Karlsruhe Institute of Technology

Module Handbook
BSc Mechanical Engineering (B.Sc.)

Valid from Winter Term 2013/2014
Long version
Date: 10/01/2013

Faculty of Mechanical Engineering

KIT - University of the State of Baden-Wuerttemberg and
National Research Center of the Helmholtz Association

www.kit.edu

Publisher:

Faculty of Mechanical Engineering
Karlsruhe Institute of Technology (KIT)
76128 Karlsruhe
www.mach.kit.edu

Frontpage Image: Rolls-Royce plc

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Fassung vom 17. Juli 2013

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Vertiefungsrichtungen:	MSc	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
Fakultäten:	mach	Fakultät für Maschinenbau
	inf	Fakultät für Informatik
	etit	Fakultät für Elektrotechnik und Informationstechnik
	ciw	Fakultät für Chemieingenieurwesen und Verfahrenstechnik
	phys	Fakultät für Physik
	wiwi	Fakultät für Wirtschaftsingenieurwesen
Semester:	WS	Wintersemester
	SS	Sommersemester
	ww	wahlweise (Angebot im Sommer- und Wintersemester)
Schwerpunkte:	Kat	Kategorie der Fächer im Schwerpunkt
	K, KP	Kernmodulfach, ggf. Pflicht im Schwerpunkt
	E	Ergänzungsfach im Schwerpunkt
	EM	Ergänzungsfach ist nur im Masterstudiengang wählbar
Leistungen:	V	Vorlesung
	Ü	Übung
	P	Praktikum
	LP	Leistungspunkte
	mPr	mündliche Prüfung
	sPr	schriftliche Prüfung
	Gew	Gewichtung einer Prüfungsleistung im Modul bzw. in der Gesamtnote
Sonstiges:	B.Sc.	Studiengang Bachelor of Science
	M.Sc.	Studiengang Master of Science
	SPO	Studien- und Prüfungsordnung
	SWS	Semesterwochenstunden
	WPF	Wahlpflichtfach
	w	wählbar
	p	verpflichtend

1 Studienpläne, Module und Prüfungen

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

1.1 Prüfungsmodalitäten

In jedem Semester sind für schriftliche Prüfungen mindestens ein Prüfungstermin und für mündliche Prüfungen mindestens zwei Termine anzubieten. Prüfungstermine sowie Termine, zu denen die Meldung zu den Prüfungen spätestens erfolgen muss, werden von der Prüfungskommission festgelegt. Die Meldung für die Fachprüfungen erfolgt in der Regel mindestens eine Woche vor der Prüfung. Melde- und Prüfungstermine werden rechtzeitig durch Anschlag bekanntgegeben, bei schriftlichen Prüfungen mindestens 6 Wochen vor der Prüfung.

Über Hilfsmittel, die bei einer Prüfung benutzt werden dürfen, entscheidet der Prüfer. Eine Liste der zugelassenen Hilfsmittel ist gleichzeitig mit der Ankündigung des Prüfungstermins bekanntzugeben.

Für die Erfolgskontrollen in den Schwerpunkt-Modulen gelten folgende Regeln:
Die Fachprüfungen sind grundsätzlich mündlich abzunehmen, bei unvertretbar hohem Prüfungsaufwand kann eine mündlich durchzuführende Prüfung auch schriftlich abgenommen werden.
Die Prüfung im Kernbereich eines Schwerpunkts ist an einem einzigen Termin anzulegen. Erfolgskontrollen im Ergänzungsbereich können separat erfolgen. Bei mündlichen Prüfungen in Schwerpunkten bzw. Schwerpunkt-Teilmodulen soll die Prüfungsdauer 5 Minuten pro Leistungspunkt betragen. Erstreckt sich eine mündliche Prüfung über mehr als 12 LP soll die Prüfungsdauer 60 Minuten betragen.

Erfolgskontrollen anderer Art können beliebig oft wiederholt werden.

1.2 Module des Bachelorstudiums „B.Sc.“

Voraussetzung für die Zulassung zu den Fachprüfungen ist der Nachweis über die angegebenen Studienleistungen. Schriftliche Prüfungen werden als Klausuren mit der angegebenen Prüfungsdauer in Stunden abgenommen. Benotete Erfolgskontrollen gehen mit dem angegebenen Gewicht (Gew) in die Modulnote bzw. die Gesamtnote ein.

Das in § 18 Abs. 2 SPO beschriebene Modul „Schlüsselqualifikationen“ bilden die im nachfolgend aufgeführten Block (7) zusammengefassten Veranstaltungen „ Arbeitstechniken im Maschinenbau“ und „MKL - Konstruieren im Team“ mit einem Umfang von 6 Leistungspunkten. Der in seinen fachspezifischen Inhalten dem untenstehenden Block (6) „Maschinenkonstruktionslehre“ zugeordnete und mit insgesamt 4 Leistungspunkten bewertete Workshop „MKL – Konstruieren im Team“ wird wegen den hier integrativ in teamorientierter Projektarbeit vermittelten Lehrinhalten mit 2 Leistungspunkten dem Block (7) „Schlüsselqualifikationen“ zugerechnet.

Module	Veranstaltung	Koordinator	Studien-leistung	LP	Erfolgs-kon-trolle	Pr (h)	Gew
1 Höhere Mathematik	Höhere Mathematik I	Kirsch	ÜSchein	7	sPr	2	7
	Höhere Mathematik II		ÜSchein	7	sPr	2	7
	Höhere Mathematik III		ÜSchein	7	sPr	2	7
2 Naturwissen-schaftliche Grundlagen	Grundlagen der Chemie	Deutsch-mann		3	sPr	2	3
	Wellenphänomene in der Physik	Pilawa		4	sPr	2	4
3 Technische Mechanik	Technische Mechanik I	Böhlke	ÜSchein	6	sPr	1,5	6
	Technische Mechanik II	Böhlke	ÜSchein	5	sPr	1,5	5
	Technische Mechanik III	Seemann	ÜSchein	5	sPr	3	10
	Technische Mechanik IV	Seemann	ÜSchein	5			

Studienplan der Fakultät für Maschinenbau für den Bachelor- und Masterstudiengang Maschinenbau.
Gültig ab 01.10.2013, auf Beschlussfassung des Fakultätsrats am 17.07.2013. Seite 3 von 18

Module	Veranstaltung	Koordinator	Studien-leistung	LP	Erfolgs-kon-trolle	Pr (h)	Gew
4 Werkstoffkunde	Werkstoffkunde I	Heilmaier		7	mPr		15
	Werkstoffkunde II			5			
	Werkstoffkunde-Praktikum		PSchein	3			
5 Technische Thermodynamik	Technische Thermo-dynamik und Wärme-übertragung I	Maas	ÜSchein	6,5	sPr	4	13
	Technische Thermo-dynamik und Wärme-übertragung II	Maas	ÜSchein	6,5			
6 Maschinen-konstruktions-lehre	Maschinenkonstruktions-lehre I	Albers	ÜSchein	4	sPr	5	18
	Maschinenkonstruktions-lehre II		ÜSchein	4			
	Maschinenkonstruktions-lehre III		ÜSchein	4			
	MKL – Konstruieren im Team (mkl III)		ÜSchein	1			
	Maschinenkonstruktions-lehre IV		ÜSchein	4			
	MKL –Konstruieren im Team (mkl IV)		ÜSchein	1			
7 Schlüssel-qualifikationen	Arbeitstechniken im Maschinenbau	Deml		4	Schein	-	6
	MKL III – Konstruieren im Team	Albers		1	Schein	-	
	MKL IV – Konstruieren im Team			1	Schein	-	
8 Betriebliche Produktions-wirtschaft	Betriebliche Produktionswirtschaft	Furmans		5	sPr	3	5
9 Informatik	Informatik im Maschinenbau	Ovtcharova	PSchein	8	sPr	3	8
10 Elektrotechnik	Elektrotechnik und Elektronik	Becker		8	sPr	3	8
11 Mess- und Regelungs-technik	Grundlagen der Mess- und Regelungstechnik	Stiller		7	sPr	3	7
12 Strömungslehre	Strömungslehre	Frohnapfel		7	sPr	3	7
13 Maschinen und Prozesse	Maschinen und Prozesse	Kubach	PSchein	7	sPr	3	7
14 Wahlpflichtfach	siehe Kapitel 2.1			5	sPr/ mPr	1,5-3	5
15 Schwerpunkt	Schwerpunkt-Kern siehe Kapitel 6	SP-Verantwort-licher		8	mPr		8
	Schwerpunkt-Ergänzung siehe Kapitel 6	SP-Verantwort-licher		4	mPr		4

Erfolgskontrollen in Zusatzmodulen können schriftliche Prüfungen, mündliche Prüfungen oder Erfolgskontrollen anderer Art sein.
Zusätzlich ist ein Berufs-Fachpraktikum (s. Punkt 4) im Umfang von 6 Wochen zu absolvieren (8 LP).

1.3 Studienplan des 1. Abschnitts des Bachelorstudiums „B.Sc.“

Lehrveranstaltungen 1. bis 4. Semester	WS 1. Sem.			SS 2. Sem.			WS 3. Sem.			SS 4. Sem.		
	V	Ü	P	V	Ü	P	V	Ü	P	V	Ü	P
Höhere Mathematik I-III	4	2		4	2		4	2				
Grundlagen der Chemie	2											
Wellenphänomene in der Physik										2	1	
Technische Mechanik I-IV	3	2		2	2		2	2		2	2	
Werkstoffkunde I, II	4	1		3	1							
Werkstoffkunde-Praktikum[1]						2						
Technische Thermodynamik und Wärmeübertragung I, II							3	2		3	2	
Maschinenkonstruktionslehre I-IV	2	1		2	2		2	2		2	1	
MKL – Konstruieren im Team									1			1
Betriebliche Produktionswirtschaft										3	1	
Informatik im Maschinenbau	2	2	2									
Elektrotechnik und Elektronik							4	2				
Arbeitstechniken Maschinenbau				1		1						
Berufliches Grundpraktikum (6 Wochen vor Studienbeginn)												

Lehrveranstaltungen 5. bis 6. Semester	WS 5. Sem.			SS 6. Sem.		
	V	Ü	P	V	Ü	P
Grundlagen der Mess- und Regelungstechnik	3	1				
Strömungslehre	3	1				
Maschinen und Prozesse	2		2			
Wahlpflichtfach (2+1 bzw. 3 SWS)	2	1		(2)	(1)	
Schwerpunkt (6 SWS variabel)	3	()	()	3	()	()
Berufs-Fachpraktikum	(6 Wochen)					

1.4 Studienplan des 2. Abschnitts des Bachelorstudiums „B.Sc.“

Die Bachelorarbeit (12 LP) bildet den zweiten Abschnitt des Bachelorstudiums und ist im Anschluss an den ersten Abschnitt zu absolvieren. Die Durchführung und Benotung der Bachelorarbeit ist in § 11 der Studien- und Prüfungsordnung für den Bachelorstudiengang Maschinenbau geregelt.

