparted basics of the gearwheel and gearing theory.
- are able to specify the different manufacturing processes and machine technologies for producing gearings. Furthermore they are able to explain the functional principles and the dis-/advantages of these manufacturing processes.
- can apply the basics of the gearing theory and manufacturing processes on new problems.
- are able to read and interpret measuring records for gearings. are able to make an appropriate selection of a process based on a given application
- can describe the entire process chain for the production of toothed components and their respective influence on the resulting workpiece properties.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
Based on the gearing theory, manufacturing processes and machine technologies for producing gearings, the needs of modern gear manufacturing will be discussed in the lecture. For this purpose, various processes for various gear types are taught which represent the state of the art in practice today. A classification in soft and hard machining and furthermore in cutting and non-cutting technologies will be made. For comprehensive understanding the processes, machine technologies, tools and applications of the manufacturing of gearings will be introduced and the current developments presented. For assessment and classification of the applications and the performance of the technologies, the methods of mass production and manufacturing defects will be discussed. Sample parts, reports from current developments in the field of research and an excursion to a gear manufacturing company round out the lecture.

Workload
regular attendance: 21 hours
self-study: 99 hours
**11.154 Course: Global Production and Logistics [T-MACH-110337]**

**Responsible:** Prof. Dr.-Ing. Kai Furmans  
Prof. Dr.-Ing. Gisela Lanza  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:** M-MACH-102618 - Major Field: Production Technology

<table>
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<tr>
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**Events**

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<th>SWS</th>
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<tr>
<td>SS 2019</td>
<td>2149600</td>
<td>Global Production and Logistics - Part 2: Global Logistics</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Furmans</td>
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<tr>
<td>WS 19/20</td>
<td>2149610</td>
<td>Global Production and Logistics - Part 1: Global Production</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Lanza</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
oral exam (40 min)

**Prerequisites**  
The following courses must not be started:

- Globale Production and Logistics - Part 1: Global Production [T-MACH-105158 oder T-MACH-108848]
- Globale Production and Logistics - Part 2: Global Logistics [T-MACH-105159]

**Modeled Conditions**  
The following conditions have to be fulfilled:

1. The course T-MACH-108848 - Global Production and Logistics - Part 1: Global Production must not have been started.  
2. The course T-MACH-105158 - Global Production and Logistics - Part 1: Global Production must not have been started.  
3. The course T-MACH-105159 - Global Production and Logistics - Part 2: Global Logistics must not have been started.

*Below you will find excerpts from events related to this course:*

**Global Production and Logistics - Part 2: Global Logistics**  
2149600, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**  
**Media:**
- presentations, black board
Notes
Characteristics of global trade
  • Incoterms
  • Customs clearance, documents and export control

Global transport and shipping
  • Maritime transport, esp. container handling
  • Air transport

Modeling of supply chains
  • SCOR model
  • Value stream analysis

Location planning in cross-border-networks
  • Application of the Warehouse Location Problem
  • Transport Planning

Inventory Management in global supply chains
  • Stock keeping policies

Inventory management considering lead time and shipping costs

After taking this course students are able to:
  • assign basic problems of planning and operation of global supply chains and plan them with appropriate methods,
  • describe requirements and characteristics of global trade and transport, and
  • evaluate characteristics of the design from logistic chains regarding their suitability.

The assessment consists of a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The main exam is offered every summer semester. A second date for the exam is offered in winter semester only for students that did not pass the main exam.

Recommendations:
We recommend the course "Logistics - organisation, design and control of logistic systems " (2118078) beforehand.

regular attendance: 21 hours
self-study: 99 hours

Learning Content
Characteristics of global trade
  • Incoterms
  • Customs clearance, documents and export control

Global transport and shipping
  • Maritime transport, esp. container handling
  • Air transport

Modeling of supply chains
  • SCOR model
  • Value stream analysis

Location planning in cross-border-networks
  • Application of the Warehouse Location Problem
  • Transport Planning

Inventory Management in global supply chains
  • Stock keeping policies

Inventory management considering lead time and shipping costs

Workload
regular attendance: 21 hours
self-study: 99 hours
Literature

Elective literature:

- Arnold/Isermann/Kuhn/Tempelmeier. HandbuchLogistik, Springer Verlag, 2002 (Neuausgabe in Arbeit)
- Domschke. Logistik, Rundreisen und Touren, Oldenbourg Verlag, 1982
- Domschke/Drexl. Logistik, Standorte, Oldenbourg Verlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Tempelmeier. Bestandsmanagement in Supply Chains, Books on Demand 2006

Global Production and Logistics - Part 1: Global Production
2149610, WS 19/20, 2 SWS, Language: German, Open in study portal

Description

Media:

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

Therefore, the lecture first of all discusses the connections and interdependencies between the business strategy and the production strategy and illustrates necessary tasks for the definition of a production strategy. Methods for site selection, for the site-specific adaptation of product design and production technology as well as for the establishment of new production sites and for the adaptation of existing production networks to changing framework conditions are subsequently taught within the context of the design of the network footprint. With regard to the management of global production networks, the lecture addresses challenges associated with coordination, procurement and order management in global networks. The lecture is complemented by a discussion on the use of industry 4.0 applications in global production and current trends in planning, designing and managing global production networks.

The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Framework for planning, designing and managing global production networks
- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
- Design of global production networks
  - Basic types of network structures
  - Planning process for the design of the network footprint
  - Adaptation of the network footprint
  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management
- Trends in planning, designing and managing global production networks

Learning Outcomes:
The students ...

- can explain the general conditions and influencing factors of global production
- are capable to apply defined procedures for site selection and to evaluate site decisions with the help of different methods
- are able to select the adequate scope of design for site appropriate production and product construction cases specifically
- can state the central elements in the planning process of establishing a new production site.
- are capable to make use of the methods to design and scale global production networks for company-individual problems
- are able to show up the challenges and potentials of the departments sales, procurement as well as research and development on global basis.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Recommendations:
Combination with Global Production and Logistics – Part 2
Learning Content
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

Therefore, the lecture first of all discusses the connections and interdependencies between the business strategy and the production strategy and illustrates necessary tasks for the definition of a production strategy. Methods for site selection, for the site-specific adaptation of product design and production technology as well as for the establishment of new production sites and for the adaptation of existing production networks to changing framework conditions are subsequently taught within the context of the design of the network footprint. With regard to the management of global production networks, the lecture addresses challenges associated with coordination, procurement and order management in global networks. The lecture is complemented by a discussion on the use of industry 4.0 applications in global production and current trends in planning, designing and managing global production networks.

The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Framework for planning, designing and managing global production networks
- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
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  - Planning process for the design of the network footprint
  - Adaptation of the network footprint
  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management
- Trends in planning, designing and managing global production networks

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Lecture Notes
recommended secondary literature:
Course: Global Production and Logistics - Part 1: Global Production [T-MACH-108848]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory

### Events

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<th>Type</th>
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<th>Recurrence</th>
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<td>WS 19/20</td>
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<td>Global Production and Logistics - Part 1: Global Production</td>
<td>Lecture (V)</td>
<td>2 SWS</td>
<td>Each winter term</td>
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### Exams

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<td>SS 2019</td>
<td>76-T-MACH-108848</td>
<td>Global Production and Logistics - Part 1: Global Production</td>
<td>Prüfung (PR)</td>
<td>Lanza</td>
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**Competence Certificate**

Oral Exam (20 min)

**Prerequisites**

"T-MACH-105158 - Globale Produktion und Logistik - Teil 1: Globale Produktion" must not be commenced.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-105158 - Global Production and Logistics - Part 1: Global Production must not have been started.

Below you will find excerpts from events related to this course:

#### Global Production and Logistics - Part 1: Global Production

2149610, WS 19/20, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

Therefore, the lecture first of all discusses the connections and interdependencies between the business strategy and the production strategy and illustrates necessary tasks for the definition of a production strategy. Methods for site selection, for the site-specific adaptation of product design and production technology as well as for the establishment of new production sites and for the adaptation of existing production networks to changing framework conditions are subsequently taught within the context of the design of the network footprint. With regard to the management of global production networks, the lecture addresses challenges associated with coordination, procurement and order management in global networks. The lecture is complemented by a discussion on the use of industry 4.0 applications in global production and current trends in planning, designing and managing global production networks.

The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Framework for planning, designing and managing global production networks
- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
- Design of global production networks
  - Basic types of network structures
  - Planning process for the design of the network footprint
  - Adaptation of the network footprint
  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management

- Trends in planning, designing and managing global production networks

Learning Outcomes:
The students ...

- can explain the general conditions and influencing factors of global production
- are capable to apply defined procedures for site selection and to evaluate site decisions with the help of different methods
- are able to select the adequate scope of design for site-appropriate production and product construction specifically
- can state the central elements in the planning process of establishing a new production site.
- are capable to make use of the methods to design and scale global production networks for company-individual problems
- are able to show up the challenges and potentials of the departments sales, procurement as well as research and development on global basis.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Recommendations:
Combination with Global Production and Logistics – Part 2
Learning Content
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

Therefore, the lecture first of all discusses the connections and interdependencies between the business strategy and the production strategy and illustrates necessary tasks for the definition of a production strategy. Methods for site selection, for the site-specific adaptation of product design and production technology as well as for the establishment of new production sites and for the adaptation of existing production networks to changing framework conditions are subsequently taught within the context of the design of the network footprint. With regard to the management of global production networks, the lecture addresses challenges associated with coordination, procurement and order management in global networks. The lecture is complemented by a discussion on the use of industry 4.0 applications in global production and current trends in planning, designing and managing global production networks.

The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
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- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
- Design of global production networks
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  - Planning process for the design of the network footprint
  - Adaptation of the network footprint
  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management
- Trends in planning, designing and managing global production networks

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Lecture Notes
recommended secondary literature:
11.156 Course: Global Production and Logistics - Part 1: Global Production [T-MACH-105158]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102618 - Major Field: Production Technology

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<tr>
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<td>2149610</td>
<td>Global Production and Logistics - Part 1: Global Production</td>
<td>Lecture (V)</td>
<td>2 SWS</td>
<td>Lanza</td>
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**Exams**

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<td>Global Production and Logistics - Part 1: Global Production</td>
<td>Prüfung (PR)</td>
<td>Lanza</td>
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</table>

**Competence Certificate**  
Written Exam (60 min)

**Prerequisites**
"T-MACH-108848 - Globale Produktion und Logistik - Teil 1: Globale Produktion" must not be commenced.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-108848 - Global Production and Logistics - Part 1: Global Production must not have been started.

*Below you will find excerpts from events related to this course:*

**Global Production and Logistics - Part 1: Global Production**
2149610, WS 19/20, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**
Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

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The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Framework for planning, designing and managing global production networks
- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
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  - Basic types of network structures
  - Planning process for the design of the network footprint
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  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management
- Trends in planning, designing and managing global production networks

Learning Outcomes:
The students ...

- can explain the general conditions and influencing factors of global production
- are capable to apply defined procedures for site selection and to evaluate site decisions with the help of different methods
- are able to select the adequate scope of design for siteappropriate production and product construction casespecifically
- can state the central elements in the planning process of establishing a new production site.
- are capable to make use of the methods to design and scale global production networks for company-individual problems
- are able to show up the challenges and potentials of the departments sales, procurement as well as research and development on global basis.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Recommendations:
Combination with Global Production and Logistics – Part 2
Learning Content
The lecture examines the management of global production networks of manufacturing companies. It gives an overview of the influencing factors and challenges of global production. In-depth knowledge of common methods and procedures for planning, designing and managing global production networks is imparted.

Therefore, the lecture first of all discusses the connections and interdependencies between the business strategy and the production strategy and illustrates necessary tasks for the definition of a production strategy. Methods for site selection, for the site-specific adaptation of product design and production technology as well as for the establishment of new production sites and for the adaptation of existing production networks to changing framework conditions are subsequently taught within the context of the design of the network footprint. With regard to the management of global production networks, the lecture addresses challenges associated with coordination, procurement and order management in global networks. The lecture is complemented by a discussion on the use of industry 4.0 applications in global production and current trends in planning, designing and managing global production networks.

The topics include:

- Basic conditions and influencing factors of global production (historical development, targets, chances and threats)
- Framework for planning, designing and managing global production networks
- Production strategies for global production networks
  - From business strategy to production strategy
  - Tasks of the production strategy (product portfolio management, circular economy, planning of production depth, production-related research and development)
- Design of global production networks
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  - Planning process for the design of the network footprint
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  - Site selection
  - Location-specific adaptation of production technology and product design
- Management of global production networks
  - Network coordination
  - Procurement process
  - Order management
- Trends in planning, designing and managing global production networks

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Lecture Notes
recommended secondary literature:
11.157 Course: Global Production and Logistics - Part 2: Global Logistics [T-MACH-105159]

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory
- M-MACH-102640 - Major Field: Technical Logistics

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<tr>
<td>Written examination</td>
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<td>Lecture (V)</td>
<td>2 SWS</td>
<td>Furmans</td>
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**Exams**

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<tbody>
<tr>
<td>SS 2019</td>
<td>Prüfung (PR)</td>
<td>Furmans</td>
<td></td>
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</tbody>
</table>

**Competence Certificate**

The assessment consists of a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

**Prerequisites**

none

**Recommendation**

We recommend attending the course "Logistics - organization, design and control of logistic systems " (2118078) beforehand.

Below you will find excerpts from events related to this course:

**Global Production and Logistics - Part 2: Global Logistics**

2149600, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

presentations, black board
Notes
Characteristics of global trade

- Incoterms
- Customs clearance, documents and export control

Global transport and shipping

- Maritime transport, esp. container handling
- Air transport

Modeling of supply chains

- SCOR model
- Value stream analysis

Location planning in cross-border-networks

- Application of the Warehouse Location Problem
- Transport Planning

Inventory Management in global supply chains

- Stock keeping policies

Inventory management considering lead time and shipping costs

After taking this course students are able to:

- assign basic problems of planning and operation of global supply chains and plan them with appropriate methods,
- describe requirements and characteristics of global trade and transport, and
- evaluate characteristics of the design from logistic chains regarding their suitability.

The assessment consists of a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

The main exam is offered every summer semester. A second date for the exam is offered in winter semester only for students that did not pass the main exam.

Recommendations:

We recommend the course "Logistics - organisation, design and control of logistic systems " (2118078) beforehand.

regular attendance: 21 hours
self-study: 99 hours

Learning Content
Characteristics of global trade

- Incoterms
- Customs clearance, documents and export control

Global transport and shipping

- Maritime transport, esp. container handling
- Air transport

Modeling of supply chains

- SCOR model
- Value stream analysis

Location planning in cross-border-networks

- Application of the Warehouse Location Problem
- Transport Planning

Inventory Management in global supply chains

- Stock keeping policies

Inventory management considering lead time and shipping costs

Workload
regular attendance: 21 hours
self-study: 99 hours
Literature

Elective literature:

- Arnold/Isermann/Kuhn/Tempelmeier. HandbuchLogistik, Springer Verlag, 2002 (Neuaufgabe in Arbeit)
- Domschke. Logistik, Rundreisen und Touren, Oldenbourg Verlag, 1982
- Domschke/Drexel. Logistik, Standorte, Oldenbourg Verlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Tempelmeier. Bestandsmanagement in SupplyChains, Books on Demand 2006
## 11.158 Course: Handling Characteristics of Motor Vehicles I [T-MACH-105152]

**Responsible:** Dr.-Ing. Hans-Joachim Unrau  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
- M-MACH-102607 - Major Field: Vehicle Technology

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### Events

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<td>Handling Characteristics of Motor Vehicles I</td>
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### Exams

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<td>Handling Characteristics of Motor Vehicles I</td>
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### Competence Certificate

Verbally  

Duration: 30 up to 40 minutes  

Auxiliary means: none

### Prerequisites

none

Below you will find excerpts from events related to this course:

### Handling Characteristics of Motor Vehicles I  
2113807, WS 19/20, 2 SWS, Language: German, Open in study portal

#### Learning Content

1. Problem definition: Control loop driver - vehicle - environment (e.g. coordinate systems, modes of motion of the car body and the wheels)

2. Simulation models: Creation from motion equations (method according to D'Alembert, method according to Lagrange, programme packages for automatically producing of simulation equations), model for handling characteristics (task, motion equations)

3. Tyre behavior: Basics, dry, wet and winter-smooth roadway

#### Workload

Regular attendance: 22.5 hours  
Self-study: 97.5 hours

#### Literature

11.59 Course: Handling Characteristics of Motor Vehicles II [T-MACH-105153]

**Responsible:** Dr.-Ing. Hans-Joachim Unrau
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology

### Events

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**SS 2019**

2114838 Handling Characteristics of Motor Vehicles II

**Exams**

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**Competence Certificate**

Oral Examination

**Duration:** 30 up to 40 minutes

**Auxiliary means:** none

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

### Handling Characteristics of Motor Vehicles II

2114838, SS 2019, 2 SWS, Language: German, Open in study portal

**Learning Content**

1. Vehicle handling: Bases, steady state cornering, steering input step, single sine, double track switching, slalom, cross-wind behavior, uneven roadway

2. Stability behavior: Basics, stability conditions for single vehicles and for vehicles with trailer

**Workload**

Regular attendance: 22.5 hours
Self-study: 97.5 hours

**Literature**

11.160 Course: Hands-on BioMEMS [T-MACH-106746]

**Responsible:** Prof. Dr. Andreas Guber  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<td>Lecture (V)</td>
<td>Rajabi, Guber</td>
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**Competence Certificate**  
Oral presentation and discussion (30 Min.)

**Prerequisites**

none
11.161 Course: Heat and Mass Transfer [T-MACH-105292]

**Responsible:** Prof. Dr.-Ing. Henning Bockhorn  
Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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**Exams**

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<td>Prüfung (PR)</td>
<td>Maas</td>
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**Competence Certificate**

- Written exam, 3 h

**Prerequisites**

none

Below you will find excerpts from events related to this course:

### Heat and mass transfer

2165512, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**

**Learning Content**

- Steady and unsteady heat transfer in homogenous materials; Plates, pipe sections and spherical shells  
- Molecular diffusion in gases; analogies between heat conduction and mass diffusion  
- Convective, forced heat transfer in pipes/channels and around plates and profiles.  
- Convective mass transfer, heat-/mass transfer analogy  
- Multi phase convective heat transfer (condensation, evaporation)  
- Radiative heat transfer

**Annotation**

Compulsory elective subject: 5 LP

**Workload**

- General attendance: 22.5 h  
- Self-study: 97.5 h

**Literature**

- Maas; Vorlesungsskript “Wärme- und Stoffübertragung”  
## 11.162 Course: Heat Transfer in Nuclear Reactors [T-MACH-105529]

**Responsible:** Prof. Dr.-Ing. Xu Cheng  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

### Type
- Oral examination

### Credits
- 4

### Recurrence
- Each winter term

### Version
- 1

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**Competence Certificate**  
oral exam, 20 min

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

### Flow and heat transfer in nuclear reactors  
2189907, WS 19/20, 2 SWS, Language: English, [Open in study portal]

**Notes**
1. Reactor types and thermal-hydraulic design criteria  
2. Heat transfer processes and modeling  
3. Pressure drop calculation  
4. Temperature distribution in nuclear reactor  
5. Numerical analysis methods for nuclear reactor thermal-hydraulics

**Learning Content**
1. Reactor types and thermal-hydraulic design criteria  
2. Heat transfer processes and modeling  
3. Pressure drop calculation  
4. Temperature distribution in nuclear reactor  
5. Numerical analysis methods for nuclear reactor thermal-hydraulics

**Workload**  
**Time of attendance:** 21 hours  
**Self-study:** 99 hours

**Literature**
1. L.S. Tong, J. Weisman, Thermal-hydraulics of pressurized water reactors, American Nuclear Society, La Grande Park, Illinois, USA  
11.163 Course: Heatpumps [T-MACH-105430]

Responsible: Prof. Dr. Ulrich Maas
              Heiner Wirbser

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
         M-MACH-102635 - Major Field: Engineering Thermodynamics
         M-MACH-102648 - Major Field: Energy Technology for Buildings

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<td>Maas, Wirbser</td>
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Competence Certificate
Oral exam (20 min)

Prerequisites
none

Below you will find excerpts from events related to this course:

**Learning Content**
The aim of this lecture is to promote heat pumps as heating systems for small an medium scale facilities and to discuss their advantages as well as their drawbacks. After considering the actual energy situation and the political requirements the different aspects of heat pumps are elucidated. The requirements concerning heat sources, the different components and the various types of heat pumps are discussed. In addition ecological and economical aspects are taken into consideration. The coupling of heat pumps with heat accumulators in heating systems will also be part of the lecture.

**Workload**
Regular attendance: 21 hours
Self-study: 100 hours

**Literature**
Vorlesungsunterlagen
Bach, K.: Wärmepumpen, Bd. 26 Kontakt und Studium, Lexika Verlag, 1979
**11.164 Course: High Performance Computing [T-MACH-105398]**

**Responsible:** Prof. Dr. Britta Nestler  
Dr.-Ing. Michael Selzer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<td>Lecture / Practice (VÜ)</td>
<td>Nestler, Selzer, Hötzer</td>
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**Competence Certificate**
At the end of the semester, there will be a written exam (90 min).

**Prerequisites**
none

**Recommendation**
preliminary knowledge in mathematics, physics and materials science  
regular participation in the additionally offered computer exercises

*Below you will find excerpts from events related to this course:*

**High Performance Computing**
2183721, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**
Slides of the lecture, exercise sheets, solution files of the computer exercises.
Notes
Topics of the high performance computing course are:

- architectures of parallel platforms
- parallel programming models
- performance analysis of concurrent programs
- parallelization models
- MPI and OpenMP
- Monte-Carlo method
- 1D & 2D heat diffusion
- raycasting
- N-body problem
- simple phase-field models

The student

- can explain the foundations and strategies of parallel programming
- can efficiently apply high performance computers for simulations by elaborating respective parallelisation techniques.
- has an overview of typical applications and the specific requirements for parallelization.
- knows the concepts of parallelisation and is capable to apply these to efficiently use high performance computing resources and the growing performance of multi core processors in science and industry.
- has experiences in programming of parallel algorithms through integrated computer exercises.

preliminary knowledge in mathematics, physics and materials science recommended

regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

We regularly discuss exercises at the computer.
At the end of the semester, there will be a written exam.

Learning Content
Topics of the high performance computing course are:

- architectures of parallel platforms
- parallel programming models
- key figures and performance analysis of concurrent programs
- parallelization models
- MPI and OpenMP
- parallel I/O (MPI-I/O)
- vector processing (SIMD)
- cache coherence protocols
- interconnection networks
- simple phase-field models

Workload
regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

Literature

1. Lecture Notes; Problem Sheets; Program templates
2. Foundations of Multithreaded, Parallel, and Distributed Programming, Gregory R. Andrews; Addison Wesley 2000
Course: High Performance Powder Metallurgy Materials [T-MACH-102157]

Responsible: Dr. Günter Schell
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102611 - Major Field: Materials Science and Engineering
M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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Events
SS 2019 2126749 Advanced powder metals 2 SWS Lecture (V) Schell
Exams
SS 2019 76-T-MACH-102157 High Performance Powder Metallurgy Materials Prüfung (PR) Schell
WS 19/20 76-T-MACH-102157 High Performance Powder Metallurgy Materials Prüfung (PR) Schell

Competence Certificate
oral exam, 20-30 min

Prerequisites
none

Below you will find excerpts from events related to this course:

Advanced powder metals
2126749, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
The lecture gives an overview on production, properties and application of structural and functional powder metallurgy material. The following groups of materials are presented: PM High Speed Steels, Cemented Carbides, PM Metal Matrix Composites, PM Specialities, PM Soft Magnetic and Hard Magnetic Materials.

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature
- R.M. German. "Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
11.166 Course: High Temperature Materials [T-MACH-105459]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102649 - Major Field: Advanced Materials Modelling

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**Competence Certificate**

Oral exam, about 25 minutes

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**High Temperature Structural Materials**

2174600, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

- Phenomenology of High Temperature Deformation
- Deformation Mechanisms
- High Temperature Structural Materials

**learning objectives:**

Students are able to

- Define properly the term "high temperature" with respect to materials
- Describe the shape of the creep curve based on underlying deformation mechanisms
- Rationalize the influence of relevant parameters such as temperature, stress, microstructure on the high temperature deformation behavior
- Develop strategies for improving creep resistance of alloys via modifying their composition
- Select properly industrially relevant high temperature structural materials for various applications

**requirements:**

Relevant Bachelor degree, **Recommendations:** None

**workload:**

Regular attendance 28 h, self study 92 h

**Learning Content**

- Phenomenology of High Temperature Deformation
- Deformation Mechanisms
- High Temperature Structural Materials
Workload
Regular attendance 28 h, self study 92 h

Literature
11.167 Course: HoC lectures [T-MACH-106377]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier  
**Organisation:** KIT Department of Mechanical Engineering

Part of: M-MACH-102824 - Key Competences

### Type
Completed coursework

### Credits
2

### Recurrence
Each term

### Version
1

**Competence Certificate**
See course

**Prerequisites**
none

**Responsible:** Prof. Dr.-Ing. Rüdiger Dillmann  
Prof. Uwe Spetzger

**Organisation:** KIT Department of Informatics

**Part of:** M-MACH-102615 - Major Field: Medical Technology

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**Exams**

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Course: Human Factors Engineering I [T-MACH-105518]

**Responsible:** Prof. Dr.-Ing. Barbara Deml

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology

### Type
- Written examination

### Credits
- 4

### Recurrence
- Each winter term

### Version
- 2

#### Events
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**Competence Certificate**
- written exam, 60 minutes
- The exams are only offered in German!

**Prerequisites**
- none

*Below you will find excerpts from events related to this course:

**Human Factors Engineering I: Ergonomics**
- 2109035, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)
Notes
The course "Human Factors Engineering I: Ergonomics" takes place in the first half of the semester, until 2019/12/05, on Wednesday and Thursday.

In the second half of the semester, beginning with 2019/12/11, the course "Human Factors Engineering II: Work Organisation" takes place on Wednesday and Thursday.

Content of teaching:
1. Principles of human work
2. Behavioural-science data acquisition
3. Workplace design
4. Work environment design
5. Work management
6. Labour law and advocacy groups

Learning target:
The students acquire a basic knowledge in the field of ergonomics:

- They are able to consider cognitive, physiological, anthropometric, and safety technical aspects in order to design workplaces ergonomically.
- Just as well they know physical and psycho-physical fundamentals (e. g. noise, lighting, climate) in the field of work-environmental design.
- Furthermore the students are able to evaluate workplaces by knowing and being able to apply essential methods of time studies and payment systems.
- Finally, they get a first, overall insight into the German labour law as well as into the organisation of advocacy groups beyond companies.

Further on the participants get to know basic methods of behavioral-science data acquisition (e. g. eye-tracking, ECG, dual-task-paradigm).

Learning Content
1. Principles of human work
2. Behavioural-science data acquisition
3. Workplace design
4. Work environment design
5. Work management
6. Labour law and advocacy groups

Workload
The amount of work accounts for 120 h (=4 ECTS).

Literature
The lecture material is available on ILIAS for download.
11.170 Course: Human Factors Engineering II [T-MACH-105519]

**Responsible:** Prof. Dr.-Ing. Barbara Deml

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102596 - Compulsory Elective Subject Economics/Law
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation

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**Events**

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**Exams**

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**Competence Certificate**

written exam, 60 minutes

The exams are only offered in German!

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Human Factors Engineering II: Work Organisation**

2109036, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)
Notes
Content of teaching:

1. Fundamentals of work organization
2. Empirical research methods
3. Individual level
   - personnel selection
   - personnel development
   - personnel assessment
   - work satisfaction/motivation
4. Group level
   - interaction and communication
   - management of employees
   - team work
5. Organizational level
   - structural organization
   - process organization
   - production organization

Learning target:
The students gain a first insight into empirical research methods (e.g., experimental design, statistical data evaluation). Particularly, they acquire a basic knowledge in the field of work organisation:

- **Organizational level.** Within this module the students gain also a fundamental knowledge in the field of structural, process, and production organization.
- **Group level.** Besides, they get to know basic aspects of industrial teamwork and they know relevant theories in the field of interaction and communication, the management of employees as well as work satisfaction and motivation.
- **Individual level.** Finally, the students get to know also methods in the field of personnel selection, development, and assessment.

Learning Content

1. Fundamentals of work organization
2. Empirical research methods
3. Individual level
   - personnel selection
   - personnel development
   - personnel assessment
   - work satisfaction/motivation
4. Group level
   - interaction and communication
   - management of employees
   - team work
5. Organizational level
   - structural organization
   - process organization
   - production organization

Workload
The amount of work is 120 h (≈4 ECTS).

Literature
The lecture material is available on ILIAS for download.

**Responsible:** Prof. Dr.-Ing. Barbara Deml  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102600 - Major Field: Man - Technology - Organisation

**Type**  
Examination of another type

**Credits**  
4

**Recurrence**  
Each summer term

**Version**  
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**Competence Certificate**  
Scientific report (about 6 pages), poster, and presentation

**Prerequisites**  
In order to attend this lecture, it is necessary having completed "Arbeitswissenschaft I" or "Arbeitswissenschaft II" successfully.

**Modeled Conditions**  
You have to fulfill one of 2 conditions:

1. The course T-MACH-105518 - Human Factors Engineering I must have been passed.  
2. The course T-MACH-105519 - Human Factors Engineering II must have been passed.

**Below you will find excerpts from events related to this course:**

**Human Factors Engineering III: Empirical research methods**  
2110036, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Lecture / Practice (VÜ)**

**Notes**

The aim of the event is for the participants to know and be able to apply research methods in the field of ergonomics. The participants will get an introduction into the basics of experimental design and learn about essential methods of data collection and statistical data evaluation. Subsequently, the participants will carry out, evaluate and present their own experimental studies on topics such as "Digital Human Models", "Eyetracking" or "Driving Simulation" in the form of laboratory internships.

Translated with www.DeepL.com/Translator
11.172 Course: Human-Machine-Interaction [T-INFO-101266]

**Responsible:** Prof. Dr.-Ing. Michael Beigl  
**Organisation:** KIT Department of Informatics  
**Part of:** M-MACH-102598 - Major Field: Advanced Mechatronics  
M-MACH-102614 - Major Field: Mechatronics

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**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-INFO-106257 - Human-Machine-Interaction Pass must have been passed.

**Responsible:** Prof. Dr.-Ing. Michael Beigl  
**Organisation:** KIT Department of Informatics  
**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102614 - Major Field: Mechatronics

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**Type:** Completed coursework  
**Credits:** 0  
**Recurrence:** Each summer term  
**Version:** 1
# 11.174 Course: Humanoid Robots - Practical Course [T-INFO-105142]

**Responsible:** Prof. Dr.-Ing. Tamim Asfour  
**Organisation:** KIT Department of Informatics  
**Part of:** M-MACH-102633 - Major Field: Robotics

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*Below you will find excerpts from events related to this course:*

**Humanoid Robotics Laboratory**  
24890, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)  

**Practical course (P)**

**Learning Content**

In this block course, a complex task will be implemented in a small team. The exercise addresses algorithmic questions in the context of humanoid robotics, such as active perception with stereo or depth cameras, grasping and manipulation planning, action representation with DMS, HMMs or splines, reproduction of motions, or active balancing with humanoid robots.

**Workload**

90 h
11.175 Course: Human-oriented Productivity Management: Personnel Management [T-MACH-106374]

**Responsible:** Dr.-Ing. Patricia Stock  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102600 - Major Field: Man - Technology - Organisation  
M-MACH-102613 - Major Field: Lifecycle Engineering  
M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**  
oral exam (approx. 20 min)  
The exam is offered in German only!

**Prerequisites**  
Timely pre-registration in ILIAS, since participation is limited.

*Below you will find excerpts from events related to this course:*
Notes

1. Introduction: change of the working world, work organisation of successful companies, requirements for Industrial Engineering
2. Human-oriented Productivity Management
3. Organisation of enterprises:
   - Process-oriented work organisation
   - Operational and organisational structure
   - Holistic production systems
4. Basics of personnel management:
   - Identification of available capacity & capacity requirements
   - Management of working time
   - Types of mobile working
5. Systematic design of the human-resource allocation
6. Case study (group work)
7. Presentation of the solutions developed

   • Knowledge in Production Management/Industrial Engineering is required
   • Knowledge of Work Science and Economics is helpful

Learning target:

The student is capable ...

• to describe and explain the current megatrends, resulting challenges for enterprises as well as operational success factors
• to explain tasks and methods of human-oriented productivity management
• to analyse an existing working system
• to determine the available capacity and the capacity needed of a work system
• to use basic methods and tools of personnel management and to evaluate existing solutions
• to systematically design and organise the employment of staff

Annotation

• Compact course (one week full-time)
• Limited number of participants; seats are assigned according the date of registration
• Registration via ILIAS is required

Literature

Handout and literature is available on ILIAS for download.
11.176 Course: Hybrid and Electric Vehicles [T-ETIT-100784]

**Responsible:** Dr.-Ing. Klaus-Peter Becker  
**Organisation:** KIT Department of Electrical Engineering and Information Technology  
**Part of:**  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102614 - Major Field: Mechatronics

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**Prerequisites**

none
11.177 Course: Hydraulic Fluid Machinery [T-MACH-105326]

**Responsible:** Dr. Balazs Pritz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102627 - Major Field: Energy Converting Engines

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**Competence Certificate**

oral exam, 40 min.

**Prerequisites**

None.

*Below you will find excerpts from events related to this course:*

**Hydraulic Fluid Machinery**

2157432, SS 2019, 4 SWS, Language: German, [Open in study portal](#)

**Learning Content**

1. Introduction
2. Basic equations
3. System analysis
4. Elementary Theory (Euler's equation of Fluid Machinery)
5. Operation and Performance Characteristics
6. Similarities, Specific Values
7. Control technics
8. Wind Turbines, Propellers
9. Cavitation
10. Hydrodynamic transmissions and converters

**Workload**

regular attendance: 56 hours
self-study: 150 hours
preparation for exam: 40 hours

**Literature**

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Bohl, W.: Strömungsmaschinen I & II, Vogel-Verlag
6. Kreispumpenlexikon. KSB Aktiengesellschaft
11.178 Course: Hydrodynamic Stability: From Order to Chaos [T-MACH-105425]

**Responsible:** Prof. Dr. Andreas Class  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanic

### Type
Oral examination  

### Credits
4

### Recurrence
Each summer term  

### Version
1

#### Events

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#### Exams

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### Competence Certificate

oral exam, Duration: 30 minutes  
Auxiliary means: none

### Prerequisites

The partial performance number T-MACH-108846 - "Stability: From Order to Chaos" (Nat/Inf/Etit) must not be started or completed. The partial services T-MACH-108846 - "Stability: From Order to Chaos" (Nat/Inf/Etit) and T-MACH-105425 - "Hydrodynamic Stability: From Order to Chaos" are mutually exclusive.

### Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-MACH-108846 - Stability: from order to chaos must not have been started.

### Recommendation

Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

Below you will find excerpts from events related to this course:

### Hydrodynamic Stability: From Order to Chaos

2154437, SS 2019, 2 SWS, Language: German/English, [Open in study portal](#)

**Description**

**Media:**
Black board
Notes
The students can apply the analytic and numerical methods for an evaluation of stability properties of hydrodynamic systems. They are qualified to discuss the characteristic influence of parameter changes (e.g. Reynolds number) on the calculated results with respect to the flow character and properties (e.g. transition laminar/turbulent flow).

Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).

Typical hydrodynamic instabilities are summarized in the lecture.

The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.

Covered is:
- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Learning Content
Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).

Typical hydrodynamic instabilities are summarized in the lecture.

The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.

Covered is:
- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Annotation
Lecture also offered as a block-lecture within the AREVA Nuclear Professional School (www.anps.kit.edu)

Workload
regular attendance: 21h
self-study: 99h

Literature
Script
11.179 Course: Hydrogen in Materials [T-MACH-108853]

Responsibility: Prof. Dr. Astrid Pundt
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102611 - Major Field: Materials Science and Engineering

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Competence Certificate
Oral exam, about 25 minutes

Prerequisites
none

Recommendation
Materials Science or Materials Physics and Metals
11.180 Course: Hydrogen Technologies [T-MACH-105416]

**Responsible:** Dr. Thomas Jordan
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology

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**Competence Certificate**
oral exam, Duration: approximately 30 minutes
Auxiliary: no tools or reference materials may be used during the exam

**Prerequisites**
none

**Recommendation**
Fundamentals Thermodynamics

Below you will find excerpts from events related to this course:

**Hydrogen Technologies**
2170495, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Notes**
The course content is the cross-cutting issue of hydrogen as energy carrier. After successful participation the students may reflect on the fundamental technological basis of an energy system using predominantly hydrogen as an energy carrier or energy storage. Based on this knowledge they may objectify the principle idea of an hydrogen economy.

The students know the fundamental physical and chemical properties of hydrogen and may apply their knowledge on thermodynamics to compare efficiencies of different solutions with hydrogen. They can list, compare and evaluate established and future solutions for production, storage and distribution of hydrogen. They can explain advantages and disadvantages of using hydrogen in conventional combustion processes versus using hydrogen in different fuel cells. In particular the can describe the specific safety aspects related to hydrogen, compare them with other energy vectors and evaluate different measures for risk mitigation.

- Basic concepts
- Production
- Transport and storage
- Application
- Safety aspects

**Learning Content**
Basic concepts
Production
Transport and storage
Application
Safety aspects

**Annotation**
Recommendation: Fundamentals Thermodynamics

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Workload
regular attendance: 21 h
self-study: 99 h

Literature
Ullmann's Encyclopedia of Industrial Chemistry
11.181 Course: Ignition systems [T-MACH-105985]

**Responsible:** Dr.-Ing. Olaf Toedter

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**

oral exam, 20 min

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Ignition systems**

2133125, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

- Ignition Process
- Spark Ignition
- Principle of Spark Ignition Systems
- Limits of Spark Ignition
- New Developments of Spark Ignition Systems
- New an Alternative Ignition Systems
Course: Industrial Aerodynamics [T-MACH-105375]

**Responsible:** Prof. Dr.-Ing. Thomas Breitling
               Prof. Dr.-Ing. Bettina Frohnapfel

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102634 - Major Field: Fluid Mechanics

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**Exams**

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**Competence Certificate**
oral exam - 30 minutes

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Industrial aerodynamics**
2153425, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**
Power Point
Notes
This compact lecture deals with flow, mixing and combustion phenomena with significance in vehicle development. A special focus is set on the optimization of external car and truck aerodynamics, thermal comfort in passenger compartments, analyses of cooling flows and improvement of charge motion, mixing and combustion in piston engines. These fields are explained in their phenomenology, the corresponding theories are discussed and the tools for measurement and simulation are introduced and demonstrated. The focus of this lecture is on industry relevant methods for analyses and description of forces, flow structures, turbulence, flows with heat transfer and phase transition and reactive flows. In addition an introduction to modern methods in accuracy control and efficiency improvement of numerical methods for industrial use is given. The integration and interconnection of the methods in the development processes are discussed examplary.

An excursion to the Daimler AG wind tunnel and the research and development centers is planned.

- Industrial flow measurement techniques
- Flow simulation and control of numerical errors, turbulence modeling
- Cooling flows
- Flow mixing and combustion at direct injected Diesel engines
- Flow mixing and combustion at gasoline engine
- Vehicle aerodynamics
- HVAC-Systems and thermal comfort
- Aeroacoustics

Students can describe the different challenges of aerodynamical flow that occur in vehicles. They are qualified to analyze external flows around the vehicles, flows in the passenger compartments (thermal comfort), as well as cooling flows, charge motion, mixing and combustion processes in the engine.

Learning Content
This compact lecture deals with flow, mixing and combustion phenomena with significance in vehicle development. A special focus is set on the optimization of external car and truck aerodynamics, thermal comfort in passenger compartments, analyses of cooling flows and improvement of charge motion, mixing and combustion in piston engines. These fields are explained in their phenomenology, the corresponding theories are discussed and the tools for measurement and simulation are introduced and demonstrated. The focus of this lecture is on industry relevant methods for analyses and description of forces, flow structures, turbulence, flows with heat transfer and phase transition and reactive flows. In addition an introduction to modern methods in accuracy control and efficiency improvement of numerical methods for industrial use is given. The integration and interconnection of the methods in the development processes are discussed examplary.

An excursion to the Daimler AG wind tunnel and the research and development centers is planned.

- Industrial flow measurement techniques
- Flow simulation and control of numerical errors, turbulence modeling
- Cooling flows
- Flow mixing and combustion at direct injected Diesel engines
- Flow mixing and combustion at gasoline engine
- Vehicle aerodynamics
- HVAC-Systems and thermal comfort
- Aeroacoustics

Annotation
Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

Workload
attendance: 22.5h
self-study: 100h

Literature
Script
11.183 Course: Information Engineering [T-MACH-102209]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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**Competence Certificate**  
Alternative exam assessment (written composition and speech)

**Prerequisites**  
None
11.184 Course: Information Processing in Mechatronic Systems [T-MACH-105328]

Responsible: Prof. Dr.-Ing. Michael Kaufmann
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102624 - Major Field: Information Technology

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Competence Certificate
Written exam (Duration: 1 h)

Prerequisites
none

Below you will find excerpts from events related to this course:

Information Processing in Mechatronic Systems
2105022, WS 19/20, 2 SWS, Language: German, Open in study portal

Notes
Content:
Information processing components – consisting of sensors, actors, hardware and software – are of essential importance for the implementation of mechatronic functions.

Based on requirements on information processing in mechatronic systems typical hardware and software solutions are examined. Characteristics, advantages, disadvantages and application areas are discussed. Solutions are examined regarding real-time capabilities, dependability, safety and fault tolerance. Bus communication in mechatronic systems is examined. Description methods and several approaches of functional description are considered. An approach on the development of information processing components is developed. Lecture topics are complemented by practical examples.

Outline:
- Requirements on information processing components,
- Characteristics of information processing components
- Real-time capabilities, dependability, safety and fault tolerance
- Architectures of information processing components
- Communication in mechatronic systems
- Descriptive models und functional description
- Development of information processing components
- Software quality

Learning objectives:
Students have fundamental knowledge about selection, conceptual design and development of information processing components in mechatronic systems.
Learning Content
Information processing components – consisting of sensors, actors, hardware and software – are of essential importance for the implementation of mechatronic functions.

Based on requirements on information processing in mechatronic systems typical hardware and software solutions are examined. Characteristics, advantages, disadvantages and application areas are discussed. Solutions are examined regarding real-time capabilities, dependability, safety and fault tolerance. Bus communication in mechatronic systems is examined. Description methods and several approaches of functional description are considered. An approach on the development of information processing components is developed. Lecture topics are complemented by practical examples.

Outline:
- Requirements on information processing components,
- Characteristics of information processing components
- Real-time capabilities, dependability, safety and fault tolerance
- Architectures of information processing components
- Communication in mechatronic systems
- Descriptive models and functional description
- Development of information processing components
- Software quality

Workload
General attendance: 21 h
Self-study: 99 h
## 11.185 Course: Information Processing in Sensor Networks [T-INFO-101466]

**Responsible:** Prof. Dr.-Ing. Uwe Hanebeck  
**Organisation:** KIT Department of Informatics  
**Part of:**  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102624 - Major Field: Information Technology

### Type
Oral examination

### Credits
6

### Recurrence
Irregular

### Version
1

### Events

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### Exams

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<td>Information Processing in Sensor Networks</td>
<td>Prüfung (PR)</td>
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</table>
Course: Information Systems and Supply Chain Management [T-MACH-102128]

**Responsible:** Dr. Christoph Kilger  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems  
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory

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**Competence Certificate**

The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Information Systems in Logistics and Supply Chain Management**

**Description**

**Media:** presentations

**Learning Content**

1) Overview of logistics systems and processes  
2) Basic concepts of information systems and information technology  
3) Introduction to IS in logistics: Overview and applications  
4) Detailed discussion of selected SAP modules for logistics support

**Annotation**

none

**Workload**

regular attendance: 21 hours  
self-study: 99 hours

**Literature**


Responsible: Prof. Dr.-Ing. Xu Cheng
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102608 - Major Field: Nuclear Energy
M-MACH-102610 - Major Field: Power Plant Technology

Type: Oral examination
Credits: 4
Recurrence: Each summer term
Version: 1

Events
SS 2019 2130973 Innovative Nuclear Systems 2 SWS Cheng

Exams
SS 2019 76-T-MACH-105404 Innovative Nuclear Systems Prüfung (PR) Cheng

Competence Certificate
oral exam, 20 min

Prerequisites
none

Below you will find excerpts from events related to this course:

Innovative Nuclear Systems
2130973, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
1. state of the art and development tendencies in nuclear systems
2. advanced concepts in light water cooled systems
3. new developments in fast reactors
4. development tendencies in gas-cooled plants
5. transmutation systems for waste management
6. fusionsystems

Workload
Time of attendance: 21 hours
Self-study: 100 hours
11.188 Course: Innovative Project [T-MACH-109185]

Responsible: Prof. Dr. Andreas Class  
Prof. Dr. Orestis Terzidis

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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<td>Innovative Project</td>
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Competence Certificate

Students have to deliver pitch-talk supported by slides to convince a committee about their results. A fictive project proposal of 10 to 15 pages.

Prerequisites

none

Recommendation

Participates need to bring their own laptop with Skype installed.

Recommended English proficiency equivalent to:

- **IELTS Academic test**  
  An overall band score of at least 6.5 (with no section lower than 5.5)
- **University of Cambridge**  
  Certificate in Advanced English, CAE (grades A – C)  
  Certificate of Proficiency in English, CPE (grades A – C)
- **TOEFL Internet-based test, IBT**  
  A total score of at least 92, with a minimum score of 22 from the writing section

Annotation

The subject of the project is provided by industry partner or the innovation department from KIT or INP Grenoble. Representatives of industry partner will be addressee for the pitch-talk.

Below you will find excerpts from events related to this course:
Notes
The lecture will be executed with the partner university INP Grenoble. Participates need to bring there own laptop with Skype installed. Teams of 2-3 students.

- Understand the physics of the technology of the invention considered in the project
- Understand the claims of the patent considered in the project
- Apply a structured technology application selection methodology.
- Student understand the methodology of TAS, which provides the background to become a TAS coach.
- Students are enabled to prepare a proposal for funding.

The TAS (technology application selection) methodology provides tools that help to successfully advance an invention with a low technology readiness level to a higher technology readiness level. Skills that are typically provided by a classical engineering education supports both the early phase of an invention where a deep basic understanding is required and the industrial exploration building on a first prototype. The gap that arises between the invention and its later industrialized application is rarely addressed, so that many inventions will not make it to the market. In the course, we practice bridging the technology gap for the case of a real invention provided by an industry partner or University. We experiment with teams consisting of team members located at different universities and from different disciplines.

The scenario addressed is an inventor who calls some of his friends within her/his personal network. The group will work remotely via video conference employing a structured TAS process. Creativity will be fertilized by teamwork and linking the invention to a selection of potential technologies. In an in-depth analysis of these links, each group narrows down their pool of ideas to one candidate. Finally, the group will try to convince the fellow teams (and the inventor) to support their idea. For this purpose, a pitch talk is prepared and delivered in front of all teams leading to a unique vote of all teams for one technology application. In addition the students prepare fictive proposals for start-up based on their TAS.

Learning Content
The TAS (technology application selection) methodology provides tools that help to successfully advance an invention with a low technology readiness level to a higher technology readiness level. Skills that are typically provided by a classical engineering education supports both the early phase of an invention where a deep basic understanding is required and the industrial exploration building on a first prototype. The gap that arises between the invention and its later industrialized application is rarely addressed, so that many inventions will not make it to the market. In the course, we practice bridging the technology gap for the case of a real invention provided by an industry partner or University. We experiment with teams consisting of team members located at different universities and from different disciplines.

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Annotation
The subject of the project is provided by industry partner or the innovation department from KIT or INP Grenoble. Representatives of industry partner will be addressee for the pitch-talk.

Workload
approx. 180 hours:
3 credit points - skype participation and resulting in TAS - 90 hours
1 credit point - pitch talk - 30 hours
2 credit points - for writting proposal - 60 hours
Course: Integrated Information Systems for Engineers [T-MACH-102083]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each summer term

**Version**
- 2

**Events**

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**Competence Certificate**
- Oral examination 20 min.

**Prerequisites**
- None

**Below you will find excerpts from events related to this course:**

**Integrated Information Systems for engineers**
- Lecture / Practice (VÜ)
- 2121001, SS 2019, 3 SWS, Language: German, Open in study portal

**Learning Content**
- Information systems, information management
- CAD, CAP and CAM systems
- PPS, ERP and PDM systems
- Knowledge management and ontology
- Process modeling

**Workload**
- Regular attendance: 31.5 hours, self-study: 108 hours

**Literature**
- Lecture slides
11.190 Course: Integrated Product Development [T-MACH-105401]

Responsible: Prof. Dr.-Ing. Albert Albers
Albers Assistenten

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102626 - Major Field: Integrated Product Development

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**Competence Certificate**
oral examination (60 minutes)

**Prerequisites**
none

**Annotation**
Due to organizational reasons, the number of participants is limited. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK homepage from april to july. The selection itself is made by Prof. Albers in personal interviews.

*Below you will find excerpts from events related to this course:*

**Integrated Product Development**
2145156, WS 19/20, 4 SWS, Language: German, Open in study portal

Lecture (V)
Notes
Registration required in the previous summer semester. The lecture starts in first week of October.

Prerequisites:
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).

Due to organizational reasons, the number of participants is limited. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK homepage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations:
none

Workload:
regular attendance: 84 h
self-study: 288 h

Examination:
oral examination (60 minutes)
combined examination of lectures, tutorials and project work

Course content:
organizational integration: integrated product engineering model, core team management and simultaneous engineering informational integration: innovation management, cost management, quality management and knowledge management personal integration: team coaching and leadership management

Learning objectives:
The Students are able to ...

- analyze and evaluate product development processes based on examples and their own experiences.
- plan, control and evaluate the working process systematically.
- choose and use suitable methods of product development, system analysis and innovation management under consideration of the particular situation.
- prove their results.
- develop complex technical solutions in a team and to present them to qualified persons as well as non-qualified persons
- to design overall product development processes under consideration of market-, customer- and company- aspects

Workshop Product Development
2145157, WS 19/20, 4 SWS, Language: German, Open in study portal
Notes

Prerequisites:
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).

Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK homepage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations:
none

Workload:
regular attendance: 84 h
self-study: 288 h

Examination:
lectures: 21 h
preparation to exam: 99 h

Course content:
problem solving: analysis techniques, creativity techniques and evaluation methods
professional skills: presentation techniques, moderation and teamcoaching
development tools: MS Project, Szenario-Manager & Pro/Engineer Wildfire

Learning objectives:
The theoretical background taught in the lecture, is deepened through methodworkshops, business games and case studies. The reflexion of the onself procedure allows for an applicability and practicability of the contents in the accompanying development project as well as for the career entry.
Notes
Participation only possible in combination with the lecture 2145156 'Integrated Product Development'.

Prerequisites:
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).

Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations:
none

Workload:
regular attendance: 21 h
self-study: 99 h

Examination:
oral examination (60 minutes)
combined examination of lectures, tutorials and project work

Course content:
The project work begins with the early stages of product development, i.e. the identification of market trends and needs. Based on this information the students develop scenarios for future markets and create product profiles, which describe the customers and their demands without anticipating possible product solutions. After having passed several following milestones for ideas, concepts and designs, virtual prototypes and function prototypes are presented to an audience. The project work is supported by coaching through skilled faculty staff. Additionally weekly tutorials, respectively workshops are given. For doing the project the teams gain access to team workspaces featuring IT-infrastructure and relevant software, such as office, CAD or FEA. Further on the teams learn how team cooperation and knowledge management can be supported in design project by using a wiki system.s

Learning objectives:
The center of "Integrated Product Development" constitutes itself in the development of a technical product within independent working student teams on the basis of the market situation up to virtual and real prototypes. Thereby the integrate treatment of the product development process is of importance. The project teams hereby represent development departments of medium sized companies, in which the presented methods and tools are field - experienced applied and ideas are transformed into concrete product models.
For the preparation of this development project the basics of 3D-CAD-modelling (Pro/ENGINEER) as well as different tools and methods of creative designing, of sketching and solution finding are mediated in workshops. Special events impart an insight of presentation techniques and the meaning of technical design.
Course: Integrated Production Planning in the Age of Industry 4.0 [T-MACH-108849]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102618 - Major Field: Production Technology

<table>
<thead>
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<th>Type</th>
<th>Credits</th>
<th>Recurrence</th>
<th>Version</th>
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</thead>
<tbody>
<tr>
<td>Oral examination</td>
<td>8</td>
<td>Each summer term</td>
<td>1</td>
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**Events**

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<tr>
<td>SS 2019</td>
<td>2150660</td>
<td>Integrated Production Planning in the Age of Industry 4.0</td>
<td>6 SWS</td>
<td>Lecture / Practice (VÜ)</td>
<td>8</td>
<td>Lanza</td>
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**Exams**

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<th>Term</th>
<th>Code</th>
<th>Title</th>
<th>Type</th>
<th>Instructor</th>
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<tbody>
<tr>
<td>SS 2019</td>
<td>76-T-MACH-108849</td>
<td>Integrated Production Planning in the Age of Industry 4.0</td>
<td>Prüfung (PR)</td>
<td>Lanza</td>
</tr>
</tbody>
</table>

**Competence Certificate**

Oral Exam (40 min)

**Prerequisites**

"T-MACH-109054 - Integrierte Produktionsplanung im Zeitalter von Industrie 4.0" as well as "T-MACH-102106 Integrierte Produktionsplanung" must not be commenced.

Below you will find excerpts from events related to this course:

**Integrated Production Planning in the Age of Industry 4.0**

2150660, SS 2019, 6 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
Integrated production planning in the age of industry 4.0 will be taught in the context of this engineering science lecture. In addition to a comprehensive introduction to Industry 4.0, the following topics will be addressed at the beginning of the lecture:

- Basics, history and temporal development of production
- Integrated production planning and integrated digital engineering
- Principles of integrated production systems and further development with Industry 4.0

Building on this, the phases of integrated production planning are taught in accordance with VDI Guideline 5200, whereby special features of parts production and assembly are dealt with in the context of case studies:

- Factory planning system
- Definition of objectives
- Data collection and analysis
- Concept planning (structural development, structural dimensioning and rough layout)
- Detailed planning (production planning and control, fine layout, IT systems in an industry 4.0 factory)
- Preparation and monitoring of implementation
- Start-up and series support

The lecture contents are rounded off by numerous current practical examples with a strong industry 4.0 reference. Within the exercises the lecture contents are deepened and applied to specific problems and tasks.