[1] Das Werkstoffkunde-Praktikum findet in der vorlesungsfreien Zeit zwischen SS und WS statt und beansprucht eine Woche.

1.5 Masterstudium mit Vertiefungsrichtungen

Es stehen folgende Vertiefungsrichtungen zur Auswahl:

Vertiefungsrichtung	Abk.	Verantwortlicher
Allgemeiner Maschinenbau	MSc	Furmans
Energie- und Umwelttechnik	E+U	Maas
Fahrzeugtechnik	FzgT	Gauterin
Mechatronik und Mikrosystemtechnik	M+M	Bretthauer
Produktentwicklung und Konstruktion	PEK	Albers
Produktionstechnik	PT	Lanza
Theoretischer Maschinenbau	ThM	Böhlke
Werkstoffe und Strukturen für Hochleistungssysteme	W+S	Heilmaier

Das Masterstudium kann sowohl zum Winter- als auch zum Sommersemester aufgenommen werden. Wegen der freien Wahl der Module lässt sich für das Masterstudium kein allgemeingültiger Studienplan angeben. Die Wahlmöglichkeiten in den Wahlpflichtfächern und Schwerpunkten richten sich nach der gewählten Vertiefungsrichtung. Schriftliche Prüfungen werden als Klausuren mit der angegebenen Prüfungsdauer in Stunden abgenommen. Benotete Erfolgskontrollen gehen mit dem angegebenen Gewicht (Gew) in die Gesamtnote ein.

Folgende Module sind im Masterstudiengang zu belegen:

	Module	Veranstaltung	LP	Erfolgs-kontrolle	Pr. (h)	Gew
1.	Wahlpflichtfach 1	siehe Kapitel 2.1	5	sPr/mPr	1,5-3/	5
2.	Wahlpflichtfach 2	siehe Kapitel 2.1	5	sPr/mPr	1,5-3/	5
3.	Wahlpflichtfach 3	siehe Kapitel 2.1	5	sPr/mPr	1,5-3/	5
4.	Wahlfach	siehe Kapitel 2.5	4	mPr		4
5.	Modellbildung und Simulation	Modellbildung und Simulation	7	sPr	3	7
6.	Produktentstehung	Produktentstehung – Entwicklungsmethodik	6	sPr	2	15
		Produktentstehung – Fertigungs- und Werkstofftechnik	9	sPr	3	
7.	Fachpraktikum	Siehe Kapitel 3	3	Schein		
8.	Mathematische Methoden	siehe Kapitel 2.2	6	sPr	3	6
9.	Schwerpunkt 1 – Kern und Ergänzung	siehe Kapitel 6	16	mPr		16
10.	Schwerpunkt 2 – Kern und Ergänzung	siehe Kapitel 6	16	mPr		16
11.	Wahlfach Nat/inf/etit	siehe Kapitel 2.3	6	Schein		
12.	Wahlfach Wirtschaft/Recht	siehe Kapitel 2.4	4	Schein		

Erfolgskontrollen in Zusatzmodulen können schriftliche Prüfungen, mündliche Prüfungen oder Erfolgskontrollen anderer Art sein.

Zusätzlich ist ein Berufspraktikum im Umfang von 6 Wochen zu absolvieren (8 LP).
Im Anschluss an die Modulprüfungen ist eine Masterarbeit (20 LP) zu erstellen.

2 Zugelassene Wahl- und Wahlpflichtfächer

Jedes Fach bzw. jedes Modul kann nur einmal im Rahmen des Bachelorstudienganges und des konsekutiven Masterstudiengangs Maschinenbau gewählt werden.
Wahlpflichtfächer im Bachelor- und Masterstudiengang: Im Bachelorstudiengang muss ein Wahlpflichtfach (WPF) gewählt werden. Im Masterstudiengang werden drei WPF abhängig von der jeweiligen Vertiefungsrichtung belegt.

In den Vertiefungsrichtungen ist die Wahl der WPF eingeschränkt: Eines der mit „p“ gekennzeichneten WPF muss gewählt werden, die beiden anderen WPF müssen aus dem mit w gekennzeichneten Angebot ausgewählt werden. In einem konsekutiven Masterstudium kann ein solches p-Wahlpflichtfach durch ein w-Wahlpflichtfach ersetzt werden, wenn das entsprechende Wahlpflichtfach bereits im Bachelorstudium belegt wurde. Für manche Schwerpunkte kann die Wahl eines Wahlpflichtfachs empfohlen sein (siehe Hinweis beim jeweiligen Schwerpunkt im aktuellen Modulhandbuch).

Folgende Wahlpflichtfächer (WPF) sind derzeit vom Fakultätsrat für den Bachelorstudiengang und die Vertiefungsrichtungen des Masterstudiengangs genehmigt.

Nr.	**Wahlpflichtfächer (WPF)**	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(1)	Arbeitswissenschaft 1		w				w	w		
(2)	Einführung in die Mechatronik	w	w	w	w	p	w	w		
(3)	Elektrotechnik II				w					
(4)	Fluidtechnik	w	w	w	w		w	w	w	
(5)	Wahrscheinlichkeitstheorie und Statistik				w	w			w	
(6)	Einführung in die Mehrkörper-dynamik	w	w	w	w	w	w	w	w	w
(7)	Mathematische Methoden der Dynamik	w	w		w	w	w		w	
(8)	Mathematische Methoden der Festigkeitslehre	w	w		w	w	w	w	w	w
(9)	Mathematische Methoden der Schwingungslehre	w	w		w	w	w		w	
(10)	Mathematische Methoden der Strömungslehre	w	w	w	w				w	
(11)	Mathematische Methoden der Strukturmechanik		w			w	w		w	w
(12)	Grundlagen der Mikrosystem-technik I oder II		w			w	w	w		
(13)	Physikalische Grundlagen der Lasertechnik	w	w	w	w	w	w	w		w
(14)	Numerische Mathematik für Informatiker und Ingenieure			w	w	w		w	w	
(15)	Einführung in die moderne Physik *oder* Physik für Ingenieure	w	w	w	w	w			w	w
(16)	Product Lifecycle Management	w	w		w	w	w	w		
(17)	Simulation von Produktions-systemen und -prozessen	w	w					w		
(18)	Mathematische Modelle von Produktionssystemen		w					w	w	

Nr.	**Wahlpflichtfächer (WPF)**	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(19)	Systematische Werkstoff-auswahl	w	w	w	w	w	w	w	w	p
(20)	Wärme- und Stoffübertragung	w	w	p	w	w	w		w	
(21)	Technische Informations-systeme	w	w		w	w	w	w		
(22)	Modellierung und Simulation	w	w					w	w	w
(23)	Wissenschaftliches Program-mieren für Ingenieure mit Üb.	w	w						w	w
(24)	Mikrostruktursimulation	w	w						w	w
(25)	CAE-Workshop	w	w	w	w	w	w	w		w
(26)	Grundlagen der technischen Verbrennung I	w	w	w	w	w			w	
(27)	Grundlagen der technischen Logistik	w	w	w	w	w	w	w	w	w
(28)	Virtual Engineering Specific Topics	w								
(29)	Service Operations Manage-ment	w						w		
(30)	Industrial Management Case Study	w								
(31)	Maschinendynamik	w	w	w	w	w	w	w	w	w
(32)	Technische Schwingungslehre	w	w	w	w	w	w	w	w	w
(33)	Mathématiques appliquées aux Sciences de l'Ingénieur	w								

Im Masterstudiengang kann ein Wahlpflichtfach aus der Liste der wählbaren Veranstaltungen für das Wahlfach (2.5) gewählt werden.

2.1 Mathematische Methoden im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch.

2.2 Wahlfach aus dem Bereich Naturwissenschaften/Informatik/Elektrotechnik im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch. Der Wechsel der gewählten Veranstaltung ist bis zum Bestehen der Erfolgskontrolle möglich.

2.3 Wahlfach aus dem Bereich Wirtschaft/Recht im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch. Der Wechsel der gewählten Veranstaltung ist bis zum Bestehen der Erfolgskontrolle möglich.

2.4 Wahlfach im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch. Andere Veranstaltungen, auch aus anderen Fakultäten, können mit Genehmigung der Prüfungskommission gewählt werden.

3 Fachpraktikum im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch. Der Wechsel der gewählten Veranstaltung ist bis zum Bestehen der Erfolgskontrolle möglich.

4 Berufspraktikum

Das Berufspraktikum (gemäß SPO § 12) besteht im Bachelorstudiengang aus Grund- und Fachpraktikum (je 6 Wochen) und im Masterstudiengang aus einem Fachpraktikum (6 Wochen). Das Grundpraktikum sollte möglichst in einem geschlossenen Zeitraum vor Beginn des Bachelorstudiums durchgeführt werden. Die Abschnitte der Fachpraktika (im Weiteren Berufs-Fachpraktikum genannt) im Rahmen des Bachelor- und des Masterstudiums sollen in geschlossenen Zeiträumen in beliebiger Reihenfolge durchgeführt werden.

4.1 Inhalt und Durchführung des Berufspraktikums

Nicht das Praktikantenamt, sondern das für den Wohnsitz des Interessenten zuständige Arbeitsamt und mancherorts auch die Industrie- und Handelskammer weisen geeignete und anerkannte Ausbildungsbetriebe nach. Da Praktikantenstellen nicht vermittelt werden, müssen sich die Interessenten selbst mit der Bitte um einen Praktikantenplatz an die Betriebe wenden. Das Praktikantenverhältnis wird rechtsverbindlich durch den zwischen dem Betrieb und dem Praktikanten abzuschließenden Ausbildungsvertrag. Im Vertrag sind alle Rechte und Pflichten des Praktikanten und des Ausbildungsbetriebes sowie Art und Dauer der berufspraktischen Tätigkeit festgelegt. Betrieb steht hier synonym für Firmen, Unternehmen etc., die eine anerkannte Ausbildungsstätte beinhalten.

Um eine ausreichende Breite der berufspraktischen Ausbildung zu gewährleisten, sollen sowohl für das Grundpraktikum als auch für die Berufs-Fachpraktika Tätigkeiten aus verschiedenen Arbeitsgebieten nachgewiesen werden.

Die Tätigkeiten im Grundpraktikum können aus folgenden Gebieten gewählt werden:

- spanende Fertigungsverfahren,
- umformende Fertigungsverfahren,
- urformende Fertigungsverfahren und
- thermische Füge- und Trennverfahren.

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

Die Tätigkeiten im Berufs-Fachpraktikum müssen inhaltlich denen eines Ingenieurs entsprechen und können aus folgenden Gebieten gewählt werden:

- Wärmebehandlung,
- Werkzeug- und Vorrichtungsbau,
- Instandhaltung, Wartung und Reparatur,
- Qualitätsmanagement,
- Oberflächentechnik,
- Entwicklung, Konstruktion und Arbeitsvorbereitung,
- Montage-/Demontage und
- andere fachrichtungsbezogene praktische Tätigkeiten entsprechend den gewählten Schwerpunkten (evtl. in Absprache mit dem Praktikantenamt).

Aus diesen acht Gebieten sollen im Bachelor mindestens drei, im Master mindestens zwei weitere unterschiedliche Gebiete nachgewiesen werden. Dabei wird empfohlen, dass die Tätigkeiten aus dem Gebiet des im Studium gewählten Schwerpunktes bzw. der im Master gewählten Vertiefungsrichtung sind oder damit in Zusammenhang stehen.

Tätigkeiten, die an Universitäten, gleichgestellten Hochschulen oder in vergleichbaren Forschungseinrichtungen durchgeführt wurden, werden grundsätzlich nicht als Berufs-Fachpraktikum anerkannt.

Die vorgeschriebenen 12 bzw. 6 Wochen des Berufspraktikums sind als Minimum zu betrachten. Es wird empfohlen, freiwillig weitere praktische Tätigkeiten in einschlägigen Betrieben durchzuführen.

Fragen der Versicherungspflicht regeln entsprechende Gesetze. Während des Praktikums im Inland sind die Studierenden weiterhin Angehörige der Universität und entsprechend versichert. Versicherungsschutz für Auslandspraktika gewährleistet eine Auslandsversicherung, die vom Praktikanten oder dem Ausbildungsbetrieb abgeschlossen wird.

Ausgefallene Arbeitszeit muss in jedem Falle nachgeholt werden. Bei Ausfallzeiten sollte der Praktikant den auszubildenden Betrieb um eine Vertragsverlängerung ersuchen, um den begonnenen Abschnitt seiner berufspraktischen Tätigkeit im erforderlichen Maße durchführen zu können.

4.2 Anerkennung des Berufspraktikums

Die Anerkennung des Berufspraktikums erfolgt durch das Praktikantenamt der Fakultät für Maschinenbau. Zur Anerkennung ist die Vorlage des Ausbildungsvertrags, eines ordnungsgemäß abgefassten Praktikumsberichts für das Grundpraktikum (von der Firma bestätigt) und eines Original-Tätigkeitsnachweises (Zeugnis) für das Berufs-Fachpraktikum erforderlich. Art und Dauer der einzelnen Tätigkeitsabschnitte müssen aus den Unterlagen klar ersichtlich sein.

Für das Grundpraktikum muss ein Bericht angefertigt werden, der eine geistige Auseinandersetzung mit dem bearbeiteten Thema erkennen lässt. Eine chronologische Auflistung der Tätigkeiten oder eine reine Prozessbeschreibung ist hierfür nicht ausreichend. Die Praktikanten berichten über ihre Tätigkeiten und die dabei gemachten Beobachtungen und holen dazu die Bestätigung des Ausbildungsbetriebes ein. Die Berichterstattung umfasst wöchentliche Arbeitsberichte (Umfang ca. 1 DIN A4-Seite pro Woche) für das Grundpraktikum. Dabei ist die Form frei wählbar (Handschrift, Textsystem, Computergraphik, etc.).

Zur Anerkennung des Berufs-Fachpraktikums wird ein Zertifikat des Ausbildungsbetriebes („Praktikantenzeugnis") benötigt, das Art und Dauer der Tätigkeiten während des Berufs-Fachpraktikums beschreibt. Eventuelle Fehltage sind zu vermerken und müssen nachgeholt werden. Zu Fehltagen zählen u.a. auch Urlaubstage und Abwesenheit wegen Arbeitsunfähigkeit.

Das Praktikantenamt entscheidet, inwieweit die praktische Tätigkeit der Praktikantenordnung entspricht und daher als Praktikum anerkannt werden kann. Ein Praktikum, über das nur unzureichende (unvollständige oder nicht verständlich abgefasste) Berichte vorliegen, wird nur zu einem Teil der Dauer anerkannt.

Wird im Rahmen des Bachelorstudiums ein Berufs-Fachpraktikum anerkannt, das die geforderte Mindestdauer von 6 Wochen überschreitet, so wird die Verlängerungsdauer im Rahmen des konsekutiven Masterstudiums als Berufs-Fachpraktikumszeit anerkannt.

Es wird nachdrücklich empfohlen, einen Teil des Berufspraktikums im Ausland abzuleisten. Für das Berufsleben ist es vorteilhaft, Teile insbesondere des Berufs-Fachpraktikums im Ausland durchzuführen. Berufspraktische Tätigkeiten in ausländischen Betrieben werden nur anerkannt, wenn sie den o.a. Richtlinien entsprechen und Berichte in der im Studienplan genannten Form angefertigt werden.

Für Ausländer aus Ländern, die nicht zur europäischen Union gehören, gelten diese Richtlinien ebenfalls.

4.3 Sonderbestimmungen zur Anerkennung

Eine Lehre, die den Anforderungen des Berufspraktikums entspricht, wird anerkannt. Bei der Bundeswehr erbrachte Ausbildungszeiten in Instandsetzungseinheiten sind mit maximal 6 Wochen als Berufspraktikum anrechenbar, wenn Tätigkeiten gemäß Kapitel 4.1 durchgeführt wurden. Zwecks Anerkennung sind die entsprechenden Berichte und Bescheinigungen (Ausbildungs- und Tätigkeitsnummer und Materialerhaltungsstufe) beim Praktikantenamt einzureichen.

Die praktische Ausbildung an Technischen Gymnasien wird entsprechend den nachgewiesenen Schulstunden als Grundpraktikum anerkannt. Hierbei können maximal 6 Wochen (entspricht 240 Vollzeit-Stunden) auf die berufspraktische Tätigkeit angerechnet werden.

Während des Bachelorstudiums erbrachte Berufspraktika können im Masterstudium anerkannt werden, sofern sie nicht bereits als Berufspraktikum für den Bachelorstudiengang anerkannt wurden.

5 Bachelor- und Masterarbeit

Die Bachelorarbeit darf an allen Instituten der Fakultät Maschinenbau absolviert werden.
Für die Betreuung der Masterarbeit stehen je nach Vertiefungsrichtung folgende Institute (●) zur Wahl:

Institut für	Abk.	MSc	E+UT	FzgT	M+M	PEK	PT	ThM	W+S
Angewandte Informatik/ Automatisierungstechnik	AIA	●	●	●	●	●	●	●	●
Angewandte Werkstoffphysik	IAM-AWP	●	●	●	●	●	–	●	●
Arbeitswissenschaft und Betriebsorganisation	ifab	●	●	–	–	●	●	–	–
Fahrzeugsystemtechnik	FAST	●	●	●	●	●	–	●	●
Fördertechnik und Logistiksysteme	IFL	●	–	–	–	●	●	●	–
Informationsmanagement im Ingenieurwesen	IMI	●	–	●	●	●	●	–	–
Keramik im Maschinenbau	IAM-KM	●	●	–	–	●	–	–	●
Fusionstechnologie und Reaktortechnik	IFRT	●	●	–	–	–	–	–	–
Kolbenmaschinen	IFKM	●	●	●	–	●	–	–	–
Mess- und Regelungstechnik mit Maschinenlaboratorium	MRT	●	●	●	●	●	–	●	–
Mikrostrukturtechnik	IMT	●	●	●	●	●	●	–	–
Produktentwicklung	IPEK	●	●	●	●	●	●	–	●
Produktionstechnik	WBK	●	–	●	●	●	●	–	●
Strömungsmechanik	ISTM	●	●	●	–	–	–	●	–
Fachgebiet Strömungsmaschinen	FSM	●	●	●	–	●	–	–	–
Technische Mechanik	ITM	●	●	●	●	●	●	●	●
Thermische Strömungsmaschinen	ITS	●	●	●	–	●	–	●	●
Technische Thermodynamik	ITT	●	●	●	–	–	–	●	–
Werkstoffkunde	IAM-WK	●	●	●	●	●	●	●	●
Zuverlässigkeit von Bauteilen und Systemen	IAM-ZBS	●	●	●	●	●	–	●	●

In interdisziplinär ausgerichteten Vertiefungsrichtungen ist die Beteiligung von Instituten anderer Fakultäten erwünscht. Mit Zustimmung der Vertiefungsrichtungsverantwortlichen kann die Prüfungskommission auch Masterarbeiten an anderen Instituten der Fakultät für Maschinenbau genehmigen. Zustimmung und Genehmigung sind vor Beginn der Arbeit einzuholen.