Learning Outcomes:
The students ...

- can discuss basic questions of production technology.
- are able to apply the methods of integrated production planning they have learned about to new problems.
- are able to analyze and evaluate the suitability of the methods, procedures and techniques they have learned about for a specific problem.
- can apply the learned methods of integrated production planning to new problems.
- can use their knowledge targeted for efficient production technology.

Workload:
MACH:
regular attendance: 63 hours
self-study: 177 hours

WING:
regular attendance: 63 hours
self-study: 207 hours

Learning Content
Integrated production planning in the age of industry 4.0 will be taught in the context of this engineering science lecture. In addition to a comprehensive introduction to Industry 4.0, the following topics will be addressed at the beginning of the lecture:

- Basics, history and temporal development of production
- Integrated production planning and integrated digital engineering
- Principles of integrated production systems and further development with Industry 4.0

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- Preparation and monitoring of implementation
- Start-up and series support

The lecture contents are rounded off by numerous current practical examples with a strong industry 4.0 reference. Within the exercises the lecture contents are deepened and applied to specific problems and tasks.
Workload

**MACH:**
- regular attendance: 63 hours
- self-study: 177 hours

**WING:**
- regular attendance: 63 hours
- self-study: 207 hours

Literature

Lecture Notes
11.192 Course: Integrative Strategies in Production and Development of High Performance Cars [T-MACH-105188]

Responsible: Karl-Hubert Schlichtenmayer
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102605 - Major Field: Engineering Design
M-MACH-102607 - Major Field: Vehicle Technology
M-MACH-102618 - Major Field: Production Technology

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<th>Version</th>
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<tr>
<td>Written exam</td>
<td>4</td>
<td>Each summer term</td>
<td>1</td>
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Events

SS 2019 2150601 Integrative Strategies in Production and Development of High Performance Cars 2 SWS Lecture (V) Schlichtenmayer

Exams

SS 2019 76-T-MACH-105188 Integrative Strategies in Production and Development of High Performance Cars Prüfung (PR) Lanza

Competence Certificate
Written Exam (60 min)

Prerequisites
none

Below you will find excerpts from events related to this course:

Integrative Strategies in Production and Development of High Performance Cars
2150601, SS 2019, 2 SWS, Language: German, Open in study portal

Description
Media:
Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/).
Notes
The lecture deals with the technical and organizational aspects of integrated development and production of sports cars on the example of Porsche AG. The lecture begins with an introduction and discussion of social trends. The deepening of standardized development processes in the automotive practice and current development strategies follow. The management of complex development projects is a first focus of the lecture. The complex interlinkage between development, production and purchasing are a second focus. Methods of analysis of technological core competencies complement the lecture. The course is strongly oriented towards the practice and is provided with many current examples.

The main topics are:

- Introduction to social trends towards high performance cars
- Automotive Production Processes
- Integrative R&D strategies and holistic capacity management
- Management of complex projects
- Interlinkage between R&D, production and purchasing
- The modern role of manufacturing from a R&D perspective
- Global R&D and production
- Methods to identify core competencies

Learning Outcomes:
The students ...

- are capable to specify the current technological and social challenges in automotive industry.
- are qualified to identify interlinkages between development processes and production systems.
- are able to explain challenges and solutions of global markets and global production of premium products.
- are able to explain modern methods to identify key competences of producing companies.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
The lecture deals with the technical and organizational aspects of integrated development and production of sports cars on the example of Porsche AG. The lecture begins with an introduction and discussion of social trends. The deepening of standardized development processes in the automotive practice and current development strategies follow. The management of complex development projects is a first focus of the lecture. The complex interlinkage between development, production and purchasing are a second focus. Methods of analysis of technological core competencies complement the lecture. The course is strongly oriented towards the practice and is provided with many current examples.

The main topics are:

- Introduction to social trends towards high performance cars
- Automotive Production Processes
- Integrative R&D strategies and holistic capacity management
- Management of complex projects
- Interlinkage between R&D, production and purchasing
- The modern role of manufacturing from a R&D perspective
- Global R&D and production
- Methods to identify core competencies

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Lecture Slides

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  
Frank Zacharias

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102633 - Major Field: Robotics
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

**Type:** Oral examination  
**Credits:** 4  
**Recurrence:** Each term  
**Version:** 1

**Events**

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<th>Event Title</th>
<th>Duration</th>
<th>Instructor</th>
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<tr>
<td>SS 2019</td>
<td>2147160</td>
<td>Patents and Patentstrategies in innovative companies</td>
<td>2 SWS</td>
<td>Zacharias</td>
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<tr>
<td>WS 19/20</td>
<td>2147161</td>
<td>Intellectual Property Rights and Strategies in Industrial Companies</td>
<td>2 SWS</td>
<td>Lecture (V) Zacharias</td>
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</table>

**Competence Certificate**  
oral exam (20 min)

**Prerequisites**  
none

**Recommendation**  
None

*Below you will find excerpts from events related to this course:*

## Patents and Patentstrategies in innovative companies

2147160, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Description**

**Media**

- Beamer
Notes
Attendance at lectures (5 L): 24h
Personal preparation and follow-up of lecture and exercise: 5h
Preparation exam: 31h

The students understand and are able to describe the basics of intellectual property, particularly with regard to the filing and obtaining of property rights. They can name the criteria of project-integrated intellectual property management and strategic patenting in innovative companies. Students are also able to describe the key regulations of the law regarding employee invention and to illustrate the challenges of intellectual properties with reference to examples.

The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual property and current trends in the sector. Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.

Lecture overview:

1. Introduction to intellectual property
2. The profession of the patent attorney
3. Filing and obtaining intellectual property rights
4. Patent literature as a source of knowledge and information
5. The law regarding employee inventions
6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Learning Content
The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual property and current trends in the sector. Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.

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6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Workload
Attendance at lectures (5 L): 24h
Personal preparation and follow-up of lecture and exercise: 5h
Preparation exam: 31h

Intellectual Property Rights and Strategies in Industrial Companies
2147161, WS 19/20, 2 SWS, Language: German, Open in study portal
Learning Content
The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual property and current trends in the sector.

Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.

Lecture overview:
1. Introduction to intellectual property
2. The profession of the patent attorney
3. Filing and obtaining intellectual property rights
4. Patent literature as a source of knowledge and information
5. The law regarding employee inventions
6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Workload
regular attendance: 21 h
self-study: 99 h
11.194 Course: International Production Engineering A [T-MACH-110334]

**Responsible:** Prof. Dr.-Ing. Jürgen Fleischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology

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<tr>
<th>Events</th>
<th>SS 2019</th>
<th>2150600</th>
<th>International Production Engineering A</th>
<th>SWS</th>
<th>Lecture (V)</th>
<th>Fleischer</th>
</tr>
</thead>
</table>

**Type** Oral examination  
**Credits** 4  
**Recurrence** Each summer term  
**Version** 1

**Competence Certificate**  
Oral Exam (20 min)

**Prerequisites**  
One of the following courses must be started:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-109055 - Machine Tools and Industrial Handling

**Modeled Conditions**  
You have to fulfill one of 2 conditions:

1. The course T-MACH-108844 - Automated Manufacturing Systems must have been started.
2. The course T-MACH-109055 - Machine Tools and Industrial Handling must have been started.

**Recommendation**  
This course can only be attended in combination with International Production Engineering B in the next winter semester.

Below you will find excerpts from events related to this course:

**International Production Engineering A**  
2150600, SS 2019, SWS, Language: German/English, Open in study portal

**Description**  
**Media:**
Lecture documents will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The course "International Production Engineering" offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the validation is carried out using modern analytical and numerical methods. The results of the project will be presented and discussed to the project partner in a final meeting.

The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay at the Advanced Manufacturing Technology Center (AMTC) in Shanghai. The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner.

The project offers students...

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context,
- to gain insights into a wide range of development activities relevant for their future careers,
- cooperation with an attractive industrial partner,
- work in a team with other students with competent support from scientific staff,
- first practical experience in project management,
- international practical experience.

Learning Outcomes:
The students...

- can develop ideas for technical solutions in the environment of production plants in a team and evaluate their feasibility according to technical and economic criteria
- are capable of selecting the essential components and modules of a production plant and carrying out the necessary calculations
- can use FEM simulations to predict and evaluate the static and dynamic behavior of an assembly
- are able to present, plan and assess their own work and decision-making processes
- are able to apply basic methods of project management in an international environment.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
The course "International Production Engineering" offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the validation is carried out using modern analytical and numerical methods. The results of the project will be presented and discussed to the project partner in a final meeting.

The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay at the Advanced Manufacturing Technology Center (AMTC) in Shanghai. The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner.

The project offers students...

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context,
- to gain insights into a wide range of development activities relevant for their future careers,
- cooperation with an attractive industrial partner,
- work in a team with other students with competent support from scientific staff,
- first practical experience in project management,
- international practical experience.

Workload
Regular attendance: 21 hours
Self-study: 99 hours
11.195 Course: International Production Engineering B [T-MACH-110335]

**Responsible:** Prof. Dr.-Ing. Jürgen Fleischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each winter term

**Version**
- 1

| Events |  | 
|--------|---|---|
| WS 19/20 | 2149620 | International Production Engineering B |
| SWS | Lecture (V) | Fleischer |

**Competence Certificate**

Oral Exam (20 min)

**Prerequisites**

Successful completion of the following course:

- T-MACH-110334 - International Production Engineering A

Furthermore successful completion of one of the following courses:

- T-MACH-108844 - Automated Manufacturing Systems
- T-MACH-109055 - Machine Tools and Industrial Handling

**Modeled Conditions**

The following conditions have to be fulfilled:

1. You have to fulfill one of 2 conditions:
   1. The course T-MACH-108844 - Automated Manufacturing Systems must have been passed.
   2. The course T-MACH-109055 - Machine Tools and Industrial Handling must have been passed.
2. The course T-MACH-110334 - International Production Engineering A must have been passed.

Below you will find excerpts from events related to this course:

**International Production Engineering B**

2149620, WS 19/20, SWS, Language: German/English, Open in study portal

**Description**

**Media:**

Lecture documents will be provided in Ilias (https://ilias.studium.kit.edu/).
Notes
The course “International Production Engineering” offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the validation is carried out using modern analytical and numerical methods. The results of the project will be presented and discussed to the project partner in a final meeting.

The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay at the Advanced Manufacturing Technology Center (AMTC) in Shanghai. The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner.

The project offers students ...

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context
- to gain insights into a wide range of development activities relevant for their future careers
- cooperation with an attractive industrial partner
- work in a team with other students with competent support from scientific staff
- first practical experience in project management
- international practical experience.

Learning Outcomes:
The students ...

- can develop ideas for technical solutions in the environment of production plants in a team and evaluate their feasibility according to technical and economic criteria
- are capable of selecting the essential components and modules of a production plant and carrying out the necessary calculations
- can use FEM simulations to predict and evaluate the static and dynamic behavior of an assembly
- are able to present, plan and assess their own work and decision-making processes
- are able to apply basic methods of project management in an international environment.

Workload:
Regular attendance: 21 hours
Self-study: 99 hours

Learning Content
The course “International Production Engineering” offers a practical insight into the development of production plants in an international environment. A student team works on a current and concrete problem in the field of production engineering, which is introduced into the project by an industrial partner who is operating as well in Germany as in China.

As part of the course "International Production Engineering A", the problem will initially be transferred into work packages. According to the elaborated project plan, ideas and concepts for a solution of the problem will be generated and developed. Based on the concepts, the validation is carried out using modern analytical and numerical methods. The results of the project will be presented and discussed to the project partner in a final meeting.

The practical implementation of the developed solution is part of the course "International Production Engineering B" during an eight-week research stay at the Advanced Manufacturing Technology Center (AMTC) in Shanghai. The project will be carried out by the students under the guidance of scientific staff and in cooperation with the industrial partner.

The project offers students ...

- the unique opportunity to put the contents of the accompanying lecture into practice in an interdisciplinary and creative context
- to gain insights into a wide range of development activities relevant for their future careers
- cooperation with an attractive industrial partner
- work in a team with other students with competent support from scientific staff
- first practical experience in project management
- international practical experience.
Annotation
For organizational reasons, the number of participants in the course is limited. Hence, a selection process will take place. Applications can be made via the homepage of wbk (http://www.wbk.kit.edu/studium-und-lehre.php). The lecture can only be attended in combination with International Production Engineering A. Requirements for the lecture are a passed examination in "Machine Tools and Industrial Handling" or "Automated Production Systems" as well as a participation in the course "International Production Engineering A" in the previous summer semester.

Workload
Regular attendance: 21 hours
Self-study: 99 hours
Course: Introduction into Mechatronics [T-MACH-100535]

**Responsible:** Moritz Böhland  
Dr.-Ing. Maik Lorch  
PD Dr.-Ing. Markus Reischl

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology

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**Events**

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<td>WS 19/20</td>
<td>2105011</td>
<td>Introduction into Mechatronics</td>
<td>3</td>
<td>Lecture (V)</td>
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<td>Reischl, Lorch, Böhland</td>
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**Exams**

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<td>Introduction into Mechatronics</td>
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</tbody>
</table>

**Competence Certificate**

Oral exam (Duration: 2h)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Introduction into Mechatronics**

2105011, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)
Notes

Content:

• Introduction
• Structure of mechatronic systems
• Mathematical treatment of mechatronic systems
• Sensors and actuators
• Measurements: acquisition and interpretation
• Modelling of mechatronic systems
• Control and feedback control systems
• Information processing

Learning objectives:
The student has knowledge about the specific challenge of interdisciplinary collaboration within the framework of mechatronics. He is able to explain the origin, necessity and methodic implementation of interdisciplinary collaboration, to name the main difficulties as well as the special features within the development of mechatronic products from the point of view of development methodic.

The student has fundamental knowledge of modeling mechanical, hydraulically and electrically part systems and about suitable optimization methods.

The student knows the difference in use of the term "system" in mechatronic and mechanical use.

Learning Content

• Introduction
• Structure of mechatronic systems
• Mathematical treatment of mechatronic systems
• Sensors and actuators
• Measurements: acquisition and interpretation
• Modelling of mechatronic systems
• Control and feedback control systems
• Information processing

Workload

regular attendance: 31.5 h
self-study: 148 h

Literature

Course: Introduction into the Multi-Body Dynamics [T-MACH-105209]

**Responsible:** Prof. Dr.-Ing. Wolfgang Seemann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

**Type**
- Written examination

**Credits**
- 5

**Recurrence**
- Each summer term

**Version**
- 2

**Events**

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<tr>
<td>Seemann</td>
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</tbody>
</table>

**Competence Certificate**

Written examination, 180 min.

**Prerequisites**

none

**Recommendation**

Engineering Mechanics III/IV

Below you will find excerpts from events related to this course:

**Introduction into the multi-body dynamics**

<table>
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<tr>
<th>Events</th>
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<th>Credits</th>
<th>Recurrence</th>
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<td>SS 2019</td>
<td>Lecture (V)</td>
<td>3 SWS</td>
<td>Each summer term</td>
<td>2</td>
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</tbody>
</table>

**Learning Content**

The role of multibody systems in engineering, kinematics of a single rigid body, Kinematics of multibody systems, rotation matrix, angular velocity, derivatives in different reference systems, holonomic and non-holonomic constraints, Newton-Euler's equations, principle of d'Alembert, principle of virtual power, Lagrange's equations, Kane's equations, structure of the equations of motion

**Workload**

time of attendance: 21.5h; self-study: 98h
Literature
Wittenburg, J.: Dynamics of Systems of Rigid Bodies, Teubner Verlag, 1977
de Jal'on, J. G., Bayo, E.: Kinematik and Dynamic Simulation of Multibody System.
Kane, T.: Dynamics of rigid bodies.
11.198 Course: Introduction to Ceramics [T-MACH-100287]

**Responsible:** Prof. Dr. Michael Hoffmann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Events**

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<td>WS 19/20</td>
<td>2125757</td>
<td>Introduction to Ceramics</td>
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<td>Lecture (V)</td>
<td>Hoffmann</td>
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**Exams**

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<th>SWS</th>
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<tr>
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<td>76-T-MACH-100287</td>
<td>Introduction to Ceramics</td>
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<td>Prüfung (PR)</td>
<td>Hoffmann, Schell, Wagner</td>
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<tr>
<td>WS 19/20</td>
<td>76-T-MACH-100287</td>
<td>Introduction to Ceramics</td>
<td></td>
<td>Prüfung (PR)</td>
<td>Hoffmann, Schell, Wagner</td>
</tr>
</tbody>
</table>

**Competence Certificate**

The assessment consists of an oral exam (30 min) taking place at a specific date. 
The re-examination is offered at a specific date.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

### Introduction to Ceramics

**2125757, WS 19/20, 3 SWS, Language: German,** [Open in study portal](#)

**Description**

**Media:**

Slides for the lecture:

available under [http://www.iam.kit.edu/km](http://www.iam.kit.edu/km)

**Learning Content**

After a short introduction to interatomic bonding, fundamental concepts of crystallography, the stereographic projection and the most important symmetry elements will be given. Different types of crystal structures are explained and the relevance of imperfections are analysed with respect to the mechanical and electrical properties of ceramics. Then, the impact of surfaces, interfaces and grain boundaries for the preparation, microstructural evolution and the resulting properties is discussed. Finally, an introduction is given to ternary phase diagrams.

The second part of the course covers structure, preparation and application aspects of nonmetallic inorganic glasses, followed by an introduction to the properties and processing methods of fine-grained technical powders. The most relevant shaping methods, such as pressing, slip casting, injection moulding and extrusion are introduced. Subsequently, the basics of science of sintering and the mechanisms for normal and abnormal grain growth are discussed. Mechanical properties of ceramics are analysed using basic principles of linear elastic fracture mechanics, Weibull statistics, concepts for subcritical crack growth and creep models to explain the behaviour at elevated temperatures. Furthermore it is demonstrated that mechanical properties can be significantly enhanced by various types of microstructural toughening mechanisms. The electronic and ionic conductivity of ceramic materials are explained based on defect-chemical considerations and band structure models. Finally, the characteristics of a dielectric, pyroelectric, and piezoelectric behaviour is discussed.

**Workload**

regular attendance: 45 hours

self-study: 135 hours

Master Program Mechanical Engineering (M.Sc.)

Module Handbook as of 11.09.2019 505
Literature

- Kingery, Bowen, Uhlmann, "Introduction To Ceramics", Wiley
- Y.-M. Chiang, D. Birnie III and W.D. Kingery, "Physical Ceramics", Wiley
- S.J.L. Kang, "Sintering, Densification, Grain Growth & Microstructure", Elsevier
11.199 Course: Introduction to Industrial Production Economics [T-MACH-105388]

**Responsible:** Simone Dürrschnabel

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102613 - Major Field: Lifecycle Engineering
- M-MACH-102618 - Major Field: Production Technology

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<td>oral examination</td>
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<td>Each winter term</td>
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**Competence Certificate**
oral exam (approx. 30 min)

The exam is offered in German only!

**Prerequisites**
none
11.200 Course: Introduction to Microsystem Technology - Practical Course [T-MACH-108312]

**Responsible:** Dr. Arndt Last

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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**Events**

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<td>SS 2019</td>
<td>2143877</td>
<td>Introduction to Microsystem Technology - Practical Course</td>
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<td>Practical course (P)</td>
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<tr>
<td>WS 19/20</td>
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<td>Introduction to Microsystem Technology - Practical Course</td>
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**Exams**

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<td>SS 2019</td>
<td>76-T-MACH-108312</td>
<td>Introduction to Microsystem Technology - Practical Course</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**

non-graded written examination

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Introduction to Microsystem Technology - Practical Course**

2143877, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

In the practical training includes nine experiments:

1. Hot embossing of plastics micro structures
2. Micro electroforming
4. UV-lithography
5. Optical waveguides
6. Capillary electrophoresis on a chip
7. SAW gas sensor
8. Metrology
9. Atomic force microscopy

Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

**Workload**

Time of attendance: 21 h + 2 h exam
Privat studies: 5 h preparing experiments + 10 h preparing the exam
Learning Content
In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
4. UV-lithography
5. Optical waveguides
6. Capillary electrophoresis on a chip
7. SAW gas sensor
8. Metrology
9. Atomic force microscopy
Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

Workload
Time of attendance: 21 h + 2 h exam
Privat studies: 5 h preparing experiments + 10 h preparing the exam
11.201 Course: Introduction to Microsystem Technology I [T-MACH-105182]

**Responsible:** Dr. Vlad Badilita
Dr. Mazin Jouda
Prof. Dr. Jan Gerrit Korvink

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102647 - Major Field: Microactuators and Microsensors
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology

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**Competence Certificate**
written examination for implementation in a major field, 30 min oral exam for elective subject

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Introduction to Microsystem Technology I**

2141861, WS 19/20, 2 SWS, Language: English, Open in study portal

**Learning Content**

- Introduction in Nano- and Microtechnologies
- Silicon and processes for fabricating microelectronics circuits
- Basic physics background and crystal structure
- Materials for micromachining
- Processing technologies for microfabrication
- Silicon micromachining
- Examples

**Workload**

- Literature: 20 h
- Lessons: 21 h
- Preparation and Review: 50 h
- Exam preparation: 30 h

**Literature**

M. Madou
Fundamentals of Microfabrication
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011
11.202 Course: Introduction to Microsystem Technology II [T-MACH-105183]

**Responsible:** Dr. Mazin Jouda  
Prof. Dr. Jan Gerrit Korvink

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102616 - Major Field: Microsystem Technology  
- M-MACH-102647 - Major Field: Microactuators and Microsensors  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology

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**Events**

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<th>Introduction to Microsystem Technology II</th>
<th>2 SWS</th>
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**Exams**

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<th>Introduction to Microsystem Technology II</th>
<th>Prüfung (PR)</th>
<th>Korvink, Badilita</th>
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</thead>
</table>

**Competence Certificate**  
written examination for major field, oral exam (30 min) for elective field

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Introduction to Microsystem Technology II**

*2142874, SS 2019, 2 SWS, Language: English,* [Open in study portal]

**Learning Content**
- Introduction in Nano- and Microtechnologies  
- Lithography  
- LIGA-technique  
- Mechanical microfabrication  
- Patterning with lasers  
- Assembly and packaging  
- Microsystems

**Workload**

- Literature: 20 h  
- Lessons: 21 h  
- Preparation and Review: 50 h  
- Exam preparation: 30 h

**Literature**

M. Madou  
Fundamentals of Microfabrication  
Taylor & Francis Ltd.; Auflage: 3. Auflage. 2011
11.203 Course: Introduction to Neutron Cross Section Theory and Nuclear Data Generation [T-MACH-105466]

**Responsible:** Dr. Ron Dagan  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102608 - Major Field: Nuclear Energy

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<tr>
<td>SS 2019</td>
<td>2190490</td>
<td>Introduction to Neutron Cross Section Theory and Nuclear Data Generation</td>
<td>Lecture (V)</td>
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<td>Dagan</td>
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**Exams**

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<td>Introduction to Neutron Cross Section Theory and Nuclear Data Generation</td>
<td>Prüfung (PR)</td>
<td>Dagan, Stieglitz</td>
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<td>76-T-MACH-105466</td>
<td>Introduction to Neutron Cross Section Theory and Nuclear Data Generation</td>
<td>Prüfung (PR)</td>
<td>Dagan, Stieglitz</td>
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</table>

**Competence Certificate**  
oral exam of about 30 minutes

**Prerequisites**  
none

**Annotation**  
none

Below you will find excerpts from events related to this course:

**Introduction to Neutron Cross Section Theory and Nuclear Data Generation**

2190490, SS 2019, 2 SWS, Language: English, [Open in study portal](#)
Notes
Cross section characterization
Summary of basic cross section theory
Resonance cross section
Doppler broadening
Scattering kernels
Basic of slowing down theory
Unit cell based XS data generation
Cross sections Data libraries
Data Measurements
The students:
  • Understand the special importance of cross sections in various domains of natural science (Reactor physics, Material research, Solar radiation etc.)
  • Are familiar with the theoretical methods and experimental effort to generate cross sections data.

Regular attendance: 26 h
self study: 94 h
oral exam about 30 min.

Learning Content
Cross section characterization
Summary of basic cross section theory
Resonance cross section
Doppler broadening
Scattering kernels
Basic of slowing down theory
Unit cell based XS data generation
Cross sections Data libraries
Data Measurements

Workload
Regular attendance: 26 h
self study: 94 h

Literature
P. Tippler, R. Llewellyn Modern Physics 2008
11.204 Course: Introduction to Nonlinear Vibrations [T-MACH-105439]

**Responsible:** Prof. Dr.-Ing. Alexander Fidlin

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-104443 - Major Field: Vibration Theory

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<tr>
<td>WS 19/20</td>
<td>2162247</td>
<td>Introduction to Nonlinear Vibrations</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
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<td>WS 19/20</td>
<td>2162248</td>
<td>Introduction into the nonlinear vibrations (Tutorial)</td>
<td>2 SWS</td>
<td>Practice (Ü)</td>
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**Competence Certificate**
oral exam, 30 min.

**Prerequisites**
none

**Recommendation**
Vibration theory, Mathematical Methods of Vibration Theory, Dynamic Stability

Below you will find excerpts from events related to this course:

**Introduction to Nonlinear Vibrations**
2162247, WS 19/20, 2 SWS, Language: German, Open in study portal

**Learning Content**
- dynamic systems
- basic ideas of asymptotic methods
- perturbation methods: Linstedt-Poincare, averaging, multiple scales
- limit cycles
- nonlinear resonance
- basics of the bifurcation analysis, bifurcation diagrams
- types of bifurcations
- discontinuous systems
- dynamic chaos

**Workload**
time of attendance: 39 h
self-study: 201 h
Literature


Introduction into the nonlinear vibrations (Tutorial)
2162248, WS 19/20, 2 SWS, Language: German, Open in study portal

Workload

time of attendance: 10,5h; self-study: 20h
### 11.205 Course: Introduction to Nuclear Energy [T-MACH-105525]

**Responsibility:** Prof. Dr.-Ing. Xu Cheng  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102608 - Major Field: Nuclear Energy  
- M-MACH-102610 - Major Field: Power Plant Technology  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Events**

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<td>WS 19/20</td>
<td>2189903</td>
<td>Introduction to Nuclear Energy</td>
<td>2 SWS</td>
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<td></td>
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**Exams**

|        | 76-T-MACH-105525 | Introduction to Nuclear Energy | Prüfung (PR) | Cheng |
|--------|------------------|--------------------------------|---------------|

**Competence Certificate**

oral exam, 30 min

**Prerequisites**

none
Course: Introduction to Numerical Fluid Dynamics [T-MACH-105515]

Responsibility: Dr. Balazs Pritz
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102634 - Major Field: Fluid Mechanic

Events

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Competence Certificate
Certificate of participation

Prerequisites
none

Below you will find excerpts from events related to this course:

**Introduction to numerical fluid dynamics**
2157444, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Practical course (P)**

**Learning Content**
In the lab, the components of the cycle of computational fluid dynamics are worked through. In the first instance moderately complicated geometries will be generated and meshed. After the configuration and running the calculation, the results are presented and evaluated in a visualization software. While in the first part of the course these steps are worked out under guidance, calculation cycles are carried out independently in the second part. The test cases are discussed in detail and allow to strengthen the affinity to the fluid dynamics.

**Content:**
1. Brief introduction into Linux
2. Mesh generation with ICEMCFD
3. Data visualisation and interpretation with Tecplot
4. Handling of the flow solver SPARC
5. Self-designed calculation: flat plate
6. Introduction to unsteady calculations: flow around a circular cylinder

**Annotation**
In winter term 2012/2013:
Course: Computational Methods in Fluid Mechanics (Exercise) [2157442]

**Workload**
regular attendance: 22,5 hours
self-study: 97,5 hours

**Literature**
Lecture notes/handout
11.207 Course: Introduction to numerical mechanics [T-MACH-108718]

**Responsible:** Prof. Dr. Eckart Schnack

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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**Exams**

| SS 2019 | 76-T-MACH-108718 | Introduction to numerical mechanics | Prüfung (PR) |

**Competence Certificate**

Oral Exam, 20 minutes

**Prerequisites**

None

**Annotation**

The lecture notes are made available via ILIAS.
11.208 Course: Introduction to the Finite Element Method [T-MACH-105320]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke  
Dr.-Ing. Tom-Alexander Langhoff

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102628 - Major Field: Lightweight Construction

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**Exams**

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<td>Introduction to the Finite Element Method</td>
<td>Prüfung (PR)</td>
<td>Böhlke, Langhoff</td>
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</table>

**Competence Certificate**

written exam (90 min)

**Prerequisites**

Passing the Tutorial “Introduction to the Finite element method“ (T-MACH-110330) is a prerequisite for taking part in the exam.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-110330 - Tutorial Introduction to the Finite Element Method must have been passed.

**Annotation**

Knowledge of the contents of the courses "Continuum Mechanics of Solids and Fluids" and "Mathematical Methods of Continuum Mechanics" as well as the corresponding tutorials are expected

The assignment of the restricted places in the associated Lab Course is crucial to the institute.

**Below you will find excerpts from events related to this course:**

**Notes**

- introduction and motivation, elements of tensor calculus
- Discrete FEM: systems of bars and springs
- Formulations of boundary value problems (1D)
- Approximations in FEM
- FEM for scalar and vector-valued field problems
- Solution methods for linear systems of equations
11.209 Course: Introduction to Theory of Materials [T-MACH-105321]

**Responsible:** Prof. Dr. Marc Kamlah  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102646 - Major Field: Applied Mechanics  
M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Events**

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<td>2 SWS</td>
<td>Prüfung (PR)</td>
<td>Kamlah</td>
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**Competence Certificate**  
oral exam

*Below you will find excerpts from events related to this course:*

### Introduction to Theory of Materials  
2182732, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Learning Content**

Following a brief introduction into continuum mechanics at small deformations, the classification into elastic, viscoelastic, plastic and viscoplastic constitutive models of solids is discussed. Then, one after the other, the four groups of elastic, viscoelastic, plastic and viscoplastic constitutive models are motivated and mathematically formulated. Their properties are demonstrated by means of elementary analytical solutions and examples.

**Workload**

regular attendance: 22.5 hours  
self-study: 97.5 hours

**Literature**

[2] Lecture Notes
11.210 Course: IoT Platform for Engineering [T-MACH-106743]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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<td>3 SWS</td>
<td>Ovtcharova, Maier</td>
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<td>WS 19/20</td>
<td>2123352</td>
<td>IoT platform for engineering</td>
<td>SWS</td>
<td>Ovtcharova, Maier</td>
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</table>

**Competence Certificate**

Assessment of another type (graded), procedure see webpage. Number of participants limited to 20 people. There is a participant selection process.

*Below you will find excerpts from events related to this course:*

**IoT platform for engineering**

2123352, SS 2019, 3 SWS, [Open in study portal](#)

**Notes**

Number of participants limited to 15 people. There is a participant selection process.

**IoT platform for engineering**

2123352, WS 19/20, SWS, Language: German, [Open in study portal](#)

**Learning Content**

Industry 4.0, IT systems for fabrication and assembly, process modelling and execution, project work in teams, practice-relevant I4.0 problems, in automation, manufacturing industry and service.
11.211 Course: IT-Fundamentals of Logistics [T-MACH-105187]

**Responsible:** Prof. Dr.-Ing. Frank Thomas  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems  
- M-MACH-102640 - Major Field: Technical Logistics

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<td>IT-Fundamentals of Logistics</td>
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**Exams**

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<td>IT-Fundamentals of Logistics</td>
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<td>Furmans, Mittwollen</td>
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**Competence Certificate**

The assessment consists of an oral exam (30min) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**

none

**Annotation**

1) Detailed script can be downloaded online (www.tup.com), updated and enhanced annually.
2) CD-ROM with chapters and exercises at the end of the semester available from the lecturer, also updated and enhanced annually.

Below you will find excerpts from events related to this course:

**IT-Fundamentals of Logistics**

2118183, SS 2019, 2 SWS, Language: German, Open in study portal
Learning Content
The rapid development of information technology influences business processes drastically.
A strategic IT-orientation for an enterprise without a critical appreciation of worldwide IT-development (where the half-life value of IT for logistic systems knowledge is less than 3 years) is dangerous. The pressure of costs is always in focus. For this purpose the contents of this course, as well as the detailed script will be continuously revised, and the influences on business processes will be shown in practical examples.

Focuses:

- **System architecture in Material Flow Control Systems (MFCS)**
  
  A guiding principle for a new system architecture for MFC systems is the consideration of making new standardized, functional groups available for re-usability.

- **Design and application of innovative Material Flow Control Systems (MFCS)**
  
  The most important task of the MFCS is the commissioning of conveying systems with driving commands in a way that optimally utilizes the facility and serves the logistics processes on schedule.

- **Identification of goods – Application in Logistics**
  
  Along with business processes, coded information is the link between the flow of information and the flow of materials, and contributes to error prevention in the communication between people and machines.

- **Data communication in Intra-logistics**
  
  Information describes the content of a message that is of value to the recipient. The recipient can be both a human and a machine.

- **Business processes for Intra-logistics – Software follows function!**
  
  If the business processes from Goods Incoming to Goods Outgoing are adapted with reusable building blocks then capabilities become visible. Against this background the consideration becomes apparent, how, through an innovative software architecture, a reusable building-block based framework can be made.
  
  Therefore applies: Software follows function. And only if all project requirements are documented in the planing phase, and supported together in an inter-disciplinary team - consisting of logistics planners, the customers (users) and the implementation leader (IL).

- **Software development in accordance with industrial standards**
  
  Today's development of object-oriented software, and the increasing penetration of industrial software production with this technology, makes it possible to create system designs that already offer these opportunities in their facility - both for a high degree of reuse and for easier adaptability.
  
  In software development, object-oriented methods are used to improve the productivity, maintainability and software quality. An important aspect of object-orientation is: the objects used are primarily intended to depict the real world.

Annotation
1) Detailed script can be downloaded online (www.tup.com), updated and enhanced annually.
2) CD-ROM with chapters and exercises at the end of the semester available from the lecturer, also updated and enhanced annually.

Workload
regular attendance: 21 hours
self-study: 99 hours
### 11.212 Course: Lab Computer-Aided Methods for Measurement and Control [T-MACH-105341]

**Responsible:** Prof. Dr.-Ing. Christoph Stiller  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102633 - Major Field: Robotics

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<td>3 SWS</td>
<td>Practical course (P)</td>
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**Competence Certificate**

Colloquia

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Lab Computer-aided methods for measurement and control**

2137306, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)

**Practical course (P)**

**Notes**

**Lerninhalt (EN):**

1. Digital technology  
2. Digital storage oscilloscope and digital spectrum analyzer  
3. Supersonic computer tomography  
4. Lighting and image acquisition  
5. Digital image processing  
6. Image interpretation  
7. Control synthesis and simulation  
8. Robot: Sensors  
9. Robot: Actuating elements and path planning  

The lab comprises 9 experiments.

**Voraussetzungen: Recommendations:**

Basic studies and preliminary examination; basic lectures in automatic control

**Arbeitsaufwand (EN):** 120 hours

**Lernziele (EN):**

Powerful and cheap computation resources have led to major changes in the domain of measurement and control. Engineers in various fields are nowadays confronted with the application of computer-aided methods. This lab tries to give an insight into the modern domain of measurement and control by means of practically oriented and flexible experiments. Based on experiments on measurement instrumentation and digital signal processing, elementary knowledge in the domain of visual inspection and image processing will be taught. Thereby, commonly used software like MATLAB/Simulink will be used in both simulation and realization of control loops. The lab closes with selected applications, like control of a robot or supersonic computer tomography.
Learning Content
1. Digital technology
2. Digital storage oscilloscope and digital spectrum analyzer
3. Supersonic computer tomography
4. Lighting and image acquisition
5. Digital image processing
6. Image interpretation
7. Control synthesis and simulation
8. Robot: Sensors
9. Robot: Actuating elements and path planning
The lab comprises 9 experiments.

Workload
120 hours

Literature
Instructions to the experiments are available on the institute's website
11.213 Course: Lab Course Experimental Solid Mechanics [T-MACH-105343]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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</table>

**Competence Certificate**

passed / not passed

Each participant has to hand in six lab course report (eon for each day of lab course), which will be evaluated. At the end of the lab course, the participants have to give a colloquium (approx 20 min) about a given topic of the experiments done.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Lab course experimental solid mechanics**

2162275, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Practical course (P)**

**Learning Content**

- Anisotropic materials
- Experiments for determination of the five material constants of thermoelasticity
- Experiments for determination of parameters of the inelastic material behaviour

**Workload**

regular attendance: 21,5 hours

self-study: 98,5 hours

**Literature**

is announced during lab course
11.214 Course: Laboratory Exercise in Energy Technology [T-MACH-105331]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
Prof. Dr. Ulrich Maas  
Heiner Wirbser

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102591 - Laboratory Course  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Competence Certificate**

1 report, approx. 12 pages  
Discussion of the documented results with the assistants

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Laboratory Exercise in Energy Technology**  
2171487, SS 2019, 3 SWS, Language: German, Open in study portal

**Practical course (P)**

**Learning Content**

- Micro gas turbine
- Several test rigs for the investigation of heat transfer at thermally high loaded components
- Optimization of components of the internal air and oil system
- Characterization of spray nozzles
- Investigation of pollutant and noise emission as well as reliability and material deterioration
- Exhaust gas treatment
- Exhaust gas turbocharger
- Cooling Tower
- Heatpump
- Plant oil stove
- Heat capacity
- Wood combustion

**Annotation**

Online registration within the first two weeks of the lecture period at: http://www.its.kit.edu
Workload
regular attendance: 42h
self-study: 78h

Laboratory Exercise in Energy Technology
2171487, WS 19/20, 3 SWS, Language: German, Open in study portal

Practical course (P)

Learning Content

- Micro gas turbine
- Several test rigs for the investigation of heat transfer at thermally high loaded components
- Optimization of components of the internal air and oil system
- Characterization of spray nozzles
- Investigation of pollutant and noise emission as well as reliability and material deterioration
- Exhaust gas treatment
- Exhaust gas turbocharger
- Cooling Tower
- Heat pump
- Plant oil stove
- Heat capacity
- Wood combustion

Annotation
Online registration within the first two weeks of the lecture periode at: http://www.its.kit.edu

Workload
regular attendance: 42h
self-study: 78h
11.215 Course: Laboratory Laser Materials Processing [T-MACH-102154]

**Responsible:** Dr.-Ing. Johannes Schneider  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102591 - Laboratory Course  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102618 - Major Field: Production Technology

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**Events**

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<td>WS 19/20</td>
<td>Laboratory &quot;Laser Materials Processing&quot;</td>
<td>3 SWS</td>
<td>Practical course (P)</td>
<td>Schneider, Pfleging</td>
</tr>
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</table>

**Exams**

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<tr>
<th>Events</th>
<th>Course</th>
<th>Type</th>
<th>Exam Type</th>
<th>Grading</th>
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<tbody>
<tr>
<td>SS 2019</td>
<td>Laboratory Laser Materials Processing</td>
<td>Prüfung (PR)</td>
<td>Schneider</td>
<td></td>
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<tr>
<td>WS 19/20</td>
<td>Laboratory Laser Materials Processing</td>
<td>Prüfung (PR)</td>
<td>Schneider</td>
<td></td>
</tr>
</tbody>
</table>

**Competence Certificate**

The assessment consists of a colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.

**Prerequisites**

none

**Recommendation**

basic knowledge of physics, chemistry and material science  
The attendance to one of the courses Physical Basics of Laser Technology (2181612) or Laser Application in Automotive Engineering (2182642) is strongly recommended.

**Annotation**

The maximum number of students is 12 per semester.

Below you will find excerpts from events related to this course:

**Laboratory "Laser Materials Processing"**

2183640, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**  
lecture notes via ILIAS
Notes
The laboratory compromises 8 half-day experiments, which address the following laser processing topics of metals, ceramics and polymers:

- safety aspects
- surface hardening and remelting
- melt and reactive cutting
- surface modification by dispersing or alloying
- welding
- surface texturing
- metrology

There are used CO2-, excimer-, Nd:YAG- and high power diode-laser sources within the laboratory.

The student:

- can describe the influence of laser, material and process parameters and can choose suitable parameters for the most important methods of laser-based processing in automotive engineering.
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Basic knowledge of physics, chemistry and material science is assumed.

The attendance to one of the courses Physical Basics of Laser Technology (2181612) or Laser Application in Automotive Engineering (2182642) is strongly recommended.

regular attendance: 34 hours
self-study: 86 hours

The assessment consists of a colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.

Learning Content
The laboratory compromises 8 half-day experiments, which address the following laser processing topics of metals, ceramics and polymers:

- safety aspects
- surface hardening and remelting
- melt and reactive cutting
- surface modification by dispersing or alloying
- welding
- surface texturing
- metrology

There are used CO2-, excimer-, Nd:YAG- and high power diode-laser sources within the laboratory.

Annotation
The maximum number of students is 12 per semester.

Workload
regular attendance: 34 hours
self-study: 86 hours

Literature


Laboratory "Laser Materials Processing"
2183640, WS 19/20, 3 SWS, Language: German, Open in study portal

Description
Media:
lecture notes via ILIAS
Notes
The laboratory compromises 8 half-day experiments, which address the following laser processing topics of metals, ceramics and polymers:

- safety aspects
- surface hardening and remelting
- melt and reactive cutting
- surface modification by dispersing or alloying
- welding
- surface texturing
- metrology

There are used CO2-, excimer-, Nd:YAG- and high power diode-laser sources within the laboratory.

The student

- can describe the influence of laser, material and process parameters and can choose suitable parameters for the most important methods of laser-based processing in automotive engineering.
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Basic knowledge of physics, chemistry and material science is assumed.

The attendance to one of the courses Physical Basics of Laser Technology (2181612) or Laser Application in Automotive Engineering (2182642) is strongly recommended.

regular attendance: 34 hours
self-study: 86 hours

The assessment consists of a colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.

Learning Content
The laboratory compromises 8 half-day experiments, which address the following laser processing topics of metals, ceramics and polymers:

- safety aspects
- surface hardening and remelting
- melt and reactive cutting
- surface modification by dispersing or alloying
- welding
- surface texturing
- metrology

There are used CO2-, excimer-, Nd:YAG- and high power diode-laser sources within the laboratory.

Annotation
The maximum number of students is 12 per semester.

Workload
regular attendance: 34 hours
self-study: 86 hours

Literature
11.216 Course: Laboratory Mechatronics [T-MACH-105370]

**Responsible:** Dr.-Ing. Maik Lorch  
Prof. Dr.-Ing. Wolfgang Seemann  
Prof. Dr.-Ing. Christoph Stiller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102591 - Laboratory Course  
M-MACH-102601 - Major Field: Automation Technology  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102609 - Major Field: Cognitive Technical Systems  
M-MACH-102614 - Major Field: Mechatronics  
M-MACH-102624 - Major Field: Information Technology  
M-MACH-102633 - Major Field: Robotics  
M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

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<th>Version</th>
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<tr>
<td>WS 19/20</td>
<td>Laboratory mechatronics</td>
<td>3 SWS</td>
<td>Practical course (P)</td>
<td>Seemann, Stiller, Lorch, Böhland, Burgert</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
certificate of successful attendance

**Prerequisites**  
None

Below you will find excerpts from events related to this course:

**Laboratory mechatronics**  
2105014, WS 19/20, 3 SWS, Language: German, Open in study portal

**Notes**  
**Part I**  
Control, programming and simulation of robots  
CAN-Bus communication  
Image processing / machine vision  
Dynamic simulation of robots in ADAMS

**Part II**  
Solution of a complex problem in team work

**Learning objectives:**  
The student is able to ...  
- use his knowledge about mechatronics and microsystems technology to solve a practical problem. The laboratory course comprises simulation, bus communication, measurement instrumentation, control engineering and programming.  
- integrate the different subsystems from a manipulator to a working compound system in teamwork.
Learning Content
Part I
Control, programming and simulation of robots
CAN-Bus communication
Image processing / machine vision
Dynamic simulation of robots in ADAMS

Part II
Solution of a complex problem in team work

Workload
regular attendance: 33.5 h
self-study: 88.5 h

Literature
Manuals for the laboratory course on Mechatronics
11.217 Course: Laboratory Production Metrology [T-MACH-108878]

**Responsible:** Dr.-Ing. Benjamin Häfner
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102591 - Laboratory Course
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102633 - Major Field: Robotics

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<tr>
<th>Type</th>
<th>Credits</th>
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<th>Version</th>
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<td>Examination of another type</td>
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**Events**

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<th>2150550</th>
<th>Laboratory Production Metrology</th>
<th>3 SWS</th>
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**Exams**

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<th>76-T-MACH-108878</th>
<th>Laboratory Production Metrology</th>
<th>Prüfung (PR)</th>
<th>Häfner</th>
</tr>
</thead>
</table>

**Competence Certificate**

Alternative Test Achievement: Group presentation of 15 min at the beginning of each experiment and evaluation of the participation during the experiments

and

Oral Exam (15 min)

**Prerequisites**

none

**Annotation**

For organizational reasons the number of participants for the course is limited. Hence a selection process will take place. Applications are made via the homepage of wbk (http://www.wbk.kit.edu/studium-und-lehre.php).

Below you will find excerpts from events related to this course:

**Laboratory Production Metrology**

2150550, SS 2019, 3 SWS, Language: German, [Open in study portal](http://www.wbk.kit.edu/studium-und-lehre.php)

**Description**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/). Additional reference to literature will be provided, as well.
Notes
During this course, students get to know measurement systems that are used in a production system. In the age of Industry 4.0, sensors are becoming more important. Therefore, the application of in-line measurement technology such as machine vision and non-destructive testing is focused. Additionally, laboratory based measurement technologies such as computed tomography are addressed. The student learn the theoretical background as well as practical applications for industrial examples. The students use sensors by themselves during the course. Additionally, they are trained on how to integrate sensors in production processes and how to analyze measurement data with suitable software.

The following topics are addressed:

- Classification and examples for different measurement technologies in a production environment
- Machine vision with optical sensors
- Information fusion based on optical measurements
- Robot-based optical measurements
- Non-destructive testing by means of acoustic measurements
- Coordinate measurement technology
- Industrial computed tomography
- Measurement uncertainty evaluation
- Analysis of production data by means of data mining

Learning Outcomes:
The students ...  
- are able to name, describe and mark out different measurement technologies that are relevant in a production environment.
- are able to conduct measurements with the presented in-line and laboratory based measurement systems.
- are able to analyze measurement results and assess the measurement uncertainty of these.
- are able to deduce whether a work piece fulfills quality relevant specifications by analysing measurement results.
- are able to use the presented measurement technologies for a new task.

Workload:
regular attendance: 31,5 hours
self-study: 88,5 hours

Learning Content
During this course, students get to know measurement systems that are used in a production system. In the age of Industry 4.0, sensors are becoming more important. Therefore, the application of in-line measurement technology such as machine vision and non-destructive testing is focused. Additionally, laboratory based measurement technologies such as computed tomography are addressed. The student learn the theoretical background as well as practical applications for industrial examples. The students use sensors by themselves during the course. Additionally, they are trained on how to integrate sensors in production processes and how to analyze measurement data with suitable software. The following topics are addressed:

- Classification and examples for different measurement technologies in a production environment
- Machine vision with optical sensors
- Information fusion based on optical measurements
- Robot-based optical measurements
- Non-destructive testing by means of acoustic measurements
- Coordinate measurement technology
- Industrial computed tomography
- Measurement uncertainty evaluation
- Analysis of production data by means of data mining

Workload
regular attendance: 31,5 hours
self-study: 88,5 hours
# 11.218 Course: Laser in Automotive Engineering [T-MACH-105164]

**Responsible:** Dr.-Ing. Johannes Schneider  
**Organisation:** KIT Department of Mechanical Engineering

### Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102628 - Major Field: Lightweight Construction

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<th>Credits</th>
<th>Recurrence</th>
<th>Version</th>
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</thead>
<tbody>
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<td>Each summer term</td>
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### Events

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<th>Credits</th>
<th>Time Period</th>
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<th>Type</th>
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</table>
| SS 2019 | 4 | Laser in automotive engineering | 2 | Lecture (V)  
| Exams | | | | |
| SS 2019 | | Laser in Automotive Engineering | | Prüfung (PR) |
| WS 19/20 | | Laser in Automotive Engineering | | Prüfung (PR) |

### Competence Certificate

oral examination (30 min)

no tools or reference materials

### Prerequisites

It is not possible to combine this brick with the brick Physical Basics of Laser Technology [T-MACH-109084] and the brick Physical Basics of Laser Technology [T-MACH-102102]

### Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-MACH-102102 - Physical Basics of Laser Technology must not have been started.
2. The course T-MACH-109084 - Physical Basics of Laser Technology must not have been started.

### Recommendation

preliminary knowledge in mathematics, physics and materials science

Below you will find excerpts from events related to this course:

**Laser in automotive engineering**  
2182642, SS 2019, 2 SWS, Language: German, [Open in study portal](#)  

**Description**

**Media:**

lecture notes via ILIAS
Notes
Based on a short description of the physical basics of laser technology the lecture reviews the most important high power lasers and their various applications in automotive engineering. Furthermore the application of laser light in metrology and safety aspects will be addressed.

- physical basics of laser technology
- laser beam sources (Nd:YAG-, CO2-, high power diode-laser)
- beam properties, guiding and shaping
- basics of materials processing with lasers
- laser applications in automotive engineering
- economical aspects
- safety aspects

The student

- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of Nd:YAG-, CO2- and high power diode-laser sources.
- can describe the most important methods of laser-based processing in automotive engineering and illustrate the influence of laser, material and process parameters
- can analyse manufacturing problems and is able to choose a suitable laser source and process parameters.
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Basic knowledge of physics, chemistry and material science is assumed.
It is not possible, to combine this lecture with the lecture Physical basics of laser technology [2181612].

regular attendance: 22,5 hours
self-study: 97,5 hours
oral examination (ca. 30 min)

no tools or reference materials

Learning Content
Based on a short description of the physical basics of laser technology the lecture reviews the most important high power lasers and their various applications in automotive engineering. Furthermore the application of laser light in metrology and safety aspects will be addressed.

- physical basics of laser technology
- laser beam sources (Nd:YAG-, CO2-, high power diode-laser)
- beam properties, guiding and shaping
- basics of materials processing with lasers
- laser applications in automotive engineering
- economical aspects
- safety aspects

Annotation
It is allowed to select only one of the lectures "Laser in automotive engineering" (2182642) or "Physical basics of laser technology" (2181612) during the Bachelor and Master studies.

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Literature
### 11.219 Course: Leadership and Conflict Management [T-MACH-105440]

**Responsible:** Hans Hatzl  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102596 - Compulsory Elective Subject Economics/Law  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102600 - Major Field: Man - Technology - Organisation  
- M-MACH-102605 - Major Field: Engineering Design

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<tbody>
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<td>Oral examination</td>
<td>4</td>
<td>Each summer term</td>
<td>1</td>
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</table>

**Events**

| SS 2019 | 2110017 | Leadership and Conflict Management (in German) | 2 SWS | Lecture (V) | Hatzl |

**Exams**

| SS 2019 | 76-T-MACH-105440 | Leadership and Conflict Management | Prüfung (PR) | Deml |

**Competence Certificate**

oral exam (approx. 30 min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

### Leadership and Conflict Management (in German)

2110017, SS 2019, 2 SWS, Language: German, Open in study portal

**Notes**

1. Introduction to the course  
2. Goal definition and goal achievement  
3. Management techniques within planning  
4. Communication and information  
5. Decision-making  
6. Leadership and co-operation  
7. Self management  
8. Conflict management  
9. Case studies

**Requirements:**

- Compact course  
- Limited number of participants; seats are assigned according the date of registration  
- Registration via ILIAS is required  
- Compulsory attendance during the whole lecture

**Recommendations:**

- Knowledge of Work Science and Economics is helpful

**Learning objective:**

- Knowledge of techniques for management and leadership  
- Preparation for management and leadership tasks in the job
Learning Content

1. Introduction to the course
2. Goal definition and goal achievement
3. Management techniques within planning
4. Communication and information
5. Decision-making
6. Leadership and co-operation
7. Self management
8. Conflict management
9. Case studies

Workload
The amount of work accounts for 120 h (=4 ECTS).

Literature
Handout and literature are available on ILIAS for download.
Course: Leadership and Management Development [T-MACH-105231]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  
Andreas Ploch

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102596 - Compulsory Elective Subject Economics/Law  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102599 - Major Field: Powertrain Systems  
M-MACH-102600 - Major Field: Man - Technology - Organisation  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102618 - Major Field: Production Technology  
M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

<table>
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<tr>
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**Events**

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<tr>
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<td>2145184</td>
<td>Leadership and Product</td>
<td></td>
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<tr>
<td></td>
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<td>Development</td>
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<td>2 SWS</td>
<td>Lecture (V)</td>
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<td></td>
<td>Ploch</td>
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</table>

**Competence Certificate**
oral exam (20 min)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Leadership and Product Development**
2145184, WS 19/20, 2 SWS, Open in study portal

**Learning Content**
Leadership theories  
Management tools  
Communication as management tool  
Change management  
Management development and MD-Programs  
Assessment center and management audits  
Team work, team development und team roles  
Intercultural competences  
Leadership and ethics, Corporate Governance  
Executive Coaching  
Lectures of industrial experts

**Workload**
regular attendance: 21 h  
self-study: 99 h
### 11.221 Course: Learning Factory “Global Production” [T-MACH-105783]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:** M-MACH-102618 - Major Field: Production Technology

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<tbody>
<tr>
<td>WS 19/20</td>
<td>Examination of another type</td>
<td>4</td>
<td>Each winter term</td>
<td>3</td>
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</table>

**Competence Certificate**  
Alternative test achievement (graded):  
- Knowledge acquisition in the context of the seminar (3 achievements 20 min each) with weighting 40%.  
- Interaction between participants with weighting 15%.  
- Scientific colloquium (in groups of 3 students approx. 45 min each) with weighting 45%.

**Prerequisites**  
none

**Annotation**  
For organisational reasons, the number of participants for the course is limited to 20. As a result, a selection process will take place. Applications must be submitted via the wbk homepage (http://www.wbk.kit.edu/studium-und-lehre.php).  
Due to the limited number of participants, advance registration is required.  
Students should have previous knowledge in at least one of the following areas:  
- Integrated Production Planning  
- Global Production and Logistics  
- Quality Management

---

**Below you will find excerpts from events related to this course:**

### Learning Factory “Global Production”

2149612, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**  
**Media:**  
E-learning platform ilias, powerpoint, photo protocol. The media are provided through ilias (https://ilias.studium.kit.edu/).
Notes
The learning factory “Global Production” serves as a modern teaching environment for the challenges of global production. To make this challenges come alive, students can run a production of electric motors under real production conditions. The course is divided into e-learning units and presence dates. The e-learning units help to learn essential basics and to immerse themselves in specific topics (e.g. selection of location, supplier selection and planning of production networks). The focus of the presence appointments is the case-specific application of relevant methods for planning and control of production systems that are suitable for the location. In addition to traditional methods and tools to organize lean production systems (e.g. Kanban and JIT/ JIS, Line Balancing) the lecture in particular deals with site-specific quality assurance and scalable automation. Essential methods for quality assurance in complex production systems are taught and brought to practical experience by a Six Sigma project. In the area of scalable automation, it is important to find solutions for the adaption of the level of automation of the production system to the local production conditions (e.g. automated workpiece transport, integration of lightweight robots for process linking) and to implement them physically. At the same time safety concepts should be developed and implemented as enablers for human-robot collaboration. The course also includes an excursion to the production plant for the manufacturing of electric motors of an industrial partner.

Main focus of the lecture:
- site selection
- site-specific factory planning
- site-specific quality assurance
- scalable automation
- supplier selection

Learning Outcomes:
The students are able to …
- evaluate and select alternative locations using appropriate methods.
- use methods and tools of lean management to plan and manage production systems that are suitable for the location.
- use the Six Sigma method and apply goal-oriented process management.
- select an appropriate level of automation of the production units based on quantitative variables.
- make use of well-established methods for the evaluation and selection of suppliers.
- apply methods for planning a global production network depending on company-specific circumstances to sketch a suitable network and classify and evaluating it according to specific criteria.
- apply the learned methods and approaches with regard to problem solving in a global production environment and able to reflect their effectiveness.

Workload:
e-Learning: ~ 24 h
regular attendance: ~ 36 h
self-study: ~ 60 h
Learning Content
The learning factory “Global Production” serves as a modern teaching environment for the challenges of global production. To make these challenges come alive, students can run a production of electric motors under real production conditions. The course is divided into e-learning units and presence dates. The e-learning units help to learn essential basics and to immerse themselves in specific topics (e.g. selection of location, supplier selection and planning of production networks). The focus of the presence appointments is the case-specific application of relevant methods for planning and control of production systems that are suitable for the location. In addition to traditional methods and tools to organize lean production systems (e.g. Kanban and JIT/JIS, Line Balancing) the lecture in particular deals with site-specific quality assurance and scalable automation. Essential methods for quality assurance in complex production systems are taught and brought to practical experience by a Six Sigma project. In the area of scalable automation, it is important to find solutions for the adaption of the level of automation of the production system to the local production conditions (e.g. automated workpiece transport, integration of lightweight robots for process linking) and to implement them physically. At the same time safety concepts should be developed and implemented as enablers for human-robot collaboration.

The course also includes an excursion to the production plant for the manufacturing of electric motors of an industrial partner.

Main focus of the lecture:
- site selection
- site-specific factory planning
- site-specific quality assurance
- scalable automation
- supplier selection

Annotation
For organisational reasons, the number of participants for the course is limited to 20. As a result, a selection process will take place. Applications must be submitted via the wbk homepage (http://www.wbk.kit.edu/studium-und-lehre.php).

Due to the limited number of participants, advance registration is required.

Students should have previous knowledge in at least one of the following areas:
- Integrated Production Planning
- Global Production and Logistics
- Quality Management

Workload
e-Learning: ~ 24 h
regular attendance: ~ 36 h
self-study: ~ 60 h
11.222 Course: Lightweight Engineering Design [T-MACH-105221]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Norbert Burkardt

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102605 - Major Field: Engineering Design  
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102628 - Major Field: Lightweight Construction  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102636 - Major Field: Thermal Turbomachines  
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

**Type**  
Written examination

**Credits**  
4

**Recurrence**  
Each summer term

**Version**  
2

**Events**

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<td>2 SWS</td>
<td>Each summer term</td>
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<td>SS 2019</td>
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**Exams**

| SS 2019 | Lightweight Engineering Design | Prüfung (PR) | Albers, Burkardt |

**Competence Certificate**  
Written examination (90 min)

**Prerequisites**  
None

**Below you will find excerpts from events related to this course:**

**Lightweight Engineering Design**  
2146190, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Notes**

General aspects of lightweight design, lightweight strategies, construction methods, design principles, lightweight construction, stiffening techniques, lightweight materials, virtual product engineering, bionics, joining techniques, validation, recycling

Additionally, guest speakers from industry will present lightweight design from an practical point of view.

The students are able to...

- evaluate the potential of central lightweight strategies and their application in design processes.
- apply different stiffing methods qualitatively and to evaluate their effectiveness.
- evaluate the potential of computer-aided engineering as well as the related limits and influences on manufacturing.
- reflect the basics of lightweight construction from a system view in the context of the product engineering process.
11.223 Course: Localization of Mobile Agents [T-INFO-101377]

Responsible: Prof. Dr.-Ing. Uwe Hanebeck
Organisation: KIT Department of Informatics
Part of: M-MACH-102609 - Major Field: Cognitive Technical Systems
M-MACH-102633 - Major Field: Robotics

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Below you will find excerpts from events related to this course:

Localization of Mobile Agents

Learning Content

This module provides a systematic introduction into the topic of localization methods. In order to facilitate understanding, the module is divided into four main topics. Dead reckoning treats the instantaneous determination of a vehicle’s position based on dynamic parameters like velocity or steering angle. Localization with the help of measurements of known landmarks is part of static localization. In addition to the closed-form solutions for particular measurements (distances and angles), the least squares method for fusion arbitrary measurements is also introduced. Dynamic localization treats the combination of dead reckoning and static localization. The central part of the lecture is the derivation of the Kalman filter, which has been successfully applied in several practical applications. Finally, simultaneous localization and mapping (SLAM) is introduced, which allows localization in case of (partly) unknown landmark positions.

Workload

The amount of work required is ca.180 hours.
11.224 Course: Logistics - Organisation, Design and Control of Logistic Systems [T-MACH-102089]

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems

### Type
- **Written examination**

### Credits
- **6**

### Recurrence
- **Each summer term**

### Version
- **1**

### Events

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### Competence Certificate

The assessment consists of a 90 minutes written examination (according to §4(2), 1 of the examination regulation).

### Prerequisites

None

### Recommendation

Recommended are lectures on “Linear Algebra” and “Stochastic”.

**Below you will find excerpts from events related to this course:**

**Logistics - Organisation, Design, and Control of Logistic Systems**

2118078, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**
- Blackboard, LCD projector, in exercises also PCs.
Learning Content

Introduction
- historical overview
- lines of development

Structure of logistics systems

Distribution logistics
- location planning
- Vehicle Routing Planning
- distribution centers

Inventory management
- demand forecasting
- Inventory management policies
- Bullwhip effect

Production logistics
- layout planning
- material handling
- flow control

Supply Management
- information flow
- transportation organization
- controlling and development of a logistics system
- co-operation mechanisms
- Lean SCM
- SCOR model

Identification Technologies

Workload
180 hrs

Literature
- Arnold/Isermann/Kuhn/Tempelmeier. Handbuch Logistik, Springer Verlag, 2002 (Neuauflage in Arbeit)
- Domschke. Logistik, Rundreisen und Touren, Oldenbourg Verlag, 1982
- Domschke/Drexl. Logistik, Standorte, Oldenbourg Verlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Tempelmeier. Bestandsmanagement in Supply Chains, Books on Demand 2006
Course: Machine Dynamics [T-MACH-105210]

**Responsible:** Prof. Dr.-Ing. Carsten Proppe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

**Type**

- Written examination

**Credits**

- 5

**Recurrence**

- Each summer term

**Version**

- 1

**Events**

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**Exams**

| SS 2019 | 76-T-MACH-105210 | Machine Dynamics | Prüfung (PR) | Proppe |

**Competence Certificate**

written exam, 180 min.

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Machine Dynamics**

2161224, SS 2019, 2 SWS, Language: English, Open in study portal

**Learning Content**

1. Introduction
2. Machine as mechatronic system
3. Rigid rotors: equations of motion, transient and stationary motion, balancing
4. Flexible rotors: Laval rotor (equations of motion, transient and stationary behavior, critical speed, secondary effects, refined models)
5. Slider-crank mechanisms: kinematics, equations of motion, mass and power balancing

**Workload**

Lectures and exercises: 32 h

Studies: 118 h
**Literature**

Holzweißig, Dresig: Lehrbuch der Maschinendynamik, 1979

Dresig, Vulfson: Dynamik der Mechanismen, 1989

**Machine Dynamics (Tutorial)**
2161225, SS 2019, 1 SWS, Language: English, [Open in study portal](#)

**Learning Content**
Exercises related to the lecture
11.226 Course: Machine Dynamics II [T-MACH-105224]

**Responsible:** Prof. Dr.-Ing. Carsten Proppe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

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**Competence Certificate**

oral exam, 30 min.

**Prerequisites**

none

**Recommendation**

Machine Dynamics

Below you will find excerpts from events related to this course:

**Machine Dynamics II**

2162220, WS 19/20, 2 SWS, Language: English, Open in study portal

**Learning Content**

- hydrodynamic bearings
- rotating shafts in hydrodynamic bearings
- belt drives
- vibration of turbine blades

**Workload**

Lectures: 20 h
Self-studies: 100 h

**Literature**

11.227 Course: Machine Tools and Industrial Handling [T-MACH-109055]

**Responsible:** Prof. Dr.-Ing. Jürgen Fleischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**

Oral exam (40 minutes)

**Prerequisites**

"T-MACH-102158 - Werkzeugmaschinen und Handhabungstechnik" must not be commenced.

**Below you will find excerpts from events related to this course:**

**Machine Tools and Industrial Handling**

2149902, WS 19/20, 6 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture gives an overview of the construction, use and application of machine tools and industrial handling equipment. In the course of the lecture a well-founded and practice-oriented knowledge for the selection, design and evaluation of machine tools is conveyed. First, the main components of the machine tools are systematically explained and their design principles as well as the integral machine tool design are discussed. Subsequently, the use and application of machine tools will be demonstrated using typical machine examples. Based on examples from current research and industrial applications, the latest developments are discussed, especially concerning the implementation of Industry 4.0.

The individual topics are:

- Frames and frame components
- Feed axes
- Spindles
- Peripheral equipment
- Control unit
- Metrological evaluation and machine testing
- Process monitoring
- Maintenance of machine tools
- Safety assessment of machine tools
- Machine examples

Learning Outcomes:
The students ...

- are able to assess the use and application of machine tools and handling equipment and to differentiate between them in terms of their characteristics and design.
- can describe and discuss the essential elements of the machine tool (frame, main spindle, feed axes, peripheral equipment, control unit).
- are able to select and dimension the essential components of a machine tool.
- are capable of selecting and evaluating machine tools according to technical and economic criteria.

Workload:

MACH:
regular attendance: 63 hours
self-study: 177 hours

WING:
regular attendance: 63 hours
self-study: 207 hours

Learning Content
The lecture gives an overview of the construction, use and application of machine tools and industrial handling equipment. In the course of the lecture a well-founded and practice-oriented knowledge for the selection, design and evaluation of machine tools is conveyed. First, the main components of the machine tools are systematically explained and their design principles as well as the integral machine tool design are discussed. Subsequently, the use and application of machine tools will be demonstrated using typical machine examples. Based on examples from current research and industrial applications, the latest developments are discussed, especially concerning the implementation of Industry 4.0.

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- Peripheral equipment
- Control unit
- Metrological evaluation and machine testing
- Process monitoring
- Maintenance of machine tools
- Safety assessment of machine tools
- Machine examples

Annotation
None
Workload
MACH:
regular attendance: 63 hours
self-study: 177 hours
Wiling;/TVWL
regular attendance: 63 hours
self-study: 207 hours
11.228 Course: Machine Vision [T-MACH-105223]

**Responsible:** Dr. Martin Lauer
Prof. Dr.-Ing. Christoph Stiller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102609 - Major Field: Cognitive Technical Systems
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102633 - Major Field: Robotics

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**Competence Certificate**

Type of Examination: written exam
Duration of Examination: 60 minutes

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Machine Vision**

2137308, WS 19/20, 4 SWS, Language: English, Open in study portal

**Lecture / Practice (VÜ)**

**Notes**

**Lernziele (EN):**

*Machine vision (or computer vision)* describes all kind of techniques that can be used to extract information from camera images in an automated way. Considerable improvements of machine vision techniques throughout recent years, e.g. by the advent of deep learning, have caused growing interest in these techniques and enabled applications in various domains, e.g. robotics, autonomous driving, gaming, production control, visual inspection, medicine, surveillance systems, and augmented reality.

The participants should gain an overview over the basic techniques in machine vision and obtain hands-on experience.
Learning Content
The lecture on machine vision covers basic techniques of machine vision. It focuses on the following topics:

- image preprocessing
- edge and corner detection
- curve and parameter fitting
- color processing
- image segmentation
- camera optics
- pattern recognition
- deep learning

Image preprocessing:
The chapter on image processing discusses techniques and algorithms to filter and enhance the image quality. Starting from an analysis of the typical phenomena of digital camera based image capturing the lecture introduces the Fourier transform and the Shannon-Nyquist sampling theorem. Furthermore, it introduces gray level histogram based techniques including high dynamic range imaging. The discussion of image convolution and typical filters for image enhancement concludes the chapter.

Edge and corner detection:
Gray level edges and gray level corners play an important role in machine vision since gray level edges often reveal valuable information about the boundaries and shape of objects. Gray level corners can be used as feature points since they can be identified easily in other images. This chapter introduces filters and algorithms to reveal gray level edges and gray level corners like the Canny edge detector and the Harris corner detector.

Curve and parameter fitting:
In order to describe an image by means of geometric primitives (e.g. lines, circles, ellipses) instead of just pixels robust curve and parameter fitting algorithms are necessary. The lecture introduces and discusses the Hough transform, total least sum of squares parameter fitting as well as robust alternatives (M-estimators, least trimmed sum of squares, RANSAC).

Color processing:
The short chapter on color processing discusses the role of color information in machine vision and introduces various models for color understanding and color representation. It concludes with the topic of color consistency.

Image Segmentation:
Image segmentation belongs to the core techniques of machine vision. The goal of image segmentation is to subdivide the image into several areas. Each area shares common properties, i.e. similar color, similar hatching, or similar semantic interpretation. Various ideas for image segmentation exist which can be used to create more or less complex algorithms. The lecture introduces the most important approaches ranging from the simpler algorithms like region growing, connected components labeling, and morphological operations up to highly flexible and powerful methods like level set approaches and random fields.

Camera optics:
The content of an image is related by the optics of the camera to the 3-dimensional world. In this chapter the lecture introduces optical models that describe the relationship between the world and the image including the pinhole camera model, the thin lens model, telecentric cameras, and catadioptric sensors. Furthermore, the lecture introduces camera calibration methods that can be used to determine the optical mapping of a real camera.

Pattern recognition:
Pattern recognition aims at recognizing semantic information in an image, i.e. not just analyzing gray values or colors of pixels but revealing which kind of object is shown by the pixels. This task goes beyond classical measurement theory and enters the large field of artificial intelligence. Rather than just being developed and optimized by a programmer, the algorithms are adapting themselves to their specific task using training algorithms that are based on large collections of sample images.

The chapter of pattern recognition introduces standard techniques of pattern recognition in the context of image understanding like the support vector machine (SVM), decision trees, ensemble and boosting techniques. It combines those classifiers with powerful feature representation techniques like the histogram of oriented gradients (HOG) features, locally binary patterns (LBP), and Haar features.

Deep learning:
Throughout recent years standard pattern recognition techniques have more and more been outperformed by deep learning techniques. Deep learning is based on artificial neural networks, a very generic and powerful form of a classifier. The lecture introduces multi layer perceptrons as the most relevant form of artificial neural networks, discusses training algorithms and strategies to achieve powerful classifiers based on deep learning including deep auto encoders, convolutional networks, and multi task learning, among others.

Workload:
240 hours
Literature
Main results are summarized in the slides that are made available as pdf-files. Further recommendations will be presented in the lecture.
### Course: Magnet Technology of Fusion Reactors [T-MACH-105434]

**Responsible:** Dr. Walter Fietz  
Dr. Klaus-Peter Weiss  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102643 - Major Field: Fusion Technology

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**Competence Certificate**  
Oral examination of about 30 minutes

**Prerequisites**  
none

**Annotation**  
none

Below you will find excerpts from events related to this course:

#### Magnet Technology of Fusion Reactors

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Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019
Notes
In Greifswald/Germany the fusion experiment Wendelstein 7-X is now in operation to demonstrate the performance of Stellerator-type fusion machines. In South of France the fusion reactor ITER is under construction which will demonstrate the production of energy by fusion. In both machines the plasma inclusion will be ensured by magnets and to produce high magnetic fields in an efficient way, these magnets have to be superconducting. Design, construction and operation of such magnets is a technologic challenge because low temperature (4.5 K) and high currents (typ. 68 kA) are necessary.

The lecture will show basic principles for design and construction of such magnets and includes:

- Introduction with examples to nuclear fusion and to magnetic plasma confinement
- Basics of low temperature and high temperature properties and cryotechnique
- Material testing and critical material properties at low temperatures
- Principles of magnet design, construction and safe magnet operation
- Present status and magnet examples from fusion projects ITER, W7-X and JT-60SA
- Application of high temperature superconductors on fusion and power engineering

The goal of the lecture is to impart the fundamentals of construction of superconducting magnets. Magnet technology is inherently of multidisciplinary character e.g. material properties at low temperature, high voltage and high current technique. The use of superconductors is mandatory to reach highest magnetic fields with comparable small losses. Examples of magnets from power application, basic research and fusion reactor construction are discussed.

Lecture Content:

- Basics of nuclear fusion and design aspects of fusion magnets
- Superconductors - basics and stability
- Low temperature cryogenic aspects
- Low temperature and high temperature superconductors
- Cryogenic material testing and properties of fusion materials at low temperatures
- Quench and high voltage aspects for magnets
- Status and magnets of fusion machines ITER, W7-X, JT-60SA & future DEMO
- Impact of high temperature superconductors on fusion and power engineering

Educational objective: The students know:

- Magnetic plasma confinement principles in connection with fusion machine
- Examples and basic properties of different superconductors
- Basics of formation of superconducting cables and magnet construction
- Generation of low temperature, cryostat construction
- Basics of magnet design and magnet safety
- Material testing and material properties at low temperatures
- High-temperature superconductor use in magnet construction and power application

Recommendations:
Knowledge in energy technology, power plants, material testing is welcomed
- Time of attendance: 2 SWS, Other: excursion, etc. 5 hours
- Self-study: preparation and postprocessing LV (course): 1 hour / week
- Preparation for the examination: 80 hours per semester
Oral examination of about 30 minutes

Learning Content
The goal of the lecture is to impart the fundamentals of construction of superconducting magnets. Magnet technology is inherently of multidisciplinary character e.g. material properties at low temperature, high voltage and high current technique. The use of superconductors is mandatory to reach highest magnetic fields with comparable small losses. Examples of magnets from power application, basic research and fusion reactor construction are discussed.

Lecture Content:

- Introduction to plasma, fusion and electromagnets
- Introduction superconductivity - basics and materials
- Creation of low temperatures, cryo-technique
- Material properties at low temperature
- Magnet design and calculation
- Magnet stability, quench safety and high voltage protection
- Magnet examples
- High-temperature superconductors (HTS)
- HTS-application (cable, motor/generator, FCL, current leads, fusion reactors)
Workload
- Time of attendance: 2 SWS, Other: excursion, etc. 5 hours
- Self-study: preparation and postprocessing LV (course): 1 hour / week
- Preparation for the examination: 80 hours per semester
11.230 Course: Magnetohydrodynamics [T-MACH-108845]

**Responsible:** Prof. Dr. Leo Bühler  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering

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<td>Completed coursework (oral)</td>
<td>6</td>
<td>Each winter term</td>
<td>1</td>
</tr>
</tbody>
</table>

**Competence Certificate**  
The study performance is considered to have been passed if all exercise assignments have been successfully processed and the final colloquium (30 minutes) has been successfully passed.

No auxiliary mean

**Prerequisites**  
The partial performance number T-MACH-105426 "Magnetohydrodynamics" must not be started or completed. The partial services T-MACH-108845 "Magnetohydrodynamics" (Nat/Inf/Etit) and T-MACH-105426 "Magnetohydrodynamics" are mutually exclusive.

**Modeled Conditions**  
The following conditions have to be fulfilled:

1. The course T-MACH-105426 - Magnetohydrodynamics must not have been started.

**Recommendation**  
Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

Below you will find excerpts from events related to this course:

**Magnetohydrodynamics**  
2153429, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**

- Introduction  
- Basics of electro and fluid dynamics  
- Exact solutions, Hartmann flow, pump, generator, channel flows  
- Inductionless approximation  
- Developing flows, change of cross-section, variable magnetic fields  
- Alfvén waves  
- Stability, transition to turbulence  
- Liquid dynamos

Educational objective: The students can describe the fundamentals of magnetohydrodynamics. They are qualified to explain the interrelations of electro and fluid dynamics so as to analyze magnetohydrodynamic flows in engineering applications or for phenomena in geo and astrophysics.
Learning Content

- Introduction
- Basics of electro and fluid dynamics
- Exact solutions, Hartmann flow, pump, generator, channel flows
- Inductionless approximation
- Developing flows, change of cross-section, variable magnetic fields
- Alfven waves
- Stability, transition to turbulence
- Liquid dynamos

Annotation
Recommendation: Fluid Mechanics

Workload
regular attendance: 21 hours
self-study: 90 hours

Literature
R. Moreau, 1990, Magnetohydrodynamics, Kluwer Academic Publisher
11.231 Course: Magnetohydrodynamics [T-MACH-105426]

**Responsibility:** Prof. Dr. Leo Bühler  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanics  
- M-MACH-102643 - Major Field: Fusion Technology

**Events**

<table>
<thead>
<tr>
<th>Events</th>
<th>Type</th>
<th>Credits</th>
<th>Recurrence</th>
<th>Version</th>
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<tbody>
<tr>
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<td>Oral examination</td>
<td>4</td>
<td>Each winter term</td>
<td>1</td>
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</tbody>
</table>

**Competence Certificate**

oral  
Duration: 30 minutes  
No auxiliary means

**Prerequisites**

The partial performance number T-MACH-108845 "Magnetohydrodynamics" (Nat/Inf/Etit) must not be started or completed.  
The partial services T-MACH-108845 "Magnetohydrodynamics" (Nat/Inf/Etit) and T-MACH-105426 "Magnetohydrodynamics" are mutually exclusive.

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-108845 - Magnetohydrodynamics must not have been started.

**Recommendation**

Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

Below you will find excerpts from events related to this course:

**Notes**

- Introduction  
- Basics of electro and fluid dynamics  
- Exact solutions, Hartmann flow, pump, generator, channel flows  
- Inductionless approximation  
- Developing flows, change of cross-section, variable magnetic fields  
- Alfvén waves  
- Stability, transition to turbulence  
- Liquid dynamos

Educational objective: The students can describe the fundamentals of magnetohydrodynamics. They are qualified to explain the interrelations of electro and fluid dynamics so as to analyze magnetohydrodynamic flows in engineering applications or for phenomena in geo and astrophysics.
Learning Content

- Introduction
- Basics of electro and fluid dynamics
- Exact solutions, Hartmann flow, pump, generator, channel flows
- Inductionless approximation
- Developing flows, change of cross-section, variable magnetic fields
- Alfven waves
- Stability, transition to turbulence
- Liquid dynamos

Annotation
Recommendation: Fluid Mechanics

Workload
regular attendance: 21 hours
self-study: 90 hours

Literature
R. Moreau, 1990, Magnetohydrodynamics, Kluwer Academic Publisher
11.232 Course: Manufacturing Technology [T-MACH-102105]

**Responsible:** Prof. Dr.-Ing. Volker Schulze
Dr.-Ing. Frederik Zanger

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102618 - Major Field: Production Technology

<table>
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<tbody>
<tr>
<td>Written exam</td>
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<td>Each winter term</td>
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**Type:**
- Written examination

**Credits:** 8

**Recurrence:** Each winter term

**Version:** 3

**Events**

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<th>Semester</th>
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<th>Event Name</th>
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<td>WS 19/20</td>
<td>2149657</td>
<td>Manufacturing Technology</td>
<td>6</td>
<td>Lecture / Practice (VÜ)</td>
<td>8</td>
<td>Schulze, Zanger</td>
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**Exams**

<table>
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<tr>
<th>Semester</th>
<th>Event Code</th>
<th>Event Name</th>
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<tr>
<td>SS 2019</td>
<td>76-T-MACH-102105</td>
<td>Manufacturing Technology</td>
<td>8</td>
<td>Schulze</td>
</tr>
</tbody>
</table>

**Competence Certificate**

Written Exam (180 min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Description**

**Media:**

Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).
Notes
The objective of the lecture is to look at manufacturing technology within the wider context of production engineering, to provide an overview of the different manufacturing processes and to impart detailed process knowledge of the common processes. The lecture covers the basic principles of manufacturing technology and deals with the manufacturing processes according to their classification into main groups regarding technical and economic aspects. The lecture is completed with topics such as process chains in manufacturing.

The following topics will be covered:

- Quality control
- Primary processing (casting, plastics engineering, sintering, additive manufacturing processes)
- Forming (sheet-metal forming, massive forming, plastics engineering)
- Cutting (machining with geometrically defined and geometrically undefined cutting edges, separating, abrading)
- Joining
- Coating
- Heat treatment and surface treatment
- Process chains in manufacturing

This lecture provides an excursion to an industry company.

Learning Outcomes:
The students ...

- are capable to specify the different manufacturing processes and to explain their functions.
- are able to classify the manufacturing processes by their general structure and functionality according to the specific main groups.
- have the ability to perform a process selection based on their specific characteristics.
- are enabled to identify correlations between different processes and to select a process regarding possible applications.
- are qualified to evaluate different processes regarding specific applications based on technical and economic aspects.
- are experienced to classify manufacturing processes in a process chain and to evaluate their specific influence on surface integrity of workpieces regarding the entire process chain.

Workload:
regular attendance: 63 hours
self-study: 177 hours

Learning Content
The objective of the lecture is to look at manufacturing technology within the wider context of production engineering, to provide an overview of the different manufacturing processes and to impart detailed process knowledge of the common processes. The lecture covers the basic principles of manufacturing technology and deals with the manufacturing processes according to their classification into main groups regarding technical and economic aspects. The lecture is completed with topics such as process chains in manufacturing.

The following topics will be covered:

- Quality control
- Primary processing (casting, plastics engineering, sintering, additive manufacturing processes)
- Forming (sheet-metal forming, massive forming, plastics engineering)
- Cutting (machining with geometrically defined and geometrically undefined cutting edges, separating, abrading)
- Joining
- Coating
- Heat treatment and surface treatment
- Process chains in manufacturing

This lecture provides an excursion to an industry company.

Annotation
None

Workload
regular attendance: 63 hours
self-study: 177 hours

Literature
Lecture Notes
11.233 Course: Master's Thesis [T-MACH-105299]

**Responsible:** Prof. Dr.-Ing. Martin Heilmäier  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102858 - Master's Thesis

<table>
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<th>Type</th>
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</thead>
<tbody>
<tr>
<td>Final Thesis</td>
<td>30</td>
<td>Each term</td>
<td>1</td>
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</table>

**Competence Certificate**
The master thesis is designed to show that the student is able to deal with a problem of his/her subject area in an independent manner and within the given period of time using scientific methods.  
The maximal processing time of the master thesis takes three months. With consent of the examiner the thesis can be written in another language than German as well. The date of issue of the subject has to be fixed by the supervisor and the student and to be put on record at the examination board. The subject of the master thesis may be only returned once and only within the first month of processing time.  
On a reasoned request of the student, the examination board can extend the processing time by up to one month. If the master thesis is not completed in time, this examination is “failed” (5.0), unless the student is not responsible.  
The master thesis is to be evaluated by not less than a professor or a senior scientist according to § 14 Abs. 3 Ziff. 1 KITG and another examiner. Generally, one of the two examiners is the person who has assigned the thesis. If the examiners do not agree, the master thesis is graded by the examination board within this assessment; another expert can be appointed too. The master thesis has to be graded within a period of six weeks after the submission.

**Prerequisites**
The requirement for admission to the master thesis module are 74 ECTS. As to exceptions, the examination board decides on a request of the student (see § 14 (1) SPO).

**Modeled Conditions**
The following conditions have to be fulfilled:

1. You need to earn at least 74 credits in the following fields:
   - Advanced Engineering Fundamentals
   - Specialization

**Responsible:** Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102629 - Major Field: Logistics and Material Flow Theory

<table>
<thead>
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<th>Version</th>
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<tbody>
<tr>
<td>Examination of another type</td>
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<td>Each winter term</td>
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**Events**

<table>
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<tr>
<th>Term</th>
<th>Code</th>
<th>Subject</th>
<th>Number of SWS</th>
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<tr>
<td>WS 19/20</td>
<td>2117051</td>
<td>Material flow in logistic systems</td>
<td>6 SWS</td>
<td>Furmans</td>
</tr>
<tr>
<td>SS 2019</td>
<td>76-T-MACH-102151</td>
<td>Material Flow in Logistic Systems</td>
<td>Prüfung (PR)</td>
<td>Furmans</td>
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</tbody>
</table>

**Competence Certificate**

The assessment (Prüfungsleistung anderer Art) consists of the following assignments:

- 40% assessment of the final case study as individual performance,
- 60% semester evaluation which includes working on 5 case studies and defending those (for both assessment types, the best 4 of 5 tries count for the final grade):
  - 40% assessment of the result of the case studies as group work,
  - 20% assessment of the oral examination during the case study colloquiums as individual performance.

A detailed description of the learning control can be found under Annotations.

**Prerequisites**

none

**Recommendation**

Recommended elective subject: Probability Theory and Statistics

**Annotation**

Students are divided into groups for this course. Five case studies are carried out in these groups. The results of the group work during the lecture period are presented and evaluated in writing. In the oral examination during the case study colloquiums, the understanding of the result of the group work and the models dealt with in the course is tested. The participation in the oral defenses is compulsory and will be controlled. For the written submission the group receives a common grade, in the oral defense each group member is evaluated individually.

After the lecture period, there is the final case study. This case study contains the curriculum of the whole semester. The students work individually on this case study which takes place at a predefined place and time (duration: 4h).

*Below you will find excerpts from events related to this course:*

**Material flow in logistic systems**

<table>
<thead>
<tr>
<th>Code</th>
<th>Term</th>
<th>Subject</th>
<th>Language</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>2117051</td>
<td>WS 19/20</td>
<td>Material flow in logistic systems</td>
<td>German</td>
<td>4h</td>
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</tbody>
</table>

**Description**

Students are divided into groups for this course. Five case studies are carried out in these groups. The results of the group work during the lecture period are presented and evaluated in writing. During the colloquiums, the result of the case study is presented and the understanding of the group work and the models dealt with in the course are tested in an oral defense. The participation in the colloquiums is compulsory and will be controlled. For the written submission and the presentation the group receives a common grade, in the oral defense each group member is evaluated individually.

After the lecture period, there is the final case study. This case study contains the curriculum of the whole semester. The students work individually on this case study which takes place at a predefined place and time (duration: 4h).

**Media:** Presentations, black board, book, video recordings
Learning Content:

- Elements of material flow systems (conveyor elements, fork, join elements)
- Models of material flow networks using graph theory and matrices
- Queuing theory, calculation of waiting time, utilization
- Warehousing and order-picking
- Shuttle systems
- Sorting systems
- Simulation
- Calculation of availability and reliability
- Value stream analysis

After successful completion of the course, you are able (alone and in a team) to:

- Accurately describe a material handling system in a conversation with an expert.
- Model and parameterize the system load and the typical design elements of a material handling system.
- Design a material handling system for a task.
- Assess the performance of a material handling system in terms of the requirements.
- Change the main lever for influencing the performance.
- Expand the boundaries of today's methods and system components conceptually if necessary.

Literature:

Arnold, Dieter; Furmans, Kai: Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009

Description:

Students are divided into groups for this course. Five case studies are carried out in these groups. The results of the group work during the lecture period are presented and evaluated in writing. During the colloquia, the result of the case study is presented and the understanding of the group work and the models dealt with in the course are tested in an oral defense. The participation in the colloquia is compulsory and will be controlled. For the written submission and the presentation the group receives a common grade, in the oral defense each group member is evaluated individually.

After the lecture period, there is the final case study. This case study contains the curriculum of the whole semester. The students work individually on this case study which takes place at a predefined place and time (duration: 4h).

We strongly recommend to attend the introductory session at 16.10.2019. In this session, the teaching concept of "Materialfluss in Logistiksystemen" is explained and outstanding issues are clarified.

Workload:

- Regular attendance: 35 h
- Self-study: 135 h
- Group work: 100 h

Competence Certificate:

The assessment (Prüfungsleistung anderer Art) consists of the following assignments:

- 40% assessment of the final case study as individual performance,
- 60% semester evaluation which includes working on 5 case studies and defending those (For both assessment types, the best 4 of 5 tries count for the final grade.):
  - 40% assessment of the result and the presentation of the case studies as group work,
  - 20% assessment of the oral examination during the colloquia as individual performance.

Learning Content

- Elements of material flow systems (conveyor elements, fork, join elements)
- Models of material flow networks using graph theory and matrices
- Queuing theory, calculation of waiting time, utilization
- Warehousing and order-picking
- Shuttle systems
- Sorting systems
- Simulation
- Calculation of availability and reliability
- Value stream analysis

Annotation

none
Workload
Regular attendance: 35 h
Self-study: 135 h
Group work: 100 h

Literature
Arnold, Dieter; Furmans, Kai: Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009
11.235 Course: Materials Characterization [T-MACH-107684]

**Responsible:** Dr.-Ing. Jens Gibmeier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

### Type
- Oral examination

### Credits
- 4

### Recurrence
- Each winter term

### Version
- 3

#### Events

<table>
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<th>Lecture Code</th>
<th>Modul</th>
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<tbody>
<tr>
<td>WS 19/20</td>
<td>2174586</td>
<td>materials characterization</td>
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</table>

#### Exams

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<tr>
<th>Semester</th>
<th>Lecture Code</th>
<th>Modul</th>
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<tbody>
<tr>
<td>SS 2019</td>
<td>76-T-MACH-107684</td>
<td>Materials Characterization</td>
</tr>
<tr>
<td>WS 19/20</td>
<td>76-T-MACH-107684</td>
<td>Materials Characterization</td>
</tr>
</tbody>
</table>

### Competence Certificate

Oral exam, about 25 minutes

### Prerequisites

Successful participation in Exercises for Materials Characterization is the condition for the admittance to the oral exam in Materials Characterization.

### Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-MACH-107685 - Exercises for Materials Characterization must have been passed.

### Below you will find excerpts from events related to this course:

#### materials characterization

2174586, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

### Notes

The following methods will be introduced within this lecture:

- microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy
- material and microstructure analyses by means of X-ray, neutron and electron beams
- analysis methods at SEM/TEM (e.g. EELS)
- spectroscopic methods (e.g. EDS / WDS)

### learning objectives:

The students have fundamental knowledge about methods of material analysis. They have a basic understanding to transfer this fundamental knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure.

### requirements:

none

### workload:

The workload for the module "Materials Characterization" is 180 h per semester and consists of the presence during the lectures (21 h) and tutorials (12 h) as well as self-study for the lecture (99 h) and for the tutorials (48 h).

### Learning Content

The following methods will be introduced within this lecture:

- microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy
- material and microstructure analyses by means of X-ray, neutron and electron beams
- analysis methods at SEM/TEM (e.g. EELS)
- spectroscopic methods (e.g. EDS / WDS)
Workload
The workload for the module “Materials Characterization” is 180 h per semester and consists of the presence during the lectures (21 h) and tutorials (12 h) as well as self-study for the lecture (99 h) and for the tutorials (48 h).

Literature
Lecture notes (will be provided at the beginning of the lecture).
Literature will be announced at the beginning of the lecture.
11.236 Course: Materials in Additive Manufacturing [T-MACH-110165]

**Responsible:** Dr.-Ing. Stefan Dietrich

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

<table>
<thead>
<tr>
<th>Type</th>
<th>Credits</th>
<th>Recurrence</th>
<th>Version</th>
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</thead>
<tbody>
<tr>
<td>Oral examination</td>
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<td>Each winter term</td>
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**Events**

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<tr>
<td>WS 19/20</td>
<td>2173600</td>
<td>Materials in Additive Manufacturing</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Dietrich</td>
</tr>
</tbody>
</table>

**Competence Certificate**
oral exam, about 25 minutes

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Materials in Additive Manufacturing**

2173600, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Notes**

- **learning objectives:**
  - none

- **requirements:**
  - none

- **workload:**
  - none
**11.237 Course: Materials Modelling: Dislocation Based Plasticity [T-MACH-105369]**

**Responsible:** Dr. Daniel Weygand  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102646 - Major Field: Applied Mechanics

<table>
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<th>Version</th>
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<tr>
<td>Oral exam</td>
<td>4</td>
<td>Each summer term</td>
<td>2</td>
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**Events**

| SS 2019   | 2182740 | Materials modelling: dislocation based plasticity | 2 SWS | Lecture (V) | Weygand |

**Exams**

| SS 2019   | 76-T-MACH-105369 | Materials Modelling: Dislocation Based Plasticity | Prüfung (PR) | Weygand |

**Competence Certificate**  
oral exam ca. 30 minutes

**Prerequisites**  
none

**Recommendation**  
preliminary knowledge in mathematics, physics and materials science

*Below you will find excerpts from events related to this course:*

**Materials modelling: dislocation based plasticity**  
2182740, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

1. Introduction  
2. elastic fields of dislocations  
3. slip, crystallography  
4. equations of motion of dislocations  
   a) fcc  
   b) bcc  
5. interaction between dislocations  
6. molecular dynamics  
7. discrete dislocation dynamics  
8. continuum description of dislocations  

The student

- has the basic understanding of the physical basics to describe dislocations and their interaction with point, line and area defects.  
- can apply modelling approaches for dislocation based plasticity.  
- can explain discrete methods for modelling of microstructural evolution processes.

preliminary knowledge in mathematics, physics and materials science recommended  
regular attendance: 22,5 hours  
self-study: 97,5 hours  
oral exam ca. 30 minutes
Learning Content
1. Introduction
2. elastic fields of dislocations
3. slip, crystallography
4. equations of motion of dislocations
   a) fcc
   b) bcc
5. interaction between dislocations
6. molecular dynamics
7. discrete dislocation dynamics
8. continuum description of dislocations

Workload
regular attendance: 22.5 hours
self-study: 97.5 hours

Literature
11.238 Course: Materials of Lightweight Construction [T-MACH-105211]

Responsible: Dr.-Ing. Wilfried Liebig
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102628 - Major Field: Lightweight Construction

<table>
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<tbody>
<tr>
<td>Oral examination</td>
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Events

<table>
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<tr>
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<th>Credits</th>
<th>Lecture (V)</th>
<th>Liebig, Elsner</th>
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<tbody>
<tr>
<td>SS 2019 2174574</td>
<td>2 SWS</td>
<td>Materials for Lightweight Construction</td>
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Exams

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<th>Credits</th>
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<th>Liebig, Weidenmann</th>
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<td>SS 2019 76-T-MACH-105211</td>
<td></td>
<td>Materials of Lightweight Construction</td>
<td></td>
</tr>
</tbody>
</table>

Competence Certificate

Oral exam, about 25 minutes

Prerequisites

none

Recommendation

Materials Science I/II

Below you will find excerpts from events related to this course:

Materials for Lightweight Construction

2174574, SS 2019, 2 SWS, Language: German, [Open in study portal]
Notes

Introduction

Constructive, production-orientied and material aspects of lightweight construction

Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys
Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys
Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys
High-strength steels
High-strength structural steels,
Heat-treatable steels, press-hardening and hardenable steels
Composites - mainly PMC
Matrices
Reinforcements
Basic mechanical principles of composites
Hybrid composites
Special materials for lightweight design
Beryllium alloys
Metallic Glasses
Applications

learning objectives:
The students are capable to name different lightweight materials and can describe their composition, properties and fields of application. They can describe the hardening mechanisms of lightweight materials and can transfer this knowledge to applied problems.
The students can apply basic mechanical models of composites and can depict differences in the mechanical properties depending on composition and structure. The students can describe the basic principle of hybrid material concepts and can judge their advantages in comparison to bulk materials. The students can name special materials for lightweight design and depict differences to conventional materials. The students have the ability to present applications for different lightweight materials and can balance reasons for their use.

requirements:
Werkstoffkunde I/II (recommended)

workload:
The workload for the lecture “Materials for Lightweight Construction” is 120 h per semester and consists of the presence during the lectures (24 h), preparation and rework time at home (48 h) and preparation time for the oral exam (48 h).
Learning Content
Introduction
Constructive, production-orientied and material aspects of lightweight construction
Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys
Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys
Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys
High-strength steels
High-strength structural steels,
Heat-treatable steels, press-hardening and hardenable steels
Composites - mainly PMC
Matrices
Reinforcements
Basic mechanical principles of composites
Hybrid composites
Special materials for lightweight design
Beryllium alloys
Metallic Glasses
Applications

Workload
The workload for the lecture "Materials for Lightweight Construction" is 120 h per semester and consists of the presence during the lectures (24 h), preparation and rework time at home (48 h) and preparation time for the oral exam (48 h).

Literature
Presentation slides and additional lecture notes are handed out during the lecture, additional literature recommendations given
11.239 Course: Materials Science and Engineering III [T-MACH-105301]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

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<td>Oral examination</td>
<td>8</td>
<td>Each winter term</td>
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**Events**
- WS 19/20 2173553 Materials Science and Engineering III 4 SWS Lecture (V) Heilmaier, Lang
- WS 19/20 2173554 Übungen zu Werkstoffkunde III 1 SWS Practice (Ü) Heilmaier, Kauffmann

**Exams**
- SS 2019 76-T-MACH-105301 Materials Science III Prüfung (PR) Heilmaier, Lang

**Competence Certificate**
Oral exam, about 35 minutes

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Materials Science and Engineering III** 2173553, WS 19/20, 4 SWS, Language: German, Open in study portal

**Notes**
Properties of pure iron; thermodynamic foundations of single-component and of binary systems; nucleation and growth; diffusion processes in crystalline iron; the phase diagram Fe-Fe3C; effects of alloying on Fe-C-alloys; nonequilibrium microstructures; multicomponent iron-based alloys; heat treatment technology; hardenability and hardenability tests.

**Learning objectives:**
The students are familiar with the thermodynamic foundations of phase transformations, the kinetics of phase transformations in the solid states (nucleation and growth phenomena), the mechanisms of microstructure formation and microstructure-property relationships and can apply them to metallic materials. They can assess the effects of heat treatments and of alloying on the microstructure and the properties of iron-based materials (steels in particular). The can select steels for structural applications in mechanical engineering and subject them to appropriate heat treatments.

**Requirements:**
Basic knowledge in materials science and engineering (Werkstoffkunde I/II)

**Workload:**
- regular attendance: 53 hours
- self-study: 187 hours

**Learning Content**
Properties of pure iron; thermodynamic foundations of single-component and of binary systems; nucleation and growth; diffusion processes in crystalline iron; the phase diagram Fe-Fe3C; effects of alloying on Fe-C-alloys; nonequilibrium microstructures; multicomponent iron-based alloys; heat treatment technology; hardenability and hardenability tests.

**Workload**
- regular attendance: 53 hours
- self-study: 187 hours
Literature
Lecture Notes; Problem Sheets; Bhadeshia, H.K.D.H. & Honeycombe, R.W.K.
Steels – Microstructure and Properties

Responsible: Prof. Dr. Eckart Schnack
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102614 - Major Field: Mechatronics

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Events

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<td>2 SWS</td>
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<td>SS 2019</td>
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<td>Prüfung (PR)</td>
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Competence Certificate
Oral Examination Certificate Duration: 20 minutes

Prerequisites
None

Recommendation
none

Below you will find excerpts from events related to this course:

Mathematical Foundation for Computational Mechanics
2162240, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

Learning Content
Variational formulations. Functional analysis. Lagrange d process. Various function space definitions relating to the elasticity and dynamics of the mechanics. Measurements which enable the field calculation to be defined in applications.

Workload
Contact time: 22.5 hrs; Self-study: 97.5 hrs

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102594 - Mathematical Methods
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

**Type:** Written examination

**Credits:** 4

**Recurrence:** Each winter term

**Expansion:** 1 terms

**Version:** 1

**Events**

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<td></td>
<td>Lecture (V)</td>
<td>Böhlke</td>
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</table>

**Competence Certificate**
written exam (90 min). Additives as announced.

**Prerequisites**
Passing the Tutorial to Mathematical Methods of Continuum Mechanics (T-MACH-110376)

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-110376 - Tutorial Mathematical Methods in Continuum Mechanics must have been passed.

**Below you will find excerpts from events related to this course:**

**Mathematical Methods in Continuum Mechanics**
2161254, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Lecture (V)**

**Notes**
Tensor algebra

- vectors; basis transformation; dyadic product; tensors of 2nd order
- properties of 2nd order tensors: symmetry, anti-symmetry, orthogonality etc.
- eigenvalue problem, theorem of Cayley-Hamilton, invariants; tensors of higher order
- tensor algebra in curvilinear coordinate systems
- tensor analysis in curvilinear coordinate systems
- Differentiation of tensor functions

Application of tensor calculus in strength of materials

- kinematics of infinitesimal and finite deformations
- transport theorem, balance equations, stress tensor
- constitutive equations for solids and fluids
- Formulation of initial-boundary-value problems
Learning Content
Tensor algebra

• vectors; basis transformation; dyadic product; tensors of 2nd order
• properties of 2nd order tensors: symmetry, anti-symmetry, orthogonality etc.
• eigenvalue problem, theorem of Cayley-Hamilton, invariants; tensors of higher order
• tensor algebra in curvilinear coordinate systems
• tensor analysis in curvilinear coordinate systems
• Differentiation of tensor functions

Application of tensor calculus in strength of materials

• kinematics of infinitesimal and finite deformations
• transport theorem, balance equations, stress tensor
• constitutive equations for solids and fluids
• Formulation of initial-boundary-value problems

Workload
regular attendance: 31,5 hours
self-study: 88,5 hours

Literature
lecture notes
11.242 Course: Mathematical Methods in Dynamics [T-MACH-105293]

**Responsible:** Prof. Dr.-Ing. Carsten Proppe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102594 - Mathematical Methods
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

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<td>Übungen zu Mathematische Methoden der Dynamik</td>
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<td>Practice (Ü)</td>
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<td>Oestringer, Proppe</td>
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</table>

**Competence Certificate**
written examination, 180 min.

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Mathematical Methods in Dynamics**
2161206, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Learning Content**
Dynamics of continua:
- Concept of continuum, geometry of continua, kinematics and kinetics of continua

Dynamics of rigid bodies:
- Kinematics and kinetics of rigid bodies

Variational principles:
- Principle of virtual work, variational calculations, Principle of Hamilton

Approximate solution methods:
- Methods of weighted residuals, method of Ritz

**Workload**
- Lectures and exercises: 32 h
- Studies: 148 h
Literature
Lecture notes (available online)

J.E. Marsden, T.J.R. Hughes: Mathematical foundations of elasticity, New York, Dover, 1994

P. Haupt: Continuum mechanics and theory of materials, Berlin, Heidelberg, 2000

M. Riemer: Technische Kontinuumsmechanik, Mannheim, 1993


Übungen zu Mathematische Methoden der Dynamik
2161207, WS 19/20, 1 SWS, Language: German, Open in study portal

Learning Content
Excercises related to the lecture
11.243 Course: Mathematical Methods in Fluid Mechanics [T-MACH-105295]

**Responsible:** Prof. Dr.-Ing. Bettina Frohnapfel  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
M-MACH-102594 - Mathematical Methods  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102634 - Major Field: Fluid Mechanic  
M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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<td>Lecture (V)</td>
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<td>SS 2019 2154433</td>
<td>1 SWS</td>
<td>Tutorial in Mathematical Methods of Fluid Mechanics</td>
<td>Practice (Ü)</td>
<td>Frohnapfel, Stroh, Gatti</td>
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<tr>
<td>SS 2019 2154540</td>
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**Exams**

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<td>Prüfung (PR)</td>
<td>Mathematical Methods in Fluid Mechanics</td>
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**Competence Certificate**
written examination - 3 hours

**Prerequisites**
none

**Recommendation**
Basic Knowledge about Fluid Mechanics

Below you will find excerpts from events related to this course:

**Mathematical Methods in Fluid Mechanics**
2154432, SS 2019, 2 SWS, Language: German/English, Open in study portal

**Description**

Media:  
chalk board, Power Point
Notes
The students can to simplify the Navier-Stokes equations for specific flow problems. They are able to employ mathematical method in fluid mechanics effectively in order to solve the resulting conservation equations analytically, if possible, or to enable simpler numerical access to the problem. They can describe the limits of applicability of the assumptions made to model the flow behavior.

The lecture will cover a selection of the following topics:

- Potential flow theory
- Creeping flows
- Lubrication theory
- Boundary-layer theory
- Laminar-turbulent transition (linear stability theory)
- Turbulent flows
- Numerical solution of the governing equation (finite difference methods)

The students can to simplify the Navier-Stokes equations for specific flow problems. They are able to employ mathematical method in fluid mechanics effectively in order to solve the resulting conservation equations analytically, if possible, or to enable simpler numerical access to the problem. They can describe the limits of applicability of the assumptions made to model the flow behavior.

Learning Content
The lecture will cover a selection of the following topics:

- Potential flow theory
- Creeping flows
- Lubrication theory
- Boundary-layer theory
- Laminar-turbulent transition (linear stability theory)
- Turbulent flows
- Numerical solution of the governing equation (finite difference methods)

Workload
regular attendance: 30 hours
self-study: 150 hours

Literature
Learning Content
The exercises will practise the lecture topics:

- Curvilinear coordinates and tensor calculus
- Potential flow theory
- Boundary-layer theory
- Laminar-turbulent transition (linear stability theory)
- Turbulent flows
- Numerical solution of the governing equation (finite difference methods)

Workload
regular attendance: 10,5 hours
self-study: 49,5 hours

Literature
## 11.244 Course: Mathematical Methods in Micromechanics [T-MACH-110378]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:**  
- M-MACH-102594 - Mathematical Methods  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102646 - Major Field: Applied Mechanics  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering  
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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### Competence Certificate
written exam (180 min). Additives as announced.

### Prerequisites
Passing the tutorial to Mathematical Methods in Micromechanics T-MACH-110379

### Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-106831 - Tutorial Mathematical Methods in Structural Mechanics must have been passed.
11.245 Course: Mathematical Methods in Strength of Materials [T-MACH-100297]

Responsible:  Prof. Dr.-Ing. Thomas Böhlke
Organisation:  KIT Department of Mechanical Engineering

Part of:  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology

Type: Written examination
Credits: 5
Recurrence: Each winter term
Version: 4

Competence Certificate
written exam (90 min). Additives as announced.

Prerequisites
Passing the Tutorial to Mathematical Methods of Strength of Materials

Modeled Conditions
The following conditions have to be fulfilled:

1. The course T-MACH-106830 - Tutorial Mathematical Methods in Strength of Materials must have been passed.
### 11.246 Course: Mathematical Methods in Structural Mechanics [T-MACH-105298]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlike

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction

#### Events

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<td>Each summer term</td>
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| SS 2019    | 2162204 | Sprechstunde zu Mathematische Methoden der Strukturmechanik | 2 SWS | Consultation-hour (Sprechst.) | N.N. |
| SS 2019    | 2162280 | Mathematical Methods in Micromechanics | 2 SWS | Lecture (V) | Böhlike |

#### Exams

| SS 2019    | 76-T-MACH-105298 | Mathematical Methods in Structural Mechanics | Prüfung (PR) | Böhlike, Langhoff |

**Competence Certificate**
written exam (180 min). Additives as announced.

**Prerequisites**
Passing the tutorial to Mathematical Methods in Structural Mechanics T-MACH-106831

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-106831 - Tutorial Mathematical Methods in Structural Mechanics must have been passed.

**Recommendation**
This course is geared to MSc students. The contents of the lecture "Mathematical methods in Strength of Materials" are assumed to be known.

**Below you will find excerpts from events related to this course:**

### V Mathematical Methods in Micromechanics

2162280, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Notes
I Basics of variational calculus
• functionals; Frechet-differential; Gateaux-differential; maximum or minimum problems
• lemma of variational calculus and Lagrange delta-process; Euler-Lagrange-equations

II Applications: Principals of continuums mechanics
• variational principals in mechanics; variational formulierung of boundary value problem of elastostatic

III Applications: Homogenization methods for materials with microstructure
• mesoscopic and macroscopic stress and strain measures
• Mean values of ensembles, ergodicity
• effective elastic properties
• Homogenization of thermo-elastic properties
• Homogenization of plastic and visco-plastic properties
• Fe-based homogenization

Workload
regular attendance: 31,5 hours
self-study: 118,5 hours
Course: Mathematical Methods of Vibration Theory [T-MACH-105294]

Responsible: Prof. Dr.-Ing. Wolfgang Seemann
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102594 - Mathematical Methods
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystems Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

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Events

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Exams

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<td>2 SWS</td>
<td>Mathematical methods of vibration theory</td>
<td>Each summer term</td>
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Competence Certificate
written examination, 180 min.