6 Schwerpunkte im Bachelor- und im Masterstudiengang

Generell gilt, dass jede Lehrveranstaltung und jeder Schwerpunkt nur einmal entweder im Rahmen des Bachelor- oder des Masterstudiengangs gewählt werden kann.

6.1 Zuordnung der Schwerpunkte zum Bachelorstudiengang und zu den Vertiefungsrichtungen des Masterstudiengangs

Folgende Schwerpunkte sind derzeit vom Fakultätsrat für den Bachelor- und den Masterstudiengang genehmigt. In einigen Vertiefungsrichtungen ist die Wahl des **ersten** Masterschwerpunkts eingeschränkt (einer der mit „p“ gekennzeichneten Schwerpunkte ist zu wählen).
In einem konsekutiven Masterstudium kann ein solcher p-Schwerpunkt durch einen w-Schwerpunkt ersetzt werden, wenn der p-Schwerpunkt bereits im Bachelorstudium gewählt wurde.

Nr.	Schwerpunkt	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(1)	Advanced Mechatronics		w	w	w	p	w	w	w	
(2)	Antriebssysteme	w	w		w		w	w		
(3)	Arbeitswissenschaft		w	w			w	p		
(4)	Automatisierungstechnik		w	w	w	p	w	w	w	
(5)	Berechnungsmethoden im MB	w	w	w	w				w	
(6)	Computational Mechanics		w		w	w	w		p	
(7)	Dimensionierung und Validierung mechanischer Konstruktionen	w								
(8)	Dynamik und Schwingungslehre		w	w	w		w		p	
(9)	Dynamische Maschinenmodelle	w	w					w	w	
(10)	Entwicklung und Konstruktion	w	w	w	w		w	w		
(11)	Fahrdynamik, Fahrzeugkomfort und –akustik		w		w	w	w		w	
(12)	Kraftfahrzeugtechnik	w	w		p		w			
(13)	Festigkeitslehre/ Kontinuumsmechanik	w	w	w	w	w	w	w	p	p
(14)	Gelöscht									
(15)	Grundlagen der Energietechnik	w	w	p	w	w	w			
(16)	Industrial Engineering (engl.)		w				w	w		
(17)	Informationsmanagement	w								
(18)	Informationstechnik	w	w	w	w	w	w	w	w	
(19)	Informationstechnik für Logistiksysteme		w				w	w		
(20)	Integrierte Produktentwicklung		w	w	w		p	w		
(21)	Kerntechnik		w	w					w	
(22)	Kognitive Technische Systeme		w		w	w	w	w	w	
(23)	Kraftwerkstechnik		w	w			w			
(24)	Kraft- und Arbeitsmaschinen	w	w	w	w		w			
(25)	Leichtbau		w	w	w		w	w		w
(26)	Materialwissenschaft und Werkstofftechnik	w	w	w	w	w	w	w	w	p

Nr.	Schwerpunkt	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(27)	Modellierung und Simulation in der Energie- und Strömungstechnik		w	w	w	w	w			
(28)	Lifecycle Engineering		w		w	w	p	p		
(29)	Logistik und Materialflusslehre		w				w	p		
(30)	Mechanik und Angewandte Mathematik		w	w	w	w	w	w	p	w
(31)	Mechatronik	w	w	w	w	p	w	w	w	
(32)	Medizintechnik		w			w	w			
(33)	Mikrosystemtechnik		w	w	w	p	w	w		
(34)	Mobile Arbeitsmaschinen		w		p	w	w	w		
(35)	Modellbildung und Simulation		w		w	w	w	w	p	w
(36)	Polymerengineering		w	w	w		w	w		w
(37)	Produktionsmanagement		w					w		
(38)	Produktionssysteme	w								
(39)	Produktionstechnik		w		w		w	p		
(40)	Robotik		w			p	w	w	w	
(41)	Strömungslehre		w	w	w		w		p	
(42)	Gelöscht									
(43)	Technische Keramik und Pulverwerkstoffe		w	w	w		w			w
(44)	Technische Logistik	w	w				w	w		
(45)	Technische Thermodynamik		w	w	w	w	w		w	w
(46)	Thermische Turbomaschinen		w	w	w				w	w
(47)	Tribologie		w	w	w	w	w	w	w	w
(48)	Verbrennungsmotoren	w	w	w	p		w			
(49)	Zuverlässigkeit im Maschinenbau		w	w	w	w	w	w	w	p
(50)	Bahnsystemtechnik	w	w		p	w	w			
(51)	Entwicklung innovativer Geräte		w	w	w		p	w		
(52)	Production Engineering	w								
(53)	Fusionstechnologie		w	w					w	

Im Masterstudiengang Maschinenbau ohne Vertiefungsrichtung dürfen nur zwei Schwerpunkte kombiniert werden, die von zwei verschiedenen Instituten dominiert werden.

6.2 Wahlmöglichkeiten für den Schwerpunkt im Bachelorstudiengang

Für den Schwerpunkt werden mindestens 12 LP gewählt, davon müssen mindestens 8 LP Kernmodulfächer (K) sein, die im Block geprüft werden. „KP“ bedeutet, dass das Fach im Kernmodulbereich Pflicht ist, sofern es nicht bereits belegt wurde. Die übrigen Leistungspunkte können auch aus dem Ergänzungsbereich (E) kommen. Dabei dürfen nicht mehr als 4 LP Praktika belegt werden, die auch mit einer unbenoteten Erfolgskontrolle abgeschlossen werden können. Die Bildung der Schwerpunktnote erfolgt dann anhand der mit einer Benotung abgeschlossenen Teilmodule.
Die als Ergänzungsfächer (E) angegebenen Veranstaltungen verstehen sich als Empfehlung, andere Fächer auch aus anderen Fakultäten, können mit Genehmigung des jeweiligen Schwerpunkt-Verantwortlichen gewählt werden. Dabei ist eine Kombination mit Veranstaltungen aus den Bereichen Informatik, Elektrotechnik und Mathematik in einigen Vertiefungsrichtungen besonders willkommen. Mit „EM“ gekennzeichnete Fächer stehen nur im Masterstudiengang zur Wahl. Für manche Schwerpunkte ist die Belegung von bestimmten Wahlpflichtfächern (WPF) empfohlen.

Es dürfen im Schwerpunkt maximal 16 LP erworben werden. In jedem Fall werden bei der Festlegung der Schwerpunktnote alle Teilmodulnoten gemäß ihrer Leistungspunkte gewichtet. Bei der Bildung der Gesamtnote wird der Schwerpunkt mit 12 LP gewertet.

6.3 Wahlmöglichkeiten in den einzelnen Schwerpunkten im Masterstudiengang

Für jeden Schwerpunkt werden mindestens 16 LP gewählt, davon müssen mindestens 8 LP Kernmodulfächer (K) sein, die im Block geprüft werden. „KP“ bedeutet, dass das Fach im Kernmodulbereich Pflicht ist, sofern es nicht bereits belegt wurde. Die übrigen Leistungspunkte können auch aus dem Ergänzungsbereich (E) kommen. Dabei dürfen nicht mehr als 4 LP Praktika belegt werden, die auch mit einer unbenoteten Erfolgskontrolle abgeschlossen werden können. Die Bildung der Schwerpunktnote erfolgt dann anhand der mit einer Benotung abgeschlossenen Teilmodule.
Die als Ergänzungsfächer (E) angegebenen Veranstaltungen verstehen sich als Empfehlung, andere Fächer auch aus anderen Fakultäten, können mit Genehmigung des jeweiligen Schwerpunkt-Verantwortlichen gewählt werden. Dabei ist eine Kombination mit Veranstaltungen aus den Bereichen Informatik, Elektrotechnik und Mathematik in einigen Vertiefungsrichtungen besonders willkommen. Mit „EM“ gekennzeichnete Fächer stehen nur im Masterstudiengang zur Wahl. Für manche Schwerpunkte ist die Belegung von bestimmten Wahlpflichtfächern (WPF) empfohlen.
Es dürfen in jedem Schwerpunkt maximal 20 LP erworben werden. In jedem Fall werden bei der Festlegung der Schwerpunktnote alle Teilmodulnoten gemäß ihrer Leistungspunkte gewichtet. Bei der Bildung der Gesamtnote wird jeder Schwerpunkt mit 16 LP gewertet.

6.4 Schwerpunkte im Bachelor- und im Masterstudiengang Maschinenbau

Die Beschreibung der Schwerpunkte hinsichtlich der jeweils darin enthaltenen Lehrveranstaltungen sind in den aktuellen Modulhandbüchern des Bachelor- und Masterstudiengangs nachzulesen.

SP 1: Advanced Mechatronics (Bretthauer)

SP 2: Antriebssysteme (Albers)

SP 3: Arbeitswissenschaft (Deml)

SP 4: Automatisierungstechnik (Bretthauer)

SP 5: Berechnungsmethoden im MB (Seemann)

SP 6: Computational Mechanics (Proppe)

SP 7: Dimensionierung und Validierung mechanischer Konstruktionen (Böhlke)

SP 8: Dynamik und Schwingungslehre (Seemann)

SP 9: Dynamische Maschinenmodelle (Seemann)

SP 10: Entwicklung und Konstruktion (Albers)

SP 11: Fahrdynamik, Fahrzeugkomfort und -akustik (Gauterin)

SP 12: Kraftfahrzeugtechnik (Gauterin)

SP 13: Festigkeitslehre/ Kontinuumsmechanik (Böhlke)

SP 15: Grundlagen der Energietechnik (Bauer)

SP 16: Industrial Engineering (engl.) (Deml)

SP 17: Informationsmanagement (Ovtcharova)

SP 18: Informationstechnik (Stiller)

SP 19: Informationstechnik für Logistiksysteme (Furmans)

SP 20: Integrierte Produktentwicklung (Albers)

SP 21: Kerntechnik (Cheng)

SP 22: Kognitive Technische Systeme (Stiller)

SP 23: Kraftwerkstechnik (Bauer)

SP 24: Kraft- und Arbeitsmaschinen (Gabi)

SP 25: Leichtbau (Henning)

SP 26: Materialwissenschaft und Werkstofftechnik (Heilmaier)

SP 27: Modellierung und Simulation in der Energie- und Strömungstechnik (Maas)