Prerequisites
none

Recommendation
Engineering Mechanics III/IV

Below you will find excerpts from events related to this course:

Mathematical methods of vibration theory
2162241, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
Linear, time-invariant, ordinary single differential equations: homogeneous solution; harmonic, periodic and non-periodic excitations; Duhamel's integral; Fourier and Laplace transform; introduction into the theory of distributions; Systems of ordinary differential equations: matrix notation, eigenvalue theory, fundamental matrix, forced vibrations via modal expansion and transition matrix; Introduction into the dynamic stability theory; Partial differential equations: solution in product form, eigenvalue theory, modal expansion using Ritz series; Variational methods, Hamilton's principle, boundary value problems representing vibrating continua; Perturbation methods

Workload
time of attendance: 24h; self-study: 65h

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Mathematical methods of vibration theory (Tutorial)
2162242, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
Seven tutorials with examples of the contents of the course

Workload
time of attendance: 10.5h; self-study: 20h

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik
Course: Mathematical Models and Methods for Production Systems [T-MACH-105189]

**Responsible:** Marion Baumann  
Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102594 - Mathematical Methods  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102613 - Major Field: Lifecycle Engineering  
- M-MACH-102618 - Major Field: Production Technology  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102742 - Fundamentals and Methods of Production Technology  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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**Events**

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<td>WS 19/20</td>
<td>2117059</td>
<td>Mathematical models and methods for Production Systems</td>
<td>4 SWS</td>
<td>Lecture (V)</td>
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<td>Baumann, Furmans</td>
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**Competence Certificate**
The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**Mathematical models and methods for Production Systems**

2117059, WS 19/20, 4 SWS, Language: English, [Open in study portal](#)
Notes
Media:
black board, lecture notes, presentations

Learning Content:
- single server systems: \( M/M/1, M/G/1 \): priority rules, model of failures
- networks: open and closed approximations, exact solutions and approximations
- application to flexible manufacturing systems, AGV (automated guided vehicles) - systems
- modeling of control approaches like constant work in process (ConWIP) or kanban
- discrete-time modeling of queuing systems

Learning Goals:
Students are able to:
- Describe queueing systems with analytical solvable stochastic models,
- Derive approaches for modeling and controlling material flow and production systems based on models of queueing theory,
- Use simulation and exakt methods.

Recommendations:
- Basic knowledge of statistic
- recommended compulsory optional subject: Stochastics
- recommended lecture: Materials flow in logistic systems (also parallel)

Workload:
regular attendance: 42 hours
self-study: 198 hours
11.249 Course: Mathematical Models and Methods in Combustion Theory [T-MACH-105419]

Responsible: Dr. Viatcheslav Bykov
Prof. Dr. Ulrich Maas

Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102635 - Major Field: Engineering Thermodynamics

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<td>Mathematical models and methods in combustion theory</td>
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Competence Certificate
oral exam (20 min)

Prerequisites
none

Below you will find excerpts from events related to this course:

Mathematical models and methods in combustion theory
2165525, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
The lecture shall introduce the basics of the mathematical modeling and the analysis of reacting flow systems. The fundamental models of combustion processes are outlined together with asymptotical methods, which deliver reasonable approximate solutions for numerous combustion processes. Many examples of simplified models for the description of auto-ignition, explosions, flame quenching and detonations will be presented and discussed. The main analytical methods will be illustrated using these simple examples.

Workload
Regular attendance: 22.5 h
Self-study: 97.5 h

Literature
### 11.250 Course: Measurement [T-ETIT-101937]

**Responsible:** Prof. Dr.-Ing. Fernando Puente León  
**Organisation:** KIT Department of Electrical Engineering and Information Technology  
**Part of:** M-MACH-102615 - Major Field: Medical Technology

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<td>Practice (Ü)</td>
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Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019
11.251 Course: Measurement II [T-MACH-105335]

Responsibility: Prof. Dr.-Ing. Christoph Stiller
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102609 - Major Field: Cognitive Technical Systems
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102624 - Major Field: Information Technology
- M-MACH-102633 - Major Field: Robotics

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Exams

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<td>Measurement II</td>
<td>Prüfung (PR)</td>
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Competence Certificate
written exam
60 min.
2 DIN A4 Self-created formular sheets allowed

Prerequisites
none

Below you will find excerpts from events related to this course:

Measurement II

Lerninhalt (EN):
1. Amplifiers
2. Digital technology
3. Stochastic modeling for measurement applications
4. Estimation
5. Kalman Filter
6. Environmental perception

Lernziele (EN):
The capabilities of modern sensor technology pave the way for novel applications in engineering. Especially digital measurement techniques may be used even in very complex environments and thus have strong impact on technological progress. Stochastic models of measurement processes form the basis for meaningful information processing and provide a valuable tool for engineering. This interdisciplinary lecture addresses students in mechanical engineering and related subjects. The lecture gives an overview of digital technology and stochastics. These areas form the basics of estimation methods that can be embedded elegantly in the theory of state observers. Applications in signal processing for modern environmental perception (video, Lidar, Radar) illustrate the discussed subjects.
Learning Content
1. Amplifiers
2. Digital technology
3. Stochastic modeling for measurement applications
4. Estimation
5. Kalman Filter
6. Environmental perception

Workload
120 hours

Literature
Various Scripts
11.252 Course: Measurement Instrumentation Lab [T-MACH-105300]

**Responsible:** Max Spindler  
Prof. Dr.-Ing. Christoph Stiller  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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</table>

**Competence Certificate**
Non graded colloquia

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Measurement Instrumentation Lab**

2138328, SS 2019, 2 SWS, Language: German, Open in study portal

**Practical course (P)**

**Notes**

Please consider the bulletin on our website!

**A Signal recording**

- measurement of temperature
- measurement of lengths

**B Signal pre-processing**

- bridge circuits and principles of measurement
- analog/digital transducers

**C Signal processing**

- measuring stochastic signals

**D Complete systems**

- system identification
- inverse pendulum
- mobile robot platform

**Recommendations:**

Basic studies and preliminary examination; basic lectures in automatic control

Arbeitsaufwand: 90 hours

**Lernziele (EN):**

The laboratory complements the course “Introduction to Measurement and Control”. While the course is organized into principles and subsystems, the laboratory presents complete measurement systems and methods for the most relevant industrial measurands.
Learning Content

A Signal recording
- measurement of temperature
- measurement of lengths

B Signal pre-processing
- bridge circuits and principles of measurement
- analog/digital transducers

C Signal processing
- measuring stochastic signals

D Complete systems
- system identification
- inverse pendulum
- mobile robot platform

Workload
90 hours
11.253 Course: Mechanics and Strength of Polymers [T-MACH-105333]

**Responsible:** Prof. Dr.-Ing. Bernd-Steffen von Bernstorff

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102632 - Major Field: Polymer Engineering

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**Competence Certificate**
Oral exam, about 25 minutes

**Prerequisites**
none

**Recommendation**
Basic knowledge in materials science (e.g. lecture materials science I and II)

Below you will find excerpts from events related to this course:

**Mechanics and Strengths of Polymers**
2173580, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**
Molecular structure and morphology of polymers, temperature- and time dependency of mechanical behavior, viscoelasticity, time/temperature- superposition principle, yielding, crazing and fracture of polymers, failure criterions, impact and dynamic loading, corresponding principle, tough/brittle-transition, introduction to the principles of fiber reinforcement and multiple cracking in composites

**Learning objectives:**
The students are prepared to
- repeat the calculus on strength and design of engineering parts exposed to complex loadings,
- estimate the influence of time and temperature on the strength of polymeric materials,
- relate the strength of materials to their molecular structure, morphology and processing parameters and
- derive failure mechanisms for homogenous polymers and composite materials therefrom.

**Requirements:**
Basic knowledge in materials science (e.g. lecture materials science I and II)

**Workload:**
The workload for the lecture Mechanics and Strengths of Polymers is 120 h per semester and consists of the presence during the lecture (28 h) as well as preparation and rework time at home (92 h).

**Learning Content**
Molecular structure and morphology of polymers, temperature- and time dependency of mechanical behavior, viscoelasticity, time/temperature- superposition principle, yielding, crazing and fracture of polymers, failure criterions, impact and dynamic loading, corresponding principle, tough/brittle-transition, introduction to the principles of fiber reinforcement and multiple cracking in composites.
Workload
The workload for the lecture Mechanics and Strengths of Polymers is 120 h per semester and consists of the presence during the lecture (28 h) as well as preparation and rework time at home (92 h).

Literature
A literature list, specific documents and partial lecture notes shall be handed out during the lecture.
11.254 Course: Mechanics in Microtechnology [T-MACH-105334]

**Responsible:** Dr. Christian Greiner  
Dr. Patric Gruber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102616 - Major Field: Microsystem Technology  
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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<td>SS 2019</td>
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**Competence Certificate**  
Oral examination, ca. 30 min

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Mechanics in Microtechnology**  
2181710, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**
1. Introduction: Application and Processing of Microsystems  
2. Scaling Effects  
3. Fundamentals: Stress and Strain, (anisotropic) Hooke's Law  
4. Fundamentals: Mechanics of Beams and Membranes  
5. Thin Film Mechanics: Origin and Role of Mechanical Stresses  
6. Characterization of Mechanical Properties of Thin Films and Small Structures: Measurement of Stresses and Mechanical Parameters such as Young's Modulus and Yield Strength; Thin Film Adhesion and Stiction  
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Electrostatics,...  
8. Aktuation: Inverse Piezo-electric Effect, Shape Memory, Electromagnetic Actuation,...

The students know and understand size and scaling effects in micro- and nanosystems. They understand the impact of mechanical phenomena in small dimensions. Based on this they can judge how they determine material processing as well as working principles and design of microsensors and microactuators.

regular attendance: 22.5 hours  
self-study: 97.5 hours  
oral exam ca. 30 minutes
Learning Content
1. Introduction: Application and Processing of Microsystems
2. Scaling Effects
3. Fundamentals: Stress and Strain, (anisotropic) Hooke's Law
4. Fundamentals: Mechanics of Beams and Membranes
5. Thin Film Mechanics: Origin and Role of Mechanical Stresses
6. Characterization of Mechanical Properties of Thin Films and Small Structures: Measurement of Stresses and Mechanical Parameters such as Young's Modulus and Yield Stress; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Electrostatics, ...
8. Actuation: Inverse Piezo-electric Effect, Shape Memory, Electromagnetic Actuation, ...

Workload
regular attendance: 22.5 hours
self-study: 97.5 hours

Literature
Folien,
2. L.B. Freund and S. Suresh: "Thin Film Materials"
11.255 Course: Mechanics of Laminated Composites [T-MACH-108717]

Responsible: Prof. Dr. Eckart Schnack
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102611 - Major Field: Materials Science and Engineering
M-MACH-102628 - Major Field: Lightweight Construction

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Competence Certificate

Oral exam, approx. 20 minutes

Prerequisites

none

Annotation

The lecture notes are made available via ILIAS.

Below you will find excerpts from events related to this course:

Mechanics of laminated composites

2161983, WS 19/20, 2 SWS, Open in study portal

Learning Content

Definition of composites, definition of static and kinematic groups. Definition of material laws. Transformation of the state values of composites and transformation of the material properties for the coordinate systems in the design of machine structures.

Workload

Contact time: 22.5 hrs; Self-study: 97.5 hrs
### Course: Medical Imaging Techniques I [T-ETIT-101930]

| Responsible: | Prof. Dr. Olaf Dössel |
| Organisation: | KIT Department of Electrical Engineering and Information Technology |
| Part of: | M-MACH-102615 - Major Field: Medical Technology |

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**Prerequisites**

none
### 11.257 Course: Medical Imaging Techniques II [T-ETIT-101931]

**Responsible:** Prof. Dr. Olaf Dössel  
**Organisation:** KIT Department of Electrical Engineering and Information Technology  
**Part of:** M-MACH-102615 - Major Field: Medical Technology

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<td>Medical Imaging Techniques II</td>
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### 11.258 Course: Medical Robotics [T-INFO-101357]

**Responsible:** Prof. Dr.-Ing. Torsten Kröger  
Jun.-Prof. Dr. Franziska Mathis-Ullrich  

**Organisation:** KIT Department of Informatics  

**Part of:**  

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<td>Mathis-Ullrich</td>
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11.259 Course: Metal Forming [T-MACH-105177]

**Responsible:** Dr.-Ing. Thomas Herlan

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each summer term

**Version**
- 1

**Events**

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**Exams**

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<td>Schulze</td>
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**Competence Certificate**
- Oral Exam (20 min)

**Prerequisites**
- none

*Below you will find excerpts from events related to this course:*

**Metal Forming**

2150681, SS 2019, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**
- Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
At the beginning of the lecture the basics of metal forming are briefly introduced. The focus of the lecture is on massive forming (forging, extrusion, rolling) and sheet forming (car body forming, deep drawing, stretch drawing). This includes the systematic treatment of the appropriate metal forming Machines and the corresponding tool technology. Aspects of tribology, as well as basics in material science and aspects of production planning are also discussed briefly. The plastic theory is presented to the extent necessary in order to present the numerical simulation method and the FEM computation of forming processes or tool design. The lecture will be completed by product samples from the forming technology.

The topics are as follows:

- Introduction and basics
- Hot forming
- Metal forming machines
- Tools
- Metallographic fundamentals
- Plastic theory
- Tribology
- Sheet forming
- Extrusion
- Numerical simulation

Learning Outcomes:
The students ...

- are able to reflect the basics, forming processes, tools, Machines and equipment of metal forming in an integrated and systematic way.
- are capable to illustrate the differences between the forming processes, tools, machines and equipment with concrete examples and are qualified to analyze and assess them in terms of their suitability for the particular application.
- are also able to transfer and apply the acquired knowledge to other metal forming problems.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
At the beginning of the lecture the basics of metal forming are briefly introduced. The focus of the lecture is on massive forming (forging, extrusion, rolling) and sheet forming (car body forming, deep drawing, stretch drawing). This includes the systematic treatment of the appropriate metal forming Machines and the corresponding tool technology. Aspects of tribology, as well as basics in material science and aspects of production planning are also discussed briefly. The plastic theory is presented to the extent necessary in order to present the numerical simulation method and the FEM computation of forming processes or tool design. The lecture will be completed by product samples from the forming technology.

The topics are as follows:

- Introduction and basics
- Hot forming
- Metal forming machines
- Tools
- Metallographic fundamentals
- Plastic theory
- Tribology
- Sheet forming
- Extrusion
- Numerical simulation

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours
11.260 Course: Metallographic Lab Class [T-MACH-105447]

**Responsible:** Ulla Hauf

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102591 - Laboratory Course
- M-MACH-102611 - Major Field: Materials Science and Engineering

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**Exams**

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<td>Metallographic Lab Class</td>
<td>Prüfung (PR)</td>
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**Competence Certificate**

Colloquium for every experiment, about 60 minutes, protocol

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Metallographic Lab Class**

2175590, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Notes**

learning objectives:

requirements:

workload:
Notes
Light microscope in metallography
metallographic sections of metallic materials
Investigation of the microstructure of unalloyed steels and cast iron
Microstructure development of steels with accelerated cooling from the austenite area
Investigation of microstructures of alloyed steels
Investigation of failures quantitative microstructural analysis
Microstructural investigation of technically relevant non-ferrous metals
Application of Scanning electron microscope

learning objectives:
The students in this lab class gain are able to perform standard metallographic preparations and are able to apply standard software for quantitative microstructural analyses. Based on this the student can interpret unetched as well as etched microstructures with respect to relevant microstructural features. They can draw concluding correlations between heat treatments, ensuing microstructures and the resulting mechanical as well as physical properties of the investigated materials.

requirements:
Material Science I/II

workload:
The workload for the Metallographic Lab Class is 120 h per semester and consists of the presence during the lab course (25 h) as well as preparation and rework time at home (95 h).

Learning Content
Light microscope in metallography
metallographic sections of metallic materials
Investigation of the microstructure of unalloyed steels and cast iron
Microstructure development of steels with accelerated cooling from the austenite area
Investigation of microstructures of alloyed steels
Investigation of failures quantitative microstructural analysis
Microstructural investigation of technically relevant non-ferrous metals
Application of Scanning electron microscope

Workload
The workload for the Metallographic Lab Class is 120 h per semester and consists of the presence during the lab course (25 h) as well as preparation and rework time at home (95 h).

Literature
E. Macherauch: Praktikum in Werkstoffkunde, 10th edition, 1992

Literature List will be handed out with each experiment
### 11.261 Course: Metals [T-MACH-105468]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier  
Prof. Dr. Astrid Pundt

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<td>Lecture (V)</td>
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<td>Übungen zur Vorlesung &quot;Metalle&quot;</td>
<td>1 SWS</td>
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**Exams**

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**Competence Certificate**

Oral exam, about 20 minutes

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Metals**

2174598, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Notes**

Properties of pure elements; thermodynamic foundations of single-component and of binary systems, as well as multiphase systems; nucleation and growth; diffusion processes in crystalline materials; phase diagrams; effects of alloying; nonequilibrium microstructures; heat treatment technology

**learning objectives:**

The students are familiar with the thermodynamic foundations of phase transformations, the kinetics of phase transformations in the solid state, the mechanisms of microstructure formation and microstructure-property relationships and can apply them to metallic materials. They can assess the effects of heat treatments and of alloying on the microstructure and the mechanical and physical properties of metallic materials. This competence is in particular deepened for iron- and aluminum-based alloys.

**requirements:**

Materials physics

**workload:**

Regular attendance: 42 h  
Self-study: 138 h

**Learning Content**

Properties of pure elements; thermodynamic foundations of single-component and of binary systems, as well as multiphase systems; nucleation and growth; diffusion processes in crystalline materials; phase diagrams; effects of alloying; nonequilibrium microstructures; heat treatment technology

**Workload**

Regular attendance: 42 h  
Self-study: 138 h
Notes
Properties of pure elements; thermodynamic foundations of single-component and of binary systems, as well as multiphase systems; nucleation and growth; diffusion processes in crystalline materials; phase diagrams; effects of alloying; nonequilibrium microstructures; heat treatment technology

Learning objectives:
The Students have hands-on experience in the application of thermodynamic foundations of phase transformations, the kinetics of phase transformations in the solid state, the mechanisms of microstructure formation and microstructure-property relationships. They can assess the effects of heat treatments and of alloying on the microstructure and the mechanical and physical properties of metallic materials. This competence is in particular practiced for iron- and aluminum-based alloys.

Requirements:
Materials physics

Workload:
Regular attendance: 14 h
Self-study: 16 h

Learning Content
Properties of pure elements; thermodynamic foundations of single-component and of binary systems, as well as multiphase systems; nucleation and growth; diffusion processes in crystalline materials; phase diagrams; effects of alloying; nonequilibrium microstructures; heat treatment technology

Workload
Regular attendance: 14 h
Self-study: 16 h

Literature
http://dx.doi.org/10.1007/978-3-662-47952-0 (frei über die KIT-Lizenz abrufbar)
http://www.ifw-dresden.de/institutes/imw/lectures/pwe
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC309606810
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC052463656
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC27759961X
http://dx.doi.org/10.1007/978-3-662-47952-0 (frei über die KIT-Lizenz abrufbar)
http://dx.doi.org/10.1007/978-3-662-22561-1 (frei über die KIT-Lizenz abrufbar)
http://dx.doi.org/10.1007/978-3-662-17717-0 (frei über die KIT-Lizenz abrufbar)
http://dx.doi.org/10.1007/978-3-658-13795-3 (frei über die KIT-Lizenz abrufbar)
11.262 Course: Methods and Processes of PGE - Product Generation Development [T-MACH-109192]

Responsible: Prof. Dr.-Ing. Albert Albers
Norbert Burkardt
Prof. Dr.-Ing. Sven Matthiesen

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102718 - Product Development - Methods of Product Development

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Exams

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<td>SS 2019</td>
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<td>Methods and Processes of PGE - Product Generation Engineering</td>
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Competence Certificate

Written exam (processing time: 120 min + 10 min reading time)

Auxiliaries:

- Calculator
- German dictionary (books only)

Prerequisites

None

Annotation

This lecture is the basis for the main subject Integrated Product Development, which is offered as a specialisation.

Below you will find excerpts from events related to this course:

Methods and processes of PGE - Product Generation Development

2146176, SS 2019, 3 SWS, Language: German, Open in study portal
Notes

Note:
This lecture is the basis for the main subject Integrated Product Development, which is offered as a specialisation.

Recommendations:
none

Workload:
regular attendance: 31.5 h
self-study: 148.5 h

Examination:
Written exam
Duration: 120 minutes (+10 minutes reading time)

Auxiliaries:
• Calculator
• German dictionary (books only)

Course content:
Basics of Product Development: Basic Terms, Classification of the Product
Development into the industrial environment, generation of costs / responsibility for costs
Concept Development: List of demands / Abstraction of the Problem Definition / Creativity Techniques / Evaluation and selection of solutions
Drafting: Prevailing basic rules of Design / Design Principles as a problem oriented accessory
Rationalization within the Product Development: Basics of Development
Management/ Simultaneous Engineering and Integrated Product Development/Development of Product Lines and Modular Construction Systems
Quality Assurance in early Development Phases: Methods of Quality Assurance in an overview/QFD/FMEA

Learning objectives:
The students are able to ...
• classify product development in companies and differentiate between different types of product development.
• name the relevant influencing factors of a market for product development.
• name, compare and use the central methods and process models of product development within moderate complex technical systems.
• explain problem solving techniques and associated development methods.
• explain product profiles and to differentiate and choose suitable creative techniques of solution/idea generation finding on this basis.
• use design guidelines to create simple technical systems and to explain these guidelines.
• name and compare quality assurance methods; to choose and use suitable methods for particular applications.
• explain the different methods of design of experiment.
• explain the costs in development process.
### 11.263 Course: Methods of Signal Processing [T-ETIT-100694]

**Responsible:** Prof. Dr.-Ing. Fernando Puente León  
**Organisation:** KIT Department of Electrical Engineering and Information Technology  
**Part of:** M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering

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**Prerequisites**

none
**11.264 Course: Micro- and nanosystem integration for medical, fluidic and optical applications [T-MACH-108809]**

**Responsible:** Dr. Ulrich Gengenbach  
Prof. Dr. Veit Hagenmeyer  
Dr. Liane Koker  
PD Dr.-Ing. Ingo Sieber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102633 - Major Field: Robotics

**Type**  
- Oral examination

**Credits**  
- 4

**Recurrence**  
- Each winter term

**Version**  
- 1

### Events

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### Exams

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**Prerequisites**

T-MACH-105695 "Selected topics of system integration for micro- and nanotechnology" must not be started.

Below you will find excerpts from events related to this course:

**Micro- and nanosystem integration for medical, fluidic and optical applications**  
2105032, WS 19/20, 2 SWS, Language: German, Open in study portal  
Lecture (V)
Notes

Content:

- Introduction to the role of system integration in the product development process
- Simplistic modeling and use of analogies in system design
- Introduction to modeling and simulation in system design
- Mechanics simulation
- Optics simulation
- Fluidics simulation
- Coupling of simulation tools
- Requirements for system integration of active implants
- Design of active implants
- Approaches to system integration of active implants
- Test methods (hermeticity, accelerated aging etc.)
- Micro-optical subsystems
- Micro-fluidic subsystems
- Self-assembly as integration process at micro and nano scale

Learning objectives:

The students ...:

- have a fundamental understanding of modeling using analogies
- know the basics of modeling and simulation in design of mechanical, optical, and fluidic subsystems
- can assess the need for inter-domain simulations
- understand the challenges in the design of active implants
- have an overview of different active implants and their applications
- know approaches to system integration and packaging of active implants
- are familiar with different methods of testing with the focus on hermeticity
- have an overview of processes for the integration of micro-optical and micro-fluidic subsystems
- gain insight into technical applications of self-assembly processes

Learning Content

- Introduction to the role of system integration in the product development process
- Simplistic modeling and use of analogies in system design
- Introduction to modeling and simulation in system design
- Mechanics simulation
- Optics simulation
- Fluidics simulation
- Coupling of simulation tools
- Requirements for system integration of active implants
- Design of active implants
- Approaches to system integration of active implants
- Test methods (hermeticity, accelerated aging etc.)
- Micro-optical subsystems
- Micro-fluidic subsystems
- Self-assembly as integration process at micro and nano scale

Workload

regular attendance: 21 hours
self-study: 99 hours
11.265 Course: Micro Magnetic Resonance [T-MACH-105782]

Responsible: Prof. Dr. Jan Gerrit Korvink  
Dr. Neil MacKinnon

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102616 - Major Field: Microsystem Technology  
M-MACH-102647 - Major Field: Microactuators and Microsensors

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Competence Certificate

Own Presentation, participation at the course discussions, result is passed or failed.

Prerequisites

none

Below you will find excerpts from events related to this course:

Micro Magnetic Resonance

2141501, WS 19/20, 2 SWS, Language: English, [Open in study portal]

Learning Content

Nuclear magnetic resonance (NMR), or magnetic resonance in general (MR) is a powerful, non-invasive technique useful for gaining atomic level structural details on samples ranging from soluble small molecules to large membrane bound proteins. Traditional NMR hardware used for exciting the sample and detecting the signal is traditionally on the macroscale in terms of physical dimensions. Recently, miniaturization of NMR systems has developed into an active research area driven primarily by the enhanced mass sensitivity and the ability for system integration with smaller NMR detectors. In this seminar course, we will explore some of the state-of-the-art applications of micro-NMR, including visiting research laboratories within Germany active in micro-MR. A selection of representative research papers will be provided, from which each student will select one paper to learn in depth and finally present in a style as if they performed the research themselves. The course will first offer a series of introductory lectures, followed by a series of tutorial sessions in which each student may discuss with experts. Finally, individual student presentations with discussion will be held.

Topics to be offered:

- Novel micro-NMR detectors (solenoid, strip line, microslot, CMOS, printed, etc.)
- Novel nano-MR detectors (MRFM, NV centers, etc.)
- Computation (design optimization, MOR, MRI image processing, NMR spectral prediction, etc.)
- Signal enhancement strategies (hyperpolarization DNP, PHIP, Xe, refrigeration)
- System hyphenation (chromatography, flow cells, LoC, orthogonal analysis, etc.)
- Complex mixtures (metabolomics, in vivo applications on small organisms)
- Biomedical MR sensors (catheters, implantable, etc.)

Workload

Course participation 28 h
Preparation of own lecture 60 h
Self study time 35 h
**Literature**

Links to all literature journal articles will be provided to the students. Example research journal sources will include Nature, Nature Communications, Science, PNAS, JMR, etc. For general reading, some recommended sources are:

11.266 Course: Microactuators [T-MACH-101910]

Responsible: Prof. Dr. Manfred Kohl
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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Exams

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Competence Certificate
written exam, 60 min.

Prerequisites
none

Below you will find excerpts from events related to this course:

Microactuators
2142881, SS 2019, 2 SWS, Language: German, Open in study portal

Description

Media:
Script of ppt-slides

Learning Content
- Basic knowledge in the material science of the actuation principles
- Layout and design optimization
- Fabrication technologies
- Selected developments
- Applications

The lecture includes amongst others the following topics:
- Microelectromechanical systems: linear actuators, microreleas, micromotors
- Medical technology and life sciences: Microvalves, micropumps, microfluidic systems
- Microrobotics: Microgrippers, polymer actuators (smart muscle)
- Information technology: Optical switches, mirror systems, read/write heads

Annotation
Details will be announced at the beginning of the lecture

Workload
lecture time 1.5 h/week
self preparation: 8.5 h/week
Literature
- Lecture notes
- M. Kohl, Shape Memory Microactuators, M. Kohl, Springer-Verlag Berlin, 2004
**11.267 Course: Microenergy Technologies [T-MACH-105557]**

**Responsible:** Prof. Dr. Manfred Kohl

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Type:** Oral examination

**Credits:** 4

**Recurrence:** Each summer term

**Version:** 1

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### Events

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### Exams

| SS 2019 | 76-T-MACH-105557 | Prüfung (PR) | Kohl |

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**Competence Certificate**

Oral examination (30 Min.)

**Prerequisites**

none

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Below you will find excerpts from events related to this course:

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**Microenergy Technologies**

2142897, SS 2019, 2 SWS, Language: English, [Open in study portal]

**Learning Content**

- Basic physical principles of energy conversion
- Layout and design optimization
- Technologies
- Selected devices
- Applications

The lecture includes amongst others the following topics:

- Micro energy harvesting of vibrations
- Thermal micro energy harvesting
- Microtechnical applications of energy harvesting
- Heat pumps in micro technology
- Micro cooling

**Workload**

- time of attendance: 1.5 hours/week
- Self-study: 8.5 hours/week

**Literature**

- Lecture notes (overhead transparencies) "Micro Energy Technologies"
11.268 Course: Microstructure Characteristics Relationships [T-MACH-105467]

**Responsible:** Dr. Patric Gruber  
Prof. Dr. Oliver Kraft

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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<td>SS 2019</td>
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<td>Microstructure Characteristics Relationships (Tutorial)</td>
<td>Practice (Ü)</td>
<td>Gruber</td>
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**Competence Certificate**
oral exam, 30 min

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**Microstructure Characteristics Relationships**
2178124, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Learning Content**
The following subjects are treated for the different material classes:
- plasticity
- fracture mechanics: experimental methods and analytical description of crack propagation and material behaviour at cracks
- fatigue: cyclic plasticity, riss initiation and propagation, damage analysis
- creep: time dependent plastic deformation and creep fracture

Besides the description of the material behaviour an overview of the corresponding experimental methods for mechanical characterisation will be given.
11.269 Course: Microsystem product design for young entrepreneurs [T-MACH-105814]

**Responsible:** Prof. Dr. Jan Gerrit Korvink

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102616 - Major Field: Microsystem Technology

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**Microsystem product design for young entrepreneurs**

4 SWS Practical course (P) Korvink, Mager

**Competence Certificate**

The class is a laboratory course that is taken in groups, hence the active and productive participation in the team effort is evaluated. To check the individual performance, there will be weekly discussions about the project. To evaluate each group's progress, there will be 2 presentation during the duration of the course. The final mark is determined from the marks obtained in the presentation and an oral group examination of 1 hour.

**Prerequisites**

none
11.270 Course: Microsystem Simulation [T-MACH-108383]

Responsible: Prof. Dr. Jan Gerrit Korvink
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102616 - Major Field: Microsystem Technology

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<td>Lecture / Practice (VÜ)</td>
<td>Korvink</td>
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Competence Certificate
written exam

Prerequisites
none

Below you will find excerpts from events related to this course:

Microsystem Simulation
2142875, SS 2019, 3 SWS, Language: English, Open in study portal

Lecture / Practice (VÜ)

Learning Content
This lecture consists of the following 12 topics, one presented each week of semester:
1. The Act of Modelling
2. Mathematica Introduction
3. Equation Types
4. Approximation and Integration
5. Differentiation and Finite Differences
6. Geometry and Meshing
7. Weighted Residual Methods
8. Finite Element Method
9. Numerical Solving
10. Computational Post-processing
11. Program Structure
12. Commercial Programs

Attendees will first learn how to approach the modelling process. Afterwards, they will learn the fundamental numerical mathematics techniques with which to form numerical simulation models, which in turn will lead to computational programs. The lecture offers one hour of exercises where students can consult the lecturers on the topics of the lecture. Students are offered numerous learning goals per chapter, to simplify the attendance of lectures.

Students are expected to work with the program Mathematica® to complete their exercises. It provides a symbolical and numerical environment, and offers high level graphics for ease of programming. All programming exercises will be in Mathematica®, so as to speed up the learning process.

The written examination questions draw from the examples provided during the lecture (recorded on the slides and on the black board during class) as well as from the exercises.

Annotation
Examinations take place during the lecture free periods. The dates are provided at the beginning of semester.
Workload
lectures: 30 hours
self study: 60 hours
preparation for examination: 30 hours

Literature
The following references are used by the lecturers to prepare the lecture. Students are not required to access most of these, but of course it does not hurt! Hints for efficient further reading, depending on interest, will be provided during the lecture.

- E. Buckingham, On physically similar systems: illustrations on the use of dimensional equations, Phys. Rev. 4, 345–376 (1914)
- E. Buckingham, Model Experiments and the Forms of Empirical Equations, ASME 263–296 (1915)
- Bengt Fornberg, Calculation of Weights in Finite Difference Formulas, SIAM Rev. 40(3) 1998
- Mathematica Help Documentation
- Rick Beatson and Leslie Greengard, A short course on fast multipole methods
11.271 Course: Miniaturized Heat Exchangers [T-MACH-108613]

Responsible: Prof. Dr.-Ing. Jürgen Brandner
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102616 - Major Field: Microsystem Technology

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Events

SS 2019 | 2142880 | Miniaturized Heat Exchangers | 2 SWS | Lecture (V) | Brandner

Competence Certificate
oral exam, 20 min.

Prerequisites
none
11.272 Course: Mobile Machines [T-MACH-105168]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102630 - Major Field: Mobile Machines

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**Competence Certificate**
The assessment consists of an oral exam (45 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**
none

**Recommendation**
Knowledge in Fluid Power Systems is required. It is recommended to attend the course *Fluid Power Systems [2114093]* beforehand.

**Annotation**
After completion of the course the students have knowledge of:

- a wide range of mobile machines
- operation modes and working cycles of important mobile machines
- selected subsystems and components

**Content:**
- Introduction of the required components and machines
- Basics and structure of mobile machines
- Practical insight in the development techniques

**Below you will find excerpts from events related to this course:**

**V Mobile Machines**
2114073, SS 2019, 4 SWS, Language: German, [Open in study portal]

**Description**
**Media:**
Lecture notes.

**Learning Content**

- Introduction of the required components and machines
- Basics of the structure of the whole system
- Practical insight in the development techniques
**Workload**

- regular attendance: 42 hours
- self-study: 184 hours
11.273 Course: Model Based Application Methods [T-MACH-102199]

Responsible: Dr. Frank Kirschbaum
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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Competence Certificate
take-home exam, short presentation with oral examination

Prerequisites
none
11.274 Course: Modeling and Simulation [T-MACH-105297]

**Responsible:** Prof. Dr.-Ing. Kai Furmans  
Prof. Dr.-Ing. Marcus Geimer  
Dr. Balazs Pritz  
Prof. Dr.-Ing. Carsten Proppe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102592 - Modeling and Simulation

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**Competence Certificate**
The assessment consists of a 180 minutes written examination.

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Modelling and Simulation**
2185227, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Description**

Media: presentations

**Learning Content**

Introduction: Overview, concept formation, simulation studies, time/event-discrete models, event-oriented/process orientated/transaction-oriented view, typical model classes (operation/maintenance, storekeeping, loss-susceptible systems)

Time-continuous models with concentrated parameters, model characteristics and model analysis Numerical treatment of ordinary differential equations and differential-algebraic sets of equations coupled simulations with concentrated parameters

Time-continuous models with distributed parameters, description of systems by means of partial differential equations, model reduction, numerical solution procedures for partial differential equations

**Annotation**
none
Workload
regular attendance: 42 hours
self-study: 168 hours

Literature
None.
11.275 Course: Modeling of Thermodynamical Processes [T-MACH-105396]

**Responsible:** Prof. Dr. Ulrich Maas  
Dr.-Ing. Robert Schießl

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102604 - Major Field: Computational Mechanics  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102635 - Major Field: Engineering Thermodynamics

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**Competence Certificate**  
Oral exam (30 min)

**Prerequisites**  
none

**Below you will find excerpts from events related to this course:**

**Modeling of Thermodynamical Processes**  
2167523, SS 2019, 3 SWS, Language: German, [Open in study portal]

**Learning Content**  
Thermodynamic basics  
Numerical solver strategies for algebraic equations  
Optimization issues  
Ordinary and partial differential equations  
Application to various problems in thermodynamics (engine processes, determination of equilibrium states, unsteady processes in inhomogeneous systems)

**Workload**  
regular attendance: 32 hours  
Self-study, exam preparation, Prüfungsvorleistung: 150,0 hours

**Literature**  
Lecture notes  
Numerical Recipes C, FORTRAN; Cambridge University Press  
R.W. Hamming; Numerical Methods for scientists and engineers; Dover Books On Engineering; 2nd edition; 1973  
J. Kopitz, W. Polifke; Wärmeübertragung; Pearson Studium; 1. Auflage

**Modeling of Thermodynamical Processes**  
2167523, WS 19/20, 3 SWS, Language: German, [Open in study portal]
Learning Content
Thermodynamic basics
Numerical solver strategies for algebraic equations
Optimization issues
Ordinary and partial differential equations
Application to various problems in thermodynamics (engine processes, determination of equilibrium states, unsteady processes in inhomogeneous systems)

Workload
regular attendance: 33.8 h
Self-study, exam preparation, Prüfungsvorleistung: 146.3 h

Literature
Lecture notes
Numerical Recipes C, FORTRAN; Cambridge University Press
R.W. Hamming; Numerical Methods for scientists and engineers; Dover Books On Engineering; 2nd edition; 1973
J. Kopitz, W. Polifke; Wärmeübertragung; Pearson Studium; 1. Auflage
11.276 Course: Modelling and Simulation [T-MACH-100300]

Responsible: Prof. Dr. Peter Gumbsch  
Prof. Dr. Britta Nestler

Organisation: KIT Department of Mechanical Engineering

Part of:  
M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
M-MACH-102742 - Fundamentals and Methods of Production Technology  
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering  
M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

Type | Credits | Recurrence | Version
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Written examination | 5 | Each term | 2

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<td>Numerical methods and simulation techniques</td>
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Competence Certificate
Written exam, 90 min

Prerequisites
none

Recommendation
preliminary knowledge in mathematics, physics and materials science

Below you will find excerpts from events related to this course:

Modelling and Simulation
2183703, SS 2019, 2+1 SWS, Language: German, [Open in study portal](#)

Description

Media:

Slides and black board. The slides will be provided as a manuscript for the course.
Notes
The course gives an introduction to modelling and simulation techniques. The following topics are included:
- splines, interpolation methods, Taylor series
- finite difference method
- dynamical systems
- numerics of partial differential equations
- mass and heat diffusion
- microstructure simulation
- parallel and adaptive algorithms
- high performance computing
- practical exercises

The student can

- explain the basic algorithms and numerical methods which are beside other applications relevant for materials simulations.
- describe and apply numerical solution methods for partial differential equations and dynamical systems
- apply numerical methods to solve heat and mass diffusion problems which can also be used to model microstructure formation processes
- has experiences in how to implement and program the introduced numerical methods from an integrated computer lab.

preliminary knowlegde in mathematics, physics and materials science recommended
regular attendance: 22,5 hours lecture, 11,5 hours exercises
self-study: 116 hours

We regularly hand out exercise sheets. In addition, the course will be accompanied by practical exercises at the computer.
written examination: 90 minutes

Learning Content
The course gives an introduction to modelling and simulation techniques. The following topics are included:
- splines, interpolation methods, Taylor series
- finite difference method
- dynamical systems
- numerics of partial differential equations
- mass and heat diffusion
- microstructure simulation
- parallel and adaptive algorithms
- high performance computing
- practical exercises

Workload
regular attendance: 22,5 hours lecture, 11,5 hours exercises
self-study: 116 hours

Literature

Description
Media:
Slides and black board. The slides will be provided as a manuscript for the course.
Notes
The course gives an introduction to modelling and simulation techniques. The following topics are included:
- splines, interpolation methods, Taylor series
- finite difference method
- dynamical systems
- numerics of partial differential equations
- mass and heat diffusion
- microstructure simulation
- parallel and adaptive algorithms
- high performance computing
- practical exercises

The student can

- explain the basic algorithms and numerical methods which are beside other applications relevant for materials simulations.
- describe and apply numerical solution methods for partial differential equations and dynamical systems.
- apply numerical methods to solve heat and mass diffusion problems which can also be used to model microstructure formation processes.
- has experiences in how to implement and program the introduced numerical methods from an integrated computer lab.

preliminary knowledge in mathematics, physics and materials science recommended
regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

We regularly hand out exercise sheets. In addition, the course will be accompanied by practical exercises at the computer.
written examination: 90 minutes

Learning Content
The course gives an introduction to modelling and simulation techniques. The following topics are included:

- polynom interpolation methods, splines, Taylor series
- zero point algorithms
- regression methods
- numerical differentiation and integration
- finite difference method
- dynamical systems, ordinary partial differential equations
- numerics of partial differential equations
- mass and heat diffusion equation
- computer lab in the programming language C, practical exercises

In parallel to the lecture, regular exercise sheets are provided and discussed. In addition, the course will be accompanied by practical exercises at the computer. Precondition to register for the written exam is the successful participation in the accompanying computer lab by presenting the solved exercise sheets at the PC.

Workload
regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

Literature

11.277 Course: Modelling of Microstructures [T-MACH-105303]

**Responsible:** Dr. Anastasia August  
Prof. Dr. Britta Nestler  

**Organisation:** KIT Department of Mechanical Engineering  

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering  
- M-MACH-102646 - Major Field: Applied Mechanics  
- M-MACH-102647 - Major Field: Microactuators and Microsensors  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering  
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

**Type:** Oral examination  
**Credits:** 5  
**Recurrence:** Each winter term  
**Version:** 2

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<td>Modelling of Microstructures</td>
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**Competence Certificate**  
oral exam 30 min

**Prerequisites**  
none

**Recommendation**  
materials science  
fundamental mathematics

**Below you will find excerpts from events related to this course:**

**Modelling of Microstructures**  
2183702, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)

**Description**  
**Media:**  
Black board and slides.
Notes

- Brief Introduction in thermodynamics
- Statistical interpretation of entropy
- Gibbs free energy and phase diagrams
- Free energy functional
- Phasefield equation
- Gibbs-Thomson-equation
- Driving forces
- Grand chemical potential functional and the evolution equations
- For compare: Free energy functional with driving forces

The student can

- explain the thermodynamic and statistical foundations for liquid-solid and solid-solid phase transition processes and apply them to construct phase diagrams.
- describe the specific characteristics of dendritic, eutectic and peritectic microstructures.
- explain the mechanisms of grain and phase boundary motion induced by external fields
- use the phase-field method for simulation of microstructure formation processes using modeling approaches and challenges of current research
- has experiences in computing and conduction simulations of microstructure formation from an integrated computer lab.

knowledge in materials science and in fundamental mathematics recommended

regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

We regularly hand out exercise sheets. The individual solutions will be corrected.

oral exam ca. 30 min

Learning Content

- Brief Introduction in thermodynamics
- Statistical interpretation of entropy
- Gibbs free energy and phase diagrams
- Free energy functional
- Phasefield equation
- Gibbs-Thomson-equation
- Driving forces
- Grand chemical potential functional and the evolution equations
- For compare: Free energy functional with driving forces

Workload

regular attendance: 22.5 hours lecture, 11.5 hours exercises
self-study: 116 hours

Literature

4. Gaskell, D.R., Introduction to the thermodynamics of materials
5. Problem sheets
11.278 Course: Modern Control Concepts I [T-MACH-105539]

**Responsible:**
Dr. Lutz Groell  
PD Dr.-Ing. Jörg Matthes

**Organisation:**
KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102633 - Major Field: Robotics

**Type**
- Written examination

**Credits**
- 4

**Recurrence**
- Each summer term

**Version**
- 1

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**Competence Certificate**
Written exam (Duration: 1 h)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Modern Control Concepts I**
2105024, SS 2019, 2 SWS, Language: German, Open in study portal

**Notes**

**Content:**
1. Introduction (classification, overviews, model simplification)  
2. Simulation and analysis of dynamical systems with Matlab  
3. Linearisation (equilibrium manifold, low-delta-method, Hartman-Grobman-theorem, design methodology for linear setpoint controller)  
4. Two-degree-of-freedom control (structure, reference signal design)  
5. PID-Controller (practical realisation, design hints, anti-windup-methods, Smith-predictor, switching technics, complex example)  
6. Multi variable control and advanced control structures  
7. State space (geometric view, role of zeros)  
8. Tracking control with state feedback and supplemental integrator  
9. Observer (LQG-design, disturbance observer, reduced observer)  
10. Limits of control (existence subject, limits in time and frequency domain)

**Recommendations:**
Measurement and control systems

**Learning objectives:**
After completion this lecture, the students are able

- to analyse linear systems with respect to different properties,  
- to design linear feedback systems with feedforward add-on in time and frequency domain under consideration of input saturation, time delay, unmeasurable states and couplings between system parts,  
- to use Matlab for simulation, analysis and synthesis in numerical and computeralgebraic way,  
- to realise controllers per software in practice
Learning Content

1. Introduction (classification, overviews, model simplification)
2. Simulation and analysis of dynamical systems with Matlab
3. Linearisation (equilibrium manifold, low-delta-method, Hartman-Grobman-theorem, design methodology for linear setpoint controller)
4. Two-degree-of-freedom control (structure, reference signal design)
5. PID-Controller (practical realisation, design hints, anti-windup-methods, Smith-predictor, switching technics, complex example)
6. Multi variable control and advanced control structures
7. State space (geometric view, role of zeros)
8. Tracking control with state feedback and supplemental integrator
9. Observer (LQG-design, disturbance observer, reduced observer)
10. Limits of control (existence subject, limits in time and frequency domain)

Workload
General attendance: 21 h
Self-study: 99 h

Literature
Course: Modern Control Concepts II [T-MACH-106691]

**Responsible:** Dr. Lutz Groell

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology

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### Competence Certificate

oral exam (Duration: 30min)

### Prerequisites

none

Below you will find excerpts from events related to this course:

**Modern Control Concepts II**

2106032, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

### Workload

- Regular attendance: 30 hours
- Self-study: 90 hours

### Literature

- Skogestad, S., Postlethwaite, I.: Multivariable Feedback Control, 2001
11.280 Course: Modern Control Concepts III [T-MACH-106692]

**Responsible:** Dr. Lutz Groell  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102598 - Major Field: Advanced Mechatronics  
M-MACH-102601 - Major Field: Automation Technology

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**Competence Certificate**
oral exam (Duration: 30min)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Modern Control Concepts III**

2106035, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Workload**

Regular attendance: 24 hours  
Self-study: 96 hours

**Literature**

11.281 Course: Motor Vehicle Labor [T-MACH-105222]

**Responsible:** Dr.-Ing. Michael Frey

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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**Competence Certificate**
Colloquium before each experiment
After completion of the experiments: written examination
Duration: 90 minutes
Auxiliary means: none

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Motor Vehicle Laboratory**
2115808, SS 2019, 2 SWS, Language: German, Open in study portal

**Practical course (P)**

**Learning Content**
1. Determination of the driving resistances of a passenger vehicle on a roller dynamometer; measurement of the engine performance of the test vehicle

2. Investigation of a twin-tube and a single-tube shock absorber

3. Behavior of car tyres under longitudinal forces and lateral forces

4. Behavior of car tires on wet road surface

5. Rolling resistance, energy dissipation and high-speed strength of car tires

6. Investigation of the moment transient characteristic of a Visco clutch

**Workload**
regular attendance: 31,5 hours
self-study: 103,5 hours

**Literature**


3. Gnader, R.: Documents to the Motor Vehicle Laboratory
Motor Vehicle Laboratory
2115808, WS 19/20, 2 SWS, Language: German, Open in study portal

**Learning Content**
1. Determination of the driving resistances of a passenger vehicle on a roller dynamometer; measurement of the engine performance of the test vehicle
2. Investigation of a twin-tube and a single-tube shock absorber
3. Behavior of car tyres under longitudinal forces and lateral forces
4. Behavior of car tires on wet road surface
5. Rolling resistance, energy dissipation and high-speed strength of car tires
6. Investigation of the moment transient characteristic of a Visco clutch

**Workload**
- regular attendance: 31,5 hours
- self-study: 103,5 hours

**Literature**
3. Gnadler, R.: Documents to the Motor Vehicle Laboratory
11.282 Course: Multi-Scale Plasticity [T-MACH-105516]

**Responsible:**
Dr. Christian Greiner  
Dr. Katrin Schulz

**Organisation:**
KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
- M-MACH-102611 - Major Field: Materials Science and Engineering

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**Competence Certificate**
presentation (40%) und colloquium (30 min, 60%)

**Prerequisites**
none

**Recommendation**
preliminary knowledge in mathematics, physics, mechanics and materials science

**Annotation**
- limited number of participants  
- mandatory registration  
- mandatory attendance

**Below you will find excerpts from events related to this course:**

**Multi-scale Plasticity**

2181750, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**
black board, beamer, script
Notes
This module will attempt to provide an overview to complex subjects in the field of material mechanics. For this purpose important scientific papers will be presented and discussed. This will be done by having students read and critique one paper each week in a short review. In addition, each week will include presentation from one of the participants which aim to advocate or criticise each piece of work using the short reviews. He will also be the discussion leader, while students discuss the content, ideas, evaluation and open research questions of the paper. Using a professional conference management system (HotCRP), the student assume the role of reviewers and gain insight into the work of researchers.

The student
- can explain the physical foundations of plasticity as well as results of latest research.
- can independently read and evaluate scientific research papers.
- can present specific, technical information in structured, precise, and readable manner.
- is able to argue for and/or against a particular approach or idea using the knowledge acquired within the lecture.

preliminary knogeneous in mathematics, physics, mechanics and materials science recommended

regular attendance: 22,5 hours
self-study: 97,5 hours
Exam: presentation (40%), oral examination (30 min, 60%)

Learning Content
This module will attempt to provide an overview to complex subjects in the field of material mechanics. For this purpose important scientific papers will be presented and discussed. This will be done by having students read and critique one paper each week in a short review. In addition, each week will include presentation from one of the participants which aim to advocate or criticise each piece of work using the short reviews. He will also be the discussion leader, while students discuss the content, ideas, evaluation and open research questions of the paper. Using a professional conference management system (HotCRP), the student assume the role of reviewers and gain insight into the work of researchers.

Annotation
The maximum number of students is 14 per semester.

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours
11.283 Course: Nanotechnology for Engineers and Natural Scientists [T-MACH-105180]

**Responsible:** Prof. Dr. Martin Dienwiebel
PD Dr. Hendrik Hölscher
Stefan Walheim

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102616 - Major Field: Microsystem Technology
- M-MACH-102637 - Major Field: Tribology
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Competence Certificate**

written exam 90 min

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Nanotechnology for Engineers and Natural Scientists**

2142861, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Notes
1) Introduction into nanotechnology
2) History of scanning probe techniques
3) Scanning tunneling microscopy (STM)
4) Atomic force microscopy (AFM)
5) Dynamic Modes (DFM, ncAFM, MFM, KPFM, ...)
6) Friction force microscopy & nanotribology
7) Nanolithography
8) Other families of the SPM family

The student can

- explain the most common measurement principles of nanotechnology especially scanning probe methods and is able to use them for the characterisation of chemical and physical properties of surfaces
- describe interatomic forces and their influence on nanotechnology
- describe methods of micro- and nanofabrication and of nanolithography
- explain simple models used in contact mechanics and nanotribology
- describe basic concepts used for nanoscale components

preliminary knowledge in mathematics and physics

Learning Content
1) Introduction into nanotechnology
2) History of scanning probe techniques
3) Scanning tunneling microscopy (STM)
4) Atomic force microscopy (AFM)
5) Dynamic Modes (DFM, ncAFM, MFM, KPFM, ...)
6) Friction force microscopy & nanotribology
7) Nanolithography
8) Other families of the SPM family

Workload
lectures 30 h
self study 30 h
preparation for examination 30 h

Literature
1. Lecture notes, slides, script
11.284 Course: Nanotribology and -Mechanics [T-MACH-102167]

Responsible: Prof. Dr. Martin Dienwiebel
PD Dr. Hendrik Hölscher

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102637 - Major Field: Tribology

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Competence Certificate
presentation (40%) and colloquium (30 min, 60%)
no tools or reference materials

Prerequisites
none

Recommendation
preliminary knowledge in mathematics and physics

Below you will find excerpts from events related to this course:

V Nanotribology and -Mechanics
2182712, SS 2019, 2 SWS, Language: German, Open in study portal

Lecture / Practice (VÜ)
Notes
In the summer semester the lecture is offered in German and in the winter semester in English!

Part 1: Fundamentals of nanotribology
- General tribology / nanotechnology
- Forces and dissipation on the nanometer scale
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Carbon-based tribosystems
- Electronic friction
- Nanotribology in liquids
- Atomic abrasion
- Nanolubrication

Part 2: Topical papers
The student can
- explain the physical foundations and common models used in the field of nanotribology and nanomechanics
- describe the most important experimental methods in nanotribology
- critically evaluate scientific papers on nanotribological issues with respect to their substantial quality

preliminary knowledge in mathematics and physics recommended

regular attendance: 22.5 hours
preparation for presentation: 22.5 hours
self-study: 75 hours

presentation (40%) and oral examination (30 min, 60%)
no tools or reference materials

Learning Content
Part 1: Fundamentals of nanotribology
- General tribology / nanotechnology
- Forces and dissipation on the nanometer scale
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Carbon-based tribosystems
- Electronic friction
- Nanotribology in liquids
- Atomic abrasion
- Nanolubrication

Part 2: Topical papers

Workload
regular attendance: 22.5 hours
preparation for presentation: 22.5 hours
self-study: 75 hours

Literature
Edward L. Wolf
Nanophysics and Nanotechnology, Wiley-VCH, 2006

C. Mathew Mate

Lecture notes, slides and copies of articles
Notes
In the summer semester the lecture is offered in German and in the winter semester in English!

Part 1: Fundamentals of nanotribology
- General tribology / nanotechnology
- Forces and dissipation on the nanometer scale
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Carbon-based tribosystems
- Electronic friction
- Nanotribology in liquids
- Atomic abrasion
- nanolubrication

Part 2: Topical papers
The student can
- explain the physical foundations and common models used in the field of nanotribology and nanomechanics
- describe the most important experimental methods in nanotribology
- critically evaluate scientific papers on nanotribological issues with respect to their substantial quality

preliminary knowledge in mathematics and physics recommended

regular attendance: 22.5 hours
preparation for presentation: 22.5 hours
self-study: 75 hours

presentation (40%) and oral examination (30 min, 60%)
no tools or reference materials

Learning Content
Part 1: Basics:
- Nanotechnology
- Forces at nanometer scale
- contact mechanics models (Hertz, JKR, DMT)
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Atomic-Scale Wear

Part 2: Topical papers

Workload
regular attendance: 22.5 hours
preparation for presentation: 22.5 hours
self-study: 75 hours

Literature
Lecture notes, slides and copies of articles
Course: Neurovascular Interventions (BioMEMS V) [T-MACH-106747]

Responsible: Dr.-Ing. Giorgio Cattaneo
Prof. Dr. Andreas Guber

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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Competence Certificate
oral exam (30 Min.)

Prerequisites
none
11.286 Course: Neutron Physics of Fusion Reactors [T-MACH-105435]

**Responsibility:** Dr. Ulrich Fischer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

M-MACH-102643 - Major Field: Fusion Technology

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**Exams**

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**Competence Certificate**

oral exam of about 30 minutes

**Prerequisites**

none

**Annotation**

none

Below you will find excerpts from events related to this course:

**Neutron physics of fusion reactors**

2189473, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

Nuclear interaction processes and energy release

Chain reaction and criticality

Neutron transport, Boltzmann equation

Diffusion approximation, Monte Carlo method

Neutronic reactor design

The aim of this lecture is to provide the neutron physics principles required for analysis of nuclear fission and fusion reactors. First of all, the basic nuclear interaction processes are presented which are important for the physical behaviour of the reactors. Next the neutron transport phenomenon in matter is described by means of the Boltzmann transport equation. Suitable mathematical solution methods are presented such as the diffusion approximation for nuclear fission reactors and the Monte Carlo method for fusion reactors. The knowledge acquired will eventually be used to solve neutron physics problems related to the design and optimization of the reactors.

oral exam, duration: approximately 30 minutes, no tools or reference materials may be used during the exam

regular attendance: 21 h

self-study: 42 h

Admission to Campus North is required, please register to attend the lecture at: il-sekretariat@inr.kit.edu
Learning Content
Nuclear interaction processes and energy release

Chain reaction and criticality

Neutron transport, Boltzmann equation

Diffusion approximation, Monte Carlo method

Neutronic reactor design

Workload
regular attendance: 21 h
self-study: 42 h

Literature
K. H. Beckurts, K. Wirtz, Neutron Physics, Springer Verlag, Berlin, Germany (1964)


11.287 Course: NMR micro probe hardware conception and construction [T-MACH-108407]

**Responsible:** Prof. Dr. Jan Gerrit Korvink

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102616 - Major Field: Microsystem Technology

**Type**
Completed coursework

**Credits**
4

**Recurrence**
Each summer term

**Version**
1

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<th>SS 2019</th>
<th>2142551</th>
<th>NMR micro probe hardware conception and construction</th>
<th>2 SWS</th>
<th>Practical course (P)</th>
<th>Korvink, Jouda</th>
</tr>
</thead>
</table>

**Competence Certificate**
Successful participation.

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**NMR micro probe hardware conception and construction**
2142551, SS 2019, 2 SWS, Language: English, [Open in study portal](#)

**Description**
The aim of this practical block course is to familiarize the students with magnetic resonance imaging as a substantial non-invasive non-destructive imaging technique that is widely used for medical diagnosis.

It is also to give them hands-on experience on how to build the MRI probe from A to Z including

- Mechanical design
- High frequency electrical circuitry
- Testing on a commercial MRI scanner

**Learning Content**
In order to prepare attendees, the following chapters will be offered, spread over the week as lecture units, and accompanying the practical work:

- Theory of magnetic resonance imaging
- The MRI probe and the principle of reciprocity
- RF resonators
- Coaxial cables and cable traps
- Tuning and matching the MRI probe
- Effects of material susceptibility
- The mechanical support of the MRI probe
- Introduction to ParaVision, the MRI imaging software.
Course: Nonlinear Continuum Mechanics [T-MACH-105532]

11.288 Course: Nonlinear Continuum Mechanics [T-MACH-105532]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102649 - Major Field: Advanced Materials Modelling

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**Events**

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<th>2162344</th>
<th>Nonlinear Continuum Mechanics</th>
<th>2 SWS</th>
<th>Lecture (V)</th>
<th>Böhlke</th>
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</thead>
</table>

**Competence Certificate**
oral examination (approx. 25 min)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Nonlinear Continuum Mechanics**
2162344, SS 2019, 2 SWS, Language: English, [Open in study portal](#)

**Lecture (V)**

**Learning Content**
- tensor calculus, kinematics, balance equations
- principles of material theory
- finite elasticity
- infinitesimal elasto(visco)plasticity
- exact solutions of infinitesimal plasticity
- finite elasto(visco)plasticity
- infinitesimal and finite crystal(visco)plasticity
- hardening and failure
- strain localization

**Workload**
regular attendance: 31,5 hours
self-study: 118 hours

**Literature**

lecture notes

11.289 Course: Nonlinear optimization methods [T-MACH-110380]

**Responsible:** Prof. Dr. Matti Schneider

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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**Events**

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<td>2161130</td>
<td>Nonlinear optimization methods (Lecture)</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
</tr>
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</table>

**Competence Certificate**

Oral examination

*Below you will find excerpts from events related to this course:*

**Nonlinear optimization methods (Lecture)**

2161130, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

- The method of Newton-Kantorovich
- Gradient methods and their accelerations
- Constrained optimization
- Modern operator splitting schemes
11.290 Course: Novel Actuators and Sensors [T-MACH-102152]

**Responsible:** Prof. Dr. Manfred Kohl  
Dr. Martin Sommer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102616 - Major Field: Microsystem Technology  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools  
- M-MACH-102647 - Major Field: Microactuators and Microsensors  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology

**Type:** Written examination  
**Credits:** 4  
**Recurrence:** Each winter term  
**Version:** 3

**Events**  
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<td>2141865</td>
<td>Novel actuators and sensors</td>
<td>2</td>
<td>Lecture (V)</td>
<td>Kohl, Sommer</td>
</tr>
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</table>

**Competence Certificate**  
written exam, 60 minutes

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Novel actuators and sensors**  
2141865, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**  
**Media:**  
Script / script of ppt foils (part 2)
Learning Content

Contents: - Basic knowledge in the material science of actuator and sensor principles
- Layout and design optimization
- Fabrication technologies
- Selected developments
- Applications

Index: The lecture includes amongst others the following topics:

- Piezo actuators
- Magnetostrictive actuators
- Shape memory actuators
- Electro-/magnetorheological actuators
- Sensors: Concepts, materials, fabrication
- Micromechanical sensors: Pressure, force, inertia sensors
- Temperature sensors
- Micro sensors for bio analytics
- Mechano-magnetic sensors

The lecture addresses students in the fields of mechanical engineering, mechatronics and information technology, materials science and engineering, electrical engineering and economic sciences. A comprehensive introduction is given in the basics and current developments on the macroscopic length scale.

The lecture is core subject of the major course "Actuators and Sensors" of the specialization "Mechatronics and Microsystems Technology" in Mechanical Engineering.

Workload

Work Lecture:

time of attendance: 21 hours
Self-study: 99 hours

Literature
- Lecture notes
- Donald J. Leo, Engineering Analysis of Smart Material Systems, John Wiley & Sons, Inc., 2007
11.291 Course: Nuclear Fusion Technology [T-MACH-110331]

**Responsible:** Dr. Aurelian Florin Badea  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102608 - Major Field: Nuclear Energy

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**Exams**

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<td>76-T-MACH-110331</td>
<td>Nuclear Fusion Technology</td>
<td>Prüfung (PR)</td>
<td>Badea</td>
</tr>
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</table>

**Competence Certificate**

oral exam, approx. 20 min.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Nuclear Fusion Technology**

2189920, WS 19/20, 2 SWS, Language: English, [Open in study portal](#)

**Learning Content**

nuclear fission & fusion  
neutronics for fusion  
fuel cycles, cross sections  
gravitational, magnetic and inertial confinement  
fusion experimental devices  
energy balance for fusion systems; Lawson criterion and Q-factor  
materials for fusion reactors  
plasma physics, confinement  
plasma heating  
timeline of the fusion technology  
ITER, DEMO  
safety and waste management

**Workload**

120 h
11.292 Course: Nuclear Medicine and Measuring Techniques I [T-ETIT-100664]

**Responsible:** Prof. Dr. Olaf Dössel

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:** M-MACH-102615 - Major Field: Medical Technology

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<td>2305289</td>
<td>Nuclear Medicine and Measuring Techniques I</td>
<td>1</td>
<td>Lecture (V)</td>
<td>Maul, Doerfel</td>
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</table>

**Prerequisites**

- None
11.293 Course: Nuclear Power and Reactor Technology [T-MACH-110332]

**Responsible:** Dr. Aurelian Florin Badea  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102608 - Major Field: Nuclear Energy

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<td>WS 19/20</td>
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</table>

**Competence Certificate**
oral exam, approx. 20 min.

**Prerequisites**
None

Below you will find excerpts from events related to this course:

**V Nuclear Power and Reactor Technology**
2189921, WS 19/20, 3 SWS, Language: English, Open in study portal  
**Lecture (V)**

**Learning Content**
nuclear fission & fusion,  
radioactive decay, neutron excess, fission, fast and thermal neutrons, fissile and fertile nuclei,  
enrichment,  
neutron flux, cross section, reaction rate, mean free path,  
chain reaction, critical size, moderation,  
reactor dynamics,  
transport- and diffusion-equation for the neutron flux distribution,  
power distributions in reactor,  
one-group and two-group theories,  
light-water reactors,  
reactor safety,  
design of nuclear reactors,  
breeding processes,  
nuclear power systems of generation IV

**Workload**
regular attendance: 30 h  
self-study: 150 h
11.294 Course: Nuclear Power Plant Technology [T-MACH-105402]

**Responsible:** Dr. Aurelian Florin Badea  
Prof. Dr.-Ing. Xu Cheng  
Prof. Dr.-Ing. Thomas Schulenberg  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102608 - Major Field: Nuclear Energy  
M-MACH-102610 - Major Field: Power Plant Technology

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**Events**

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<th>SS 2019</th>
<th>2170460</th>
<th>Nuclear Power Plant Technology</th>
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<th>Lecture (V)</th>
<th>Cheng, Schulenberg</th>
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**Exams**

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<th>SS 2019</th>
<th>76-T-MACH-105402</th>
<th>Nuclear Power Plant Technology</th>
<th>Prüfung (PR)</th>
<th>Cheng, Schulenberg</th>
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</table>

**Competence Certificate**
oral exam, Duration: approximately 30 minutes  
no tools or reference materials may be used during the exam

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**Nuclear Power Plant Technology**
2170460, SS 2019, 2 SWS, Language: English, [Open in study portal](#)

**Description**
Powerpoint presentations  
PWR simulator  
BWR simulator
Notes
The training objective of the course is the qualification for a research-related professional activity in nuclear power plant engineering. The participants can describe the most important components of nuclear power plants and their function. You can design or modify nuclear power plants independently and creatively. They have acquired a broad knowledge of this power plant technology, including specific knowledge of core design, design of primary and secondary systems, and of nuclear safety technologies. Based on the acquired knowledge in thermodynamics and neutron physics, they can describe and analyze the specific behavior of the nuclear power plant components and assess risks. Participants of the lecture have a trained analytical thinking and judgment in the design of nuclear power plants.

**Power plants with pressurized water reactors:**

Design of the pressurized water reactor

- Fuel assemblies
- Control rods and drives
- Core instrumentation
- Reactor pressure vessel and its internals

Components of the primary system

- Primary coolant pumps
- Pressurizer
- Steam generator
- Water make-up system

Secondary system:

- Turbines
- Reheater
- Feedwater system
- Cooling systems

Containment

- Containment design
- Components of safety systems
- Components of residual heat removal systems

Control of a nuclear power plant with PWR

**Power plants with boiling water reactors:**

Design of the boiling water reactor

- Fuel assemblies
- Control elements and drives
- Reactor pressure vessel and its internals

Containment and components of safety systems

Control of a nuclear power plant with boiling water reactors
Learning Content
Power plants with pressurized water reactors:
Design of the pressurized water reactor
  • Fuel assemblies
  • Control rods and drives
  • Core instrumentation
  • Reactor pressure vessel and its internals

Components of the primary system
  • Primary coolant pumps
  • Pressurizer
  • Steam generator
  • Water make-up system

Secondary system:
  • Turbines
  • Reheater
  • Feedwater system
  • Cooling systems

Containment
  • Containment design
  • Components of safety systems
  • Components of residual heat removal systems

Control of a nuclear power plant with PWR

Power plants with boiling water reactors:
Design of the boiling water reactor
  • Fuel assemblies
  • Control elements and drives
  • Reactor pressure vessel and its internals

Containment and components of safety systems

Control of a nuclear power plant with boiling water reactors

Annotation
Recommendations:
Knowledge of thermodynamics are a mandatory requirement for this course.
Basic knowledge of the physics of nuclear fission will be helpful.

Simulator exercises with a simplified pressurized water reactor and a simplified boiling water reactor are offered to ease understanding of thermodynamics and neutron physics.

Workload
regular attendance: 48 h
self-study: 72 h

Literature
lecture notes
11.295 Course: Numerical Fluid Mechanics [T-BGU-106758]

**Responsible:** Prof. Dr.-Ing. Markus Uhlmann

**Organisation:** KIT Department of Civil Engineering, Geo- and Environmental Sciences

**Part of:** M-MACH-102634 - Major Field: Fluid Mechanic

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<td>Numerical Fluid Mechanics</td>
<td>Prüfung (PR)</td>
<td>Uhlmann</td>
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</table>

**Competence Certificate**

written exam, 90 min.

**Prerequisites**

none

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-105338 - Numerical Fluid Mechanics must not have been started.

**Recommendation**

none

**Annotation**

none
11.296 Course: Numerical Fluid Mechanics [T-MACH-105338]

**Responsible:** Dr.-Ing. Franco Magagnato

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102604 - Major Field: Computational Mechanics
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102634 - Major Field: Fluid Mechanics

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**Exams**

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<td>Numerical Fluid Mechanics</td>
<td>Prüfung (PR)</td>
<td>Frohnapfel, Magagnato</td>
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</table>

**Competence Certificate**

oral exam - 30 minutes

**Prerequisites**

none

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-BGU-106758 - Numerical Fluid Mechanics must not have been started.

**Below you will find excerpts from events related to this course:**

**V Numerical Fluid Mechanics**

2153441, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

"Powerpoint presentation", Beamer
Notes
The students can describe the modern numerical simulation methods for fluid flows and can explain their relevance for industrial projects. They can choose appropriate boundary and initial conditions as well as turbulence models. They are qualified to explain the meaning of suitable meshes for processed examples. Convergence acceleration techniques like multi grid, implicit methods etc. as well as the applicability of these methods to parallel and vector computing can be described by the students. They can identify problems that occur during application of these methods and can discuss strategies to avoid them. The students are qualified to apply commercial codes like Fluent, Star-CD, CFX etc. as well as the research code SPARC. They can describe the differences between conventional methods (RANS) and more advanced approaches like Large Eddy Simulation (LES) and Direct Numerical Simulation (DNS).

1. Governing Equations of Fluid Dynamics
2. Discretization
3. Boundary and Initial conditions
4. Turbulence Modelling
5. Mesh Generation
6. Numerical Methods
7. LES, DNS and Lattice Gas Methods
8. Pre- and Postprocessing
9. Examples of Numerical Methods for Industrial Applications

Learning Content
1. Governing Equations of Fluid Dynamics
2. Discretization
3. Boundary and Initial conditions
4. Turbulence Modelling
5. Mesh Generation
6. Numerical Methods
7. LES, DNS and Lattice Gas Methods
8. Pre- and Postprocessing
9. Examples of Numerical Methods for Industrial Applications

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Literature
11.297 Course: Numerical Fluid Mechanics with MATLAB [T-MACH-105453]

Responsibility: Prof. Dr.-Ing. Bettina Frohnapfel
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102634 - Major Field: Fluid Mechanic

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<th>Each summer term</th>
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Events

SS 2019 2154409 Numerical Fluid Mechanics with MATLAB 2 SWS Practical course (P) Stroh, Gatti, Frohnapfel

Exams

SS 2019 76-T-MACH-105453 Numerical Fluid Mechanics with MATLAB Prüfung (PR) Frohnapfel, Gatti

Competence Certificate

ungraded homework

Prerequisites

none

Below you will find excerpts from events related to this course:

Numerical Fluid Mechanics with MATLAB 2154409, SS 2019, 2 SWS, Language: German, Open in study portal

Practical course (P)

Description

Media:
Power Point, workstations: independent programming

Learning Content

Numerical Fluid Mechanics with Matlab

- Introduction to Numerics and Matlab
- Finite-Difference-Method
- Finite-Volume-Method
- boundary conditions and initial conditions
- explicit and implicit schemes
- pressure correction

Annotation

Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

Workload

attendance: 20h
self-study: 100h

Literature

### Course: Numerical Mathematics for Students of Computer Science [T-MATH-102242]

**Responsible:** Prof. Dr. Andreas Rieder  
Dr. Daniel Weiß  
Prof. Dr. Christian Wieners

**Organisation:** KIT Department of Mathematics

**Part of:**  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102594 - Mathematical Methods  
- M-MACH-102646 - Major Field: Applied Mechanics  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102742 - Fundamentals and Methods of Production Technology  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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<tr>
<td>Written exam</td>
<td>6</td>
<td>Each term</td>
<td>3</td>
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**Events**

**SS 2019 0187400**  
Numerische Mathematik für die Fachrichtungen Informatik und Ingenieurwesen  
2 SWS  
Lecture (V)  
Weiß

**SS 2019 0187500**  
Übungen zu 0187400  
1 SWS  
Practice (Ü)  
Weiß

**Exams**

**SS 2019 770100085**  
Numerical Mathematics for Students of Computer Science  
Prüfung (PR)  
Weiß

**Competence Certificate**

written exam, 120 min.

**Prerequisites**

none
### Course: Numerical Mechanics for Industrial Applications [T-MACH-108720]

**Responsible:** Prof. Dr. Eckart Schnack  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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#### Events

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<th>Numerical mechanics for industrial applications</th>
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#### Competence Certificate

Oral exam, 20 minutes

#### Prerequisites

None

Below you will find excerpts from events related to this course:

#### Learning Content


#### Workload

Contact time: 33.75 hrs; Self-study: 127 hrs
Course: Numerical Simulation of Multi-Phase Flows [T-MACH-105420]

**Responsible:** Dr. Martin Wörner

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102604 - Major Field: Computational Mechanics
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102634 - Major Field: Fluid Mechanic

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each summer term

**Version**
- 1

**Events**

| SS 2019 | 2130934 | Numerical Modeling of Multiphase Flows | 2 SWS | Lecture (V) | Wörner |

**Exams**

| SS 2019 | 76-T-MACH-105420 | Numerical Simulation of Multi-Phase Flows | Prüfung (PR) | Frohnapfel |

**Competence Certificate**
- oral exam 30 minutes

**Prerequisites**
- none

Below you will find excerpts from events related to this course:

**Numerical Modeling of Multiphase Flows**

2130934, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

1. Introduction in the subject of multi-phase flows (terms and definitions, examples)
2. Physical fundamentals (dimensionless numbers, phenomenology of single bubbles, conditions at fluid interfaces, forces on a suspended particle)
3. Mathematical fundamentals (governing equations, averaging, closure problem)
4. Numerical fundamentals (discretization in space and time, truncation error and numerical diffusion)
5. Models for interpenetrating continua (homogeneous model, algebraic slip model, standard two-fluid model and its extensions)
6. Euler-Lagrange model (particle equation of motion, particle response time, one-/two-/four-way coupling)
7. Interface resolving methods (volume-of-fluid, level-set and front-capturing method)

**Annotation**
- For some topics of the lecture exercises are provided (working on them is optional).

**Workload**
- regular attendance: 21h
- self-study: 99h

**Literature**
- Powerpoint presentations can be downloaded after each lecture from the ILIAS system.
- A list of recommended books is provided in the first lecture.
### Course: Numerical Simulation of Reacting Two Phase Flows [T-MACH-105339]

**Responsible:** Dr.-Ing. Rainer Koch  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102604 - Major Field: Computational Mechanics  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102634 - Major Field: Fluid Mechanics  
- M-MACH-102636 - Major Field: Thermal Turbomachines

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<tr>
<td>WS 19/20</td>
<td>2169458</td>
<td>Numerical simulation of reacting two phase flows</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
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<td>Numerical Simulation of Reacting Two Phase Flows</td>
<td>Prüfung (PR)</td>
<td>Koch</td>
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</table>

**Competence Certificate**  
Oral exam  
Duration: approximately 30 minutes  
no tools or reference materials are allowed

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

#### Lecture (V)

**Numerical simulation of reacting two phase flows**  
2169458, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)  

**Learning Content**  
The course is devoted to diploma/master students and doctoral candidates of mechanical and chemical engineering. It gives an overview of the numerical methods used for CFD of single and two phase flows. The course introduces methods for reacting single and two phase flows, as they are typically found in gas turbines and piston engines operated by liquid fuel.


3. Reacting flows: Combustion models; Single droplet combustion, Spray combustion.

**Workload**  
regular attendance: 21 h  
self-study: 42 h

**Literature**  
Lecture notes
11 COURSES
Course: Numerical Simulation of Turbulent Flows [T-MACH-105397]

11.302 Course: Numerical Simulation of Turbulent Flows [T-MACH-105397]

Responsible: Dr. Günther Grötzbach
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102604 - Major Field: Computational Mechanics
M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
M-MACH-102634 - Major Field: Fluid Mechanic

Type: Oral examination
Credits: 4
Recurrence: Each winter term
Version: 1

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<td>Prüfung (PR)</td>
<td>Grötzbach</td>
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</table>

Competence Certificate
oral

Duration: 30 minutes
no auxiliary means

Prerequisites
none

Recommendation
Basics in fluid mechanics

Below you will find excerpts from events related to this course:

Numerical Simulation of Turbulent Flows
2153449, WS 19/20, 3 SWS, Language: German, [Open in study portal]

Description
Media:
black board, plus pictures, movies, and script in English (distributed chapter by chapter)
Notes
The students are qualified to describe the fundamentals of direct numerical simulation (DNS) and large eddy simulation (LES) of turbulent flows. They understand the principle differences between these simulation methods and the respective properties of the conventional turbulence modelling approaches basing on Reynolds Averaged Navier-Stokes equations (RANS). They can describe subgrid scale models, peculiarities of wall and inlet/outlet modelling, suitable numerical solution schemes and evaluation methods. They have obtained the knowledge and understanding required to identify the best modelling approach (among the available methods) for the problem at hand, thus being able to solve given thermal and fluid dynamical problems appropriately.

The lecture series will introduce in following subjects of the turbulence simulation method:

- Appearance of turbulence and deduction of requirements and limits of the simulation method.
- Conservation equations for flows with heat transfer, filtering them in time or space.
- Some subgrid scale models for small scale turbulence and their physical justification.
- Peculiarities in applying boundary and initial conditions.
- Suitable numerical schemes for integration in space and time.
- Statistical and graphical methods to analyse the simulation results.
- Application examples for turbulence simulations in research and engineering

Learning Content
The lecture series will introduce in following subjects of the turbulence simulation method:

- Appearance of turbulence and deduction of requirements and limits of the simulation method.
- Conservation equations for flows with heat transfer, filtering them in time or space.
- Some subgrid scale models for small scale turbulence and their physical justification.
- Peculiarities in applying boundary and initial conditions.
- Suitable numerical schemes for integration in space and time.
- Statistical and graphical methods to analyse the simulation results.
- Application examples for turbulence simulations in research and engineering

Annotation
Recommendations: basics in fluid mechanics

Workload
regular attendance: 29h
self-study: 91h

Literature
G. Grötzbach, Script in English
11.303 Course: Occupational Safety and Environmental Protection [T-MACH-105386]

Responsible: Rainer von Kiparski
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102610 - Major Field: Power Plant Technology

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Competence Certificate
oral exam (approx. 30 min)
The exam is offered in German only!

Prerequisites
none

Below you will find excerpts from events related to this course:

Occupational Safety and Environmental Protection
2110037, SS 2019, 2 SWS, Language: German, Open in study portal

Notes
The participants have to solve a specific case study within the field of occupational safety and environmental protection. Therefore, they work in a team. The course work covers the information research as well as the presentation of the results.

Content:
- Occupational Safety and Safety Engineering
- Environmental Protection within a Production Enterprise
- Health Management

Structure:
- Terminology
- Basics of Occupational Safety and Environmental Protection
- Case Study
- Moderated Processing of a Case Study within a Small Group
Learning Content
The participants have to solve a specific case study within the field of occupational safety and environmental protection. Therefore, they work in a team. The course work covers the information research as well as the presentation of the results.

Content:
- Occupational Safety and Safety Engineering
- Environmental Protection within a Production Enterprise
- Health Management

Structure:
- Terminology
- Basics of Occupational Safety and Environmental Protection
- Case Study
- Moderated Processing of a Case Study within a Small Group

Workload
Compact course (one week full-time).
The amount of work accounts for 120 h (=4 ECTS).

Literature
Handout and literature are available on ILIAS for download.

Responsible: Prof. Dr.-Ing. Bettina Frohnapfel
Prof. Dr.-Ing. Friedrich Seiler

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102634 - Major Field: Fluid Mechanic

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Competence Certificate
oral exam 30 minutes

Prerequisites
none

Below you will find excerpts from events related to this course:

Optical Flow Measurement: Fundamentals and Applications

2153410, WS 19/20, 2 SWS, Language: German, Open in study portal

Description

Media:
Power Point

Notes
The students can thoroughly describe the introduced optical measurement techniques. From recently achieve results in shock tunnels, they are able to explain the working principle(s) of the most important registration and visualization methods working with either tracer scattering or with the information obtained with light passing directly the measuring regime. Particularly, the students are qualified to comparatively discuss the measurement techniques for velocity, density and gas temperature (listed below) and can furthermore illustrate their working principles with examples:

- shadowgraph techniques
- Schlieren method
- Mach/Zehnder- and Differential interferometer
- Particle Image Velocimetry (PIV)
- Doppler Global Velocimetry (DGV)
- Doppler picture velocimetry (DPV)
- classical single-beam
- cross-beam anemometry
- interference velocimetry
- CARS-method
- laser-induced fluorescence (LIF)
- Visualisierungsverfahren
- Registrierungsverfahren
- Lichtstreuverfahren
- Fluoreszenzverfahren
Learning Content

- Visualisations techniques
- Techniques for local point-wise measurement
- Techniques using light scattering methods
- Laser-induced fluorescence

Workload

Regular attendance: 21h
Self-study: 99h

Literature

H. Oertel sen., H. Oertel jun.: Optische Strömungsmeßtechnik, G. Braun, Karlsruhe

F. Seiler: Skript zur Vorlesung über Optische Strömungsmeßtechnik
11.305 Course: Organ Support Systems [T-MACH-105228]

**Responsible:** Prof. Dr. Christian Pylatiuk  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102615 - Major Field: Medical Technology

**Type** | **Credits** | **Recurrence** | **Version**  
--- | --- | --- | ---  
Written examination | 4 | Each summer term | 1 

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**Competence Certificate**

Written examination (Duration: 45min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Organ support systems**

2106008, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Notes**

**Content:**

- Introduction: Definitions and classification of organ support and replacement.  
- Special topics: acoustic and visual prostheses, exoskeletons, neuroprostheses, tissue-engineering, hemodialysis, heart-lung machine, artificial hearts, biomaterials.

**Learning objectives:**

Students have fundamental knowledge about functionality of organ support systems and its components. An analysis of historical developments can be done and limitations of current systems can be found. The limits and possibilities of transplantations can be elaborated.

**Learning Content**

- Introduction: Definitions and classification of organ support and replacement.  
- Special topics: acoustic and visual prostheses, exoskeletons, neuroprostheses, tissue-engineering, hemodialysis, heart-lung machine, artificial hearts, biomaterials.

**Workload**

General attendance: 21 h  
Self-study: 99 h

**Literature**

- E. Wintermantel, Suk-Woo Ha: Medizintechnik. Springer Verlag.
### 11.306 Course: Patent Law [T-INFO-101310]

- **Responsible:** Prof. Dr. Thomas Dreier
- **Organisation:** KIT Department of Informatics
- **Part of:** M-MACH-102596 - Compulsory Elective Subject Economics/Law

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</table>
11.307 Course: Photovoltaic System Design [T-ETIT-100724]

**Responsible:** Robin Grab

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:** M-MACH-102648 - Major Field: Energy Technology for Buildings

**Events**

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**Prerequisites**

none
### 11.308 Course: Photovoltaics [T-ETIT-101939]

**Responsible:** Prof. Dr.-Ing. Michael Powalla  
**Organisation:** KIT Department of Electrical Engineering and Information Technology  
**Part of:**  
- M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Prerequisites**  
"M-ETIT-100524 - Solar Energy" must not have started.
### Course: Physical and Chemical Principles of Nuclear Energy in View of Reactor Accidents and Back-End of Nuclear Fuel Cycle [T-MACH-105537]

**Responsibility:** Dr. Ron Dagan  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Competence Certificate**

oral exam, 30 min.

**Prerequisites**

none

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**Below you will find excerpts from events related to this course:**

**Physical and chemical principles of nuclear energy in view of reactor accidents and back-end of nuclear fuel cycle**

2189906, WS 19/20, 1 SWS, Language: German, Open in study portal
Notes

- Relevant physical terms of nuclear physics
- Decay heat removal - Borst-Wheeler equation
- The accidents in TMI - Three Mile Island, and Fukushima
- Fission, chain reaction and reactor control systems
- Basics of nuclear cross sections
- Principles of reactor dynamics
- Reactor poisoning
- The Idaho and Chernobyl accidents
- Principles of the nuclear fuel cycle
- Reprocessing of irradiated fuel elements and vitrification of fission product solutions
- Interim storage of nuclear residues in surface facilities
- Multi barrier concepts for final disposal in deep geological formations
- The situation in the repositories Asse II, Konrad and Morsleben

The students

- understand the physical explanations of the known nuclear accidents
- can perform simplified calculations to demonstrate the accidents outcome.
- Define safety relevant properties of low/ intermediate / high level waste products
- Are able to evaluate principles and implications of reprocessing, storage and disposal options for nuclear waste.

Regular attendance: 14 h
self study 46 h
oral exam about 20 min.

Learning Content

- Relevant physical terms of nuclear physics
- Decay heat removal - Borst-Wheeler equation
- The accidents in TMI - Three Mile Island, and Fukushima
- Fission, chain reaction and reactor control systems
- Basics of nuclear cross sections
- Principles of reactor dynamics
- Reactor poisoning
- The Idaho and Chernobyl accidents
- Principles of the nuclear fuel cycle
- Reprocessing of irradiated fuel elements and vitrification of fission product solutions
- Interim storage of nuclear residues in surface facilities
- Multi barrier concepts for final disposal in deep geological formations
- The situation in the repositories Asse II, Konrad and Morsleben

Workload

Regular attendance: 14 h
self study 46 h

Literature

AEA- Open documentation of the reactor accidents
K. Wirtz: Basics of Reactor technic Par I, II, Technic School Karlsruhe 1966 (in German)
11.310 Course: Physical Basics of Laser Technology [T-MACH-109084]

Responsible: Dr.-Ing. Johannes Schneider
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering

<table>
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Events

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<td>Each winter term</td>
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Exams

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<td>6</td>
<td>Each winter term</td>
<td>Physical Basics of Laser Technology</td>
<td>1</td>
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</table>

Competence Certificate

Colloquium (30 min)

No tools or reference materials

Prerequisites

It is not possible to combine this brick with brick Laser Application in Automotive Engineering [T-MACH-105164] and brick Physical Basics of Laser Technology [T-MACH-102102]

Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-MACH-105164 - Laser in Automotive Engineering must not have been started.
2. The course T-MACH-102102 - Physical Basics of Laser Technology must not have been started.

Recommendation

Basic knowledge of physics, chemistry, and material science

Below you will find excerpts from events related to this course:

Physical basics of laser technology

2181612, WS 19/20, 3 SWS, Language: German, Open in study portal

Description

Media:

Lecture notes via ILIAS
Notes
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned. An excursion to the laser laboratory of the Institute for Applied Materials (IAM) will be offered.

- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- savety aspects

The lecture is complemented by a tutorial.

The student

- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of different laser sources.
- can describe the influence of laser, material and process parameters for the most important methods of laser-based materials processing and choose laser sources suitable for specific applications.
- can illustrate the possible applications of laser sources in measurement and medicine technology
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Basic knowledge of physics, chemistry and material science is assumed.

regular attendance: 33,5 hours
self-study: 116,5 hours

The assessment consists of an oral exam (ca. 30 min) taking place at the agreed date (according to Section 4(2), 2 of the examination regulation). The re-examination is offered upon agreement.

It is allowed to select only one of the lectures "Laser in automotive engineering" (2182642) or "Physical basics of laser technology" (2181612) during the Bachelor and Master studies.

Learning Content
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned. An excursion to the laser laboratory of the Institute for Applied Materials (IAM) will be offered.

- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- savety aspects

The lecture is complemented by a tutorial.

Annotation
It is allowed to select only one of the lectures "Laser in automotive engineering" (2182642) or "Physical basics of laser technology" (2181612) during the Bachelor and Master studies.

Workload
regular attendance: 33,5 hours
self-study: 116,5 hours

Literature
### 11.311 Course: Physical Basics of Laser Technology [T-MACH-102102]

**Responsible:** Dr.-Ing. Johannes Schneider  
**Organisation:** KIT Department of Mechanical Engineering

- **Part of:**  
  - M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
  - M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
  - M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
  - M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
  - M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
  - M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
  - M-MACH-102742 - Fundamentals and Methods of Production Technology  
  - M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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### Events

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<td>Physical basics of laser technology</td>
<td>3 SWS</td>
<td>Lecture / Practice (VÜ)</td>
<td>Schneider</td>
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### Exams

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<th>Title</th>
<th>Type</th>
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<td>Physical Basics of Laser Technology</td>
<td>Prüfung (PR)</td>
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<tr>
<td>WS 19/20</td>
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<td>Physical Basics of Laser Technology</td>
<td>Prüfung (PR)</td>
<td>Schneider</td>
</tr>
</tbody>
</table>

### Competence Certificate

oral examination (30 min)  
no tools or reference materials

### Prerequisites

It is not possible, to combine this brick with brick Laser Application in Automotive Engineering [T-MACH-105164] and brick Physical Basics of Laser Technology [T-MACH-109084].

### Modeled Conditions

The following conditions have to be fulfilled:

1. The course T-MACH-105164 - Laser in Automotive Engineering must not have been started.
2. The course T-MACH-109084 - Physical Basics of Laser Technology must not have been started.

### Recommendation

Basic knowledge of physics, chemistry and material science

Below you will find excerpts from events related to this course:

**Physical basics of laser technology**  
2181612, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)  

**Description**

**Media:**

lecture notes via ILIAS
Notes
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned. An excursion to the laser laboratory of the Institute for Applied Materials (IAM) will be offered.

- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- safety aspects

The lecture is complemented by a tutorial.

The student

- can explain the principles of light generation, the conditions for light amplification as well as the basic structure and function of different laser sources.
- can describe the influence of laser, material and process parameters for the most important methods of laser-based materials processing and choose laser sources suitable for specific applications.
- can illustrate the possible applications of laser sources in measurement and medicine technology
- can explain the requirements for safe handling of laser radiation and for the design of safe laser systems.

Basic knowledge of physics, chemistry and material science is assumed.

regular attendance: 33,5 hours
self-study: 116,5 hours

The assessment consists of an oral exam (ca. 30 min) taking place at the agreed date (according to Section 4(2), 2 of the examination regulation). The re-examination is offered upon agreement.

It is allowed to select only one of the lectures "Laser in automotive engineering" (2182642) or "Physical basics of laser technology" (2181612) during the Bachelor and Master studies.

Learning Content
Based on the description of the physical basics about the formation and the properties of laser light the lecture goes through the different types of laser beam sources used in industry these days. The lecture focuses on the usage of lasers especially in materials engineering. Other areas like measurement technology or medical applications are also mentioned. An excursion to the laser laboratory of the Institute for Applied Materials (IAM) will be offered.

- physical basics of laser technology
- laser beam sources (solid state, diode, gas, liquid and other lasers)
- beam properties, guiding and shaping
- lasers in materials processing
- lasers in measurement technology
- lasers for medical applications
- safety aspects

The lecture is complemented by a tutorial.

Annotation
It is allowed to select only one of the lectures "Laser in automotive engineering" (2182642) or "Physical basics of laser technology" (2181612) during the Bachelor and Master studies.

Workload
regular attendance: 33,5 hours
self-study: 116,5 hours

Literature
Course: Physics for Engineers [T-MACH-100530]

**Responsible:**
Prof. Dr. Martin Dienwiebel
Prof. Dr. Peter Gumbsch
Prof. Dr. Alexander Nesterov-Müller
Dr. Daniel Weygand

**Organisation:**
KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

**Type**
Written examination

**Credits**
5

**Recurrence**
Each summer term

**Version**
1

**Events**

<table>
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<tr>
<th>SS 2019</th>
<th>2142890</th>
<th>Physics for Engineers</th>
<th>2 SWS</th>
<th>Lecture (V)</th>
<th>Weygand, Dienwiebel, Nesterov-Müller, Gumbsch</th>
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**Exams**

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<th>SS 2019</th>
<th>76-T-MACH-100530</th>
<th>Physics for Engineers</th>
<th>Prüfung (PR)</th>
<th>Gumbsch, Weygand, Nesterov-Müller, Dienwiebel</th>
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</thead>
</table>

**Competence Certificate**
written exam 90 min

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*
Notes
1) Foundations of solid state physics
   - Wave particle dualism
   - Tunnelling
   - Schrödinger equation
   - H-atom
2) Electrical conductivity of solids
   - solid state: periodic potentials
   - Pauli Principle
   - band structure
   - metals, semiconductors and isolators
   - p-n junction / diode
3) Optics
   - quantum mechanical principles of the laser
   - linear optics
   - non-linear optics

Exercises (2142891, 2 SWS) are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students and for testing progress in learning of the topics.

The student
   - has the basic understanding of the physical foundations to explain the relationship between the quantum mechanical principles and the optical as well as electrical properties of materials
   - can describe the fundamental experiments, which allow the illustration of these principles

regular attendance: 22,5 hours (lecture) and 22,5 hours (excerises 2142891)
self-study: 97,5 hours and 49 hours (excerises 2142891)
The assessment consists of a written exam (90 minutes) (following §4(2), 1 of the examination regulation).

Learning Content
1) Foundations of solid state physics
   - Wave particle dualism
   - Tunnelling
   - Schrödinger equation
   - H-atom
2) Electrical conductivity of solids
   - solid state: periodic potentials
   - Pauli Principle
   - band structure
   - metals, semiconductors and isolators
   - p-n junction / diode
3) Optics
   - quantum mechanical principles of the laser
   - linear optics
   - non-linear optics

Exercises (2142891, 2 SWS) are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students and for testing progress in learning of the topics.

Workload
regular attendance: 22,5 hours (lecture) and 22,5 hours (excerises 2142891)
self-study: 97,5 hours and 49 hours (excerises 2142891)

Literature
   - Tipler und Mosca: Physik für Wissenschaftler und Ingenieure, Elsevier, 2004
   - Harris, Moderne Physik, Pearson Verlag, 2013
11.313 Course: Planning of Assembly Systems [T-MACH-105387]

Responsible: Eberhardt Haller
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102600 - Major Field: Man - Technology - Organisation
M-MACH-102618 - Major Field: Production Technology

Type
Oral examination
Credits
4
Recurrence
Each winter term
Version
1

Events
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<th>Version</th>
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<tr>
<td>WS 19/20</td>
<td>Planning of Assembly Systems (in German)</td>
<td>2 SWS</td>
<td>Block (B)</td>
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Competence Certificate
oral exam (approx. 30 min)
The exam is offered in German only!

Prerequisites
Timely pre-registration in ILIAS, since participation is limited.

Below you will find excerpts from events related to this course:

Planning of Assembly Systems (in German)
2109034, WS 19/20, 2 SWS, Language: German, Open in study portal

Notes
Content of teaching:
1. Planning guidelines
2. Vulnerability analysis
3. Planning of work systems (technical and organisational structuring principles, capacity planning, procedure diagram, payment system)
4. Evaluation
5. Presentation

Requirements:
• Compact course (one week full-time)
• Limited number of participants; seats are assigned according the date of registration
• Registration via ILIAS is required
• Compulsory attendance during the whole lecture

Recommendations:
• Knowledge of Human Factors Engineering or Production Management/Industrial Engineering helpful

The students
• know planning guidelines
• know vulnerability analysis
• are able to plan work systems (e.g. technical or organisational structuring principles, capacity planning, procedure diagram, payment system)
• are able to evaluate a planning solution
• are able to present results
Learning Content

1. Planning guidelines
2. Vulnerability analysis
3. Planning of work systems (technical and organisational structuring principles, capacity planning, proceedence diagram, payment system)
4. Evaluation
5. Presentation

Workload
Compact course (one week full-time).
The amount of work accounts for 120 h (=4 ECTS).

Literature
Handout and literature online ILIAS.
Course: Plasticity of metals and intermetallics [T-MACH-110268]

**Responsible:** Dr.-Ing. Alexander Kauffmann  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102611 - Major Field: Materials Science and Engineering

<table>
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**Events**

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<td>2173648</td>
<td>Plasticity in metals and intermetallics</td>
<td>3</td>
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<td>Kauffmann</td>
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</table>

**Competence Certificate**

oral exam (about 25 minutes)

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Plasticity in metals and intermetallics**

2173648, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)  

**Description**

The students know the macroscopic, mesoscopic and microscopic fundamentals of plasticity in metals and alloys including their qualitative and quantitative description. Furthermore, the students are able to assess the influence of these mechanisms on the respective properties of materials. The students can describe the control of the mechanisms and properties.
Notes
The students know the macroscopic, mesoscopic and microscopic fundamentals of plasticity in metals and alloys including their qualitative and quantitative description. Furthermore, the students are able to assess the influence of these mechanisms on the respective properties of materials. The students can describe the control of the mechanisms and properties.

topics:
(i) relevance of plasticity in metals and intermetallics
(ii) macroscopic features of plasticity
(iii) repetition of fundamentals for the lecture
   - elasticity
   - strength and hardening
   - crystallography
   - defects in solids
(iv) dislocations:
   - fundamental concept
   - observation of dislocations
   - properties of dislocations
   - dislocations in fcc metals
   - dislocations in bcc metals
   - dislocations in hcp metals and complex intermetallics
(v) single crystal plasticity
   - influence of temperature, orientation, strain rate, etc. (fcc metals)
   - further examples
(vi) strength of crystalline materials
   - temperature dependence
   - Peierls stress
   - impact of solute atoms
   - impact of grain boundaries
   - impact of precipitates and dispersoids
(vii) other mechanisms of plasticity
   - deformation twinning
   - martensitic transformation
   - grain boundary sliding
(viii) summary

learning objectives:
The students know the macroscopic, mesoscopic and microscopic fundamentals of plasticity in metals and alloys including their qualitative and quantitative description. Furthermore, the students are able to assess the influence of these mechanisms on the respective properties of materials. The students can describe the control of the mechanisms and properties.

requirements:
Materials Science and Engineering I/II, Materials Physics/Metals

workload:
lecture: 42 h
private studies: 78 h
Learning Content
(i) relevance of plasticity in metals and intermetallics
(ii) macroscopic features of plasticity
(iii) repetition of fundamentals for the lecture
   - elasticity
   - strength and hardening
   - crystallography
   - defects in solids
(iv) dislocations:
   - fundamental concept
   - observation of dislocations
   - properties of dislocations
   - dislocations in fcc metals
   - dislocations in bcc metals
   - dislocations in hcp metals and complex intermetallics
(v) single crystal plasticity
   - influence of temperature, orientation, strain rate, etc. (fcc metals)
   - further examples
(vi) strength of crystalline materials
   - temperature dependence
   - Peierls stress
   - impact of solute atoms
   - impact of grain boundaries
   - impact of precipitates and dispersoids
(vii) other mechanisms of plasticity
   - deformation twinning
   - martensitic transformation
   - grain boundary sliding
(viii) summary

Workload
lecture: 42 h
private studies: 78 h

Literature
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC070938105
Hull, D. J. Bacon: „Introduction to Dislocations“, Elsevier (2011)
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC383083990 (Kapitel frei zugänglich über KIT-Lizenz abrufbar)
http://services.bibliothek.kit.edu/primo/start.php?recordid=KITSRC052463656
https://www.ifw-dresden.de/institutes/imw/events/lectures/lecture-notes/physikalische-werkstoffeigenschaften/
11.315 Course: PLM for Product Development in Mechatronics [T-MACH-102181]

**Responsible:** Prof. Dr.-Ing. Martin Eigner

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102613 - Major Field: Lifecycle Engineering

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**Events**

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<td>PLM for product development in mechatronics</td>
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<td>Lecture (V)</td>
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<td>PLM for product development in mechatronics</td>
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**Exams**

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<td>PLM for Product Development in Mechatronics</td>
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</table>

**Competence Certificate**

Oral examination 20 min.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**PLM for product development in mechatronics**

2122376, SS 2019, SWS, Language: German, [Open in study portal](#)

**Workload**

The total workload for this course is approximately 120 hours. For further information see German version.
11.316 Course: PLM in the Manufacturing Industry [T-MACH-105340]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**
oral exam, 20 min.

**Prerequisites**
None
11.317 Course: Plug-and-play material handling [T-MACH-106693]

**Responsible:** Jonathan Dziedzitz  
Prof. Dr.-Ing. Kai Furmans

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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**Events**

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<td>Plug-and-play material handling</td>
<td>Practical course (P)</td>
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<td>Plug-and-play material handling</td>
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<td>Furmans</td>
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**Competence Certificate**

Presentation of the four steps of the course content (design, implementation, test concept and evaluation)

**Prerequisites**

None
11.318 Course: Polymer Engineering I [T-MACH-102137]

**Responsible:** Prof. Dr.-Ing. Peter Elsner

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102628 - Major Field: Lightweight Construction
- M-MACH-102632 - Major Field: Polymer Engineering
- M-MACH-102637 - Major Field: Tribology

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**Competence Certificate**
- Oral exam, about 25 minutes

**Prerequisites**
- none

Below you will find excerpts from events related to this course:

**Polymer Engineering I**
- 2173590, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)
- Lecture (V)
Notes
1. Economical aspects of polymers
2. Introduction of mechanical, chemical and electrical properties
3. Processing of polymers (introduction)
4. Material science of polymers
5. Synthesis

learning objectives:
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, to equip the students with knowledge and technical skills, and to use the material "polymer" meeting its requirements in an economical and ecological way.

The students
- are able to describe and classify polymers based on the fundamental synthesis processing techniques
- can find practical applications for state-of-the-art polymers and manufacturing technologies
- are able to apply the processing techniques, the application of polymers and polymer composites regarding to the basic principles of material science
- can describe the special mechanical, chemical and electrical properties of polymers and correlate these properties to the chemical bindings.
- can define application areas and the limitation in the use of polymers

requirements:
none

workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
1. Economical aspects of polymers
2. Introduction of mechanical, chemical and electrical properties
3. Processing of polymers (introduction)
4. Material science of polymers
5. Synthesis

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Recommended literature and selected official lecture notes are provided in the lecture
11.319 Course: Polymer Engineering II [T-MACH-102138]

**Responsible:** Prof. Dr.-Ing. Peter Elsner

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102632 - Major Field: Polymer Engineering

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**Competence Certificate**

Oral exam, about 25 minutes

**Prerequisites**

none

**Recommendation**

Knowledge in Polymerengineering I

*Below you will find excerpts from events related to this course:*

**Polymer Engineering II**

2174596, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Notes
1. Processing of polymers
2. Properties of polymer components
Based on practical examples and components
2.1 Selection of material
2.2 Component design
2.3 Tool engineering
2.4 Production technology
2.5 Surface engineering
2.6 Sustainability, recycling

Learning objectives:
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, that the students gather knowledge and technical skills to use the material "polymer" meeting its requirements in an economical and ecological way.

The students
- can describe and classify different processing techniques
- and can exemplify mould design principles based on technical parts.
- know about practical applications and processing of polymer parts
- are able to design polymer parts according to given restrictions
- can choose appropriate polymers based on the technical requirements
- can decide how to use polymers regarding the production, economical and ecological requirements

Requirements:
Polymerengineering I

Workload:
The workload for the lecture Polymerengineering II is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Learning Content
1. Processing of polymers
2. Properties of polymer components
Based on practical examples and components
2.1 Selection of material
2.2 Component design
2.3 Tool engineering
2.4 Production technology
2.5 Surface engineering
2.6 Sustainability, recycling

Workload
The workload for the lecture Polymerengineering II is 120 h per semester and consists of the presence during the lecture (21 h) as well as preparation and rework time at home (99 h).

Literature
Recommended literature and selected official lecture notes are provided in the lecture.
11.320 Course: Polymers in MEMS A: Chemistry, Synthesis and Applications [T-MACH-102192]

**Responsible:** Dr.-Ing. Bastian Rapp  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102616 - Major Field: Microsystem Technology

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**Events**

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**Competence Certificate**

Oral examination

**Prerequisites**

none

_Below you will find excerpts from events related to this course:_

**Polymers in MEMS A: Chemistry, Synthesis and Applications**  
2141853, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**

The lecture slides will be given out as scriptum during each lecture course.
Learning Content
We all come in contact with numerous polymeric products in everyday life. From water bottles to packaging to the cover of the iPad, many things are made of polymers. Polymers are also important materials for modern microelectromechanical systems (MEMS) allowing effective mass market compatible products, e.g., in the life sciences or diagnostics. But polymers are not just cost-effective replacements for more expensive classical materials in MEMS (such as, e.g., silicon) – some polymers have intrinsic properties that make them ideal materials for sensors, actuators or templates for biology and chemistry in MEMS.

This lecture will introduce the basics of organic chemistry required for understanding what polymers are, how they are manufactured and which mechanisms are responsible for their unique properties. The lecture will highlight (in the context of MEMS but also in a wider scope) where and why polymers are applied with a strong focus on their chemical and physical properties (and on their synthesis).

Some of the topics covered are:

- What is the basic chemistry of polymers? What are monomers, what are macromolecules and how are they formed?
- How are polymers produced on industrial scale – but also on the laboratory scale? Numerous examples of how to make (commonly and lesser known) polymers will be discussed including materials such as Plexiglas.
- Why are polymers so important for biochemistry and tissue engineering?
- How do photoreisists work and why do some polymers contract when exposed to light?
- What are high-performance polymers and why do they have such a wide application range, e.g., in implants?
- What polymers fuel the household 3D printing community and what materials do 3D printers such as, e.g., the RepRap work with?
- How does 3D printing and rapid prototyping work and which polymers can be employed for which techniques?
- Why does silicone always smell like vinegar and why is this material so important for modern day microfluidics? How do shape memory polymers remember their shape?
- What are polymer foams and why are they not only important for heat insulation but also for organic chemistry?
- How do glue work? Why are there two-component glues, what is superglue and how can you make glue from potatoes?

The lecture will be given in German language unless non-German speaking students attend. In this case, the lecture will be given in English (with some German translations of technical vocabulary). The lecture slides are in English language and will be handed out for taking notes. Additional literature is not required.

For further details, please contact the lecturer, Dr. Ing. Bastian E. Rapp (bastian.rapp@kit.edu). Preregistration is not necessary.

The examination will be held in oral form at the end of the lecture. The lecture can be chosen as "Nebenfach" or part of a "Hauptfach". The second lecture of the lecture series "Polymers in MEMS B – Physics, manufacturing and applications" (which is also held in winter semester) can be combined with this lecture as part of a "Hauptfach". In summer semester, the third part of the lecture series "Polymers in MEMS C – Biopolymers, Biopolymers and applications" will be given which may be combined with lectures A and B to form a complete "Hauptfach".

Annotation
For further details, please contact the lecturer, Dr. Ing. Bastian E. Rapp (bastian.rapp@kit.edu). Preregistration is not necessary.

Workload
- lecture: 15 * 1.5 h (22 h)
- lecture preparation (before and after lecture): 15 * 2 h (30 h)
- preparation of final exam: 70 h
11.321 Course: Polymers in MEMS B: Physics, Microstructuring and Applications [T-MACH-102191]

**Responsible:** Dr.Ing. Matthias Worgull

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102616 - Major Field: Microsystem Technology

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**Events**

**WS 19/20** 2141854  
Polymers in MEMS B: Physics, Microstructuring and Applications  
2 SWS  
Lecture (V)  
Worgull

**Exams**

**SS 2019** 76-T-MACH-102191  
Polymers in MEMS B: Physics, Microstructuring and Applications  
Prüfung (PR)  
Worgull

**Competence Certificate**

Oral examination

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Polymers in MEMS B: Physics, Microstructuring and Applications**

Lecture (V)

**Description**

**Media:**
The lecture slides will be given out as scriptum during each lecture course.
Learning Content
We all come in contact with numerous polymeric products in everyday life. From water bottles to packaging to the cover of the iPad, many things are made of polymers. Polymers are also important materials for modern microelectromechanical systems (MEMS) allowing cost effective mass market compatible products, e.g., in the life sciences or diagnostics. But polymers are not just cost-effective replacements for more expensive classical materials in MEMS (such as, e.g., silicon) – some polymers have intrinsic properties that make them ideal materials for sensors, actuators or templates for biology and chemistry in MEMS.
This lecture will introduce the basics of physics and material science required for the understanding of the mechanical behavior seen from the engineers view. Micro and nanostructuring of polymers allows the fabrication of micro parts fulfilling their tasks in mostly invisible different applications. But also the fabrication of polymer parts with functional surfaces inspired from Bionics will be presented in this lesson. The lesson will give further an overview over the polymer based structuring processes and will underline the importance by a number of applications e.g. photonic structures or Lotus-like structures.

Some of the topics covered are:

- How can polymers described from the view of engineers?
- What are the differences between polymers and metals?
- Rheology of polymer melts – How does polymer melts flow?
- How can polymers be formed and demolded?
- Which structuring processes (replication) processes are available?
- How does stress influence molded parts (e.g. the deformation of a CD in a hot car)
- Shrinkage of polymers – which precision is achievable
- Gluing or welding – How can polymers be assembled?
- Simulation of replication processes
- Characterization of polymers – which properties can be measured?

The lecture will be given in German language unless non-German speaking students attend. In this case, the lecture will be given in English (with some German translations of technical vocabulary). The lecture slides are in English language and will be handed out for taking notes. Additional literature is not required.

For further details, please contact the lecturer, PD Dr.-Ing. Matthias Worgull (matthias.worgull@kit.edu). Preregistration is not necessary.

The examination will be held in oral form at the end of the lecture. The lecture can be chosen as "Nebenfach" or part of a "Hauptfach". The second lecture of the lecture series "Polymers in MEMS A – Chemistry, synthesis and applications" (which is also held in winter semester) can be combined with this lecture as part of a "Hauptfach". In summer semester, the third part of the lecture series "Polymers in MEMS C – Biopolymers, Biopolymers and applications" will be given which may be combined with lectures A and B to form a complete "Hauptfach".

Annotation
For further details, please contact the lecturer, PD Dr.-Ing. Matthias Worgull (matthias.worgull@kit.edu). Preregistration is not necessary.

Workload

- lecture: 15 * 1.5 h (22 h)
- lecture preparation (before and after lecture): 15 * 2 h (30 h)
- preparation of final exam: 70 h
11.322 Course: Polymers in MEMS C: Biopolymers and Bioplastics [T-MACH-102200]

Responsible:  Dr.-Ing. Bastian Rapp  
               Dr.Ing. Matthias Worgull

Organisation:  KIT Department of Mechanical Engineering

Part of:  M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
          M-MACH-102616 - Major Field: Microsystem Technology

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Events

| SS 2019 | 2142855 | Polymers in MEMS C - Biopolymers and Bioplastics | 2 SWS | Worgull, Rapp |

Exams

| SS 2019 | 76-T-MACH-102200 | Polymers in MEMS C: Biopolymers and Bioplastics | Prüfung (PR) | Worgull, Rapp |

Competence Certificate

Oral examination

Prerequisites

none

Below you will find excerpts from events related to this course:

Polymers in MEMS C - Biopolymers and Bioplastics
2142855, SS 2019, 2 SWS, Language: German, Open in study portal
Learning Content
Polymers are ubiquitous in everyday life: from packaging materials all the way to specialty products in medicine and medical engineering. Today it is difficult to find a product which does not (at least in parts) consist of polymeric materials. The question of how these materials can be improved with respect to their disposal and consumption of (natural) resources during manufacturing is often raised. Today polymers must be fully recycled in Germany and many other countries due to the fact that they do not (or only very slowly) decompose in nature. Furthermore significant reductions of crude oil consumption during synthesis are of increasing importance in order to improve the sustainability of this class of materials. With respect to disposal polymers which do not have to be disposed by combustion but rather allow natural decomposition (composting) are of increasing interest. Polymers from renewable sources are also of interest for modern microelectromechanical systems (MEMS) especially if the systems designed are intended as single-use products.