SP 28: Lifecycle Engineering (Ovtcharova)
SP 29: Logistik und Materialflusslehre (Furmans)
SP 30: Mechanik und Angewandte Mathematik (Böhlke)
SP 31: Mechatronik (Bretthauer)
SP 32: Medizintechnik (Bretthauer)
SP 33: Mikrosystemtechnik (Saile, Last)
SP 34: Mobile Arbeitsmaschinen (Geimer)
SP 35: Modellbildung und Simulation (Proppe)
SP 36: Polymerengineering (Elsner)
SP 37: Produktionsmanagement (Deml)
SP 38: Produktionssysteme (Schulze)
SP 39: Produktionstechnik (Schulze)
SP 40: Robotik (Bretthauer)
SP 41: Strömungslehre (Frohnapfel)
SP 43: Technische Keramik und Pulverwerkstoffe (Hoffmann)
SP 44: Technische Logistik (Furmans)
SP 45: Technische Thermodynamik (Maas)
SP 46: Thermische Turbomaschinen (Bauer)
SP 47: Tribologie (Gumbsch)
SP 48: Verbrennungsmotoren (Koch)
SP 49: Zuverlässigkeit im Maschinenbau (Gumbsch)
SP 50: Bahnsystemtechnik (Gratzfeld)
SP 51: Entwicklung innovativer Geräte (Matthiesen)
SP 52: Production Engineering (Deml)
SP 53: Fusionstechnologie (Stieglitz)

7 Änderungshistorie (ab 29.10.2008)

29.10.2008	Änderungen im Abschnitt 1.2 Module des Bachelorstudiums „B.Sc.“: - Prüfungen im Modul 1 - Höhere Mathematik: Getrennte Prüfungen zu HM I und HM II - Prüfungen im Modul 3 - Technische Mechanik: Getrennte Prüfungen zu TM I und TM II - Modul "Schwerpunkt": Umfang des Kernbereichs: 8LP, Umfang des Ergänzungsbereichs: 4 LP
10.12.2008	Änderungen im Abschnitt 1.3 Studienplan des 1. Abschnitts des Bachelorstudiums „B.Sc.“ - Informatik: V, Ü und P finden im ersten Semester statt Änderungen im Abschnitt 1.5 Masterstudium mit Vertiefungsrichtungen - „Es stehen folgende Vertiefungsrichtungen zur Auswahl“ Änderungen im Abschnitt 2.1 Wahlpflichtfächer im Bachelor- und Masterstudiengang - Aufnahme von „Informationssysteme“ als Wahlpflichtfach für BSc, MSc, FzgT, M+M, PEK, PT Änderungen im Abschnitt 2.5 - Umbenennung des „Allgemeinen Wahlfachs“ in „Wahlfach“ Änderungen im Abschnitt 3.1 Fachpraktikum - Tabelle wurde durch Fließtext ersetzt Änderungen im Abschnitt 4 Berufspraktikum - Die Abschnitte der Fachpraktika sollen in einem geschlossenen Zeitraum durchgeführt werden Änderungen im Abschnitt 4.3 Sonderbestimmungen zur Anerkennung - Auf Erwerb gerichtete, berufspraktische Tätigkeiten werden nicht mehr erwähnt Änderungen im Abschnitt 6.1 Zuordnung der Schwerpunkte zum Bachelor- und den Vertiefungsrichtungen des Masterstudiengangs - „Informationsmanagement“ als Schwerpunkt für BSc und FzgT zugelassen - „Lifecycle Engineering“ als Schwerpunkt für BSc zugelassen Änderungen im Abschnitt 6.3 Wahlmöglichkeiten für den Schwerpunkt im „Bachelor of Science“ - Aktualisierung des gesamten Schwerpunkt-Angebotes
	Umbenennung der „Wellenphänomene in der Physik“ in Wellenphänomene in der klassischen Physik Abschnitt 2.1: unter (18) : „Moderne Physik für Ingenieure“ anstelle der „Physik für Ingenieure“, in Abschnitt 2.1 keine Nennung der Dozenten Abschnitt 2.3: unter (11) : „Grundlagen der modernen Physik“ anstelle der „Höheren Physik für Maschinenbauer“ Einfügung einer Zwischenüberschrift 6.4 mit entsprechender Änderung des Inhaltsverzeichnisses
03.02.2010	Änderungen von Veranstaltungen in den Abschnitten 2.1 bis 2.4 Änderung im Punkt 6.1 - Schwerpunkt 50 „Bahnsystemtechnik“ in Tabelle „Schwerpunkte“ eingefügt. Änderung im Punkt 6.2 - 2. Absatz ergänzt um den Satz: „Stehen mehrere Wahlpflichtfächer (WP) als Auswahlmöglichkeit zur Verfügung, muss nur ein Wahlpflichtfach belegt werden.“ Änderungen im Punkt 6.4 - Schwerpunkttabellen ergänzt um die Spalten „Veranstaltungsnummer (VNr)“ und „Leistungspunkte (LP)“. Aktuell vorhandene Daten wurden eingefügt. - Einfügungen und Streichungen von Veranstaltungen in den Schwerpunkten - Schwerpunkt 50 „Bahnsystemtechnik“ eingefügt
07.07.2010	Änderungen im Abschnitt 1.1: Ergänzung der Prüfungsmodalitäten Änderungen im Abschnitt 1.2: Umbenennung des „Workshops Teamkonstruktion“ in „Konstruieren im Team“; Bemerkung zu Erfolgskontrollen in Zusatzmoduln im Bachelorstudium Änderungen im Abschnitt 1.4: Die Bachelorarbeit ist im Anschluss an den ersten Abschnitt zu absolvieren. Änderungen im Abschnitt 1.5: Bemerkung zu Erfolgskontrollen in Zusatzmoduln im Masterstudiumj Änderungen im Abschnitt 2.1: Für manche Schwerpunkte kann die Wahl eines Wahlpflichtfachs empfohlen sein. Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 2.3 und 2.4: Aktualisierung der wählbaren Wahlfächer Änderungen im Abschnitt 4.1:

	Grundpraktikum auch an Universitäten und vergleichbaren Einrichtungen möglich Änderungen im Abschnitt 6.1 und 6.2: Zusätzliche Erläuterung zur vertiefungsrichtungsspezifischen Schwerpunktwahl; Maximaler Umfang des Schwerpunkts im Bachelorstudium: 16 statt 14 LP Änderungen im Abschnitt 6.3 und 6.4: Überarbeitung der Formulierungen und Anpassung von SWS an LP Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes
29.06.2011	Änderungen im Abschnitt 1.4.: Ergänzung zu Durchführung Änderungen im Abschnitt 1.5.: Anpassung der Module Änderungen im Abschnitt 2.1.: Aktualisierung der Wahlpflichtfächer Änderungen im Abschnitt 2.3.: Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 4: Inhaltliche Anpassungen Änderungen im Abschnitt 4.1.: Inhaltliche Anpassung Änderungen im Abschnitt 4.2.: Inhaltliche Anpassung Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes
20.06.2012	Änderung im Abschnitt 2.4 (Wahlfach Wirtschaft /Recht): Die wählbare Fächer sind nun nicht mehr hier sondern im Modulhandbuch aufgeführt. Änderung in den Abschnitten 4. und 4.1 und 4.2 (Berufspraktikum): Inhaltliche Anpassung
24.10.2012	Änderung im Abschnitt 2.3 (Wahlfach Naturwissenschaften/Informatik/Elektrotechnik): Die wählbare Fächer sind nun nicht mehr hier, sondern im Modulhandbuch aufgeführt. Änderungen im Abschnitt 2.1: Aktualisierung der Wahlpflichtfächer Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes (SP 14 gelöscht) Änderungen der Zuordnungen zur Vertiefungsrichtung Produktionstechnik Umbenennung der Vertiefungsrichtung "Unspezifischer Master Maschinenbau" in "Allgemeiner Maschinenbau"
17.07.2013	Abschnitt 1.1: Regelung der Wiederholungsprüfungen für Erfolgskontrollen anderer Art. Änderung in Abschnitt 2 und 3 (Wahlfach, Mathematische Methoden, Fachpraktikum): Die wählbare Fächer sind nun nicht mehr hier, sondern im Modulhandbuch aufgeführt. Änderung in Abschnitt 2.1: Aktualisierung der Wahlpflichtfächer; Im Masterstudiengang kann ein Wahlpflichtfach aus der Liste der wählbaren Veranstaltungen für das Wahlfach (2.5) gewählt werden. Präzisierung zum Veranstaltungswechsel in den Abschnitten 2.3, 2.4 und 3. Abschnitt 4.2: Konkretisierungen zu Bericht und Fehltagen im Berufspraktikum Änderung der Prüfungsdauer für schriftliche Prüfungen des Wahlpflichtfachs Aktualisierung des Schwerpunktangebotes (SP 42 gelöscht) und der Modulverantwortlichen Umbenennung der „Wellenphänomene in der klassischen Physik" in "Wellenphänomene in der Physik"

2 Learning Outcomes

Learning Outcomes (B.Sc., Mechanical Engineering, KIT), 06/28/2013

Through a research and practical orientation of the six-semester Bachelor's degree program for mechanical engineering at KIT, graduates of the program are prepared for lifelong learning and employment in typical professional fields of mechanical engineering in industry, services and public administration. They acquire the academic qualifications to pursue a master's degree program in mechanical engineering or related disciplines.

In the fundamental area of the education, graduates acquire sound basic knowledge in mathematics, mechanics and materials science. This is complemented by basic knowledge of electrical engineering and computer science, business management and natural sciences. Based on that, machine design, measurement and control systems, fluid mechanics and thermodynamics are dealt with in detail. With this in-depth knowledge of theories, principles and methods, graduates can solve given problems in mechanical engineering.

Graduates are prepared for the technical and non-technical requirements of the engineering profession through team-based project work and through a twelve-week industrial internship. In this way they are able to act responsibly and appropriately in the business environment.

In a major field, an elective and in the thesis, cross-disciplinary problem-solving and synthesis skills for engineering systems are developed. Graduates are able to generate new solutions in the areas of their choice of engineering.

Graduates of the Bachelor program in mechanical engineering at KIT can select basic methods in order to create models and compare them in familiar situations. They are able to take over and to work independently on preset problems and resulting tasks in organized teams, to integrate the results of others and to present and interpret their own results in written form. They can identify, analyze and develop systems and processes, and apply predefined assessment criteria, taking into account technical, economic and social constraints.

3 Modules

3.1 All Modules

Module: Advanced Mathematics [BSc-Modul 01, HM]

Coordination: A. Kirsch, T. Arens, F. Hettlich
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
21	Every term	3

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
0131000	Advanced Mathematics I (p. 81)	4	W	7	A. Kirsch, T. Arens, F. Hettlich
0180800	Advanced Mathematics II (p. 82)	4	S	7	A. Kirsch, T. Arens, F. Hettlich
0131400	Advanced Mathematics III (p. 83)	4	W	7	A. Kirsch, T. Arens, F. Hettlich

Learning Control / Examinations
The module grade will be computed by the grades of the lectures iof the module weighted by credit points.

Conditions
None.

Learning Outcomes
The students know the basic facts and tools of one dimensional analysis. The students know the basics on vector spaces and multi-dimensional calculus and the basic techniques to solve differential equations. The students know techniques and applications of the multi-dimensional calculus (vector calculus) and have basic knowledge on partial differential equations and stochastics.

Content
Basic concepts, sequences and convergence, functions and continuity, series, differential calculus of one variable, integral calculus, vector spaces, differential equations, Laplace transform, vector-valued functions of several variables, applications of multi-dimensional calculus, domain integral, vector analysis, partial differential equations, Fourier theory, stochastics

Module: Principles of Natural Science [BSc-Modul 02, NG]

Coordination: O. Deutschmann, B. Pilawa
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7	Every term	2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
5408	Fundamentals of Chemistry (p. 77)	2	W	3	O. Deutschmann
2400411	Wave Phenomena in Physics (p. 158)	2	S	4	B. Pilawa

Learning Control / Examinations
The module grade will be computed by the grades of the lectures of the module weighted by credit points.

Conditions
none

Learning Outcomes
The students are familiar with the principles of Natural Science.
They understand the experimental basics and their mathematical description in the field of wave physics and are able to solve simple physical problems.

Content
Fundamentals of Chemistry and Wave phenomena in classical physics
Structure of matter: Basics of atomic theory, structure of the periodic system, states of matter and phase transitions

Module: Engineering Mechanics [BSc-Modul 03, TM]

Coordination: T. Böhlke, W. Seemann
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
21	Every term	4

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2161245	Engineering Mechanics I (p. 139)	3+2	W	6	T. Böhlke
2162250	Engineering Mechanics II (p. 141)	2+2	S	5	T. Böhlke
2161203	Engineering Mechanics III (p. 142)	2	W	3	W. Seemann
2161204	Engineering Mechanics III (Tutorial) (p. 151)	2	W	2	W. Seemann, Assistenten
2162231	Engineering Mechanics IV (p. 143)	2	S	3	W. Seemann
2162232	Engineering Mechanics IV (Tutorial) (p. 152)	2	S	2	W. Seemann

Learning Control / Examinations
prerequisite: attestation each semester by weekly homework assignments
"Engineering Mechanics I", written, 90 minutes;
"Engineering Mechanics II", written, 90 minutes;
"Engineering Mechanics III/IV", written, 180 Minutes;

Conditions
None.

Learning Outcomes
After having finished the lectures EM I and EM II the students can

- assess stress and strain distributions for the basic load cases within the framework of thermoelasticity
- compute and evaluate 3D stress and strain states
- apply the principle of virtual displacements
- apply energy methods and eavaluate approximate solutions
- evaluate the strability of equilibrium positions
- list elastic-plastic material laws
- solve worksheet problems to topics of the lecture using the computer algebra system MAPLE

In EM III and EM IV the students learn to analyse the motion of points and systems. Based on the axioms of Newton and Euler they know how to derive equations of motion. Besides the synthetic methods they get familiar with analytical methods which are based on energy expressions and can be applied efficiently and formalised. These methods are introduced in the scope of systems of mechanical engineering so that students can determine and analyse motions and the forces which are generated by these motions.

Content
See detailed descriptions of the contents of the lectures "Engineering Mechanics I-IV"

Module: Materials Science and Engineering [BSc-Modul 04, WK]

Coordination: M. Heilmaier
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
15	Every term	2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2173550	Materials Science and Engineering I for mach, IP-M, phys; Part 1 of class: Letters A-K (p. 159)	5	W	7	H. Seifert, K. Weidenmann, M. Heilmaier
2173551	Materials Science and Engineering I for mach, IP-M, phys; Part 2 of class: Letters L-Z (p. 160)	5	W	7	H. Seifert, K. Weidenmann, M. Heilmaier
2174560	Materials Science and Engineering II for mach, IP-M, phys; Part 1 of class: Letters A-K (p. 161)	4	S	5	H. Seifert, K. Weidenmann, M. Heilmaier
2174561	Materials Science and Engineering II for mach, IP-M, phys; Part 2 of class: Letters L-Z (p. 162)	4	S	5	H. Seifert, K. Weidenmann, M. Heilmaier
2174597	Experimental Lab Course in Material Science, mach, IP-M, part A of class, in groups (p. 71)	2	S	3	H. Seifert, K. Weidenmann, M. Heilmaier
2174587	Experimental Lab Course in Material Science, mach, IP-M, part B of class, in groups (p. 72)	2	S	3	H. Seifert, K. Weidenmann, M. Heilmaier

Learning Control / Examinations
not graded: participation in 10 lab experiments, introductory colloquia must be passed and 1 short presentation must be presented. The lab course must be finished successfully prior to the registration for the oral exam;
graded: oral exam covering the whole module, 25 minutes.

Conditions
none

Recommendations
none

Learning Outcomes
Within this Module the students should

- gain knowledge of basics about structural and functional materials
- be able to draw relationships between atomic structure, microstructure and properties
- be able to assess material properties and corresponding applications

Content
The module “Materials Science and Engineering” consists of the lectures “Materials Science and Enginnering I and II” with additional tutorials for small groups and a one week materials science laboratory course.

Module: Engineering Thermodynamics [BSc-Modul 05, TTD]

Coordination: U. Maas
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
13	Every term	2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2165501	Engineering Thermodynamics and Heat Transfer I (p. 145)	3	W	6,5	U. Maas
2166526	Technical Thermodynamics and Heat Transfer II (p. 146)	3	S	6,5	U. Maas
2165527	Tutorial: Engineering Thermodynamics I (p. 153)	2	W	0	U. Maas, Assistenten
2166527	Excercises in Technical Thermodynamics and Heat Transfer II (p. 154)	2	S	0	U. Maas
2165530	Tutorial: Engineering Thermodynamics II - Repetition (p. 155)	2	W	0	U. Maas, Halmer

Learning Control / Examinations
prerequisite: attestation each semester by weekly homework assignments
written exam, graded

Conditions
None.

Learning Outcomes
The students acquire the competency to master the fundamentals of thermodynamics and the ability to apply the knowledge an problem-solving in various branches of mechanical engineering and especially in the Energy Technology sector.
An integral part of the model is that students can define the fundamental laws of thermodynamics and their application. The students are competent in describing and comparing the main processes in energy conversion. Using tools also applied in Industry they are capable of analysing and rating the efficiency of processes. The students are capable of discussing the thermodynamical correlation of ideal gas mixtures, real gases and of humid air as well analysing them with the help of the laws of thermodynamic. Furthermore the students are capable of defining and applying the heattransfer mechanisms.

Content
Cf. detailed description of the contents of the lectures in “Engineering Thermodynamics and Heat Transfer I and II”.

Module: Mechanical Design [BSc-Modul 06, MKL]

Coordination: A. Albers, S. Matthiesen
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
18	Every term	4

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2145178	Mechanical Design I (p. 93)	3	W	4	A. Albers, Burkardt
2146178	Mechanical Design II (p. 95)	4	S	4	A. Albers, Burkardt
2145151	Mechanical Design III (p. 97)	4	W	4	A. Albers, N. Burkardt
2146177	Mechanical Design IV (p. 98)	3	S	4	A. Albers, N. Burkardt
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 111)	2	W/S	2	A. Albers, diverse

Learning Control / Examinations
The written exam with theoretical and design part concerning the whole teaching program of mechanical design I - IV.

Conditions
Requirement for the qualification to the exam is the sucessful participation in mechanical design I, mechanical design II, mechanical design III and mechanical design IV.

Learning Outcomes
The students are able to ...

- analyze the function of unknown machine elements.
- use the interpretation and dimensioning guidelines according the common standardization regulations.
- identify technical problems and to work out and evaluate systematic solutions.
- illustrate problem solving's in technical drawings and cad models according the common standardization regulations.
- estimate the volume and time need of the given tasks and to split them between the team members.
- synthesize the design steps of product engineering by means of a complex technical system.

Content
See detailed descriptions to the lectures mechanical design I-IV.