This lecture will introduce the most important classes of these so-called biopolymers and bioplastics. It will also discuss and highlight polymers which are created from naturally created analogues (e.g. via fermentation) to petrochemical polymer precursors and describe their technical processing. Numerous examples from MEMS as well as everyday life will be given.

Some of the topics covered are:

- What are biopolyurethanes and how can you produce them from castor oil?
- What are "natural glues" and how are they different from chemical glues?
- How do you make tires from natural rubbers?
- What are the two most important polymers for life on earth?
- How can you make polymers from potatoes?
- Can wood be formed by injection molding?
- How do you make buttons from milk?
- Can you play music on biopolymers?
- Where and how do you use polymers for tissue engineering?
- How can you built LEGO with DNA?

The lecture will be given in German language unless non-German speaking students attend. In this case, the lecture will be given in English (with some German translations of technical vocabulary). The lecture slides are in English language and will be handed out for taking notes. Additional literature is not required.

For further details, please contact the lecturer, Dr. Ing. Bastian E. Rapp (bastian.rapp@kit.edu) and PD Dr.-Ing. Matthias Worgull (matthias.worgull@kit.edu). Preregistration is not necessary.

Annotation
For further details, please contact the lecturer, Dr. Ing. Bastian E. Rapp (bastian.rapp@kit.edu) and PD Dr.-Ing. Matthias Worgull (matthias.worgull@kit.edu). Preregistration is not necessary.

Workload
- lecture: 15 * 1.5 h (22 h)
- lecture preparation (before and after lecture): 15 * 2 h (30 h)

preparation of final exam: 70 h

Literature
Additional literature is not required.
11.323 Course: Powertrain Systems Technology A: Automotive Systems [T-MACH-105233]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  
Sascha Ott

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102599 - Major Field: Powertrain Systems  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102637 - Major Field: Tribology

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<td>Prüfung (PR)</td>
<td>Albers, Ott</td>
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**Competence Certificate**

written examination: 60 min duration

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Powertrain Systems Technology A: Automotive Systems**

2146180, SS 2019, 2 SWS, Language: German, Open in study portal

**Notes**

**Content**

Students acquire the basic skills needed to develop future energy-efficient and at the same time comfortably drivable powertrains. This includes holistic development methods and evaluations of powertrain systems. The main topics can be divided into the following chapters:

- Powertrain System
- Driver System
- Environment System
- System Components
- Development Process

**Recommendations for additional courses:**

- Power Train Systems Technology B: Stationary Machinery

Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019
11.324 Course: Powertrain Systems Technology B: Stationary Machinery [T-MACH-105216]

**Responsible:** Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
Sascha Ott

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102633 - Major Field: Robotics

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**Competence Certificate**
written examination: 60 min duration

**Prerequisites**
None

*Below you will find excerpts from events related to this course:*

**Powertrain Systems Technology B: Stationary Machinery**
2145150, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Lecture (V)**

**Notes**

**Content**

Students acquire the basic skills needed to develop future energy-efficient and safe drive system solutions for use in industrial environments. The course considers holistic development methods and evaluations of drive systems. The focal points can be divided into the following chapters:

- Powertrain System
- Operator System
- Environment System
- System Components
- Development Process

**Recommendations:**

- Powertrain Systems Technology A: Automotive Systems
11.325 Course: Practical Course “Tribology” [T-MACH-105813]

**Responsible:** Prof. Dr. Martin Dienwiebel  
Dr.-Ing. Johannes Schneider  

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102591 - Laboratory Course  
M-MACH-102637 - Major Field: Tribology

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**Exams**

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<td>Prüfung (PR)</td>
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**Competence Certificate**

The assessment consists of a colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.

**Prerequisites**

none

**Recommendation**

The attendance to one of the course Tribology (2181114) is strongly recommended!

Below you will find excerpts from events related to this course:

Praktikum "Tribologie"

2182115, SS 2019, 3 SWS, Language: German, Open in study portal

**Notes**

The laboratory compromises five full-day experiments, which address the following topics:

- tribological system analysis  
- basics of tribological measurement techniques  
- topographical surface characterization  
- tribological model tests under sliding, rolling and abrasive conditions  
- microscopical characterization of worn surfaces

The student

- knows the most common methods of friction and wear measurement  
- knows the most common tribological model tests for the characterization of materials under sliding, rolling and abrasive conditions  
- can carry out a tribological system analysis and based on that derive suitable loading parameters for model tests

The attendance to one of the course Tribology (2181114) is strongly recommended.

regular attendance: 35 hours  
self-study: 85 hours

The assessment consists of a colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.
**Learning Content**
The laboratory compromises five full-day experiments, which address the following topics:

- tribological system analysis
- basics of tribological measurement techniques
- topographical surface characterization
- tribological model tests under sliding, rolling and abrasive conditions
- microscopical characterization of worn surfaces

**Annotation**
The maximum number of students is 12.

**Workload**
regular attendance: 35 hours
self-study: 85 hours

**Literature**


Gesellschaft für Tribologie e.V. (GFT): Arbeitsblatt 7: Tribologie – Verschleiß, Reibung: Definitionen, Begriffe, Prüfung. GFT, Moers, 2002. (Download unterwww.gft-ev.de/arbeitsblaetter.htm)

11.326 Course: Practical Course Polymers in MEMS [T-MACH-105556]

Responsible: Dr.-Ing. Bastian Rapp
Dr.Ing. Matthias Worgull

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102616 - Major Field: Microsystem Technology

Events

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<td>SS 2019</td>
<td>Completed coursework</td>
<td>2</td>
<td>Each summer term</td>
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</table>

Competence Certificate
The practical course will close with an oral examination. There will be only passed and failed results, no grades.

Prerequisites
none

Below you will find excerpts from events related to this course:

Description
Media:
descriptions of the experiments

Learning Content
This practical course complements the lectures "Polymers in MEMS A", "Polymers in MEMS B" and "Polymers in MEMS C" and will allow students to gain a deeper understanding of polymers and their processing. During the course of this practical course, various polymers will be synthesized and molded into components suitable for microelectromechanical systems (MEMS) applications. The aim of the course is to bring a polymer all the way from synthesis to application.

The practical course will be given in German language unless non-German speaking students attend. In this case, the course will be given in English (with some German translations of technical vocabulary). Lecture notes for the experiments are in English language and will be handed out to the students. The practical course will be held "en block" at the end of the semester (presumably beginning of October)

For further details, please contact the lecturer, Dr. Ing. Bastian E. Rapp (bastian.rapp@kit.edu) and PD Dr.-Ing. Matthias Worgull (matthias.worgull@kit.edu). Preregistration is mandatory. The number of participants is limited to 5 students.

Workload

- practical course: 3 * 8 h (24 h)
- experiment preparation (before and after lecture): 30 h
- preparation of final exam: 66 h

Literature
Scripts of the corresponding lectures, further literature as named there.
11.327 Course: Practical Course Technical Ceramics [T-MACH-105178]

Responsible: Dr. Günter Schell
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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<tr>
<th>Events</th>
<th>2125751</th>
<th>Practical Course Technical Ceramics</th>
<th>2 SWS</th>
<th>Practical course (P)</th>
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<td>Practical Course Technical Ceramics</td>
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</table>

Competence Certificate
Colloquium and laboratory report for the respective experiments.

Prerequisites
none

Below you will find excerpts from events related to this course:

**Practical Course Technical Ceramics**
2125751, WS 19/20, 2 SWS, Language: German, [Open in study portal]

Learning Content
Based on alumina as a model material, major test methods for the characterization of raw materials, intermediate and final products are practically applied. Topics:

- powder characterization
- Shaping of powder compacts
- sintering
- microstructural characterization
- mechanical testing

On the basis of short descriptions of the methods, the students prepare themselves, carry out the experiments and write a laboratory report.

Workload
regular attendance: 30 hours
self-study: 90 hours

Literature
Richerson, D. R.: Modern Ceramic Engineering, CRC Taylor & Francis, 2006
11.328 Course: Practical Training in Basics of Microsystem Technology [T-MACH-102164]

**Responsible:** Dr. Arndt Last

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102616 - Major Field: Microsystem Technology

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<td>2143875</td>
<td>Introduction to Microsystem Technology - Practical Course</td>
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<td>WS 19/20</td>
<td>2143877</td>
<td>Introduction to Microsystem Technology - Practical Course</td>
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**Exams**

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<td>Practical Training in Basics of Microsystem Technology</td>
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</table>

**Competence Certificate**

The assessment consists of a written exam

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Introduction to Microsystem Technology - Practical Course**

2143875, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Practical course (P)**

**Learning Content**

In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
3. Mikro optics: "LIGA-micro spectrometer"
4. UV-lithography
5. Optical waveguides
6. Capillary electrophoresis on a chip
7. SAW gas sensor
8. Metrology
9. Atomic force microscopy
Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

**Workload**

Time of attendance: 21 h + 2 h exam
Privat studies: 5 h preparing experiments + 10 h preparing the exam
Introduction to Microsystem Technology - Practical Course

Learning Content
In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
4. UV-lithography
5. Optical waveguides
6. Capillary electrophoresis on a chip
7. SAW gas sensor
8. Metrology
9. Atomic force microscopy
Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

Workload
Time of attendance: 21 h + 2 h exam
Privat studies: 5 h preparing experiments + 10 h preparing the exam
11.329 Course: Practical Training in Measurement of Vibrations [T-MACH-105373]

**Responsible:** Prof. Dr.-Ing. Alexander Fidlin

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102591 - Laboratory Course
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-104443 - Major Field: Vibration Theory

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**Events**

| SS 2019 | 2162208 | Schwingungstechnisches Praktikum | SWS | Practical course (P) | Fidlin, Aramendiz Fuentes |

| SS 2019 | 7600020 | Practical Training in Measurement of Vibrations | Prüfung (PR) | Fidlin |

**Competence Certificate**

Colloquium to each session, 10 out of 10 colloquiums must be passed

**Prerequisites**

Can not be combined with Experimental Dynamics (T-MACH-105514).

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course **T-MACH-105514 - Experimental Dynamics** must not have been started.

**Recommendation**

Vibration Theory, Mathematical Methods of Vibration Theory, Dynamic Stability, Nonlinear Vibrations
Course: Principles of Ceramic and Powder Metallurgy Processing [T-MACH-102111]

**Responsible:** Dr. Günter Schell

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Exams**

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<td>SS 2019 76-T-MACH-102111 Principles of Ceramic and Powder Metallurgy Processing Prüfung (PR) Schell</td>
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<td>Oral examination</td>
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<td>WS 19/20 76-T-MACH-102111 Principles of Ceramic and Powder Metallurgy Processing Prüfung (PR) Schell</td>
<td>4</td>
<td>Oral examination</td>
<td>Each winter term</td>
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**Competence Certificate**
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Basic principles of powder metallurgical and ceramic processing**
2193010, WS 19/20, 2 SWS, Language: German, Open in study portal

**Learning Content**
The course covers fundamentals of the process technology for shaping of ceramic or metal particle systems. Important shaping methods are reviewed. The focus is on characterization and properties of particulate systems, and, in particular, on process technology for shaping of powders, pastes, and suspensions.

**Workload**
regular attendance: 25 hours
self-study: 95 hours

**Literature**

- R.M. German. "Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
11.331 Course: Principles of Medicine for Engineers [T-MACH-105235]

**Responsible:** Prof. Dr. Christian Pylatiuk  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102615 - Major Field: Medical Technology

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<td>Principles of Medicine for Engineers</td>
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<td>Pylatiuk</td>
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</table>

**Competence Certificate**

Written examination (Duration: 45min)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Notes**

**Content:**

- Introduction: Definitions of "health" and "disease". History of medicine and paradigm shift towards evidence based medicine and personalized medicine.
- Special topics: nervous system, saltatory conduction, musculoskeletal system, cardio-circulatory system, narcosis, pain, respiratory system, sensory organs, gynaecology, digestive organs, surgery, nephrology, orthopaedics, immune system, genetics.

**Learning objectives:**

Students have fundamental knowledge about functionality and anatomy of organs within different medical disciplines. The students further know about technical methods in diagnosis and therapy, common diseases, their relevance and costs. Finally the students are able to communicate with medical doctors in a way, in which they prevent misunderstandings and achieve a more realistic idea of each others expectations.

**Learning Content**

- Introduction: Definitions of "health" and "disease". History of medicine and paradigm shift towards evidence based medicine and personalized medicine.
- Special topics: nervous system, saltatory conduction, musculoskeletal system, cardio-circulatory system, narcosis, pain, respiratory system, sensory organs, gynaecology, digestive organs, surgery, nephrology, orthopaedics, immune system, genetics.

**Annotation**

**Recommendations:** Organ support systems

**Workload**

General attendance: 21 h  
Self-study: 99 h
Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
Course: Probability Theory and Statistics [T-MATH-109620]

**Responsible:** Prof. Dr. Daniel Hug

**Organisation:** KIT Department of Mathematics

**Part of:**
- M-MACH-102594 - Mathematical Methods
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

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<tr>
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<td>Each term</td>
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**Exams**

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<th>Semester</th>
<th>Exam Code</th>
<th>Course Title</th>
<th>Type</th>
<th>Period</th>
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</table>

**Competence Certificate**

Written exam (90 min.)

**Prerequisites**

None
11.333 Course: Process Simulation in Forming Operations [T-MACH-105348]

Responsible: Dr.-Ing. Dirk Helm
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102646 - Major Field: Applied Mechanics

Type: Oral examination
Credits: 4
Recurrence: Each winter term
Version: 1

<table>
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<td>WS 19/20</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
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</table>

Competence Certificate
oral exam, 20 min.

Prerequisites
none

Below you will find excerpts from events related to this course:

Process Simulation in Forming Operations
2161501, WS 19/20, 2 SWS, Language: German, Open in study portal

Notes
Based on basics of continuum mechanics, material theory and numerics the lecture gives an introduction into the simulation of forming operations for metals

- plasticity for metallic materials: dislocations, twinning, phase transformations, anisotropy, hardening
- classification of forming operations and discussion of selected topics
- basics of tensor algebra and tensor analysis
- continuum mechanics: kinematics, finite deformations, balance laws, thermodynamics
- material theory: basics, modelling concepts, plasticity and visco plasticity, yield functions (von Mises, Hill, ...), kinematic and isotropic hardening, damage
- thermomechanical coupling
- modelling of contact
- finite element method: explicit and implicit formulations, types of elements, numerical integration of material models
- process simulation of selected problems of sheet metal forming

Learning Content
Based on basics of continuum mechanics, material theory and numerics the lecture gives an introduction into the simulation of forming operations for metals

- plasticity for metallic materials: dislocations, twinning, phase transformations, anisotropy, hardening
- classification of forming operations and discussion of selected topics
- basics of tensor algebra and tensor analysis
- continuum mechanics: kinematics, finite deformations, balance laws, thermodynamics
- material theory: basics, modelling concepts, plasticity and visco plasticity, yield functions (von Mises, Hill, ...), kinematic and isotropic hardening, damage
- thermomechanical coupling
- modelling of contact
- finite element method: explicit and implicit formulations, types of elements, numerical integration of material models
- process simulation of selected problems of sheet metal forming
**11.334 Course: Product- and Production-Concepts for modern Automobiles [T-MACH-110318]**

**Responsible:** Dr. Stefan Kienzle  
Dr. Dieter Steegmüller

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102618 - Major Field: Production Technology  
- M-MACH-102628 - Major Field: Lightweight Construction

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<td>Product- and Production-Concepts for modern Automobiles</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Steegmüller, Kienzle</td>
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</table>

**Competence Certificate**

Oral Exam (20 min)

**Prerequisites**

T-MACH-105166 - Materials and Processes for Body Lightweight Construction in the Automotive Industry must not have been started.

Below you will find excerpts from events related to this course:

**Product- and Production-Concepts for modern Automobiles**

2149670, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The lecture illuminates the practical challenges of modern automotive engineering. As former leaders of the automotive industry, the lecturers refer to current aspects of automotive product development and production.

The aim is to provide students with an overview of technological trends in the automotive industry. In this context, the course also focuses on changes in requirements due to new vehicle concepts, which may be caused by increased demands for individualisation, digitisation and sustainability. The challenges that arise in this context will be examined from both a production technology and product development perspective and will be illustrated with practical examples thanks to the many years of industrial experience of both lecturers.

The topics covered are:

- General conditions for vehicle and body development
- Integration of new drive technologies
- Functional requirements (crash safety etc.), also for electric vehicles
- Development Process at the Interface Product & Production, CAE/Simulation
- Energy storage and supply infrastructure
- Aluminium and lightweight steel construction
- FRP and hybrid parts
- Battery, fuel cell and electric motor production
- Joining technology in modern car bodies
- Modern factories and production processes, Industry 4.0.

Learning Outcomes:
The students ...

- are able to name the presented general conditions of vehicle development and are able to discuss their influences on the final product using practical examples.
- are able to name the various lightweight approaches and identify possible areas of application.
- are able to identify the different production processes for manufacturing lightweight structures and explain their functions.
- are able to perform a process selection based on the methods and their characteristics.

Workload:
regular attendance: 25 hours
self-study: 95 hours

Learning Content
The lecture illuminates the practical challenges of modern automotive engineering. As former leaders of the automotive industry, the lecturers refer to current aspects of automotive product development and production.

The aim is to provide students with an overview of technological trends in the automotive industry. In this context, the course also focuses on changes in requirements due to new vehicle concepts, which may be caused by increased demands for individualisation, digitisation and sustainability. The challenges that arise in this context will be examined from both a production technology and product development perspective and will be illustrated with practical examples thanks to the many years of industrial experience of both lecturers.

The topics covered are:

- General conditions for vehicle and body development
- Integration of new drive technologies
- Functional requirements (crash safety etc.), also for electric vehicles
- Development Process at the Interface Product & Production, CAE/Simulation
- Energy storage and supply infrastructure
- Aluminium and lightweight steel construction
- FRP and hybrid parts
- Battery, fuel cell and electric motor production
- Joining technology in modern car bodies
- Modern factories and production processes, Industry 4.0.

Workload
regular attendance: 25 hours
self-study: 95 hours
### Course: Product Development - Dimensioning of Components [T-MACH-105383]

**Responsible:** Dr.-Ing. Stefan Dietrich  
Prof. Dr.-Ing. Volker Schulze  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102593 - Product Development - Dimensioning of Components

**Events**

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**Exams**

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**Competence Certificate**

written exam (2 hours)

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Product Development - Component Dimensioning**

2150511, SS 2019, 3 / 1 SWS, Language: German, Open in study portal  
Lecture / Practice (VÜ)

**Notes**

The aim of the lecture is to present the topics of the dimensioning and the material science in their connection and to learn how to deal with corresponding methods and the combination thereof.

For the prospective engineer the most important educational objective is to understand the interaction of these topics while the interplay of the individual material stresses in the component are clarified.

The topics in detail are

- Structural dimensioning: basic stresses, superimposed stresses, notch influence, fatigue limit, fatigue strength, assessment of cracked components, operational strength, residual stresses, high temperature stress and corrosion
- Material selection: Basics, material indices, material selection diagrams, Ashby procedure, multiple boundary conditions, target conflicts, shape and efficiency.

Learning target: The students...

- are capable to design and dimension components according to their load.
- can include mechanical material properties from the mechanical material test in the dimensioning process.
- can identify superimposed total loads and critical loads on simple components and to compute them.
- acquire the skill to select materials based on the application area of the components and respective loads.

Examination: written exam (2 hours)
Learning Content
The aim of the lecture is to present the topics of the dimensioning and the material science in their connection and to learn how to deal with corresponding methods and the combination thereof.

For the prospective engineer, the most important educational objective is to understand the interaction of these topics while the interplay of the individual material stresses in the component are clarified.

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Learning target: The students...
- are capable to design and dimension components according to their load.
- can include mechanical material properties from the mechanical material test in the dimensioning process.
- can identify superimposed total loads and critical loads on simple components and to compute them.
- acquire the skill to select materials based on the application area of the components and respective loads.

written exam (2 hours)

Learning objectives:
The students...
- are capable to design and dimension components according to their load.
- can include mechanical material properties from the mechanical material test in the dimensioning process.
- can identify superimposed total loads and critical loads on simple components and to compute them.
- acquire the skill to select materials based on the application area of the components and respective loads.

requirements:

workload:

Literature
Lecture notes
**Course: Product Lifecycle Management [T-MACH-105147]**

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102613 - Major Field: Lifecycle Engineering  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology

**Type**  
- Written examination  
**Credits**  
- 4  
**Recurrence**  
- Each winter term  
**Version**  
- 2

**Events**

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**Competence Certificate**

Written examination 90 min.

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Product Lifecycle Management**

2121350, WS 19/20, 2 SWS, Language: German, [Open in study portal]

**Learning Content**

Product Lifecycle Management (PLM) is an approach to the holistic and cross-company management and control of all product-related processes and data throughout the life cycle along the extended supply chain - from design and production to sales, to the dismantling and recycling.

Product Lifecycle Management is a comprehensive approach for effective and efficient design of the product life cycle. Based on all product information, which comes up across the entire value chain and across multiple partners, processes, methods and tools are made available to provide the right information at the right time, quality and the right place.

The course covers:

- A consistent description of all business processes that occur during the product life cycle (development, production, sales, dismantling, ...)
- the presentation of methods for the performance of the PLM business processes,
- explaining the most important corporate information systems to support the life cycle (PDM, ERP, SCM, CRM systems) to sample the software manufacturer SAP

**Workload**

regular attendance: 42 hours
self-study: 128 hours
Literature
Lecture slides.


11.337 Course: Product, Process and Resource Integration in the Automotive Industry [T-MACH-102155]

**Responsible:** Dr.-Ing. Sama Mbang

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102607 - Major Field: Vehicle Technology

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**Competence Certificate**

Oral examination 20 min.

**Prerequisites**

None

**Annotation**

Limited number of participants.

---

**Below you will find excerpts from events related to this course:**

**Product, Process and Resource Integration in the Automotive Industry**

2123364, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

The lecture

- Overview of product development in the automotive sector (process- and work cycle, IT-Systems)
- Integrated product models in the automotive industry (product, process and resource)
- New CAx modeling methods (intelligent feature technology, templates & functional modeling)
- Automation and knowledge-based mechanism for product design and production planning
- Product development in accordance with defined process and requirement (3D-master principle, tolerance models)
- Concurrent Engineering, shared working
- Enhanced concepts: the digital and virtual factory (application of virtual technologies and methods in the product development)
- Systems: Siemens NX.

Additionally, a practical industrial project study is offered, which is based on an integrated application scenario (from design of production resources, over testing and validation method planning to the manufacturing and implementation of the production resources).

Since the student will be divided in small teams, this study will also teach the students about team work and distributed development.

**Annotation**

Max. 20 students, registration necessary (ILIAS)
**Workload**
regular attendance: 32 hours
self-study: 72 hours

**Literature**
Lecture slides
11.338 Course: Production and Logistics Controlling [T-WIWI-103091]

**Responsible:** Alexander Rausch  
**Organisation:** KIT Department of Economics and Management  
**Part of:** M-MACH-102629 - Major Field: Logistics and Material Flow Theory

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**Exams**

| SS 2019 | 79-T-WIWI-103091 | Production and Logistics Controlling | Prüfung (PR) | Furmans, Mittwollen |

**Competence Certificate**
The assessment consists of a written exam (60 minutes) following §4(2), 1 of the examination regulation. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

**Prerequisites**
None
**11.339 Course: Production Planning and Control [T-MACH-105470]**

**Responsible:** Dr.-Ing. Andreas Rinn

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102618 - Major Field: Production Technology

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**Events**

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<td>Production Planning and Control</td>
<td>2 SWS</td>
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**Competence Certificate**

written exam 60 minutes (if the number of participants is low, the examination is oral, 20 minutes)

**Prerequisites**

Timely pre-registration in ILIAS, since participation is limited.

*Below you will find excerpts from events related to this course:*

**Production Planning and Control**

2110032, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

1. Goals and recommendations for production planning and control
2. Strategies for work control
3. Case study: Manufacturing of bicycles
4. FASI-Plus: Simulation of a bicycle factory for the production planning and control
5. Simulation of the order processing
6. Decision making about order control and procurement of purchased parts
7. Evaluation of the simulation protocols
8. Realisation of production planning and control

**Requirements:**

- Compact course
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

**Recommendations:**

- Knowledge in Production Management/Industrial Engineering is required
- Knowledge of Work Science and Economics is helpful
- Knowledge of Informatics is not required, but helpful

**Learning targets:**

- Lerninhalte zum Thema "Produktionsmanagement" vertiefen
- Kenntnisse über die Produktionsplanung und -steuerung erweitern
- Grundlegende Techniken der Modellierung und Simulation von Produktionsystemen verstehen
Learning Content

1. Goals and recommendations for production planning and control
2. Strategies for work control
3. Case study: Manufacturing of bicycles
4. FASI-Plus: Simulation of a bicycle factory for the production planning and control
5. Simulation of the order processing
6. Decision making about order control and procurement of purchased parts
7. Evaluation of the simulation protocols
8. Realisation of production planning and control

Workload
Compact course.
The amount of work accounts for 120 h (=4 ECTS).

Literature
Handout and literature are available on ILIAS for download.
11.340 Course: Production Techniques Laboratory [T-MACH-105346]

** Responsible:** Prof. Dr.-Ing. Barbara Deml  
Prof. Dr.-Ing. Jürgen Fleischer  
Prof. Dr.-Ing. Kai Furmans  
Prof. Dr.-Ing. Jivka Ovtcharova  
** Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102591 - Laboratory Course  
M-MACH-102618 - Major Field: Production Technology  
M-MACH-102629 - Major Field: Logistics and Material Flow Theory

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**Exams**

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**Competence Certificate**

**Advanced Internship:** Participate in practice exercise courses and complete the colloquia successfully.

**Elective Subject:** Participate in practice exercise courses and complete the colloquia successfully and presentation of a specific topic.

**Prerequisites**

None

*Below you will find excerpts from events related to this course:*

**Production Techniques Laboratory**

2110678, SS 2019, 4 SWS, Language: German, Open in study portal

**Description**

**Media:**

several
Notes
The production technique laboratory (PTL) is a collaboration of the institutes wbk, IFL, IMI and ifab.

1. Computer Aided Product Development (IMI)
2. Computer communication in factory (IMI)
3. Production of parts with CNC turning machines (wbk)
4. Controlling of production systems using PLCs (wbk)
5. Automated assembly systems (wbk)
6. Optical identification in production and logistics (IFL)
7. RFID identification systems (IFL)
8. Storage and order-picking systems (IFL)
9. Production Management (ifab)
10. Time study (ifab)
11. Accomplishment of workplace design (ifab)

Recommendations:
Participation in the following lectures:
- Informationssystems in logistics and supply chain management
- Material flow in logistic systems
- Manufacturing technology
- Human Factors Engineering

Learning Objects:
The students acquire in the lab profound knowledge about the scientific theories, principles and methods of Production Engineering. Afterwards they are able to evaluate and design complex production systems according to problems of manufacturing and process technologies, materials handling, handling techniques, information engineering as well as production organisation and management.

After completion this lab, the students are able
- to analyse and solve planning and layout problems of the discussed fields,
- to evaluate and configure the quality and efficiency of production, processes and products,
- to plan, control and evaluate the production of a production enterprise,
- to configure and evaluate the IT architecture of a production enterprise,
- to design and evaluate appropriate techniques for conveying, handling and picking within a production system,
- to design and evaluate the part production and the assembly by considering the work processes and the work places.

Learning Content
The production technique laboratory (PTL) is a collaboration of the institutes wbk, IFL, IMI and ifab.

1. Computer Aided Product Development (IMI)
2. Computer communication in factory (IMI)
3. Production of parts with CNC turning machines (wbk)
4. Controlling of production systems using PLCs (wbk)
5. Automated assembly systems (wbk)
6. Optical identification in production and logistics (IFL)
7. RFID identification systems (IFL)
8. Storage and order-picking systems (IFL)
9. Production Management (ifab)
10. Time study (ifab)
11. Accomplishment of workplace design (ifab)

Annotation
none

Workload
The amount of work is 120 h (=4 ECTS).

Literature
Handouts and literature references are available online on ILIAS.
11.341 Course: Productivity Management in Production Systems [T-MACH-105523]

**Responsible:** Prof. Dr. Sascha Stowasser  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102600 - Major Field: Man - Technology - Organisation  
- M-MACH-102613 - Major Field: Lifecycle Engineering  
- M-MACH-102618 - Major Field: Production Technology  
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory

**Type**  
- Oral examination

**Credits**  
- 4

**Recurrence**  
- Each summer term

**Version**  
- 1

### Events

| SS 2019 | 2110046 | Productivity Management in Production Systems | 4 SWS | Stowasser |

| Exams |
| SS 2019 | 76-T-MACH-105523 | Productivity Management in Production Systems | Prüfung (PR) | Deml |

**Competence Certificate**  
- oral exam (approx. 30 min)
- The exam is offered in German only!

**Prerequisites**  
- none

Below you will find excerpts from events related to this course:

**Productivity Management in Production Systems**  
- 2110046, SS 2019, 4 SWS, Language: German, [Open in study portal]

**Description**  
- Media:
  - Powerpoint, movies, exercises
Notes

1. Definition and terminology of process design and industrial engineering
2. Tasks of industrial engineering
3. Actual approaches of organisation of production (Holistic production systems, Guided group work et al.)
4. Methods and principles of industrial engineering and production systems
5. Case studies and exercises for process design
6. Industry 4.0

Requirements:

- Compact course (one week full-time)
- Limited number of participants; seats are assigned according the date of registration
- Registration via ILIAS is required
- Compulsory attendance during the whole lecture

Recommendations:

- Knowledge of work science is helpful

Learning objective:

- Ability to design work operations and processes effectively and efficiently
- Instruction in methods of time study (MTM, Data acquisition etc.)
- Instruction in methods and principles of process design
- The Students are able to apply methods for the design of workplaces, work operations and processes.
- The Students are able to apply actual approaches of process and production organisation.

Learning Content

1. Definition and terminology of process design and industrial engineering
2. Tasks of industrial engineering
3. Actual approaches of organisation of production (Holistic production systems, Guided group work et al.)
4. Methods and principles of industrial engineering and production systems
5. Case studies and exercises for process design
6. Industry 4.0

Workload

Compact course (one week full-time).
The amount of work accounts for 120 h (=4 ECTS).

Literature

Handout and literature is available on ILIAS for download.
Course: Project Management in Global Product Engineering Structures [T-MACH-105347]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Peter Gutzmer  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102599 - Major Field: Powertrain Systems  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102614 - Major Field: Mechatronics  
M-MACH-102615 - Major Field: Medical Technology  
M-MACH-102630 - Major Field: Mobile Machines  
M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools  
M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Competence Certificate**
oral exam (20 min)
Aids: None

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Learning Content**
Product development process  
Coordination of product development and handling of complexity  
project management  
matrix organization  
planning / specification / target system  
interaction of development and production

**Workload**
regular attendance: 21 h  
self-study: 99 h

**Literature**
lecture notes
11 Course: Project Management in Rail Industry [T-MACH-104599]

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102641 - Major Field: Rail System Technology

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**Exams**

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**Competence Certificate**

Oral examination  
Duration: ca. 20 minutes  
No tools or reference materials may be used during the exam.

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Project Management in Rail Industry**  
2115995, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

All slides are available for download (Ilias-platform).

**Notes**

Rail vehicles are capital-intensive goods which are manufactured in small series (like aircraft). The work to be done at industry and customers is organized in "projects". This is completely different to the way of working in large-scale production (like car industry). Everybody working in this type of business is part of a project and should be aware of the typical processes.

The lecturer provides a comprehensive overview about modern project management for small series of capital-intensive goods. The content is valid not for rail vehicle business but also for other areas with similar business processes. The following topics will be discussed:

1. Introduction: definition of project and project management  
2. Project management system: project phases, main processes and supporting processes, governance  
3. Organization: organizational structure within a company, project organization, roles in a project organization  
4. Main processes: project start, project plan, work brake down structure, detailed project schedule, risk and opportunity management, change management, project closure  
5. Governance
Learning Content
Rail vehicles are capital-intensive goods which are manufactured in small series (like aircraft). The work to done at industry and customers is organized in "projects". This is completely different to the way of working in large-scale production (like car industry). Everybody working in this type of business is part of a project and should be aware of the typical processes.

The lecturer provides a comprehensive overview about modern project management for small series of capital-intensive goods. The content is valid not for rail vehicle business but also for other areas with similar business processes. The following topics will be discussed:

1. Introduction: definition of project and project management
2. Project management system: project phases, main processes and supporting processes, governance
3. Organization: organizational structure within a company, project organization, roles in a project organization
4. Main processes: project start, project plan, work brake down structure, detailed project schedule, risk and opportunity management, change management, project closure
5. Governance

Annotation
None.

Workload
Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature
A bibliography is available for download (Ilias-platform).
11.344 Course: Project Mikromanufacturing: Development and Manufacturing of Microsystems [T-MACH-105457]

**Responsible:** Prof. Dr.-Ing. Volker Schulze

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102613 - Major Field: Lifecycle Engineering
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**

Alternative test achievement (graded):

- presentation (about 15 min) with weighting 40%
- scientific colloquium (about 15 min) with weighting 40%
- Project work (graded) with weighting 20%

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Project Micro-Manufacturing: Design and Manufacturing of a Microsystem**

2149680, WS 19/20, 3 SWS, Language: German, Open in study portal

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
The course "Project micro manufacturing: design and manufacturing of a micro system" combines the basics of micro manufacturing with project work. The project work will be done in cooperation with an industry partner. The students learn the basics of micro milling, micro electric discharge machining, micro laser ablation, micro powder injection molding and micro quality assurance. Furthermore they get to know the CAD-CAM process chain. That is the manufacturing of a production out of a CAD model. The students develop ideas and concepts matching the given task and present the results to the industry partner. Then they create parts that are designed for manufacturability out of their concepts. Those parts are manufactured at the wbk and finally assembled to a prototype.

Learning Outcomes:
The students...

- are able to describe the micro manufacturing processes as well as their characteristics and applications.
- can choose suitable manufacturing processes for a given product.
- are able to describe the process along the CAD-CAM process chain from scratch to manufacturing.
- can explain how the development process for a micro product looks like.
- are able to describe how design for manufacturability works for micro products and where the differences to macroscopic scale are.

Workload:
regular attendance: 31,5 hours
self-study: 148,5 hours

Learning Content
The course "Project micro manufacturing: design and manufacturing of a micro system" combines the basics of micro manufacturing with project work. The project work will be done in cooperation with an industry partner. The students learn the basics of micro milling, micro electric discharge machining, micro laser ablation, micro powder injection molding and micro quality assurance. Furthermore they get to know the CAD-CAM process chain. That is the manufacturing of a production out of a CAD model. The students develop ideas and concepts matching the given task and present the results to the industry partner. Then they create parts that are designed for manufacturability out of their concepts. Those parts are manufactured at the wbk and finally assembled to a prototype.

Workload
regluar attendance: 31,5 hours
self-study: 148,5 hours
**11.345 Course: Project Workshop: Automotive Engineering [T-MACH-102156]**

**Responsible:** Dr.-Ing. Michael Frey  
Prof. Dr. Frank Gauterin  
Dr.-Ing. Martin Gießler

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology

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<td>3 SWS</td>
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| Exams |  
| SS 2019 | 76-T-MACH-102156 | Prüfung (PR) | Gauterin |

**Competence Certificate**

Oral examination  
Duration: 30 up to 40 minutes  
Auxiliary means: none

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Project Workshop: Automotive Engineering**  
2115817, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Learning Content**

During the Project Workshop Automotive Engineering a team of six persons will work on a task given by an German industrial partner using the instruments of project management. The task is relevant for the actual business and the results are intended to be industrialized after the completion of the project workshop.

The team will generate approaches in its own responsibility and will develop solutions for practical application. Coaching will be supplied by both, company and institute.

At the beginning in a start-up meeting goals and structure of the project will be specified. During the project workshop there will be weekly team meetings. Also a milestone meeting will be held together with persons from the industrial company. In a final presentation the project results will be presented to the company management and to institute representatives.

**Annotation**

Selection procedure, applications are to submit in the end of the preceding semester.

**Workload**

regular attendance: 49 hours  
self-study: 131 hours
**Literature**

The scripts will be supplied in the start-up meeting.

**Notes**
Limited number of participants with selection procedure, in German language. Please send the application at the end of the previous semester.
Date and room: see homepage of institute.

**Learning Content**
During the Project Workshop Automotive Engineering a team of six persons will work on a task given by an German industrial partner using the instruments of project management. The task is relevant for the actual business and the results are intended to be industrialized after the completion of the project workshop.

The team will generate approaches in its own responsibility and will develop solutions for practical application. Coaching will be supplied by both, company and institute.

At the beginning in a start-up meeting goals and structure of the project will be specified. During the project workshop there will be weekly team meetings. Also a milestone meeting will be held together with persons from the industrial company. In a final presentation the project results will be presented to the company management and to institute representatives.

**Annotation**
Selection procedure, applications are to submit in the end of the preceding semester.

**Workload**
regular attendance: 49 hours
self-study: 131 hours

**Literature**

The scripts will be supplied in the start-up meeting.
11.346 Course: ProVIL - Product development in a Virtual Idea Laboratory [T-MACH-106738]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102591 - Laboratory Course

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**Exams**

- SS 2019: 76T-MACH-106738 ProVIL - Product development in a Virtual Idea Laboratory
  - Prüfung (PR)
  - Albers

**Competence Certificate**
colloquia and presentations.

**Prerequisites**
none
## 11.347 Course: Public Law I - Basic Principles [T-INFO-101963]

**Responsible:** Prof. Dr. Nikolaus Marsch  
**Organisation:** KIT Department of Informatics  
**Part of:** M-MACH-102596 - Compulsory Elective Subject Economics/Law

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| Events   | Credits | Type                        | Lecturer |   |
|----------|---------|-----------------------------|----------|
| WS 19/20 | 24016   | Öffentliches Recht I - Grundlagen | Marsch   |   |
|          |         | 2 SWS Lecture (V)           |          |   |

| Exams   | Credits | Type                        | Lecturer |   |
|---------|---------|-----------------------------|----------|
| SS 2019 | 7500100 | Public Law I - Basic Principles | Marsch   |   |
|         |         | Prüfung (PR)                |          |   |
Course: Quality Management [T-MACH-102107]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102596 - Compulsory Elective Subject Economics/Law
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102640 - Major Field: Technical Logistics
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

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**Exams**

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<td>76-T-MACH-102107</td>
<td>Prüfung (PR)</td>
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**Competition Certificate**

Written Exam (60 min)

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Quality Management**

2149667, WS 19/20, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

**Media:**

Lecture notes will be provided in Ilias (https://ilias.studium.kit.edu/)
Notes
Based on the quality philosophies Total Quality Management (TQM) and Six Sigma, the lecture deals with the requirements of modern quality management. Within this context, the process concept of a modern enterprise and the process-specific fields of application of quality assurance methods are presented. The lecture covers the current state of the art in preventive and non-preventive quality management methods in addition to manufacturing metrology, statistical methods and service related quality management. The content is completed with the presentation of certification possibilities and legal quality aspects.

Main topics of the lecture:
- The term "Quality"
- Total Quality Management (TQM) and Six Sigma
- Universal methods and tools
- QM during early product stages – product definition
- QM during product development and in procurement
- QM in production – manufacturing metrology
- QM in production – statistical methods
- QM in service
- Quality management systems
- Legal aspects of QM

Learning Outcomes:
The students ...
- are capable to comment on the content covered by the lecture.
- are capable of substantially quality philosophies.
- are able to apply the QM tools and methods they have learned about in the lecture to new problems from the context of the lecture.
- are able to analyze and evaluate the suitability of the methods, procedures and techniques they have learned about in the lecture for a specific problem.

Workload:
regular attendance: 21 hours
self-study: 99 hours

Learning Content
Based on the quality philosophies Total Quality Management (TQM) and Six Sigma, the lecture deals with the requirements of modern quality management. Within this context, the process concept of a modern enterprise and the process-specific fields of application of quality assurance methods are presented. The lecture covers the current state of the art in preventive and non-preventive quality management methods in addition to manufacturing metrology, statistical methods and service related quality management. The content is completed with the presentation of certification possibilities and legal quality aspects.

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- QM during product development and in procurement
- QM in production – manufacturing metrology
- QM in production – statistical methods
- QM in service
- Quality management systems
- Legal aspects of QM

Annotation
None

Workload
regular attendance: 21 hours
self-study: 99 hours
11.349 Course: Radiation Protection: Ionising Radiation [T-ETIT-100663]

**Responsible:** Prof. Dr. Olaf Dössel

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:** M-MACH-102643 - Major Field: Fusion Technology

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**Prerequisites**
none
**Course: Rail System Technology [T-MACH-106424]**

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102641 - Major Field: Rail System Technology

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<td>Rail System Technology</td>
<td>Lecture (V)</td>
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**Exams**

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<td>Prüfung (PR)</td>
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<td>76-T-MACH-106424</td>
<td>Rail System Technology</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**

Oral examination  
Duration: ca. 20 minutes  
No tools or reference materials may be used during the exam.

**Prerequisites**

none

**Below you will find excerpts from events related to this course:**

**Rail System Technology**  
2115919, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**

All slides are available for download (Ilias-platform).

**Notes**

1. Railway System: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact  
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling  
3. Infrastructure: rail facilities, track alignment, railway stations, clearance diagram  
4. Wheel-rail-contact: carrying of vehicle mass, adhesion, wheel guidance, current return  
5. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles  
6. Signaling and Control: operating procedure, succession of trains, European Train Control System, blocking period, automatic train control  
7. Traction power supply: power supply of rail vehicles, power networks, filling stations  
8. History (optional)
Learning Content
1. Railway System: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
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5. Vehicle dynamics: tractive and brake effort, driving resistance, inertial force, load cycles
6. Signalling and Control: operating procedure, succession of trains, European Train Control System, blocking period, automatic train control
7. Traction power supply: power supply of rail vehicles, power networks, filling stations
8. History (optional)

Workload
Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature
A bibliography is available for download (Ilias-platform).

Rail System Technology
2115919, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
Media:
All slides are available for download (Ilias-platform).

Notes
1. Railway System: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact
2. Operation: Transportation, public transport, regional transport, long-distance transport, freight service, scheduling
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7. Traction power supply: power supply of rail vehicles, power networks, filling stations
8. History (optional)

Workload
Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature
A bibliography is available for download (Ilias-platform).
Course: Rail Vehicle Technology [T-MACH-105353]

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102641 - Major Field: Rail System Technology

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**Competence Certificate**

Oral examination

Duration: ca. 20 minutes

No tools or reference materials may be used during the exam.

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Rail Vehicle Technology**

2115996, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**

All slides are available for download (Ilias-platform).

**Notes**

1. Vehicle system technology: structure and main systems of rail vehicles
2. Car body: functions, requirements, design principles, crash elements, interfaces
3. Bogies: forces, running gears, axle configuration
4. Drives: vehicle with/without contact wire, dual-mode vehicle
5. Brakes: tasks, basics, principles, blending, brake control
6. Train control management system: definitions, networks, bus systems, components, examples
7. Vehicle concepts: trams, metros, regional trains, intercity trains, high speed trains, double deck coaches, locomotives, freight wagons
Learning Content

1. Vehicle system technology: structure and main systems of rail vehicles
2. Car body: functions, requirements, design principles, crash elements, interfaces
3. Bogies: forces, running gears, axle configuration
4. Drives: vehicle with/without contact wire, dual-mode vehicle
5. Brakes: tasks, basics, principles, blending, brake control
6. Train control management system: definitions, networks, bus systems, components, examples
7. Vehicle concepts: trams, metros, regional trains, intercity trains, high speed trains, double deck coaches, locomotives, freight wagons

Workload

Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature

A bibliography is available for download (Ilias-platform).

Notes

1. Vehicle system technology: structure and main systems of rail vehicles
2. Car body: functions, requirements, design principles, crash elements, interfaces
3. Bogies: forces, running gears, axle configuration
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Learning Content

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7. Vehicle concepts: trams, metros, regional trains, intercity trains, high speed trains, double deck coaches, locomotives, freight wagons

Workload

Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature

A bibliography is available for download (Ilias-platform).
**11.352 Course: Railways in the Transportation Market [T-MACH-105540]**

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102641 - Major Field: Rail System Technology

**Type**  
- Oral examination

**Credits**  
- 4

**Recurrence**  
- Each summer term

**Version**  
- 1

### Events

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### Competence Certificate

Oral examination

Duration: ca. 20 minutes

No tools or reference materials may be used during the exam.

### Prerequisites

none

*Below you will find excerpts from events related to this course:*

**Railways in the Transportation Market**  
2114914, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Description**

Media:

All material is available for download (Ilias-platform).

**Notes**

The lecture gives an overview about perspective, challenges and chances of rail systems in the national and European market. Following items will be discussed:

- Introduction and basics  
- Rail reform  
- Overview of Deutsche Bahn  
- Development of infrastructure  
- Regulation of railways  
- Intra- and intermodal competition  
- Field of actions in transport policy  
- Railways and environment  
- Trends in the transportation market  
- Future of Deutsche Bahn, DB 2020  
- Integration of traffic carriers  
- International passenger and freight transportation
Learning Content
The lecture gives an overview about perspective, challenges and chances of rail systems in the national and European market. Following items will be discussed:

- Introduction and basics
- Rail reform
- Overview of Deutsche Bahn
- Development of infrastructure
- Regulation of railways
- Intra- and intermodal competition
- Field of actions in transport policy
- Railways and environment
- Trends in the transportation market
- Future of Deutsche Bahn, DB 2020
- Integration of traffic carriers
- International passenger and freight transportation

Workload
Regular attendance: 21 hours
Self-study: 21 hours
Exam and preparation: 78 hours

Literature
none
Course: Reactor Safety I: Fundamentals [T-MACH-105405]

**Responsible:** Dr. Victor Hugo Sanchez-Espinoza

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102608 - Major Field: Nuclear Energy

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**Exams**

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<td>Sanchez-Espinoza</td>
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**Competence Certificate**

oral exam about 30 minutes

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Reactor Safety I: Fundamentals**

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<th>2189465</th>
<th>2 SWS</th>
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**Description**

In the lecture, the fundamental principles and concepts of reactor safety are discussed. They facilitate the assessment of the safety status of nuclear power plants and the interpretation of incidents or accidents as such as Chernobyl or Fukushima. Starting with the explanations of the technical safety features of reactor systems, the safety concepts of different reactor types are discussed. The initiation and progression of incidents/accidents as well as the methods for the safety evaluation are also treated in the lecture. Discussing the Fukushima accident, the radiological risk from nuclear power plants together with the counter measures to stop severe accident and to limit the consequences will be explained. Finally, new development to increase the safety or reactors of Generation III and IV will be presented.
Notes
This lecture will be given in English, if required in German.

The lecture discuss the fundamental principles and concepts of reactor safety including the methodologies for safety assessment and major accidents.

In the lecture, the fundamental principles and concepts of reactor safety are discussed. They facilitate the assessment of the safety status of nuclear power plants and the interpretation of incidents or accidents such as Chernobyl or Fukushima. Starting with the explanations of the technical safety features of reactor systems, the safety concepts of different reactor types are discussed. The initiation and progression of incidents/accidents as well as the methods for the safety evaluation are also treated in the lecture. Discussing the Fukushima accident, the radiological risk from nuclear power plants together with the counter measures to stop severe accident and to limit the consequences will be explained. Finally, new development to increase the safety or reactors of Generation III and IV will be presented.

Lecture Content:
- National and international nuclear regulations
- Fundamental principles of reactor safety
- Implementation of safety principles in nuclear power plants of generation 2
- Safety analysis and methods for safety assessment
- Nuclear events and accidents and its evaluation methods
- Discussion severe accidents e.g. the Fukushima accident
- Safety features of reactor systems of generation 3 and 4

Lernziele
Lecture Content:
- National and international nuclear regulations
- Fundamental principles of reactor safety
- Implementation of safety principles in nuclear power plants of generation 2
- Safety analysis and methods for safety assessment
- Nuclear events and accidents and its evaluation methods
- Discussion severe accidents e.g. the Fukushima accident
- Safety features of reactor systems of generation 3 and 4

Knowledge in energy technology, nuclear power plants, reactor physics, thermal hydraulic of nuclear reactors is welcomed.

regular attendance: 30 h
self-study: 60 h

Zielgruppe: Students of Mechanical Engineering,
oral examination, duration approximately 30 minutes

Learning Content
Lecture Content:
- National and international nuclear regulations
- Fundamental principles of reactor safety
- Implementation of safety principles in nuclear power plants of generation 2
- Safety analysis and methods for safety assessment
- Nuclear events and accidents and its evaluation methods
- Discussion severe accidents e.g. the Fukushima accident
- Safety features of reactor systems of generation 3 and 4

Workload
regular attendance: 30 h
self-study: 60 h

Literature
11.354 Course: Reduction Methods for the Modeling and the Simulation of Vombustion Processes [T-MACH-105421]

**Responsible:** Dr. Viatcheslav Bykov  
Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
M-MACH-102635 - Major Field: Engineering Thermodynamics

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**Events**

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<td>Reduction methods for the modeling and the simulation of combustion processes</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
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**Competence Certificate**  
oral exam (20 min)

**Prerequisites**  
none

*Below you will find excerpts from events related to this course:*

**Reduction methods for the modeling and the simulation of combustion processes**  
2166543, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**  
The course will introduce the principles of model reduction of chemical kinetic models of combustion processes. The basic mathematical concepts and methods of analysis of chemical reaction mechanisms will be outlined in the context of model reduction. The detailed implementation scheme of model reduction will be introduced. The course will cover simplified and idealized models of combustion (e.g. auto-ignition, explosion, deflagration etc.), which will be analyzed and reduced. The main analytical methods and numerical tools will be presented, evaluated and illustrated by using these simple examples.

**Workload**  
regular attendance: 21 hours  
self-study: 100,0 hours

**Literature**  
### 11.355 Course: Reliability Engineering 1 [T-MACH-107447]

**Responsible:** Dr.-Ing. Alexei Konnov  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102610 - Major Field: Power Plant Technology  
- M-MACH-102624 - Major Field: Information Technology  
- M-MACH-102627 - Major Field: Energy Converting Engines  
- M-MACH-102636 - Major Field: Thermal Turbomachines

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**Competence Certificate**

written exam

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

#### Reliability Engineering 1

2169550, WS 19/20, 2 SWS, Language: English, [Open in study portal](#)

**Learning Content**

Technical background: instrumentation and control systems in power plants  
Introduction to reliability theory  
Introduction to probability theory  
Introduction to formal logic  
Introduction to statistic

**Workload**

regular attendance: 25 h  
self-study: 65 h

**Literature**

Lesson script (link will be available)  
Recommended books:  
- Birolini, Alessandro: *Reliability Engineering Theory and Practice*  
- Pham, Hoang: *Handbook of reliability engineering*

**Responsible:**  
PD Dr. Patrick Jochem  
Prof. Dr. Russell McKenna

**Organisation:**  
KIT Department of Economics and Management

**Part of:**  
M-MACH-104323 - Major Field: Innovation and Entrepreneurship

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**Exams**

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<td>Fichtner</td>
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<td>7981012</td>
<td>Renewable Energy-Resources, Technologies and Economics</td>
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**Competence Certificate**

The assessment consists of a written exam (60 min., in English, answers in English or German) according to § 4 paragraph 2 Nr. 1 of the examination regulation SPO2015.

**Prerequisites**

None.

Below you will find excerpts from events related to this course:

**Learning Content**

1. General introduction: Motivation, Global situation  
2. Basics of renewable energies: Energy balance of the earth, potential definition  
3. Hydro  
4. Wind  
5. Solar  
6. Biomass  
7. Geothermal  
8. Other renewable energies  
9. Promotion of renewable energies  
10. Interactions in systemic context  
11. Excursion to the “Energieberg” in Mühlburg

**Workload**

The total workload for this course is approximately 105.0 hours. For further information see German version.
Literature

Elective literature:

### 11.357 Course: Robotics I - Introduction to Robotics [T-INFO-108014]

**Responsible:** Prof. Dr.-Ing. Tamim Asfour  
**Organisation:** KIT Department of Informatics  
**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102609 - Major Field: Cognitive Technical Systems  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102647 - Major Field: Microactuators and Microsensors  

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<td><strong>WS 19/20</strong></td>
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</table>
Below you will find excerpts from events related to this course:

### Learning Content
The lecture presents current work in the field of humanoid robotics that deals with the implementation of complex sensorimotor and cognitive abilities. In the individual topics different methods and algorithms, their advantages and disadvantages, as well as the current state of research are discussed.

The topics addressed are: biomechanical models of the human body, biologically inspired and data-driven methods of grasping, active perception, imitation learning and programming by demonstration as well as semantic representations of sensorimotor experience.

### Workload
90 h
11.359 Course: Robotics III - Sensors in Robotics [T-INFO-101352]

**Responsible:** Prof. Dr.-Ing. Tamim Asfour

**Organisation:** KIT Department of Informatics

**Part of:**
- M-MACH-102609 - Major Field: Cognitive Technical Systems
- M-MACH-102615 - Major Field: Medical Technology
- M-MACH-102633 - Major Field: Robotics

**Type:** Written examination

**Credits:** 3

**Recurrence:** Each summer term

**Version:** 1

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### Events

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<td>Robotics III - Sensors in Robotics</td>
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Below you will find excerpts from events related to this course:

#### Robotics III - Sensors and Perception in Robotics

**2400067, SS 2019, 2 SWS, Language: German/English, [Open in study portal](#)**

**Lecture (V)**

**Learning Content**

The lecture supplements the lecture Robotics I with a broad overview of sensors used in robotics. The lecture focuses on visual perception, object recognition, simultaneous localization and mapping (SLAM) and semantic scene interpretation. The lecture is divided into two parts:

In the first part a comprehensive overview of current sensor technologies is given. A basic distinction is made between sensors for the perception of the environment (exteroceptive) and sensors for the perception of the internal state (proprioceptive).