Module: Key Competences [BSc-Modul 07, SQL]

Coordination: B. Deml
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
6	Every 2nd term, Summer Term	2

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2174970	Working Methods in Mechanical Engineering (lecture) (p. 51)	1	S	2	B. Deml
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 111)	2	W/S	2	A. Albers, diverse
2110968	Workshop 'Working Methods in Mechanical Engineering' (IFAB) (p. 177)	1	S	2	P. Stock
2118973	Workshop 'Working Methods in Mechanical Engineering' (IFL) (p. 179)	1	S	2	Baur
2142975	Workshop 'Working Methods in Mechanical Engineering' (IMT) (p. 181)	1	S	2	M. Worgull
2162983	Workshop I 'Working Methods in Mechanical Engineering' (ITM) (p. 192)	1	S	2	T. Böhlke, Mitarbeiter
2178981	Workshop 'Working Methods in Mechanical Engineering' (IAM-WBM) (p. 174)	1	S	2	O. Kraft, P. Gruber
2182974	Workshop I 'Working Methods in Mechanical Engineering' (IAM-ZBS, Gumbsch) (p. 188)	1	S	2	P. Gumbsch, K. Schulz
2106984	Workshop 'Working Methods in Mechanical Engineering' (AIA) (p. 165)	1	S	2	G. Bretthauer
2114450	Workshop 'Working Methods in Mechanical Engineering' (FAST-Leichtbautechnologie) (p. 168)	1	S	2	F. Henning
2114979	Workshop 'Working Methods in Mechanical Engineering' (FAST-MOBIMA) (p. 169)	1	S	2	M. Geimer
2114989	Workshop 'Working Methods in Mechanical Engineering' (FAST - Fahrzeugtechnik) (p. 167)	1	S	2	F. Gauterin, El-Haji, Unrau
2114990	Workshop 'Working Methods in Mechanical Engineering' (FAST - Bahnsystemtechnik) (p. 166)	1	S	2	P. Gratzfeld
2126980	Workshop 'Working Methods in Mechanical Engineering' (IAM-KM) (p. 173)	1	S	2	M. Hoffmann
2128998	Workshop 'Working Methods in Mechanical Engineering' (IMI) (p. 180)	1	S	2	J. Ovtcharova, Mitarbeiter
2134996	Workshop 'Working Methods in Mechanical Engineering' (IFKM) (p. 178)	1	S	2	T. Koch
2138997	Workshop 'Working Methods in Mechanical Engineering' (MRT) (p. 186)	1	S	2	C. Stiller

2146971	Workshop I 'Working Methods in Mechanical Engineering' (IPEK) (p. 191)	1	S	2	A. Albers
2146972	Workshop II 'Working Methods in Mechanical Engineering' (IPEK) (p. 196)	1	S	2	S. Matthiesen
2150987	Workshop I 'Working Methods in Mechanical Engineering' (WBK) (p. 193)	1	S	2	V. Schulze
2150988	Workshop II 'Working Methods in Mechanical Engineering' (WBK) (p. 199)	1	S	2	G. Lanza
2150989	Workshop III 'Working Methods in Mechanical Engineering' (WBK) (p. 202)	1	S	2	J. Fleischer
2158978	Workshop 'Working Methods in Mechanical Engineering' (FSM) (p. 170)	1	S	2	M. Gabi
2162994	Workshop II 'Working Methods for Mechanical Engineering' (ITM) (p. 198)	1	S	2	C. Proppe
2162995	Workshop III 'Working Methods in Mechanical Engineering' (ITM) (p. 201)	1	S	2	W. Seemann
2166991	Workshop 'Working Methods in Mechanical Engineering' (ITT) (p. 184)	1	S	2	U. Maas
2170972	Workshop 'Working Methods in Mechanical Engineering' (ITS) (p. 183)	1	S	2	H. Bauer
2174976	Workshop I 'Working Methods in Mechanical Engineering' (IAM-WK) (p. 187)	1	S	2	M. Heilmaier
2174986	Workshop II 'Working Methods in Mechanical Engineering' (IAM-WK) (p. 194)	1	S	2	P. Elsner
2174987	Workshop 'Working Methods in Mechanical Engineering' (IAM-AWP) (p. 172)	1	S	2	H. Seifert, R. Kohler
2182982	Workshop 'Working Methods in Mechanical Engineering' (IAM-ZBS, Nestler) (p. 175)	1	S	2	B. Nestler, A. August
2190497	Workshop I 'Working Methods in Mechanical Engineering' (IFRT) (p. 190)	1	S	2	V. Sánchez-Espinoza
2190498	Workshop II 'Working Methods in Mechanical Engineering' (IFRT) (p. 195)	1	S	2	F. Arbeiter
2190975	Workshop III 'Working Methods in Mechanical Engineering' (IFRT) (p. 200)	1	S	2	X. Cheng
2110969	Working Methods in Mechanical Engineering (Lecture in English) (p. 52)	1	S	2	B. Deml
2174975	Workshop 'Working Methods in Mechanical Engineering' Heilmeier (IAM-WK) (p. 203)	1	S	2	M. Heilmaier

Learning Control / Examinations
see submodule descriptions

Conditions
None.

Learning Outcomes
After completion this module, the students are able

1. to identify and coordinate goals and the resulting working tasks, to apply a systematic and goal-oriented approach, to set priorities and to evaluate the feasibility of a task,
2. to describe and to apply goal- and resource-oriented methods for the planning of a working task under defined conditions,
3. to describe and apply methods for scientific research and the selection of relevant information according to defined criteria of quality,
4. to evaluate the quality of a scientific source,
5. to describe and apply empirical methods in mechanical engineering,
6. to document scientific information in a clear, structured and convincing style in different formats (e.g. poster, expose, abstract, bachelor thesis, construction diagrams, flow diagrams),
7. to evaluate the quality of a scientific text or poster,
8. to present scientific information in a convincing and appealing style,
9. to work in a heterogeneous team, to solve conflicts and to resume responsibility for themselve and others,
10. to communicate objective within a team, to achieve their own interests, to describe the interests of others in own words and to moderate a discussion.

Content
Contents of this module can be read in the single module components.

Module: Production Operations Management [BSc-Modul 08, BPW]

Coordination: K. Furmans
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5	Every 2nd term, Summer Term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2110085	Production Operations Management (p. 57)	4	S	5	K. Furmans, G. Lanza, F. Schultmann, B. Deml

Learning Control / Examinations
written examn, 90 min, graded

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- describe the connections between production sience, work scheduling and -design, material flow and basics of economics,
- differentiate between production systems and knows there characteristics,
- design workplaces according to the requirements,
- create a material flow system to ensure supply a production system according to the system parameters and
- Evaluate necessary systems finacially.

Content
The lecture is given in cooperation by the Institute for Conveying Technologies and Logistics (IFL), the Institute for Arbeitswissenschaft und Betriebsorganisation, the Institute of Production Science and the Institute for Industrial Production (IIP). Basic knowledge about the planning and operation of a production business is provided.
Subject areas are production science (production techniques, manufacturing and assembly systems), work scheduling, work control, work design, material flow as well as basics of economics (accounting, reinvestment analysis, legal forms).

Remarks
none

Module: Computer Science [BSc-Modul 09, Inf]

Coordination: J. Ovtcharova
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
8	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2121390	Computer Science for Engineers (p. 84)	2	W	8	J. Ovtcharova, S. Rogalski
2121391	Exercises Computer Science for Engineers (p. 150)	2	W	0	J. Ovtcharova
2121392	Computer Lab for Computer Science in Mechanical Engineering (p. 128)	2	W	0	J. Ovtcharova

Learning Control / Examinations
Science for Engineers", 100%, 180 minutes;
prerequisite: Computer Lab Certificate

Conditions
None.

Recommendations
None.

Learning Outcomes
Students can identify and explain fundamental terms, problems and concepts of computer science. They can apply the basic methods of the OO modeling with UML and implement the object-oriented programming (OOP) with the programming language JAVA.

Content
Basics: Information representation- and processing, terms and definitions: alphabet, data, signals, information, numeral systems, propositional logic and Boolean algebra, computer architectures, programming paradigms.
Object Orientation: Definition and important characteristics of object orientation, Object-oriented modeling with UML.
Data Structures: Definition, properties and application of graphs, trees, linked lists, queues and stacks.
Algorithms: Characteristics of algorithms, complexity analysis, design methods, important examples.
Database management systems: Relational data model, relational algebra, declarative language SQL.
Basics and concepts of JAVA. Introduction to programming using JAVA.

Remarks
None.

Module: Electrical Engineering [BSc-Modul 10, ET]

Coordination: K. Becker
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
8	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23339	Electrical Engineering and Electronics for Mechanical Engineers (p. 70)	6	W	8	K. Becker

Learning Control / Examinations
graded, "Electrical Engineering for Mechanical Engineers", 100%, written exam, 180 minutes.

Conditions
None

Learning Outcomes
The students have an overview of the physical basics of electrical engineering (electrical field, magnetic field, resistor, capacitor, inductor), know methods for the calculation of electrical DC- and AC-circuits, and understand the construction and steady-state performance of the basic electrical machines (transformer, DC-, induction- and synchronous machine).
The students have an overview of the most important semicon-ductor devices and their functionality, understand the basic principles of power electronic circuits and their arrangements to more complex structures (for semiconductor devices which can be switched off or can not be switched off as well), and know the basics of the operation mode of operational amplifiers.

Content
Fundamental terms, ohmic resistor, electrical field, magnetic field, oscillations, complex calculation of alternating current circuits, three phase current, measurement technique, drive engineering, DC machine, transformer, induction machine, synchronous machine, semiconductor devices, transistors and thyristors, power electronics, operational amplifiers

Module: Measurement and control systems [BSc-Modul 11, MRT]

Coordination: C. Stiller
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2137301	Measurement and Control Systems (p. 78)	3	W	7	C. Stiller

Learning Control / Examinations
written exam, 3 hours

Conditions
None.

Learning Outcomes

- Students are able to name, describe and explain control principles applied to physical quantities.
- They are able to name, analyze and assess system theoretic characteristics of dynamical systems.
- Students are able to represent real systems in a system theoretic model and to assess the suitability of a given model.
- Students are able to apply methods for controller design and to analyze their properties.
- Students are able to select appropriate principles of metrology and to model, analyze and assess measurement setups.
- Students are able to quantify and assess measurement uncertainties.

Content

Module: Fluid mechanics [BSc-Modul 12, SL]

Coordination: B. Frohnapfel
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7	Every 2nd term, Winter Term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2153412	Fluid Mechanics (german language) (p. 134)	4	W	7	B. Frohnapfel

Learning Control / Examinations
written exam, 3 hours

Conditions
None.

Learning Outcomes
After having completed this module the student is capable of deriving the mathematical equations that describe the motion of fluids and can apply these to simple examples. He/She can list the characteristic properties of fluids and can distinguish flow scenarios. The student is able to determine flow quantities for generic problems.

Content
see detailled description of the lecture “Fluid Mechanics”

Module: Machines and Processes [BSc-Modul 13, MuP]

Coordination: H. Kubach
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7	Every term	1

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2185000	Machinery and Processes (p. 91)	4	W/S	7	H. Kubach, M. Gabi, H. Bauer, U. Maas

Learning Control / Examinations
successful lab course and written exam (2 h)
Taking part at the exam is possible only when lab course has been successfully completed

Conditions
Successful lab course is a precondition to take part at the exam.