The second part of the lecture concentrates on the use of exteroceptive sensors in robotics. The topics covered include tactile exploration and visual data processing, including advanced topics such as feature extraction, object localization, simultaneous localization and mapping (SLAM) and semantic scene interpretation.

**Workload**

90h
11.360 Course: Safety Engineering [T-MACH-105171]

**Responsible:** Hans-Peter Kany

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102613 - Major Field: Lifecycle Engineering
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102640 - Major Field: Technical Logistics

**Type**
- Oral examination

**Credits**
- 4

**Recurrence**
- Each winter term

**Version**
- 2

### Events

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### Competence Certificate

The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**

none

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Below you will find excerpts from events related to this course:

**V Safety Engineering**

2117061, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**
- presentations
Notes
Media
Presentations

Learning content
The course provides basic knowledge of safety engineering. In particular the basics of health at the working place, job safety in Germany, national and European safety rules and the basics of safe machine design are covered. The implementation of these aspects will be illustrated by examples of material handling and storage technology. This course focuses on: basics of safety at work, safety regulations, basic safety principles of machine design, protection devices, system security with risk analysis, electronics in safety engineering, safety engineering for storage and material handling technique, electrical dangers and ergonomics. So, mainly, the technical measures of risk reduction in specific technical circumstances are covered.

Learning goals
The students are able to:

- Name and describe relevant safety concepts of safety engineering,
- Discuss basics of health at work and labour protection in Germany,
- Evaluate the basics for the safe methods of design of machinery with the national and European safety regulations and
- Realize these objectives by using examples in the field of storage and material handling systems.

Recommendations
None

Workload
Regular attendance: 21 hours
Self-study: 99 hours

Note
Dates: See IFL-Homepage

Learning Content
The course provides basic knowledge of safety engineering. In particular the basics of health at the working place, job safety in Germany, national and European safety rules and the basics of safe machine design are covered. The implementation of these aspects will be illustrated by examples of material handling and storage technology. This course focuses on: basics of safety at work, safety regulations, basic safety principles of machine design, protection devices, system security with risk analysis, electronics in safety engineering, safety engineering for storage and material handling technique, electrical dangers and ergonomics. So, mainly, the technical measures of risk reduction in specific technical circumstances are covered.

Annotation
none

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
11.361 Course: Scaling in Fluid Dynamics [T-MACH-105400]

**Responsible:** Prof. Dr. Leo Bühler  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanic

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<td>Bühler</td>
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**Competence Certificate**

- Oral exam  
- Duration: 20–30 minutes  
- No auxiliary means

**Prerequisites**

- none

**Recommendation**

- Fluid Mechanics (T-MACH-105207)

**Below you will find excerpts from events related to this course:**

### Scaling in fluid dynamics

**2154044, SS 2019, 2 SWS, Language: German, [Open in study portal](#)**

**Notes**

- Introduction  
- Similarity rules (examples)  
- Dimensional analysis (Pi-theorem)  
- Scaling in differential equations  
- Scaling in boundary layers  
- Self-similar solutions  
- Scaling in turbulent shear layers  
- Rotating flows  
- Magnetohydrodynamic flows

**Educational objective:** The student can extract non-dimensional number from the characteristic properties of flows. From the insights on scaling laws, the students are qualified to identify the influencing quantities from generic experiments and transfer these to real applications. The students can simplify the governing equations of fluid mechanic appropriately and can interpret the achieved results as a basis for efficient solution strategies.
Learning Content

- Introduction
- Similarity rules (examples)
- Dimensional analysis (Pi-theorem)
- Scaling in differential equations
- Scaling in boundary layers
- Self-similar solutions
- Scaling in turbulent shear layers
- Rotating flows
- Magnetohydrodynamic flows

Annotation
Recommendation: Fluid Mechanics

Workload
Regular attendance: 32 hours
self-study: 88 hours

Literature
G. I. Barenblatt, 1979, Similarity, Self-Similarity, and Intermediate Asymptotics, Plenum Publishing Corporation (Consultants Bureau)
J. Zierep, 1982, Ähnlichkeitsgesetze und Modellregeln der Strömungsmechanik, Braun
J. H. Spurk, 1992, Dimensionsanalyse in der Strömungslehre, Springer
11.362 Course: Scientific Computing for Engineers [T-MACH-100532]

**Responsible:** Prof. Dr. Peter Gumbsch  
Dr. Daniel Weygand

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering  
M-MACH-102646 - Major Field: Applied Mechanics  
M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering  
M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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<td>Scientific computing for Engineers</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Weygand, Gumbsch</td>
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**Competence Certificate**  
Written exam (90 minutes)

**Prerequisites**  
The brick cannot be combined with the brick "Application of advanced programming languages in mechanical engineering" (T-MACH-105390).

**Modeled Conditions**  
The following conditions have to be fulfilled:

1. The course T-MACH-105390 - Application of Advanced Programming Languages in Mechanical Engineering must not have been started.

Below you will find excerpts from events related to this course:

**Scientific computing for Engineers**  
2181738, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)
Notes
1. Introduction: why scientific computing
2. computer architectures
3. Introduction to Unix/Linux
4. Foundations of C++
   * program organization
   * data types, operator, control structures
   * dynamic memory allocation
   * functions
   * class
   * OpenMP parallelization
5. numeric /algorithms
   * finite differences
   * MD simulations: 2nd order differential equations
   * algorithms for particle simulations
   * solver for linear systems of eqns.

The student can
- apply the programming language C++ for scientific computing in the field of materials science
- adapt programs for use on parallel platforms
- choose suitable numerical methods for the solution of differential equations.

The lecture can not be combined with the lecture “Application of advanced programming languages in mechanical engineering” (2182735).

regular attendance: 22.5 hours
Lab: 22.5 hours (optional)
self-study: 75 hours
written exam 90 minutes

Learning Content
1. Introduction: why scientific computing
2. computer architectures
3. Introduction to Unix/Linux
4. Foundations of C++
   * program organization
   * data types, operator, control structures
   * dynamic memory allocation
   * functions
   * class
   * OpenMP parallelization
5. numeric /algorithms
   * finite differences
   * MD simulations: 2nd order differential equations
   * algorithms for particle simulations
   * solver for linear systems of eqns.

Annotation
The lecture can not be combined with the lecture “Application of advanced programming languages in mechanical engineering” (2182735).

Workload
regular attendance: 22.5 hours
Lab: 22.5 hours (optional)
self-study: 75 hours

Literature
1. C++: Einführung und professionelle Programmierung; U. Breymann, Hanser Verlag München
2. C++ and object-oriented numeric computing for Scientists and Engineers, Daoqui Yang, Springer Verlag.
3. The C++ Programming Language, Bjarne Stroustrup, Addison-Wesley
4. Die C++ Standardbibliothek, S. Kuhlins und M. Schader, Springer Verlag

Numerik:
1. Numerical recipes in C++ / C / Fortran (90), Cambridge University Press
2. Numerische Mathematik, H.R. Schwarz, Teubner Stuttgart
3. Numerische Simulation in der Molekulärkumik, Griebel, Knaepk, Zumbusch, Caglar, Springer Verlag
Notes
Exercises for the different topics of the lecture "Scientific computing for Engineers" (2181738)

Learning Content
Exercises for the different topics of the lecture "Scientific computing for Engineers" (2181738)

Workload
regular attendance: 22,5 hours

Literature
lecture notes "Scientific computing for Engineers" (2181738)
11.363 Course: Selected Applications of Technical Logistics [T-MACH-102160]

**Responsible:** Viktor Milushev  
Dr.-Ing. Martin Mittwollen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102640 - Major Field: Technical Logistics

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**Exams**

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**Competence Certificate**

The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**

none

**Recommendation**

Knowledge out of Basics of Technical Logistics (T-MACH-102163) / Elements and Systems of Technical Logistics (T-MACH-102159) preconditioned

**Below you will find excerpts from events related to this course:**

**Selected Applications of Technical Logistics**

2118087, SS 2019, 3 SWS, Language: German, [Open in study portal](#)

**Description**

**Media:**  
supplementary sheets, projector, blackboard

**Notes**

Details according schedule will be published

**Learning Content**

- design and dimension of machines from intralogistics  
- static and dynamic behaviour  
- operation properties and specifics  
- Inside practical lectures: sample applications and calculations in addition to the lectures

**Annotation**

Knowledge out of Basics of Technical Logistics preconditioned

**Workload**

presence: 36h  
rework: 84h
Literature
Recommendations during lessons
11.364 Course: Selected Applications of Technical Logistics - Project [T-MACH-108945]

**Responsible:** Viktor Milushev  
Dr.-Ing. Martin Mittwollen

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102640 - Major Field: Technical Logistics

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**Exams**

| SS 2019 | 76-T-MACH-108945 | Selected Applications of Technical Logistics - Project | Prüfung (PR) | Mittwollen |

**Competence Certificate**

presentation of performed project and defense (30min) according to §4 (2), No. 3 of the examination regulation

**Prerequisites**

T-MACH-102160 (selected applications of technical logistics) must have been started

**Modeled Conditions**

The following conditions have to be fulfilled:

1. The course T-MACH-102160 - Selected Applications of Technical Logistics must have been started.

**Recommendation**

Knowledge out of Basics of Technical Logistics (T-MACH-102163) / Elements and Systems of Technical Logistics (T-MACH-102159) preconditioned
11.365 Course: Selected Chapters of the Combustion Fundamentals [T-MACH-105428]

**Responsible:** Prof. Dr. Ulrich Maas

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102635 - Major Field: Engineering Thermodynamics

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**Events**

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**Competence Certificate**

Oral exam (20 min)

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Selected chapters of the combustion fundamentals**

2167541, SS 2019, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

Blackboard and Powerpoint presentation

**Learning Content**

Depending on the lecture: Fundamentals of chemical kinetics, of statistical modeling of turbulent flames or of droplet and spray combustion.

**Workload**

Regular attendance: 21.5 hours

Self-study: 98.5 hours

**Literature**

Lecture notes


**Selected chapters of the combustion fundamentals**

2167541, WS 19/20, 2 SWS, Language: German, Open in study portal

**Description**

**Media:**

Blackboard and Powerpoint presentation
Learning Content
Depending on the lecture: Fundamentals of chemical kinetics, of statistical modeling of turbulent flames or of droplet and spray combustion.

Workload
Regular attendance: 22.5 h
Self-study: 97.5 h

Literature
Lecture notes
11.366 Course: Selected Problems of Applied Reactor Physics and Exercises [T-MACH-105462]

**Responsible:** Dr. Ron Dagan

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- **M-MACH-102597** - Compulsory Elective Module Mechanical Engineering
- **M-MACH-102623** - Major Field: Fundamentals of Energy Technology

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<td>Prüfung (PR)</td>
<td>Dagan, Stieglitz</td>
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**Competence Certificate**
- oral exam, 1/2 hour

**Prerequisites**
- none

Below you will find excerpts from events related to this course:

**Selected Problems of Applied Reactor Physics and Exercises**
- 2190411, SS 2019, 2 SWS, Language: German, Open in study portal

**Notes**
- Nuclear energy and forces
- Radioactive decay
- Nuclear processes
- Fission and the importance of delayed neutrons
- Basics of nuclear cross sections
- Principles of chain reaction
- Static theory of mono energetic reactors
- Introduction to reactor kinetic
- student laboratory

The students
- have solid understanding of the basic reactor physics
- are able to estimate processes of growth and decay of radionuclides; out of it, they can perform dose calculation and introduce their biological hazards
- can calculate the relationship of basic parameters which are needed for a stable reactor operation
- understand important dynamical processes of nuclear reactors.

Regular attendance: 26 h
self study 94 h
oral exam about 30 min.
Learning Content

- Nuclear energy and forces
- Radioactive decay
- Nuclear processes
- Fission and the importance of delayed neutrons
- Basics of nuclear cross sections
- Principles of chain reaction
- Static theory of mono energetic reactors
- Introduction to reactor kinetic
- Student laboratory

Workload
Regular attendance: 26 h
Self study: 94 h

Literature
K. Wirtz Basics of Reactor technic Par I, II, Technic School Karlsruhe 1966 (in German)
Course: Seminar Data-Mining in Production [T-MACH-108737]

**Responsible:** Prof. Dr.-Ing. Gisela Lanza

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**

alternative test achievement (graded):

- written elaboration (workload of at least 80 h)
- oral presentation (approx. 30 min)

**Prerequisites**

none

**Annotation**

The number of students is limited to twelve. Dates and deadlines for the seminar will be announced at [https://www.wbk.kit.edu/studium-und-lehre.php](https://www.wbk.kit.edu/studium-und-lehre.php).

**Below you will find excerpts from events related to this course:**

**Seminar Data Mining in Production**

2151643, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Description**

Media:

KNIME Analytics Platform
Notes
In the age of Industry 4.0, large amounts of production data are generated by the global production networks and value chains. Their analysis enables valuable conclusions about production and lead to an increasing process efficiency. The aim of the seminar is to get to know production data analysis as an important component of future industrial projects. The students get to know the data mining tool KNIME and use it for analyses. A specific industrial use case with real production data enables practical work and offers direct references to industrial applications. The participants learn selected methods of data mining and apply them to the production data. The work within the seminar takes place in small groups on the computer. Subsequently, presentations on specific data mining methods have to be prepared.

Learning Outcomes:
The students ...

- can name, describe and distinguish between different methods, procedures and techniques of production data analysis.
- can perform basic data analyses with the data mining tool KNIME.
- can analyze and evaluate the results of data analyses in the production environment.
- are able to derive suitable recommendations for action.
- are able to explain and apply the CRISP-DM model.

Workload:
regular attendance: 10 hours
self-study: 80 hours

Learning Content
In the age of Industry 4.0, large amounts of production data are generated by the global production networks and value chains. Their analysis enables valuable conclusions about production and lead to an increasing process efficiency. The aim of the seminar is to get to know production data analysis as an important component of future industrial projects. The students get to know the data mining tool KNIME and use it for analyses. A specific industrial use case with real production data enables practical work and offers direct references to industrial applications. The participants learn selected methods of data mining and apply them to the production data. The work within the seminar takes place in small groups on the computer. Subsequently, presentations on specific data mining methods have to be prepared.

Annotation
The number of students is limited to twelve. Dates and deadlines for the seminar will be announced at https://www.wbk.kit.edu/studium-und-lehre.php.

Workload
regular attendance: 10 hours
self-study: 80 hours

Seminar Data Mining in Production
2151643, WS 19/20, 2 SWS, Language: German, Open in study portal

Description
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Annotation
The number of students is limited to twelve. Dates and deadlines for the seminar will be announced at https://www.wbk.kit.edu/studium-und-lehre.php.

Workload
regular attendance: 10 hours
self-study: 80 hours
**11.368 Course: Seminar for Rail System Technology [T-MACH-108692]**

**Responsible:** Prof. Dr.-Ing. Peter Gratzfeld  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102641 - Major Field: Rail System Technology

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**Competence Certificate**  
Examination: Writing a Seminararbeit, final presentation

**Prerequisites**  
none

**Below you will find excerpts from events related to this course:**

**Seminar for Rail System Technology**  
2115009, SS 2019, 1 SWS, Language: German, [Open in study portal](#)

**Notes**

- Railway system: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact, history, challenges and future developments in the context of mega trends
- Operation: Transportation, public/regional/long-distance transport, freight service, scheduling
- System structure of railway vehicles: Tasks and classification, main systems
- Project management: definitions, project management, main and side processes, transfer to practice
- Scientific working: structuring and writing of scientific papers, literature research, scheduling (mile stones), self-management, presentation skills, using the software Citavi for literature and knowledge management, working with templates in Word, giving and taking feedback
- The learnt knowledge regarding scientific writing is used to elaborate a Seminararbeit. To this the students create a presentation, train and reflect it and finally present it to an auditorium.

**Learning Content**

- Railway system: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact, history, challenges and future developments in the context of mega trends
- Operation: Transportation, public/regional/long-distance transport, freight service, scheduling
- System structure of railway vehicles: Tasks and classification, main systems
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- Scientific working: structuring and writing of scientific papers, literature research, scheduling (mile stones), self-management, presentation skills, using the software Citavi for literature and knowledge management, working with templates in Word, giving and taking feedback
- The learnt knowledge regarding scientific writing is used to elaborate a Seminararbeit. To this the students create a presentation, train and reflect it and finally present it to an auditorium.
Workload
Regular attendance: 21 hours
Self-study (writing Seminararbeit): 65 hours
Final presentation (including preparation): 4 hours

Literature
A bibliography is available for download (Ilias-platform).

Notes
- Railway system: railway as system, subsystems and interdependencies, definitions, laws, rules, railway and environment, economic impact, history, challenges and future developments in the context of mega trends
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- The learnt knowledge regarding scientific writing is used to elaborate a Seminararbeit. To this the students create a presentation, train and reflect it and finally present it to an auditorium.

Workload
Regular attendance: 21 hours
Self-study (writing Seminararbeit): 65 hours
Final presentation (including preparation): 4 hours

Literature
A bibliography is available for download (Ilias-platform).
Course: Signals and Systems [T-ETIT-109313]

**Responsible:** Prof. Dr.-Ing. Fernando Puente León

**Organisation:** KIT Department of Electrical Engineering and Information Technology

**Part of:**
- M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics

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**Prerequisites**

none
11.370 Course: Simulation of Coupled Systems [T-MACH-105172]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer
Yusheng Xiang

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102630 - Major Field: Mobile Machines
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

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**Competence Certificate**
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at very ordinary examination date.

A registration is mandatory, the details will be announced on the webpages of the Institute of Vehicle System Technology / Institute of Mobile Machines. In case of too many applications, attendance will be granted based on pre-qualification.

**Prerequisites**
Required for the participation in the examination is the preparation of a report during the semester. The partial service with the code T-MACH-108888 must have been passed.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-108888 - Simulation of Coupled Systems - Advance must have been passed.

**Recommendation**
- Knowledge of ProE (ideally in actual version)
- Basic knowledge of Matlab/Simulink
- Basic knowledge of dynamics of machines
- Basic knowledge of hydraulics
Annotation
After completion of course, students are able to:

- build a coupled simulation
- parametrize models
- perform simulations
- conduct troubleshooting
- check results for plausibility

The number of participants is limited.

Content:
- Basics of multi-body and hydraulic simulation programs
- Possibilities of coupled simulations
- Modelling and Simulation of Mobile Machines using a wheel loader
- Documentation of the result in a short report

Literature:
Software guide books (PDFs)
Information about wheel-type loader specifications

Below you will find excerpts from events related to this course:

Simulation of Coupled Systems
2114095, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
- Knowledge of the basics of multi-body and hydraulic simulation programs
- Possibilities of coupled simulations
- Development of a simulation model by using the example of a wheel loader
- Documentation of the result in a short report

Workload
- regular attendance: 21 hours
- total self-study: 92 hours

Literature

Elective literature:
- miscellaneous guides according the software-tools pdf-shaped
- information to the wheel-type loader
11.371 Course: Simulation of Coupled Systems - Advance [T-MACH-108888]

**Responsible:** Prof. Dr.-Ing. Marcus Geimer  
Yusheng Xiang

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102630 - Major Field: Mobile Machines  
M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics

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**Exams**

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**Competence Certificate**

Preparation of semester report

**Prerequisites**

none
11.COURSES

11.372 Course: Simulation of Optical Systems [T-MACH-105990]

**Responsible:** PD Dr.-Ing. Ingo Sieber

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102601 - Major Field: Automation Technology
M-MACH-102615 - Major Field: Medical Technology

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**Events**

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**Competence Certificate**
oral exam (Duration: 20min)

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Simulation of Optical Systems**

2105018, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

Lecture (V)
Notes
This lecture gives an introduction into optical system's design. The focus is on the system concept: design for manufacture, reliability in operation, as well as interactions between optical and non-optical system components are considered. Practical aspects of optical systems design like e.g. the consideration of design rules to ensure manufacturability, tolerancing of the optical system to ensure a reliable operation, and the coupling of optical and mechanical simulation tools will also be presented. Application of the acquired techniques will be deepened with the help of three case studies.

Content:
- Introduction
- Modeling, simulation, and systems design
- Basics of optics
- Properties of optical materials
- Optical imaging
- Ray tracing
- The optical design process
- Basics of the Finite-Element Method (FEM)
- The FEM design process
- Coupling of simulation tools
- Microoptical sub-systems

Learning objectives:
The students...
- know the basics of optical modeling and simulation.
- know the basics of modeling and simulation by means of the Finite-Element Method.
- know the basics of the optical and mechanical design process.
- are able to understand the specifications of optical systems and can use them in optical modeling.
- are able to use design rules.
- are able to conduct basic tolerance analysis.
- are able to assess the need of an inter-domain simulation.

Learning Content
- Introduction
- Modeling, simulation, and systems design
- Basics of optics
- Properties of optical materials
- Optical imaging
- Ray tracing
- The optical design process
- Basics of the Finite-Element Method (FEM)
- The FEM design process
- Coupling of simulation tools
- Microoptical sub-systems

Workload
regular attendance: 21 hours
self-study: 99 hours
11.373 Course: Simulation of the process chain of continuously fiber reinforced composite structure [T-MACH-105971]

**Responsible:** Dr.-Ing. Luise Kärger  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102628 - Major Field: Lightweight Construction  
- M-MACH-102632 - Major Field: Polymer Engineering  
- M-MACH-102646 - Major Field: Applied Mechanics

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<td>Each summer term</td>
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**Events**

| SS 2019 | 2114107 | Simulation der Prozesskette kontinuierlich verstärkter Faserverbundbauteile | 2 SWS | Lecture (V) | Kärger |

**Competence Certificate**
oral exam, 20 minutes

**Prerequisites**
none
11.374 Course: Simulator Exercises Combined Cycle Power Plants [T-MACH-105445]

Responsibilities:
- Prof. Dr.-Ing. Thomas Schulenberg
- KIT Department of Mechanical Engineering

Part of:
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102636 - Major Field: Thermal Turbomachines

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Events

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Exams

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Competence Certificate
- oral exam (ca. 15 min)

Prerequisites
- none

Recommendation
- Participation at LV-No. 2170490 "Combined Cycle Power Plants" (T-MACH-105444) is recommended.

Below you will find excerpts from events related to this course:

**Simulator Exercises Combined Cycle Power Plants**
2170491, SS 2019, 2 SWS, Language: English, [Open in study portal]

**Description**

**Media:**
- The power plant simulator is based on the control system of a real SIEMENS power plant. The English user surface is based on US standard.

**Notes**
- The training objective of the course is the qualification for a research-related professional activity in power plant engineering. On the basis of the learned fundamentals in thermodynamics, in instrumentation and control engineering, as well as on the basis of the acquired knowledge of design of combined cycle plants, the participants can operate a real combined cycle power plant. This application creates a deeper understanding of the dynamic processes of the power plant, the specific importance of the plant components and the limits of the load capacity of the components. Participants can optimize normal operation and analyze incidents. They can work self-organized and reflexive. They have communicative and organizational skills in teamwork, even under major technical challenges.
- Start-up of the power plant from scratch; load changes and shut down; dynamic response of the power plant in case of malfunctions and of sudden load changes; manual operation of selected components.

**Learning Content**
- Start-up of the power plant from scratch; load changes and shut down; dynamic response of the power plant in case of malfunctions and of sudden load changes; manual operation of selected components.

**Annotation**
- Recommendation: Participation at the lecture Combined Cycle Power Plants (2170490) is recommended.
Workload
Regular attendance: 20 hours
Self study: 40 hours

Literature
Slides and other documents of the lecture Combined Cycle Power Plants.
11.375 Course: Solar Thermal Energy Systems [T-MACH-106493]

**Responsible:** Dr. Ron Dagan

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology

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**Exams**

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<td>Solar Thermal Energy Systems</td>
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<td>Dagan, Stieglitz</td>
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</table>

**Competence Certificate**
oral exam of about 30 minutes

**Prerequisites**
none

**Recommendation**

**Literature**

Below you will find excerpts from events related to this course:

**Solar Thermal Energy Systems**

2189400, WS 19/20, 2 SWS, Language: English, [Open in study portal](#)
Notes
The course deals with fundamental aspects of solar energy
1. Introduction to solar energy – global energy panorama
2. Solar energy resource-
   Structure of the sun, Black body radiation, solar constant, solar spectral distribution
   Sun-Earth geometrical relationship
3. Passive and active solar thermal applications.
4. Solar thermal systems- solar collector-types, concentrating collectors, solar towers,
   Heat losses, efficiency
5. Selected topics on thermodynamics and heat transfer which are relevant for solar systems.
6. Introduction to Solar induced systems: Wind, Heat pumps, Biomass, Photovoltaic
7. Energy storage
The course deals with fundamental aspects of solar energy. Starting from a global energy panorama the course deals with
the sun as a thermal energy source. In this context, basic issues such as the sun’s structure, blackbody radiation and solar-
earth geometrical relationship are discussed. In the next part, the lectures cover passive and active thermal applications
and review various solar collector types including concentrating collectors and solar towers and the concept of solar
tracking. Further, the collector design parameters determination is elaborated, leading to improved efficiency. This topic is
augmented by a review of the main laws of thermodynamics and relevant heat transfer mechanisms.
The course ends with an overview on energy storage concepts which enhance practically the benefits of solar thermal
energy systems.
The students get familiar with the global energy demand and the role of renewable energies learn about improved designs
for using efficiently the potential of solar energy gain basic understanding of the main thermal hydraulic phenomena which
support the work on future innovative applications will be able to evaluate quantitatively various aspects of the thermal
solar systems.
Total 120 h, hereof 30 h contact hours and 90 h homework and self-studies
oral exam about 30 min.

Learning Content
The course deals with fundamental aspects of solar energy
1. Introduction to solar energy – global energy panorama
2. Solar energy resource-
   Structure of the sun, Black body radiation, solar constant, solar spectral distribution
   Sun-Earth geometrical relationship
3. Passive and active solar thermal applications.
4. Solar thermal systems- solar collector-types, concentrating collectors, solar towers,
   Heat losses, efficiency
5. Selected topics on thermodynamics and heat transfer which are relevant for solar systems.
6. Introduction to Solar induced systems: Wind, Heat pumps, Biomass, Photovoltaic
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tracking. Further, the collector design parameters determination is elaborated, leading to improved efficiency. This topic is
augmented by a review of the main laws of thermodynamics and relevant heat transfer mechanisms.
The course ends with an overview on energy storage concepts which enhance practically the benefits of solar thermal
energy systems.

Workload
Total 120 h, hereof 30 h contact hours and 90 h homework and self-studies
11.376 Course: Solid State Reactions and Kinetics of Phase [T-MACH-107667]

**Responsible:** Dr. Peter Franke  
Prof. Dr. Hans Jürgen Seifert

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102611 - Major Field: Materials Science and Engineering

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<td>Solid State Reactions and Kinetics of Phase Transformations (with exercises)</td>
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**Prerequisites**
The successful participation in Exercises for Solid State Reactions and Kinetics of Phase Transformations is the condition for the admittance to the oral exam in Solid State Reactions and Kinetics of Phase.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-107632 - Exercises for Solid State Reactions and Kinetics of Phase Transformations must have been passed.

**Recommendation**
Basic course in materials science and engineering  
Basic course in mathematics  
Physical chemistry

**Competence Certificate**
oral examination (about 30 min)

**Below you will find excerpts from events related to this course:**

**Solid State Reactions and Kinetics of Phase Transformations (with exercises)**

2193003, WS 19/20, 2 SWS, Language: German, [Open in study portal]
Notes
Oral examination (about 30 min)
Teaching Content:
1. Crystal Defects and Mechanisms of Diffusion
2. Microscopic Description of Diffusion
3. Phenomenological Treatment
4. Diffusion Coefficients
5. Diffusion Problems; Analytical Solutions
6. Diffusion with Phase Transformation
7. Kinetics of Microstructural Transformations
8. Diffusion at Surfaces, Grain Boundaries and Dislocations
Recommendations:
knowledge of the course "Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria" (Seifert); Basic course in materials science and Engineering; Basic course in mathematics; physical chemistry
regular attendance: 22 hours
self-study: 98 hours
The students acquire knowledge about:
  • diffusion mechanisms
  • Fick's laws
  • basic solutions of the diffusion equation
  • evaluation of diffusion experiments
  • interdiffusion processes
  • the thermodynamic factor
  • parabolic growth of layers
  • formation of pearlite
  • microstructural transformations according to the models of Avrami and Johnson-Mehl
  • TTT diagrams

Learning Content
1. Crystal Defects and Mechanisms of Diffusion
2. Microscopic Description of Diffusion
3. Phenomenological Treatment
4. Diffusion Coefficients
5. Diffusion Problems; Analytical Solutions
6. Diffusion with Phase Transformation
7. Kinetics of Microstructural Transformations
8. Diffusion at Surfaces, Grain Boundaries and Dislocations

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature
11.377 Course: Stability: from order to chaos [T-MACH-108846]

**Responsible:** Prof. Dr. Andreas Class  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102595 - Compulsory Elective Module Natural Science/Computer Science/Electrical Engineering

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**Competence Certificate**
The study performance is considered to have been passed if all exercise assignments have been successfully processed and the final colloquium (30 minutes) has been successfully passed.

no auxiliary

**Prerequisites**
The partial performance number T-MACH-105425 "Hydrodynamic Stability: From Order to Chaos" must not be startet or completed. The partial services T-MACH-108846 "Stability: from order to chaos" (Nat/Inf/Etit) and T-MACH-105425 "Hydrodynamic Stability: From Order to Chaos" are mutually exclusive.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course **T-MACH-105425 - Hydrodynamic Stability: From Order to Chaos** must not have been started.

**Recommendation**
Fluid Mechanics (T-MACH-105207)  
Mathematical Methods in Fluid Mechanics (T-MACH-105295)

**Below you will find excerpts from events related to this course:**

**Hydrodynamic Stability: From Order to Chaos**  
2154437, SS 2019, 2 SWS, Language: German/English, Open in study portal

**Description**  
**Media:**  
Black board
Notes
The students can apply the analytic and numerical methods for an evaluation of stability properties of hydrodynamic systems. They are qualified to discuss the characteristic influence of parameter changes (e.g. Reynolds number) on the calculated results with respect to the flow character and properties (e.g. transition laminar/turbulent flow).

Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).

Typical hydrodynamic instabilities are summarized in the lecture.

The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.

Covered is:
- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Learning Content
Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).

Typical hydrodynamic instabilities are summarized in the lecture.

The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.

Covered is:
- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Annotation
Lecture also offered as a block-lecture within the AREVA Nuclear Professional School (www.anps.kit.edu)

Workload
- regular attendance: 21h
- self-study: 99h

Literature
Script
11.378 Course: Strategic product development - identification of potentials of innovative products [T-MACH-105696]

**Responsible:** Prof. Dr.-Ing. Albert Albers  
Prof. Dr.-Ing. Sven Matthiesen  
Dr.-Ing. Andreas Siebe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102599 - Major Field: Powertrain Systems  
M-MACH-102605 - Major Field: Engineering Design  
M-MACH-102607 - Major Field: Vehicle Technology  
M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

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**Events**

| SS 2019         | 2146198 | Strategic product development - identification of potentials of innovative products | 2 SWS | Lecture (V) | Siebe |

**Exams**

| SS 2019         | 76-T-MACH-105696 | Strategic product development - identification of potentials of innovative products | Prüfung (PR) | Siebe, Albers |

**Competence Certificate**  
Oral exam in small groups (30 minutes)

**Prerequisites**  
The precondition of this partial work is the successful processing of a case study (T-MACH-110396): written elaboration & presentation of the results (15 minutes)

**Modeled Conditions**  
The following conditions have to be fulfilled:

1. The course T-MACH-110396 - Strategic product development - identification of potentials of innovative products - Case Study must have been passed.

Below you will find excerpts from events related to this course:

**Strategic product development - identification of potentials of innovative products**

**Learning Content**  
Introduction into future management, Development of scenarios, scenariobased strategy development, trendmanagement, strategic early detection, innovation- and technologymangement, scenarios in product development, from profiles of requirements to new products, examples out of industrial praxis.

**Workload**  
regular attendance: 21 h  
self-study: 99 h
11 Course: Strategic product development - identification of potentials of innovative products - Case Study [T-MACH-110396]

**Responsible:**
- Prof. Dr.-Ing. Albert Albers
- Prof. Dr.-Ing. Sven Matthiesen
- Dr.-Ing. Andreas Siebe

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102599 - Major Field: Powertrain Systems
- M-MACH-102605 - Major Field: Engineering Design
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102642 - Major Field: Development of Innovative Appliances and Power Tools

**Type**
- Completed coursework (practical)

**Credits**
- 1

**Recurrence**
- Each summer term

**Version**
- 1

**Events**

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**Competence Certificate**
Successful processing of a case study (T-MACH-110396): written elaboration & presentation of the results (15 minutes)

Below you will find excerpts from events related to this course:

**Learning Content**
Introduction into future management, Development of scenarios, scenario-based strategy development, trend management, strategic early detection, innovation- and technology management, scenarios in product development, from profiles of requirements to new products, examples out of industrial praxis.

**Workload**
- regular attendance: 21 h
- self-study: 99 h
**11.380 Course: Structural Analysis of Composite Laminates [T-MACH-105970]**

**Responsible:** Dr.-Ing. Luise Kärger

**Organisation:** KIT Department of Mechanical Engineering

**Type**
Oral examination

**Credits**
4

**Recurrence**
Each winter term

**Version**
1

**Events**

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**Competence Certificate**
oral exam, 20 min

**Prerequisites**
none

Below you will find excerpts from events related to this course:

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**Literature**


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Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Course: Structural and Phase Analysis [T-MACH-102170]

Responsible: Dr.-Ing. Susanne Wagner

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

Type
Oral examination
Credits
4
Recurrence
Each winter term
Version
1

Events

| Events   | Course              | Credits | Type     | Recurrence
|----------|--------------------|---------|----------|-------------
| WS 19/20 | Structural and phase analysis | 2 SWS   | Lecture (V) | Wagner, Hinterstein
| SS 2019  | Structural and Phase Analysis      |          | Prüfung (PR) | Wagner, Hinterstein
| WS 19/20 | Structural and Phase Analysis      |          | Prüfung (PR) | Wagner, Hinterstein

Competition Certificate
Oral examination

Prerequisites
none

Below you will find excerpts from events related to this course:

Structural and phase analysis
2125763, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
The course gives an overview to generation and detection of x-rays as well as their interaction with matter. It provides an introduction to crystallography and describes modern measurement and analysis methods of x-ray diffraction.

It is arranged in the following units:

- Generation and properties of X-Ray's
- Crystallography
- Fundamentals and application of different measuring methods
- Qualitative and quantitative phase analysis
- Texture analysis (pole figures)
- Residual stress measurements

Workload
regular attendance: 30 hours
self-study: 90 hours

Literature
1. Moderne Röntgenbeugung - Röntgendiffraktometrie für Materialwissenschaftler, Physiker und Chemiker, Spieß, Lothar / Schwarzer, Robert / Behnken, Herfried / Teichert, Gerd B.G. Teubner Verlag 2005
11.382 Course: Structural Ceramics [T-MACH-102179]

**Responsible:** Prof. Dr. Michael Hoffmann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102619 - Major Field: Technical Ceramics and Powder Materials

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**Competence Certificate**

Oral examination, 20 min

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Structural Ceramics**

**Description**

Media:

Slides for the lecture:

available under [http://www.iam.kit.edu/km](http://www.iam.kit.edu/km)

**Learning Content**

The lecture gives an overview on structure and properties of the technical relevant structural ceramics silicon nitride, silicon carbide, alumina, zirconia, boron nitride and fibre-reinforced ceramics. All types of structural ceramics will be discussed in detail in terms of preparation methods of the raw materials, shaping techniques, densification, microstructural development, mechanical properties and application fields.

**Annotation**

The course will not take place every year.

**Workload**

regular attendance: 21 hours

self-study: 99 hours

**Literature**


Course: Structural Materials [T-MACH-100293]

**Responsible:** Dr.-Ing. Stefan Guth  
Dr. Karl-Heinz Lang

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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**Competence Certificate**
Oral exam, about 25 minutes

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Notes**
Lectures and tutorials on the topics:
- basic loading types and superimposed loadings
- high-temperature loading
- influence of notches
- uniaxial, multiaxial and superimposed cyclic loading
- notch fatigue
- structural durability
- impact of residual stresses
- basic principles of materials selection
- dimensioning of components

**Learning objectives:**
The students are able to select materials for mechanical design and to dimension structural components according to the state of the art. They are familiar with the most important engineering materials. They can assess these materials on the basis of their characteristic properties and and they can match property profiles and requirement profiles. The dimensioning includes complex situations, such as multiaxial loading, notched components, static and dynamic loading, components with residual stresses and loading at high homologous temperatures.

**Requirements:**
none

**Workload:**
Presence: 42h  
Self study: 138h

Master Program Mechanical Engineering (M.Sc.)  
Module Handbook as of 11.09.2019
Learning Content
Lectures and tutorialy on the topics:
- basic loading types and superimposed loadings
- high-temperature loading
- influence of notches
- uniaxial, multiaxial and superimposed cyclic loading
- notch fatigue
- structural durability
- impact of residual stresses
- basic principles of materials selection
- dimensioning of components

Workload
Precence: 42h
Self study: 138h
11.384 Course: Superhard Thin Film Materials [T-MACH-102103]

Responsible: Prof. Dr. Sven Ulrich
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102637 - Major Field: Tribology

Type: Oral examination
Credits: 4
Recurrence: Each winter term
Version: 2

Events
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<td>Superhard Thin Film Materials</td>
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Exams
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<td>Superhard Thin Film Materials</td>
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</table>

Competence Certificate
oral examination (ca. 30 Minuten)

Prerequisites
none

Below you will find excerpts from events related to this course:

Superhard Thin Film Materials
2177618, WS 19/20, 2 SWS, Language: German, Open in study portal

Lecture (V)
Notes
oral examination (about 30 min), no tools or reference materials

Teaching Content:
Introduction
Basics
Plasma diagnostics
Particle flux analysis
Sputtering and ion implantation
Computer simulations

Properties of materials, thin film deposition technology, thin film analysis and modelling of superhard materials

Amorphous hydrogenated carbon
Diamond like carbon
Diamond
Cubic Boronnitride

Materials of the system metall-boron-carbon-nitrogen-silicon

Superhard materials are solids with a hardness higher than 4000 HV 0,05. The main topics of this lecture are modelling, deposition, characterization and application of superhard thin film materials.

Learning Content
Introduction
Basics
Plasma diagnostics
Particle flux analysis
Sputtering and ion implantation
Computer simulations

Properties of materials, thin film deposition technology, thin film analysis and modelling of superhard materials

Amorphous hydrogenated carbon
Diamond like carbon
Diamond
Cubic Boronnitride

Materials of the system metall-boron-carbon-nitrogen-silicon

Workload
regular attendance: 22 hours
self-study: 98 hours

Literature
G. Kienel (Ed.): Vakuumbeschichtung 1 - 5, VDI Verlag, Düsseldorf, 1994

Copies with figures and tables will be distributed
11.385 Course: Supply Chain Management [T-MACH-105181]

**Responsible:** Dr.-Ing. Knut Alicke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102613 - Major Field: Lifecycle Engineering
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems

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**Competence Certificate**
The assessment consists of an oral exam (20 min.) taking place in the recess period according to § 4 paragraph 2 Nr. 2 of the examination regulation.

**Prerequisites**
none
11.386 Course: Sustainable Product Engineering [T-MACH-105358]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
Dr. Karl-Friedrich Ziegahn

Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
  - M-MACH-102599 - Major Field: Powertrain Systems
  - M-MACH-102605 - Major Field: Engineering Design
  - M-MACH-102607 - Major Field: Vehicle Technology
  - M-MACH-102613 - Major Field: Lifecycle Engineering
  - M-MACH-102614 - Major Field: Mechatronics
  - M-MACH-102623 - Major Field: Fundamentals of Energy Technology
  - M-MACH-102633 - Major Field: Robotics
  - M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

Type: Written examination
Credits: 4
Recurrence: Each summer term
Version: 1

Events
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<th>Sustainable Product Engineering</th>
<th>2 SWS</th>
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</table>

Competence Certificate
written exam (60 min)

Prerequisites
none

Below you will find excerpts from events related to this course:

**Sustainable Product Engineering**
2146192, SS 2019, 2 SWS, Open in study portal

**Lecture (V)**

Description
Media

- Beamer

Learning Content
understanding of sustainability objectives and their role in product development, the interaction between technical products and their environment, the holistic approach and the equality of economic, social and environmental aspects and environmental aspects

skills for life-cycle product design using the example of complex automotive components such as airbag systems and other current products

understanding of product environmental stresses with relevancy to praxis at the example of technology-intensive components, robustness and durability of products as the basis for a sustainable product development, development of skills for the application of environmental simulation during the process of development of technical products

delivery of key skills such as team skills / project / self / presentation based on realistic projects

Workload
regular attendance: 21 h
self-study: 99 h
**11.387 Course: System Integration in Micro- and Nanotechnology [T-MACH-105555]**

**Responsible:** Dr. Ulrich Gengenbach  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102601 - Major Field: Automation Technology  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102615 - Major Field: Medical Technology  
- M-MACH-102633 - Major Field: Robotics  
- M-MACH-102647 - Major Field: Microactuators and Microsensors

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**Competence Certificate**

oral exam (Duration: 30 min)

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**System Integration in Micro- and Nanotechnology**

2106033, SS 2019, 2 SWS, Language: German, [Open in study portal](#)
Notes

Content:

- Introduction
- Definition system integration
- Integration of mechanical functions (flexures)
- Plasma treatment of surfaces
- Adhesive bonding
  - Packaging
  - Low Temperature Cofired Ceramics (LTCC)
  - Assembly of hybrid systems
- Monolithic/hybrid system integration
- Modular system integration
- Integration of electrical/electronic functions
- Mounting techniques
- molded Interconnect Devices (MID)
- Functional printing

- Coating
- Capping
- Housing

First steps towards system integration nanotechnology

Learning objectives:

Students acquire fundamental knowledge about challenges and system integration processes.

Learning Content

- Introduction
- Definition system integration
- Integration of mechanical functions (flexures)
- Plasma treatment of surfaces
- Adhesive bonding
  - Packaging
  - Low Temperature Cofired Ceramics (LTCC)
  - Assembly of hybrid systems
- Monolithic/hybrid system integration
- Modular system integration
- Integration of electrical/electronic functions
- Mounting techniques
- molded Interconnect Devices (MID)
- Functional printing

- Coating
- Capping
- Housing

First steps towards system integration nanotechnology

Literature

- J. Franke, Räumliche elektronische Baugruppen (3D-MID), Carl Hanser-Verlag Münhen, 2013
11.388 Course: Systematic Materials Selection [T-MACH-100531]

**Responsible:** Dr.-Ing. Stefan Dietrich  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering  
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering  
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering  
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology  
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction  
- M-MACH-102742 - Fundamentals and Methods of Production Technology  
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering  
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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| SS 2019 | 3 SWS   | Systematic Materials Selection |  3 SWS | Lecture (V)  
|         |         |               | Each summer term    |         |
| SS 2019 | 1 SWS   | Übungen zu 'Systematische Werkstoffauswahl' |  1 SWS | Practice (Ü)  
|         |         |               | Each summer term    |         |

**Exams**

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<td>Systematic Materials Selection</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**

The assessment is carried out as a written exam of 2 h.

**Prerequisites**

none

**Recommendation**

Basic knowledge in materials science, mechanics and mechanical design due to the lecture Materials Science I/II.

*Below you will find excerpts from events related to this course:*

**Systematic Materials Selection**

2174576, SS 2019, 3 SWS, Language: German, [Open in study portal](#)
Notes
Important aspects and criteria of materials selection are examined and guidelines for a systematic approach to materials selection are developed. The following topics are covered:

- Information and introduction
- Necessary basics of materials
- Selected methods / approaches of the material selection
- Examples for material indices and materials property charts
- Trade-off and shape factors
- Sandwich materials and composite materials
- High temperature alloys
- Regard of process influences
- Material selection for production lines
- Incorrect material selection and the resulting consequences
- Abstract and possibility to ask questions

Learning Objectives:
The students are able to select the best material for a given application. They are proficient in selecting materials on base of performance indices and materials selection charts. They can identify conflicting objectives and find sound compromises. They are aware of the potential and the limits of hybrid material concepts (composites, bimaterials, foams) and can determine whether following such a concept yields a useful benefit.

Requirements:
Wiling SPO 2007 (B.Sc.)
The course Material Science I [21760] has to be completed beforehand.

Wiling (M.Sc.)
The course Material Science I [21760] has to be completed beforehand.

Workload:
The workload for the lecture is 120 h per semester and consists of the presence during the lecture (30 h) as well as preparation and rework time at home (30 h) and preparation time for the oral exam (60 h).

Learning Content
Important aspects and criteria of materials selection are examined and guidelines for a systematic approach to materials selection are developed. The following topics are covered:

- Information and introduction
- Necessary basics of materials
- Selected methods / approaches of the material selection
- Examples for material indices and materials property charts
- Trade-off and shape factors
- Sandwich materials and composite materials
- High temperature alloys
- Regard of process influences
- Material selection for production lines
- Incorrect material selection and the resulting consequences
- Abstract and possibility to ask questions

Workload
The workload for the lecture is 120 h per semester and consists of the presence during the lecture (30 h) as well as preparation and rework time at home (30 h) and preparation time for the oral exam (60 h).

Literature
Lecture notes; Problem sheets; Textbook: M.F. Ashby, A. Wanner (Hrsg.), C. Fleck (Hrsg.);
Materials Selection in Mechanical Design: Das Original mit Übersetzungshilfen Easy-Reading-Ausgabe, 3. Aufl., Spektrum Akademischer Verlag, 2006
ISBN: 3-8274-1762-7
Course: Technical Design in Product Development [T-MACH-105361]

11.389 Course: Technical Design in Product Development [T-MACH-105361]

Responsible: Prof. Dr.-Ing. Albert Albers
Prof. Dr.-Ing. Sven Matthiesen
Dr.-Ing. Markus Schmid

Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102600 - Major Field: Man - Technology - Organisation
- M-MACH-102605 - Major Field: Engineering Design

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Events

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Exams

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</table>

Competence Certificate

Written exam (20 min)
Only dictionary is allowed

Prerequisites

none

Below you will find excerpts from events related to this course:

Technical Design in Product Development

2146179, SS 2019, 2 SWS, Language: German, [Open in study portal]

Description

Media:
- Beamer
- Models

Learning Content

Introduction
Relevant parameters on product value in Technical Design
Design in Methodical Development and Engineering and for a differentiated validation of products
Design in the concept stage of Product Development
Design in the draft and elaboration stage of Product Development

Workload

regular attendance: 21 h
self-study: 99 h

Literature

Hexact (R) Lehr- und Lernportal

**Responsible:** Dr. Ferdinand Schmidt  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102648 - Major Field: Energy Technology for Buildings

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**Competence Certificate**  
oral exam, 30 minutes

**Prerequisites**  
none

Below you will find excerpts from events related to this course:

**Technical energy systems for buildings 1: Processes & components**

Lecture (V)

2157200, WS 19/20, 2 SWS, Language: German, Open in study portal

**Notes**

Introduction to heating and cooling technologies for buildings, solar energy utilization in buildings (solar radiation, solar thermal energy, photovoltaics) and to energy storage in buildings (thermal and electric storage technologies). Topics covered:

- Burners, condensing and non-condensing boilers
- Cogeneration units for use in buildings
- Heat transformation: Fundamentals, vapor compression, absorption, adsorption
- Solar energy: Radiation, solar thermal collectors, photovoltaics
- energy storage in buildings: thermal and electric storage

Learning objectives:

Students know relevant technical components of energy supply systems in buildings (heating and cooling, dehumidification). They know the energy conversion processes associated with these components and can estimate their energy efficiencies as well as the most important factors influencing efficiency.

Students are familiar with the underlying physics (mostly thermodynamics) of the relevant processes. They can derive relevant figures of merit from these principles. They know the degree of technological development for the various processes and components and are aware of current research and development objectives in this field.

Oral exam: about 25 min.
No tools

**Responsible:** Dr. Ferdinand Schmidt

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102648 - Major Field: Energy Technology for Buildings

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**Competence Certificate**
oral exam, 30 minutes

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Technical energy systems for buildings 2: System concepts**

2158201, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

Introduction of relevant figures of merit for technical energy systems in buildings. Description of different system concepts for energy supply of buildings (heating, cooling, dehumidification) and evaluation according to figures of merit. Systems covered include:

- Heat pumps and heat pump systems including combination with solar thermal energy
- Cogeneration and trigeneration system (heating, cooling, power)
- Solar thermal systems: Domestic hot water, heating support, cooling and dehumidification
- District heating systems including solar thermal heat
- Photovoltaics and heat pump systems including thermal and battery storage
- Grid-reactive building technology: Smart-Metering, Smart Home, Smart Grid

**Learning outcomes:**

Students are able to develop system concepts for technical energy systems in buildings and to rationally design such systems. They know the relevant figures of merit for an energy-related as well as an economical or combined evaluation of systems, and know how to employ these figures of merit in sizing systems and components. Students are able to employ plausibility checks and to give rough estimates on building energy concepts and they know which technologies can be combined for highly efficient system combinations.

**Workload:**
30 hours course attendance, 90 hours self-study

**Oral exam appr. 25 minutes**
Course: Technology of Steel Components [T-MACH-105362]

**Responsible:** Prof. Dr.-Ing. Volker Schulze

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102618 - Major Field: Production Technology

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**Competence Certificate**

Oral exam, about 25 minutes

**Prerequisites**

None

Below you will find excerpts from events related to this course:

**Technology of steel components**

2174579, SS 2019, 2 SWS, Language: German, [Open in study portal]

**Notes**

Meaning, Development and characterization of component states
Description of the influence of component state on mechanical properties
Stability of component states
Steel manufacturing
Component states due to forming
Component states due to heat treatments
Component states due to surface hardening
Component states due to machining
Component states due to mechanical surface treatments
Component states due to joining
Summarizing evaluation

**Learning objectives:**

The students have the background to evaluate the influence of manufacture processes on the compound state of metallic compounds. The students can assess the influence and the stability of compound state under mechanical load. The students are capable to describe the individual aspects of interaction of the compound state of steel components due to forming, heat treatment, mechanical surface treatment and joining processes.

**Requirements:**

Materials Science and Engineering I & II

**Workload:**

Regular attendance: 21 hours
Self-study: 99 hours

Master Program Mechanical Engineering (M.Sc.)
Module Handbook as of 11.09.2019
Learning Content
Meaning, Development and characterization of component states
Description of the influence of component state on mechanical properties
Stability of component states
Steel manufacturing
Component states due to forming
Component states due to heat treatments
Component states due to surface hardening
Component states due to machining
Component states due to mechanical surface treatments
Component states due to joining
Summarizing evaluation

Workload
regular attendance: 21 hours
self-study: 99 hours

Literature
Script will be distributed within the lecture
VDEh: Werkstoffkunde Stahl, Bd. 1: Grundlagen, Springer-Verlag, 1984
V. Schulze: Modern Mechanical Surface Treatments, Wiley, Weinheim, 2005
Course: Ten Lectures on Turbulence [T-MACH-105456]

**Responsible:** Dr. Ivan Otic  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102608 - Major Field: Nuclear Energy  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102643 - Major Field: Fusion Technology

**Type**  
Oral examination  

**Credits**  
4

**Recurrence**  
Each winter term

**Version**  
1

### Events

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**Exams**

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<td>Ten Lectures on Turbulence</td>
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**Competence Certificate**  
oral exam, 20 min

**Prerequisites**  
none

**Below you will find excerpts from events related to this course:**

### Ten lectures on turbulence

**2189904, WS 19/20, 2 SWS, Language: English, Open in study portal**

**Learning Content**

1 Introduction  
2 Turbulent transport of momentum and heat  
3 Statistical description of turbulence  
4 Scales of turbulent ows  
5 Homogeneous turbulent shear ows  
6 Free turbulent shear ows  
7 Wall-Bounded turbulent ows  
8 Turbulence Modelling  
9 Reynolds Averaged Navier-Stokes (RANS) Simulation Approach  
10 Large Eddy Simulation (LES) Approach

**Workload**

- **Time of attendance:** 25 hours  
- **Self-study:** 100 hours

**Literature**

Reference texts:  
- Lecture Notes  
- Presentation slides

Recommended Books:  
11.394 Course: Theoretical Description of Mechatronic Systems [T-MACH-105521]

**Responsible:** Prof. Dr.-Ing. Wolfgang Seemann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102614 - Major Field: Mechatronics

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**Competence Certificate**
oral exam, approx. 30 min..

**Prerequisites**
none
11.395 Course: Theory of Stability [T-MACH-105372]

**Responsible:** Prof. Dr.-Ing. Alexander Fidlin  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102598 - Major Field: Advanced Mechatronics  
- M-MACH-102614 - Major Field: Mechatronics  
- M-MACH-102646 - Major Field: Applied Mechanics  
- M-MACH-104443 - Major Field: Vibration Theory

**Type**: Oral examination  
**Credits**: 6  
**Recurrence**: Each summer term  
**Version**: 1

**Events**

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**Exams**

| Exams | SS 2019 | 76-T-MACH-105372 | Theory of Stability | Prüfung (PR) | Fidlin |

**Competence Certificate**  
oral exam, 30 min.

**Prerequisites**  
none

**Recommendation**  
Vibration theory, Mathematical Methods of Vibration Theory

**Below you will find excerpts from events related to this course:**

**Theory of Stability**  
2163113, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- Basic concepts of stability  
- Lyapunov's functions  
- Direct lyapunov's methods  
- Stability of equilibria positions  
- Attraction area of a stable solution  
- Stability according to the first order approximation  
- Systems with parametric excitation  
- Stability criteria in the control theory

**Workload**

time of attendance: 39 h  
self-study: 201 h

**Literature**

Course: Thermal Solar Energy [T-MACH-105225]

**Responsible:** Prof. Dr. Robert Stieglitz

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102648 - Major Field: Energy Technology for Buildings

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**Competence Certificate**

Oral examination, 30 minutes

**Prerequisites**

None

*Below you will find excerpts from events related to this course:*

**Thermal Solar Energy**

2169472, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)
Notes
In detail:
1 Introduction to energy requirements and evaluation of the potential use of solar thermal energy.
2 Primary energy source SUN: sun, solar constant, radiation (direct, diffuse scattering, absorption, impact angle, radiation balance).
3 Solar collectors: schematic structure of a collector, fundamentals of efficiency, meaning of concentration and their limitations.
5 Momentum and heat transport: basic equations of single and multiphase transport, calculation methods, stability limits. optional
6 Low temperature solar thermal systems: collector types, methods for system simulation, planning and dimensioning of systems, system design and stagnation scenarios.
7 High temperature solar thermal systems: solar towers and solar-farm concept, loss mechanisms, chimney power plants and energy production processes
The lecture elaborates the basics of the solar technology and the definition of the major wordings and its physical content such as radiation, thermal use, insulation etc.. Further the design of solar collectors for different purposes is discussed and analyzed. The functional principle of solar plants is elaborated before at the end the ways for solar cooling is discussed.
The aim of the course is to provide the basic physical principles and the derivation of key parameters for the individual solar thermal use. This involves in addition to the selective absorber, mirrors, glasses, and storage technology. In addition, a utilization of solar thermal energy means an interlink of the collector with a thermal-hydraulic circuit and a storage. The goal is to capture the regularities of linking to derive efficiency correlations as a function of their use and evaluate the performance of the entire system.
Recommendations / previous knowledge
Basics in heat and mass transfer, material science and fluid mechanics, desirable are reliable knowledge in physics in optics and thermodynamics
Oral exam of about 25 minutes, no tools or reference materials may be used during the exam

Learning Content
In detail:
1 Introduction to energy requirements and evaluation of the potential use of solar thermal energy.
2 Primary energy sources SUN: sun, solar constant, radiation (direct, diffuse scattering, absorption, impact angle, radiation balance).
3 Solar panels: schematic structure of a collector, fundamentals of efficiency, meaning of concentration and their limitations.
5 Momentum and heat transport: basic equations of single and multiphase transport, calculation methods, stability limits. optional
6 Low temperature solar thermal systems: Collector variants, methods for system simulation, planning and dimensioning of systems, system design and arrest scenarios.
6 High temperature solar thermal systems: solar towers and solar-farm concept, loss mechanisms, chimney power plants and energy production processes
end
- Memory: energy content, storage types, storage materials, cost
- Solar Air Conditioning: Cooling capacity determination, climate, solar cooling method and evaluation of air conditioning.
Workload
regular attendance: 21 h
self-study: 90 h

Literature
supply of lecture material in printed and electronic form
**11.397 Course: Thermal Turbomachines I [T-MACH-105363]**

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102610 - Major Field: Power Plant Technology  
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
- M-MACH-102627 - Major Field: Energy Converting Engines  
- M-MACH-102635 - Major Field: Engineering Thermodynamics  
- M-MACH-102636 - Major Field: Thermal Turbomachines

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**Competence Certificate**  
oral exam, duration 30 min.

**Prerequisites**  
none


Below you will find excerpts from events related to this course:

**Thermal Turbomachines I**  
2169453, WS 19/20, 3 SWS, Language: German, [Open in study portal](#)  

**Learning Content**  
Basic concepts of thermal turbomachinery  
Steam Turbines - Thermodynamic process analysis  
Gas Turbines - Thermodynamic process analysis  
Combined cycle and cogeneration processes  
Overview of turbomachinery theory and kinematics  
Energy transfer process within a turbine stage  
Types of turbines (presented through examples)  
1-D streamline analysis techniques  
3-D flow fields and radial momentum equilibrium in turbines  
Compressor stage analysis and future trends in turbomachinery
Workload
regular attendance: 31.50 h
self-study: 64.40 h

Literature
Lecture notes (available via Internet)

Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

Learning Content
Basic concepts of thermal turbomachinery
Steam Turbines - Thermodynamic process analysis
Gas Turbines - Thermodynamic process analysis
Combined cycle and cogeneration processes
Overview of turbomachinery theory and kinematics
Energy transfer process within a turbine stage
Types of turbines (presented through examples)
1-D streamline analysis techniques
3-D flow fields and radial momentum equilibrium in turbines
Compressor stage analysis and future trends in turbomachinery

Workload
regular attendance: 31.50 h
self-study: 64.40 h

Literature
Lecture notes (available via Internet)

Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993
11.398 Course: Thermal Turbomachines II [T-MACH-105364]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102635 - Major Field: Engineering Thermodynamics
- M-MACH-102636 - Major Field: Thermal Turbomachines

**Type**
- Oral examination

**Credits**
- 6

**Recurrence**
- Each summer term

**Version**
- 2

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**Exams**
- SS 2019 76-T-MACH-105364
- thermal Turbomachines II
- Prüfung (PR)
- Bauer

**Competence Certificate**
- oral exam, duration: 30 min.

**Prerequisites**
- none

*Below you will find excerpts from events related to this course:*
Learning Content
General overview, trends in design and development

Comparison turbine - compressor

Integrating resume of losses

Principal equations and correlations in turbine and compressor design, stage performance

Off-design performance of multi-stage turbomachines

Control system considerations for steam and gas turbines

Components of turbomachines

Critical components

Materials for turbine blades

Cooling methods for turbine blades (steam and air cooling methods)

Short overview of power plant operation

Combustion chamber and environmental issues

Workload
regular attendance: 31,50 h
self-study: 64,40 h

Literature
Lecture notes (Available via internet)
Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

Thermal Turbomachines II (in English)
2170553, SS 2019, 3 SWS, Language: English, Open in study portal

Learning Content
Basic concepts of thermal turbomachinery

Steam Turbines - Thermodynamic process analysis

Gas Turbines - Thermodynamic process analysis

Combined cycle and cogeneration processes

Overview of turbomachinery theory and kinematics

Energy transfer process within a turbine stage

Types of turbines (presented through examples)

1-D streamline analysis techniques

3-D flow fields and radial momentum equilibrium in turbines

Compressor stage analysis and future trends in turbomachinery

Workload
regular attendance: 31,50 h
self-study: 64,40 h
Literature
Lecture notes (available via Internet)


Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

11.399 Course: Thermal-Fluid-Dynamics [T-MACH-106372]

**Responsible:** Dr. Sebastian Ruck  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102610 - Major Field: Power Plant Technology  
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering  
- M-MACH-102634 - Major Field: Fluid Mechanic  
- M-MACH-102643 - Major Field: Fusion Technology  
- M-MACH-102648 - Major Field: Energy Technology for Buildings

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**Competence Certificate**
oral exam of about 30 minutes

**Prerequisites**
none

*Below you will find excerpts from events related to this course:*

**Thermal-Fluid-Dynamics**

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**Description**

**Main Issues**

- Fundamentals of flows and heat transfer  
- Dimensionless parameters of thermal fluid dynamics  
- Statistic description and analytics of turbulent flows  
- Thermal boundary layer equations  
- Velocity and temperature laws in boundary layers  
- Convective Heat transfer of external and internal flows  
- Analogies (Prandtl-, von Kárman, Martinelli,...)  
- Methods for enhancing heat transfer  
- Strategies and methods for experimental and numerical investigation of thermal-hydraulics in R&D
Notes

Content

- Fundamentals of flows and heat transfer
- Dimensionless parameters of thermal fluid dynamics
- Laminar and turbulent thermal boundary layer equations
- Velocity and temperature laws in boundary layers
- Convective heat transfer of external and internal flows
- Heat transfer analogies (Prandtl-, von Kármán, Martinelli,...)
- Methods for enhancing heat transfer
- Strategies and methods for investigation of thermal-hydraulics in R&D

The lecture provides an overview of momentum and energy transport as occurring in power engineering components and heat exchangers. On the basis of the conservation equations and the fundamentals of thermal-hydraulics, dimensionless parameters for forced and free convection are evolved. Flows close to walls play a crucial role for the convective heat transfer and for heat exchanger components. Thus, with scaling rules the laminar and turbulent thermal boundary layer equations are introduced. In the following, velocity and temperature laws of the wall as a basis for analogies and models of computational tools are discussed and the influence of roughness and surface design are shown. Concepts of state-of-the-art turbulence modelling and their applicability for different conditions or different heat transfer fluids (e.g. liquid metals, gas, oil) are described. Analogies and correlations for internal and external forced convection are developed by means of approximation concepts. Design options to enhance the efficiency and effectiveness of heat exchangers are discussed.

The objectives of the lecture are the fundamentals of thermal-hydraulics for describing and modelling convective fluid flow as occurring in power engineering components. A major objective is the description of the convective heat transfer for external and internal flows. A key issue is the transfer of analytic models and empirical results into "state of the art" computational tools and their validation by advanced experimental methods. Within the scope of the course, the students learn (a) to develop differential equation for thermal-hydraulic problems and to describe the thermal flow field by means of dimensionless parameters, (b) to transfer a real problem to an experiment or computational model, (c) to develop analogies and correlations for heat transfer processes of forced convection, (d) to select adequate computational methods/models, (e) to evaluate and select experiments including measurement techniques with adequate instrumentation for thermal-hydraulic problems and (f) to know design option for an efficient and effective heat exchange.

Attendance time: 21 h
Preparation/follow-up time of lectures, exam preparation: 90h
Oral exam of about 30 min.

Learning Content

The lecture provides an overview of momentum and energy transport as occurring in power engineering components and heat exchangers. Conservation equations are discussed. Based on the fundamentals of thermal-hydraulics, dimensionless parameters for forced and free convection are evolved. The statistical concepts for describing turbulent flows and the corresponding transport equations are introduced. Analysis of thermal and turbulent measurement signals are discussed.

Flows close to walls play a crucial role for the convective heat transfer and for heat exchanger components. Thus, the thermal boundary layer equations are introduced for the laminar and turbulent case. Velocity and temperature laws of the wall as a basis for analogies and models of computational tools are discussed; turbulence modelling and scale-resolving methods and their applicability for different conditions or heat transfer fluids are described in the following. Analogies and correlations for internal and external forced convection are developed by means of approximation concepts. Furthermore, design options to enhance the efficiency of heat exchangers are discussed.

Solution strategies and best practical guidelines of the aforementioned methods are provided.

Workload

Attendance time: 21 h
Preparation/follow-up time of lectures, exam preparation: 90h

Literature

Literature are specified in the corresponding lectures. Teaching materials are provided online at [http://ilias.studium.kit.edu](http://ilias.studium.kit.edu). Hardcopy script for special topics during the lecture.
11.400 Course: Thin Film and Small-scale Mechanical Behavior [T-MACH-105554]

**Responsible:** Dr. Patric Gruber  
Dr. Ruth Schwaiger  
Dr. Daniel Weygand

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102649 - Major Field: Advanced Materials Modelling

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**Events**

| SS 2019 | 2178123 | Thin film and small-scale mechanical behavior | 2 SWS | Lecture (V) | Weygand, Gruber |

**Exams**

| SS 2019 | 76-T-MACH-105554 | Thin Film and Small-scale Mechanical Behavior | Prüfung (PR) | Gruber, Weygand |

**Competence Certificate**
oral exam 30 minutes

**Prerequisites**
none

**Recommendation**
preliminary knowledge in materials science, physics and mathematics
11.041 Course: Tires and Wheel Development for Passenger Cars [T-MACH-102207]

**Responsible:** Dr.-Ing. Günter Leister  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102607 - Major Field: Vehicle Technology

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**Events**

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**Exams**

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**Competence Certificate**

Oral Examination  
Duration: 30 up to 40 minutes  
Auxiliary means: none

**Prerequisites**

none

*Below you will find excerpts from events related to this course:*

**Tires and Wheel Development for Passenger Cars**  
2114845, SS 2019, 2 SWS, Open in study portal  
Lecture (V)

**Learning Content**

1. The role of the tires and wheels in a vehicle  
2. Geometrie of Wheel and tire, Package, load capacity and endurance, Book of requirement  
3. Mobility strategy, Minispare, runflat systems and repair kit.  
4. Project management: Costs, weight, planning, documentation  
5. Tire testing and tire properties  
6. Wheel technology incuding Design and manufacturing methods, Wheeltesting  
7. Tire presssure: Indirect and direct measuring systems  
8. Tire testing subjective and objective

**Workload**

regular attendance: 22.5 hours  
self-study: 97.5 hours

**Literature**

Manuscript to the lecture
11.402 Course: Tractors [T-MACH-105423]

**Responsible:** Simon Becker  
Prof. Dr.-Ing. Marcus Geimer  
Hon.-Prof. Dr. Martin Kremmer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102630 - Major Field: Mobile Machines

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**Exams**

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<td>76-T-MACH-105423</td>
<td>Tractors</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**  
The assessment consists of a written exam taking place in the recess period (90 min).

**Prerequisites**  
one

**Recommendation**  
Basic knowledge in mechanical engineering.
Annotation
Learning Outcomes
After completion of the course the Students know:

- important problems in agritechnological developments
- Customer requirements and their implementation in tractors
- Tractor technology in width and depth

Content
Tractors are one of the most underestimated vehicles in regard to performance und technics. Almost none vehicle is as multifunctional and fulfilled with high-tech as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies. During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical background, legal requirements, ways of development, agricultural organizations and the process of development itself.

In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960

Below you will find excerpts from events related to this course:

V Tractors
2113080, WS 19/20, 2 SWS, Language: German, Open in study portal
Learning Content
Tractors are one of the most underestimated vehicles in regard to performance and technics. Almost none vehicle is as multifunctional and fullfilled with high-tec as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies.

During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical background, legal requirements, ways of development, agricultural organizations and the process of development itself.

In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

Workload

- regular attendance: 21 hours
- self-study: 92 hours

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960
**Course: Tribology [T-MACH-105531]**

**Responsible:** Prof. Dr. Martin Dienwiebel  
Prof. Dr.-Ing. Matthias Scherge

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102599 - Major Field: Powertrain Systems  
- M-MACH-102637 - Major Field: Tribology  
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains

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**Events**

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<td>5 SWS</td>
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**Exams**

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<td>76-T-MACH-105531</td>
<td>Prüfung (PR)</td>
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</table>

**Competence Certificate**
oral examination (ca. 40 min)
no tools or reference materials

**Prerequisites**
admission to the exam only with successful completion of the exercises [T-MACH-109303]

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-109303 - Exercices - Tribology must have been passed.

**Recommendation**
preliminary knowledge in mathematics, mechanics and materials science

Below you will find excerpts from events related to this course:

**Tribology**
2181114, WS 19/20, 5 SWS, Language: German, Open in study portal
Notes

- Chapter 1: Friction
  adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing, environmental influences, tribological age, contact models, Simulation of contacts, roughness.
- Chapter 2: Wear
  plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-in, running-in dynamics, shear stress.
- Chapter 3: Lubrication
  base oils, Strieber plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid lubrication.
- Chapter 4: Measurement Techniques
  friction measurement, tribometer, dissipated frictional power, conventional wear measurement, continuous wear measurement(RNT)
- Chapter 5: Roughness
  profilometry, surface roughness parameters, evaluation length and filters, bearing ratio curve, measurement error
- Chapter 6: Accompanying Analysis
  multi-scale topography measurement, chemical surface analysis, structural analysis, mechanical analysis

Exercises are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students.

The student can

- describe the fundamental friction and wear mechanisms, which occur in tribologically stressed systems
- evaluate the friction and wear behavior of tribological systems
- explain the effects of lubricants and their most important additives
- identify suitable approaches to optimize tribological systems
- explain the most important experimental methods for the measurement of friction and wear, and is able to use them for the characterisation of tribo pairs
- choose suitable methods for the evaluation of roughness and topography from the nm-scale to the mm-scale and is able to interpret the determined values in respect to their effect on the tribological behavior
- describe the most important surface-analytical methods and their physical principles for the characterization of tribologically stressed sliding surfaces

Preliminary knowledge in mathematics, mechanics and materials science recommended

Regular attendance: 45 hours
Self-study: 195 hours

Oral examination (ca. 40 min)
No tools or reference materials
Admission to the exam only with successful completion of the exercises

Learning Content

- Chapter 1: Friction
  adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing, environmental influences, tribological age, contact models, Simulation of contacts, roughness.
- Chapter 2: Wear
  plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-in, running-in dynamics, shear stress.
- Chapter 3: Lubrication
  base oils, Strieber plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid lubrication.
- Chapter 4: Measurement Techniques
  friction measurement, tribometer, dissipated frictional power, conventional wear measurement, continuous wear measurement(RNT)
- Chapter 5: Roughness
  profilometry, surface roughness parameters, evaluation length and filters, bearing ratio curve, measurement error
- Chapter 6: Accompanying Analysis
  multi-scale topography measurement, chemical surface analysis, structural analysis, mechanical analysis

Exercises are used for complementing and deepening the contents of the lecture as well as for answering more extensive questions raised by the students.

Workload
Regular attendance: 45 hours
Self-study: 195 hours
Literature

11.404 Course: Turbine and Compressor Design [T-MACH-105365]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102636 - Major Field: Thermal Turbomachines

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<td>Turbine and Compressor Design</td>
<td>Prüfung (PR)</td>
<td>Schulz, Bauer</td>
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</table>

**Competence Certificate**
oral exam, duration: 20 min.

**Prerequisites**
Exams Thermal Turbomachinery I & II successfully passed.

**Modeled Conditions**
The following conditions have to be fulfilled:

1. The course T-MACH-105363 - Thermal Turbomachines I must have been passed.
2. The course T-MACH-105364 - Thermal Turbomachines II must have been passed.

Below you will find excerpts from events related to this course:

**Learning Content**
The lecture is intended to expand the knowledge from Thermal Turbomachines I+II. Thermal Turbomachines, general overview

Design of a turbomachine: Criteria and development

- Radial machines
- Transonic compressors
- Combustion chambers
- Multi-spool installations

**Workload**
regular attendance: 21 h
self-study: 42 h
Literature

Course: Turbo Jet Engines [T-MACH-105366]

Responsible: Prof. Dr.-Ing. Hans-Jörg Bauer
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102636 - Major Field: Thermal Turbomachines

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Events
- SS 2019 2170478 Turbo Jet Engines 2 SWS Lecture (V) Bauer, Mitarbeiter
- SS 2019 00003 Turbo Jet Engines Prüfung (PR) Bauer
- SS 2019 76-T-MACH-105366 Turbo Jet Engines Prüfung (PR) Bauer, Schulz

Competence Certificate
oral exam, duration: 20 min.

Prerequisites
none

Below you will find excerpts from events related to this course:

V Turbo Jet Engines 2170478, SS 2019, 2 SWS, Language: German, Open in study portal

Learning Content
Introduction to jet engines and their components
Demands on engines and propulsive efficiency
Thermodynamic and gas dynamic fundamentals and design calculations
Components of air breathing engines
Jet engine design and development process
Engine and component design
Current developments in the jet engines industry

Workload
regular attendance: 21 h
self-study: 42 h

Literature
Hagen, H.: Fluggasturbinen und ihre Leistungen, G. Braun Verlag, 1982
Hünnecke, K.: Flugtriebwerke, ihre Technik und Funktion, Motorbuch Verlag, 1993
Course: Tutorial Continuum Mechanics of solids and fluids [T-MACH-110333]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Prof. Dr.-Ing. Bettina Frohnapfel

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
M-MACH-102628 - Major Field: Lightweight Construction
M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering

- Type: Completed coursework
- Credits: 1
- Recurrence: Each winter term
- Version: 1

Events

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<td>fluids</td>
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</table>

Competence Certificate
Successfully passing the Tutorial is a prerequisite for taking part in the exam "Continuum Mechanics of Solids and Fluids" (T-MACH-110377)

For students of Mechanical Engineering (Bachelor) that have chosen the Major Field "Continuum Mechanics", the prerequisites consist of successfully solving the written homework sheets as well as the computational homework sheets using the commercial Finite Element Program Abaqus during the associated Lab Course.

For students of Mechanical Engineering (Bachelor) that have chosen a different Major Field of students from different fields of study the prerequisites consist of successfully solving only the written homework sheets. For organizational matters these students can not take part into the Lab Course.

Prerequisites
None

Below you will find excerpts from events related to this course:

Tutorial Continuum mechanics of solids and fluids
2161253, WS 19/20, 1 SWS, Language: German, Open in study portal

Notes
Please refer to the lecture "Continuum mechanics of solids and fluids".

Learning Content
see Tutorial Continuum mechanics of solids and fluids

Literature
see Tutorial Continuum mechanics of solids and fluids
11.407 Course: Tutorial Introduction to the Finite Element Method [T-MACH-110330]

Responsible: Prof. Dr.-Ing. Thomas Böhlke
Dr.-Ing. Tom-Alexander Langhoff

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102628 - Major Field: Lightweight Construction

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Events

SS 2019 2162257  Tutorial "Introduction to the Finite Element Method"  1 SWS  Practice (Ü)  Langhoff, Böhlke

Competence Certificate
Depening on the field of study, attestations have to be achieved in the following categories: written homework problems and computational homework problems
This course is passed if in total at most two attestations have finally not been passed
Successful participation in this course allows for registration to the Exam "Introduction to the Finite Element Method" (see 76-T-MACH-105320)

Annotation
Knowledge of the contents of the courses "Continuum Mechanics of Solids and Fluids" and "Mathematical Methods of Continuum Mechanics" as well as the corresponding tutorials are expected.
The assignment of the restricted places in the Lab Course is crucial to the institute.

Below you will find excerpts from events related to this course:

Tutorial "Introduction to the Finite Element Method"
2162257, SS 2019, 1 SWS, Language: German, Open in study portal

Notes
See lecture "Introduction to the Finite Element Method"
11.408 Course: Tutorial Mathematical Methods in Continuum Mechanics [T-MACH-110376]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102594 - Mathematical Methods
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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**Exams**

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**Competence Certificate**

Successfully solving the homework sheets. Details are announced in the first lecture.

**Prerequisites**

None

*Below you will find excerpts from events related to this course:*

**Tutorial Mathematical Methods in Continuum Mechanics**

2161255, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Notes**

See "Mathematical Methods in Continuum Mechanics"
11.09 Course: Tutorial Mathematical Methods in Micromechanics [T-MACH-110379]

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102594 - Mathematical Methods
- M-MACH-102602 - Major Field: Reliability in Mechanical Engineering
- M-MACH-102611 - Major Field: Materials Science and Engineering
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems

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**Competence Certificate**
Successfully solving the homework sheets. Details are given in the first lecture.

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology

**Type**
- Completed coursework

**Credits**
- 1

**Recurrence**
- Each winter term

**Version**
- 3

**Competence Certificate**
Successfully solving the homework sheets. Details are announced in the first lecture.

**Prerequisites**
None

**Responsible:** Prof. Dr.-Ing. Thomas Böhlke

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction

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**Events**

| SS 2019 | 2162281 | Tutorial "Mathematical Methods in Micromechanics" | 1 SWS | Practice (Ü) | N.N., Böhlke |

**Exams**

| SS 2019 | 76-T-MACH-106831 | Tutorial Mathematical Methods in Structural Mechanics | Prüfung (PR) | Böhlke |

**Competence Certificate**
Successfully solving the homework sheets. Details are given in the first lecture.

**Prerequisites**
none
11.412 Course: Two-Phase Flow and Heat Transfer [T-MACH-105406]

**Responsible:** Prof. Dr.-Ing. Thomas Schulenberg  
Dr. Martin Wörner

**Organisation:** KIT Department of Chemical and Process Engineering  
KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
M-MACH-102608 - Major Field: Nuclear Energy  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102634 - Major Field: Fluid Mechanic  
M-MACH-102643 - Major Field: Fusion Technology

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**Events**

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**Competence Certificate**
oral exam, duration: approximately 30 minutes  
no tools or reference materials may be used during the exam

**Prerequisites**
none

Below you will find excerpts from events related to this course:

**Two-Phase Flow and Heat Transfer**

2169470, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Description**

Media:  
Power Point presentations  
Excel analyses

**Notes**

The students can describe two-phase flows with heat transfer as phenomena occurring in steam generators and condensers (e.g. in power stations or refrigerators). They can distinguish different flow regimes and transitions and apply two-phase flow models. The students are qualified to explain the characteristics of different flow examples (e.g. pressure drop of two phase flows, pool boiling, forced convective boiling, condensation) and can analyze two-phase flow instabilities.

- Examples for technical applications  
- Definitions and averaging of two-phase flows  
- Flow regimes and transitions  
- Two-phase models  
- Pressure drop of two phase flows  
- Pool boiling  
- Forced convective boiling  
- Condensation  
- Two-phase flow instabilities
Learning Content

- Examples for technical applications
- Definitions and averaging of two-phase flows
- Flow regimes and transitions
- Two-phase models
- Pressure drop of two-phase flows
- Pool boiling
- Forced convective boiling
- Condensation
- Two-phase flow instabilities

Annotation
Recommendations: Basics of fluid mechanics and thermodynamics are a mandatory requirement.

Workload
regular attendance: 21 h
self-study: 99 h

Literature
lecture notes
11.413 Course: Vacuum and Tritium Technology in Nuclear Fusion [T-MACH-108784]

Responsible: Dr. Beate Bornschein  
Dr. Christian Day

Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102643 - Major Field: Fusion Technology

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Events

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Exams

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<td>Day, Bornschein</td>
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Competence Certificate
oral examination, 20 Minutes, any time in the year

Prerequisites
none

Recommendation
Knowledge in „Fusion Technology A“

Below you will find excerpts from events related to this course:

Vacuum and Tritium Technology in Nuclear Fusion
2190499, SS 2019, 2 SWS, Language: German/English, Open in study portal

Notes
Introduction
Tritium Handling
Tritium Plant Technologies
Tritium and Breeding
Fundamentals of Vacuum Science and Technology
Fusion Vacuum systems
Matter Injection into the Plasma Chamber
Fuel Cycle of ITER and DEMO

The students have acquired the necessary understanding in order to design and size facilities for tritium operation. They understand the process steps in the tritium plant of a fusion reactor for tritium removal and tritium recovery from tritiated exhaust gas. Furthermore, the students have understood the fundamentals of vacuum physics and are able to design and choose vacuum pumps properly.

recommended is Knowledge in "Fusion Technology A"
oral exam of about 20 min
Learning Content
Introduction
Tritium Handling
Tritium Plant Technologies
Tritium and Breeding
Fundamentals of Vacuum Science and Technology
Fusion Vacuum systems
Matter Injection into the Plasma Chamber
Fuel Cycle of ITER and DEMO
11.414 Course: Value stream within enterprises – The value chain at Bosch [T-MACH-106375]

**Responsible:** Dr. Rudolf Maier  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102824 - Key Competences

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Completed coursework

**Credits**  
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**Recurrence**  
Each winter term

**Version**  
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<td>The value stream in an industrial company - The value chain at BOSCH as an example</td>
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<td>Prüfung (PR)</td>
<td>Value stream within enterprises – The value chain at Bosch</td>
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<td>Maier</td>
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**Competence Certificate**

alternative achievement (ungraded):
- attendance on at least 12 lecture units

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**The value stream in an industrial company - The value chain at BOSCH as an example**  
2149661, WS 19/20, 2 SWS, Language: German, [Open in study portal](https://ilias.studium.kit.edu/)

**Description**

Lecture notes will be provided in Ilias  
([https://ilias.studium.kit.edu/](https://ilias.studium.kit.edu/))
Notes
The seminar provides an insight into the main functional units of a company and their typical processes by using Bosch as an example. Furthermore it is based on discussions with the students. Former Bosch top managers explain the essential business processes and functions of the individual departments as well as the classic tasks of an engineer in a worldwide operating automotive supplier. The seminar also provides an insight into the careers of the Bosch directors. In addition to the company processes, the seminar will therefore focus on reports of challenges, successes, failures and product and process innovations.

The topics are as follows:

- Introduction, strategy, innovation
- R&D, product development process
- Production
- Quality management
- Market, marketing, sales
- Aftermarket, service
- Finance, controlling
- Logistics
- Purchasing, supply chain
- IT
- HR, leadership, compliance

Learning Outcomes:
The students ...

- are able to deduce, understand and assess the structure of a global operating enterprise.
- are capable to identify and compare the work flows and processes within a global operating enterprise.
- are able to recognize and assess the problems within interfaces between functional and organizational units which are identified by the experts. Furthermore the students can develop solutions based on this knowledge in order to overcome these problems.

Workload:
regular attendance: 21 hours
self-study: 39 hours

Learning Content
The seminar provides an insight into the main functional units of a company and their typical processes by using Bosch as an example. Furthermore it is based on discussions with the students. Former Bosch top managers explain the essential business processes and functions of the individual departments as well as the classic tasks of an engineer in a worldwide operating automotive supplier. The seminar also provides an insight into the careers of the Bosch directors. In addition to the company processes, the seminar will therefore focus on reports of challenges, successes, failures and product and process innovations.

The topics are as follows:

- Introduction, strategy, innovation
- R&D, product development process
- Production
- Quality management
- Market, marketing, sales
- Aftermarket, service
- Finance, controlling
- Logistics
- Purchasing, supply chain
- IT
- HR, leadership, compliance

Workload
regular attendance: 21 hours
self-study: 39 hours
11.415 Course: Vehicle Comfort and Acoustics I [T-MACH-105154]

Responsible: Prof. Dr. Frank Gauterin
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains
- M-MACH-104443 - Major Field: Vibration Theory

Events

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Competence Certificate

Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Prerequisites

Can not be combined with lecture T-MACH-102206

Below you will find excerpts from events related to this course:

Vehicle Ride Comfort & Acoustics I

2114856, SS 2019, 2 SWS, Language: English, Open in study portal

Notes

In English language.

Learning Content

1. Perception of noise and vibrations

3. Fundamentals of acoustics and vibrations

3. Tools and methods for measurement, computing, simulation and analysis of noise and vibrations

4. The relevance of tire and chasis for the acoustic and mechanical driving comfort: phenomena, influencing parameters, types of construction, optimization of components and systems, conflict of goals, methods of development

An excursion will give insights in the development practice of a car manufacturer or a system supplier.

Workload

regular attendance: 22,5 hours
self-study: 97,5 hours
Literature
2. Russel C. Hibbeler, Technische Mechanik 3, Dynamik, Pearson Studium, München, 2006

The script will be supplied in the lectures

Vehicle Comfort and Acoustics I
2113806, WS 19/20, 2 SWS, Language: German, Open in study portal

Learning Content
1. Perception of noise and vibrations
3. Fundamentals of acoustics and vibrations
3. Tools and methods for measurement, computing, simulation and analysis of noise and vibrations
4. The relevance of tire and chasis for the acoustic and mechanical driving comfort: phenomena, influencing parameters, types of construction, optimization of components and systems, conflict of goals, methods of development

An excursion will give insights in the development practice of a car manufacturer or a system supplier.

Workload
regular attendance: 22,5 hours
self-study: 97,5 hours

Literature
2. Russel C. Hibbeler, Technische Mechanik 3, Dynamik, Pearson Studium, München, 2006

The script will be supplied in the lectures
11.416 Course: Vehicle Comfort and Acoustics II [T-MACH-105155]

**Responsible:** Prof. Dr. Frank Gauterin

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology
- M-MACH-102650 - Major Field: Combustion Engines Based Powertrains
- M-MACH-104443 - Major Field: Vibration Theory

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**Competence Certificate**

Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

**Prerequisites**

Can not be combined with lecture T-MACH-102205

**Below you will find excerpts from events related to this course:**

**Vehicle Comfort and Acoustics II**

2114825, SS 2019, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

1. Summary of the fundamentals of acoustics and vibrations

2. The relevance of road surface, wheel imperfections, springs, dampers, brakes, bearings and bushings, suspensions, engines and drive train for the acoustic and mechanical driving comfort:
   - phenomena
   - influencing parameters
   - types of construction
   - optimization of components and systems
   - conflicts of goals
   - methods of development

3. Noise emission of motor vehicles
   - noise stress
   - sound sources and influencing parameters
   - legal restraints
   - optimization of components and systems
   - conflict of goals
   - methods of development
Workload
regular attendance: 22.5 hours
self-study: 97.5 hours

Literature
The script will be supplied in the lectures.

Notes
The lecture starts in June 2016. Exact date of beginning: see homepage of institute.
In English language.

Learning Content
1. Summary of the fundamentals of acoustics and vibrations

2. The relevance of road surface, wheel imperfections, springs, dampers, brakes, bearings and bushings, suspensions, engines and drive train for the acoustic and mechanical driving comfort:
   - phenomena
   - influencing parameters
   - types of construction
   - optimization of components and systems
   - conflicts of goals
   - methods of development

3. Noise emission of motor vehicles
   - noise stress
   - sound sources and influencing parameters
   - legal restraints
   - optimization of components and systems
   - conflict of goals
   - methods of development

Workload
regular attendance: 22.5 hours
self-study: 97.5 hours

Literature
The script will be supplied in the lectures.
11.417 Course: Vehicle Ergonomics [T-MACH-108374]

Responsible: Dr.-Ing. Tobias Heine
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102600 - Major Field: Man - Technology - Organisation
M-MACH-102605 - Major Field: Engineering Design
M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
M-MACH-102607 - Major Field: Vehicle Technology
M-MACH-102630 - Major Field: Mobile Machines

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Competence Certificate

written exam, 60 minutes

Prerequisites

none

Below you will find excerpts from events related to this course:

Vehicle Ergonomics

2110050, SS 2019, 2 SWS, Language: German, Open in study portal

Notes

- Basics of physical-body related ergonomics
- Basics of cognitive ergonomics
- Theories of driver behaviour
- Interface design
- Usability testing

Learning objective:

An ergonomic vehicle is best adapted to the requirements, needs and characteristics of its users, thus enabling effective, efficient and satisfactory interaction. After attending the lecture, students will be able to analyse and evaluate the ergonomic quality of various vehicle concepts and derive design recommendations. They can consider aspects of both physical-body and cognitive ergonomics. The students are familiar with basic ergonomic methods, theories and concepts as well as with theories of human information processing, especially driver behaviour. They are able to discuss this knowledge critically and to apply it flexibly within the framework of the user-oriented design process.

Translated with www.DeepL.com/Translator

**Responsible:** Prof. Dr.-Ing. Frank Henning  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering  
- M-MACH-102607 - Major Field: Vehicle Technology  
- M-MACH-102628 - Major Field: Lightweight Construction  
- M-MACH-102632 - Major Field: Polymer Engineering  
- M-MACH-102641 - Major Field: Rail System Technology

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**Competence Certificate**  
Written exam, 90 minutes

**Prerequisites**

none

**Recommendation**

none

Below you will find excerpts from events related to this course:

**Vehicle Lightweight design – Strategies, Concepts, Materials**  
2113102, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

- strategies in lightweight design  
- shape optimization, light weight materials, multi-materials and concepts for lightweight design  
- construction methods  
- differential, integral, sandwich, modular, bionic  
- body construction  
- shell, space frame, monocoque  
- metallic materials  
- steel, aluminium, magnesium, titan

**Workload**

- lectures: 21h, preparation of examination: 79h
11.419 Course: Vehicle Mechatronics I [T-MACH-105156]

**Responsible:** Prof. Dr.-Ing. Dieter Ammon

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102598 - Major Field: Advanced Mechatronics
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102606 - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- M-MACH-102607 - Major Field: Vehicle Technology

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**Competence Certificate**
Written examination

**Duration:** 90 minutes

**Auxiliary means:** none

**Prerequisites**
none
Course: Vibration Theory [T-MACH-105290]

**Responsible:** Prof. Dr.-Ing. Alexander Fidlin
Prof. Dr.-Ing. Wolfgang Seemann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102405 - Fundamentals and Methods of General Mechanical Engineering
- M-MACH-102575 - Fundamentals and Methods of Energy and Environmental Engineering
- M-MACH-102590 - Major Field: Advanced Mechatronics
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102636 - Major Field: Thermal Turbomachines
- M-MACH-102646 - Major Field: Applied Mechanics
- M-MACH-102739 - Fundamentals and Methods of Automotive Engineering
- M-MACH-102740 - Fundamentals and Methods of Mechatronics and Microsystem Technology
- M-MACH-102741 - Fundamentals and Methods of Product Development and Construction
- M-MACH-102742 - Fundamentals and Methods of Production Technology
- M-MACH-102743 - Fundamentals and Methods of Theoretical Foundations of Mechanical Engineering
- M-MACH-102744 - Fundamentals and Methods of Materials and Structures for High Performance Systems
- M-MACH-104434 - Major Field: Modeling and Simulation in Dynamics
- M-MACH-104443 - Major Field: Vibration Theory

**Events**

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<td>WS 19/20</td>
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<td>Übungen zu Technische Schwingungslehre</td>
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**Competence Certificate**

written exam, 180 min.

**Prerequisites**

none

Below you will find excerpts from events related to this course:

**Vibration Theory**

2161212, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

Concept of vibration, superposition of vibration with equal and with different frequencies, complex frequency response.

Vibration of systems with one dof: Free undamped and damped vibration, forced vibration for harmonic, periodic and arbitrary excitation. Excitation of undamped vibration in resonance.


Vibration of systems with distributed parameters: Partial differential equations as equations of motion, wave propagation, d'Alembert's solution, Ansatz for separation of time and space, eigenvalue problem, infinite number of eigenvalues and eigenfunctions.

Introduction to rotor dynamics: Laval rotor in rigid and elastic bearings, inner damping, Laval rotor in anisotropic bearings, synchronous and asynchronous whirl, rotors with asymmetric shaft.
Workload

Time of attendance: 22.5 h; self-study: 128 h

Literature

Klotter: Technische Schwingungslehre, Bd. 1 Teil A, Heidelberg, 1978

Hagedorn, Otterbein: Technische Schwingungslehre, Bd 1 and Bd 2, Berlin, 1987

11.421 Course: Virtual Engineering (Specific Topics) [T-MACH-105381]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102597 - Compulsory Elective Module Mechanical Engineering

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**Events**

| SS 2019 | 3122031 | Virtual Engineering (Specific Topics) | 2 SWS | Lecture (V) | Ovtcharova, Mitarbeiter |

**Exams**

| SS 2019 | 76–T–MACH–105381 | Virtual Engineering (Specific Topics) | Prüfung (PR) | Ovtcharova |

**Competence Certificate**

oral exam, 20 min.

**Prerequisites**

none
Course: Virtual Engineering I [T-MACH-102123]

Responsible: Prof. Dr.-Ing. Jivka Ovtcharova
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
M-MACH-102613 - Major Field: Lifecycle Engineering

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Competence Certificate

Written examination 90 min.

Prerequisites

None

Below you will find excerpts from events related to this course:

Virtual Engineering I

2121352, WS 19/20, 2 SWS, Language: German, Open in study portal

Description

Media:
Lecture notes

Learning Content

The lecture communicates IT aspects required for understanding virtual product development processes. For this purpose, the focus is set on systems used in industry supporting the process chain of Virtual Engineering:

- Product Lifecycle Management is an approach for managing product related data across the entire lifecycle of the product, beginning with the concept phase until disassembling and recycling.
- CAx-systems for virtual product development allow modeling digital products regarding design, construction, manufacturing and maintenance.
- Validation systems enable the analysis of products regarding statics, dynamics, safety and manufacturing feasibility.

The objective of the lecture is to clarify the relationship between construction and validation operations by applying virtual prototypes and VR/AR/MR visualization techniques in combination with PDM/PLM-systems. This is taught by introducing each particular system in applied exercises.

Exercises Virtual Engineering I

2121353, WS 19/20, 2 SWS, Language: German/English, Open in study portal

Learning Content

In this module, the practical application of different CAx software systems is exemplarily conducted in small groups, the main focus being the CAD systems CATIA V5 (DASSAULT SYSTEMES) and NX 5 (Siemens PLM Software).
Workload
Regular attendance: 31.5 hours, self-study: 10.5 hours

Literature
Exercise notes
Below you will find excerpts from events related to this course:

**Virtual Engineering II**

**2122378, SS 2019, 2 SWS, Language: German/English, Open in study portal**

**Description**

**Media:**

Lecture notes

**Learning Content**

The lecture presents the IT aspects required for understanding virtual product development processes:

- Corresponding models can be visualized in Virtual Reality Systems, from individual parts to complete assemblies.
- Virtual Prototypes combine CAD-data and information about properties of components and assemblies for immersive visualization, functionality tests and functional validation in VR/AR/MR environments.
- Integrated Virtual Product Development explains product development processes from the point of view of Virtual Engineering.

The objective of this lecture is to clarify the relationship between construction and validation operations by using virtual prototypes and VR/AR/MR visualization techniques in combination with PDM/PLM-systems. This will be achieved by introducing each particular IT-system with practical-oriented exercises.
11.424 Course: Virtual Engineering Lab [T-MACH-106740]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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**Events**

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**Exams**

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**Competence Certificate**

Assessment of another type (graded), procedure see webpage.
11.425 Course: Virtual Reality Practical Course [T-MACH-102149]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102601 - Major Field: Automation Technology
- M-MACH-102612 - Major Field: Modeling and Simulation in Energy- and Fluid Engineering
- M-MACH-102614 - Major Field: Mechatronics
- M-MACH-102633 - Major Field: Robotics

**Type:** Examination of another type

**Credits:** 4

**Recurrence:** Each term

**Version:** 2

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**Events**

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**Competence Certificate**
Assessment of another type (graded)

**Prerequisites**
None

**Annotation**
Number of participants is limited

**Below you will find excerpts from events related to this course:**

---

**Virtual Reality Practical Course**

2123375, WS 19/20, 3 SWS, Language: German/English, [Open in study portal](#)

**Learning Content**
The lab course consists of:

1. Introduction and basics in virtual reality (hardware, software, application)
2. Introduction in 3DVIA Virtools tool kit as an application development system
3. Implementation and practice by developing a driving simulator in small groups.
## 11.426 Course: Virtual Training Factory 4.X [T-MACH-106741]

**Responsible:** Prof. Dr.-Ing. Jivka Ovtcharova  
**Organisation:** KIT Department of Mechanical Engineering  
**Part of:** M-MACH-102613 - Major Field: Lifecycle Engineering

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### Exams

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**Competence Certificate**  
Assessment of another type (graded), procedure see webpage.
11.427 Course: Vortex Dynamics [T-MACH-105784]

Responsibility: Dr. Jochen Kriegseis
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102627 - Major Field: Energy Converting Engines
M-MACH-102634 - Major Field: Fluid Mechanic
M-MACH-102636 - Major Field: Thermal Turbomachines

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Prerequisites

none

Competence Certificate

oral exam - 30 minutes

Below you will find excerpts from events related to this course:

Vortex Dynamics

2153438, WS 19/20, 2 SWS, Language: German, Open in study portal

Notes

The students can describe the physical basics and the mathematical description of vortex flows and are able to explain characteristic phenomena of vortex flows (e.g. vorticity, circulation and dissipation). They are qualified to analyze two- and three-dimensional vortex flows in steady and time-dependent form with respect to their structure and time-behaviour.

- Definition of a vortex
- Theoretical description of vortex flow
- Steady and time-dependent solutions of vortex flows
- Helmholtz's vortex theorems
- Vorticity equation
- Properties of various vortical structures
- Introduction of various vortex identification approaches

Learning Content

- Definition of a vortex
- Theoretical description of vortex flow
- Steady and time-dependent solutions of vortex flows
- Helmholtz's vortex theorems
- Vorticity equation
- Properties of various vortical structures
- Introduction of various vortex identification approaches

Workload

regular attendance: 20h
Self-study: 100h
Literature
11.428 Course: Warehousing and Distribution Systems [T-MACH-105174]

Responsible: Prof. Dr.-Ing. Kai Furmans
Organisation: KIT Department of Mechanical Engineering

Part of:
- M-MACH-102618 - Major Field: Production Technology
- M-MACH-102625 - Major Field: Information Technology of Logistic Systems
- M-MACH-102629 - Major Field: Logistics and Material Flow Theory
- M-MACH-102640 - Major Field: Technical Logistics

Type
- Written examination

Credits
- 3

Recurrence
- Each summer term

Version
- 2

Events

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<td>Written examination</td>
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Competence Certificate
The assessment consists of a 60 minutes written examination (according to §4(2), 1 of the examination regulation).

Prerequisites
none

Below you will find excerpts from events related to this course:

Warehousing and distribution systems
2118097, SS 2019, 2 SWS, Language: German, Open in study portal

Description
Media:
- presentations, black board

Learning Content
- Introduction
- Yard management
- Receiving
- Storage and picking
- Workshop on cycle times
- Consolidation and packing
- Shipping
- Added Value
- Overhead
- Case Study: DCRM
- Planning of warehouses
- Case study: Planning of warehouses
- Distribution networks
- Lean Warehousing

Annotation
none

Workload
- regular attendance: 21 hours
- self-study: 99 hours
Literature

ARNOLD, Dieter, FURMANS, Kai (2005)
Materialfluss in Logistiksystemen, 5. Auflage, Berlin: Springer-Verlag

ARNOLD, Dieter (Hrsg.) et al. (2008)
Handbuch Logistik, 3. Auflage, Berlin: Springer-Verlag

Warehousing Science

GUDEHUS, Timm (2005)
Logistik, 3. Auflage, Berlin: Springer-Verlag

FRAZELLE, Edward (2002)
World-class warehousing and material handling, McGraw-Hill

MARTIN, Heinrich (1999)
Praxiswissen Materialflußplanung: Transport, Hanshaben, Lagern, Kommissionieren, Braunschweig, Wiesbaden: Vieweg

WISER, Jens (2009)
Der Prozess Lagern und Kommissionieren im Rahmen des Distribution Center Reference Model (DCRM); Karlsruhe: Universitätsverlag

A comprehensive overview of scientific papers can be found at:

ROODBERGEN, Kees Jan (2007)
Warehouse Literature
11.429 Course: Wave Propagation [T-MACH-105443]

**Responsible:** Prof. Dr.-Ing. Wolfgang Seemann

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- **M-MACH-102597** - Compulsory Elective Module Mechanical Engineering
- **M-MACH-102598** - Major Field: Advanced Mechatronics
- **M-MACH-102601** - Major Field: Automation Technology
- **M-MACH-102606** - Major Field: Vehicle Dynamics, Vehicle Comfort and Acoustics
- **M-MACH-104443** - Major Field: Vibration Theory

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### Events

| WS 19/20 | 2161219 | Wave Propagation | 2 SWS | Lecture (V) | Seemann |

**Competence Certificate**

oral exam, 30 min.
11.430 Course: Welding Technology [T-MACH-105170]

Responsible: Dr. Majid Farajian
Organisation: KIT Department of Mechanical Engineering

Part of: M-MACH-102611 - Major Field: Materials Science and Engineering
M-MACH-102618 - Major Field: Production Technology

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Events

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<td>Welding Technology</td>
<td>2 SWS</td>
<td>Lecture (V)</td>
<td>Farajian</td>
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Competence Certificate
Oral exam, about 20 minutes

Prerequisites
none

Recommendation
Basics of material science (iron- and non-iron alloys), materials, processes and production, design.
All the relevant books of the German Welding Institute (DVS: Deutscher Verband für Schweißen und verwandte Verfahren) in the field of welding and joining is recommended.

Below you will find excerpts from events related to this course:

V Welding Technology
2173571, WS 19/20, 2 SWS, Language: German, Open in study portal

Lecture (V)
Notes
definition, application and differentiation: welding, welding processes, alternative connecting technologies.
history of welding technology
sources of energy for welding processes
Survey: Fusion welding, pressure welding.
weld seam preparation/design
welding positions
weldability
gas welding, thermal cutting, manual metal-arc welding
submerged arc welding
gas-shielded metal-arc welding, friction stir welding, laser beam and electron beam welding, other fusion and pressure welding processes
static and cyclic behavior of welded joints,
fatigue life improvement techniques
learning objectives:
The students have knowledge and understanding of the most important welding processes and its industrial application.
They are able to recognize, understand and handle problems occurring during the application of different welding processes relating to design, material and production.
They know the classification and the importance of welding technology within the scope of connecting processes (advantages/disadvantages, alternatives).
The students will understand the influence of weld quality on the performance and behavior of welded joints under static and cyclic load.
How the fatigue life of welded joints could be increased, will be part of the course.
requirements:
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.
workload:
The workload for the lecture Welding Technology is 120 h per semester and consists of the presence during the lecture (18 h) as well as preparation and rework time at home (102 h).

Learning Content
definition, application and differentiation: welding, welding processes, alternative connecting technologies.
history of welding technology
sources of energy for welding processes
Survey: Fusion welding, pressure welding.
weld seam preparation/design
welding positions
weldability
gas welding, thermal cutting, manual metal-arc welding
submerged arc welding
gas-shielded metal-arc welding, friction stir welding, laser beam and electron beam welding, other fusion and pressure welding processes
static and cyclic behavior of welded joints,
fatigue life improvement techniques

Workload
The workload for the lecture Welding Technology is 120 h per semester and consists of the presence during the lecture (18 h) as well as preparation and rework time at home (102 h).
Literatur
Für ergänzende, vertiefende Studien gibt das
Handbuch der Schweißtechnik von J. Ruge, Springer Verlag Berlin, mit seinen vier Bänden
Band I: Werkstoffe
Band II: Verfahren und Fertigung
Band III: Konstruktive Gestaltung der Bauteile
Band IV: Berechnung der Verbindungen
einen umfassenden Überblick. Der Stoff der Vorlesung Schweißtechnik findet sich in den Bänden I und II. Einen kompakten Einblick in die Lichtbogenschweißverfahren bietet das Bändchen
Nies: Lichtbogenschweißtechnik, Bibliothek der Technik Band 57, Verlag moderne Industrie AG und Co., Landsberg / Lech
Im Übrigen sei auf die zahlreichen Fachbücher des DVS Verlages, Düsseldorf, zu allen Einzelgebieten der Fügetechnik verwiesen.
Course: Windpower [T-MACH-105234]

**Responsible:** Dr. Norbert Lewald

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102610 - Major Field: Power Plant Technology
- M-MACH-102623 - Major Field: Fundamentals of Energy Technology
- M-MACH-102627 - Major Field: Energy Converting Engines
- M-MACH-102648 - Major Field: Energy Technology for Buildings

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**Competence Certificate**
written exam, 120 minutes

**Prerequisites**
none
Course: Workshop on computer-based flow measurement techniques [T-MACH-106707]

**Responsible:** Prof. Dr.-Ing. Hans-Jörg Bauer  
**Organisation:** KIT Department of Mechanical Engineering

**Part of:**  
M-MACH-102591 - Laboratory Course  
M-MACH-102610 - Major Field: Power Plant Technology  
M-MACH-102623 - Major Field: Fundamentals of Energy Technology  
M-MACH-102636 - Major Field: Thermal Turbomachines

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**Exams**

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**Competence Certificate**

- Group colloquia for each topic
- Duration: approximately 10 minutes
- no tools or reference materials may be used

**Prerequisites**

- none

**Below you will find excerpts from events related to this course:**

**Workshop on computer-based flow measurement techniques**  
2171488, SS 2019, 3 SWS, Language: German, [Open in study portal]

**Practical course (P)**

**Learning Content**

The laboratory course offers an introduction into the acquisition of basic test data in fluid mechanics applications as well as a basic hands-on training for the application of modern PC based data acquisition methods. The combination of lectures about measurement techniques, sensors, signal converters, I/O systems, bus systems, data acquisition, handling and control routines and tutorials for typical fluid mechanics applications allows the participant to get a comprehensive insight and a sound knowledge in this field. The graphical programming environment LabVIEW from National Instruments is used in this course as it is one of the standard software tools for data acquisition worldwide.

Basic design of measurements systems

- Logging devices and sensors
- Analog to digital conversion
- Program design and programming methods using LabView
- Data handling
- Bus systems
- Design of a computer aided data acquisition system for pressure, temperature and derived parameters
- Frequency analysis

**Annotation**

Registration during the lecture period via the website.
Workload
regular attendance: 52,5
self-study: 67,5

Literature
Germer, H.; Wefers, N.: Meßelektronik, Bd. 1, 1985
LabView User Manual
Hoffmann, Jörg: Taschenbuch der Messtechnik, 6., aktualisierte. Aufl., 2011

Workshop on computer-based flow measurement techniques
2171488, WS 19/20, 3 SWS, Language: German, Open in study portal

Practical course (P)

Learning Content
The laboratory course offers an introduction into the acquisition of basic test data in fluid mechanics applications as well as a basic hands-on training for the application of modern PC based data acquisition methods. The combination of lectures about measurement techniques, sensors, signal converters, I/O systems, bus systems, data acquisition, handling and control routines and tutorials for typical fluid mechanics applications allows the participant to get a comprehensive insight and a sound knowledge in this field. The graphical programming environment LabVIEW from National Instruments is used in this course as it is one of the standard software tools for data acquisition worldwide.

Basic design of measurements systems

- Logging devices and sensors
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- Design of a computer aided data acquisition system for pressure, temperature and derived parameters
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Annotation
Registration during the lecture period via the website.

Workload
regular attendance: 52,5
self-study: 67,5

Literature
Germer, H.; Wefers, N.: Meßelektronik, Bd. 1, 1985
LabView User Manual
Hoffmann, Jörg: Taschenbuch der Messtechnik, 6., aktualisierte. Aufl., 2011
11.433 Course: X-ray Optics [T-MACH-109122]

**Responsible:** Dr. Arndt Last

**Organisation:** KIT Department of Mechanical Engineering

**Part of:**
- M-MACH-102597 - Compulsory Elective Module Mechanical Engineering
- M-MACH-102616 - Major Field: Microsystem Technology

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**Competence Certificate**

oral exam (about 20 min)

**Prerequisites**

none

*Below you will find excerpts from events related to this course:

**X-ray Optics**

2141007, WS 19/20, 2 SWS, Language: German, [Open in study portal](#)

**Learning Content**

The lecture covers general principles of optics as well as basics, functioning and application of reflective, refractive and diffractive X-ray optical elements and systems. Selected X-ray analytical imaging methods and the necessary optical elements are discussed including their potentials and limitations.

**Annotation**

Lecture dates will be fixed in agreement with the students, see institutes website.

A visit at synchrotron ANKA is possible if requested.

**Workload**

lecture times plus assignment to review

**Literature**

M. Born und E. Wolf  
Principles of Optics, 7th (expanded) edition  
Cambridge University Press, 2010

A. Erko, M. Idir, T. Krist und A. G. Michette  
Modern Developments in X-Ray and Neutron Optics  
Springer Series in Optical Sciences, Vol. 137  
Springer-Verlag Berlin Heidelberg, 2008

D. Attwood  
Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications  
Cambridge University Press, 1999
11.434 Course: ZAK lectures [T-MACH-106376]

**Responsible:** Prof. Dr.-Ing. Martin Heilmaier  
**Organisation:** KIT Department of Mechanical Engineering  

**Part of:** M-MACH-102824 - Key Competences

**Type**  
Completed coursework

**Credits**  
2

**Recurrence**  
Each term

**Version**  
1

**Competence Certificate**  
s. course

**Prerequisites**  
none

**Annotation**  
For details of conception and contents of the courses refer to www.zak.kit.edu/sq