Learning Outcomes
The students can name and describe basic energy conversion processes and energy converting machines. They can explain the application of these energy conversion processes in various machines. They can analyze and evaluate the processes and machines in terms of functionality and efficiency and they are able to solve basic technical problems in terms of operating the machines.

Content
basics of thermodynamics
thermal fluid machines

-
- steam turbunes
- gas turbines
- combined-cycle plants
- turbines and compressors
- aircraft engines

hydraulic fluid machines

-
- oerating performance
- characterization
- control
- cavitation
- wind turbines, propellers

internal combustion engines

-

- characteristic parameters
- engine parts
- kinematics
- engine processes
- emissions

Remarks
Lab course and lecture take place in summer and winter semester.
In the SS the lecture is held in English. The lab course is always bilingual.

Module: Compulsory Elective Subject (BSc) [BSc-Modul 14, WPF]

Coordination: C. Proppe
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5	Every term	1

ID	Course	Term	Lecturer
2147175	CAE-Workshop (p. 58)	W/S	A. Albers, Assistenten
2110031	Service Operations Management (p. 61)	S	P. Stock
2105011	Introduction into Mechatronics (p. 64)	W	G. Bretthauer, A. Albers
2162235	Introduction into the multi-body dynamics (p. 65)	S	W. Seemann
3109033	Industrial Management Case Study (p. 73)	S	P. Stock
2114093	Fluid Technology (p. 75)	W	M. Geimer
2117095	Basics of Technical Logistics (p. 79)	W	M. Mittwollen, Madzharov
2165515	Fundmentals of Combustion I (p. 80)	W	U. Maas
2161224	Machine Dynamics (p. 92)	S	C. Proppe
2161230	Mathématiques appliquées aux sciences de l'ingénieur (p. 101)	S	J. Dantan
2161206	Mathematical Methods in Dynamics (p. 102)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 103)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 105)	S	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 106)	S	A. Class, B. Frohnapfel
2183702	Modelling of Microstructures (p. 109)	W	A. August, B. Nestler, D. Weygand
2183703	Modelling and Simulation (p. 112)	W/S	B. Nestler, P. Gumbsch
4040311	Modern Physics for Engineers (p. 115)	S	B. Pilawa
2181612	Physical basics of laser technology (p. 121)	W	J. Schneider
2142890	Physics for Engineers (p. 120)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2121350	Product Lifecycle Management (p. 124)	W	J. Ovtcharova
2149605	Simulation of production systems and processes (p. 132)	W	K. Furmans, V. Schulze, P. Stock
2174576	Systematic Materials Selection (p. 137)	S	J. Hoffmeister
2121001	Integrated Information Systems for engineers (p. 138)	S	J. Ovtcharova
2161212	Vibration Theory (p. 144)	W	A. Fidlin
3122031	Virtual Engineering (Specific Topics) (p. 156)	S	J. Ovtcharova
22512	Heat and mass transfer (p. 157)	W	H. Bockhorn, U. Maas
2181738	Scientific computing for Engineers (p. 164)	W	D. Weygand, P. Gumbsch

Learning Control / Examinations
graded oral or written exam, duration (depends on the lecture)

Conditions
See Studienplan

Learning Outcomes
The elective course serves as a comprehensive, in-depth analysis of fundamentals in selected areas of mechanical engineering.

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

Content
see chosen compulsory elective subject

Remarks
In total, four compulsory elective subjects have to be chosen, one in the bachelor´s program and three in the master´s program. For the bachelor´s program, a reduced catalogue exists (see Studienplan).

Module: Major Field [BSc-Modul 15, SP]

Coordination: C. Proppe
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration
12	Every term	2

Learning Control / Examinations
graded or not graded, oral or written exam, duration (depends on the lecture)

Conditions
None.

Learning Outcomes
As part of a major field a domain 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 slected domain, where they are able to generate new solutions.
The specific learning outcomes are defined by the respective coordinator of the major field.

Content
see chosen major field

Remarks
In total, three major fields have to be chosen, one in the bachelor´s program and two in the master´s program. For the bachelor´s program, a reduced catalogue exists (see Studienplan).

Module: Lectures in English [Englischsprachige Veranstaltungen]

Coordination:
Degree programme: BSc Maschinenbau (B.Sc.)
Subject:

ECTS Credits	Cycle	Duration

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
23629 + 23631	Optical Engineering (p. 119)	3	W	4,5	W. Stork
23747 + 23749	Light and Display Engineering (p. 89)	3	W	4,5	R. Kling
23430 + 23431	Modern Radio Systems Engineering (p. 113)	3	S	4,5	T. Zwick
2150653	Basics in Material Handling and Logistics Systems (p. 54)	2	S	4	M. Schwab, P. Linsel
2189904	Ten lectures on turbulence (p. 147)	2	W	4	I. Otic
2190490	Introduction to Neutron Cross Section Theory and Nuclear Data Generation (p. 86)	2	S	4	R. Dagan
2189920	Nuclear Fusion Technology (p. 116)	2	W	4	A. Badea
23211	Materials and Devices in Electrical Engineering (p. 100)	2	W	3	A. Weber
2110969	Working Methods in Mechanical Engineering (Lecture in English) (p. 52)	1	S	2	B. Deml
2110033	Introduction to Ergonomics (p. 62)				
2189908	Nuclear Thermal-Hydraulics (p. 118)	2	W	4	X. Cheng
2130910	CFD for Power Engineering (p. 59)	2	S	4	I. Otic
2142884	Microoptics and Lithography (p. 108)	2	S	4	T. Mappes
2161224	Machine Dynamics (p. 92)	3	S	5	C. Proppe
2169453	Thermal Turbomachines I (p. 148)	3	W	6	H. Bauer
2170476	Thermal Turbomachines II (p. 149)	3	S	6	H. Bauer
2581998	Basics of Liberalised Energy Markets (p. 56)	2/1	W	3,5	W. Fichtner
2199115	Chemical Fuels (p. 60)	2	S	4	G. Schaub
2118092	Selected Topics in Manufacturing Technologies (p. 53)	2	S	4	V. Schulze
2199102	Power Electronics (p. 123)	2	S	3	Prof. Dr. Alfons Kloenne
2300002	Electric Power Generation and Power Grid (p. 66)	2	W	3	B. Hoferer
23315	Electrical Machines (p. 67)	2	S	4,5	M. Doppelbauer
2581012	Renewable Energy - Resources, Technologies and Economics (p. 129)	2	W	3,5	R. McKenna
2146202	Methods of Product Development (p. 107)	2	S	6	N. Burkardt
2146203	Innovation Management (p. 85)	2	S	4	N. Burkardt
2145200	Management Training (p. 90)		W	3	N. Burkardt
2190464	Nuclear Safety II: Safety Assessment of Nuclear Power Plants (p. 127)	2	S	4	V. Sánchez-Espinoza

23682	Superconducting Materials for Energy Applications (p. 136)	2	S	3	M. Noe, Dr. F. Grilli
2400104	Power Plant Digital Control Systems with Emphasis on Safety and Availability (p. 88)	2	W	3	A. Konnov
2169461	Coal fired power plants (p. 87)	2	W	4	P. Fritz, T. Schulenberg
2170490	Combined Cycle Power Plants (p. 76)	2	S	4	T. Schulenberg
2157451	Wind and Hydropower (p. 163)	2	W	4	M. Gabi, N. Lewald
2189921	Nuclear Power and Reactor Technology (p. 117)	3	W	6	A. Badea
2581993	Risk Management in Industrial Planning and Decision-Making (p. 130)	2/0	S	3,5	F. Schultmann
2199119	Modern Software Tools in Power Engineering (p. 114)	3	S	6	T. Leibfried
2199120	Electrical Power Transmission and Grid Control (p. 69)	3	W	6	T. Leibfried
2146440	Range Extender (p. 126)	2	W	6	H. Bauer

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Remarks
The integration of these lectures into modules is described in the respective modules.

4 Courses

4.1 All Courses

Course: Working Methods in Mechanical Engineering (lecture) [2174970]

Coordinators: B. Deml
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
certificate after active participation in all four workshops

Conditions
None.

Learning Outcomes
After completion this lecture, the students are able

- *to describe and to apply goal- and resource-oriented methods for the planning of a working task under defined conditions,*
- *to describe and apply methods for scientific research and the selection of relevant information according to defined criteria of quality,*
- *to evaluate the quality of a scientific source,*
- *to describe and apply empirical methods in mechanical engineering,*
- *to document scientific information in a clear, structured and convincing style in different formats (e.g. poster, expose, abstract, bachelor thesis),*
- *to evaluate the quality of a scientific text or poster,*
- *to present scientific information in a convincing and appealing style,*
- *to work in a heterogeneous team and to solve occuring conflicts.*

Content

1. Introduction to the course
2. Scientific working techniques
3. Literature research
4. Project management
5. Time management
6. Scientific elaborations
7. Presentation techniques

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Working Methods in Mechanical Engineering (Lecture in English) [2110969]

Coordinators: B. Deml
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL], Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	en

Learning Control / Examinations
Certificate after active participation in all four workshops.

Conditions
None.

Learning Outcomes
After completion this lecture, the students are able

- *to describe and to apply goal- and resource-oriented methods for the planning of a working task under defined conditions,*
- *to describe and apply methods for scientific research and the selection of relevant information according to defined criteria of quality,*
- *to evaluate the quality of a scientific source,*
- *to describe and apply empirical methods in mechanical engineering,*
- *to document scientific information in a clear, structured and convincing style in different formats (e.g. poster, expose, abstract, bachelor thesis),*
- *to evaluate the quality of a scientific text or poster,*
- *to present scientific information in a convincing and appealing style,*
- *to work in a heterogeneous team and to solve occuring conflicts.*

Content

1. Introduction to the course
2. Scientific working techniques
3. Literature research
4. Project management
5. Time management
6. Scientific elaborations
7. Presentation techniques

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Selected Topics in Manufacturing Technologies [2118092]

Coordinators: V. Schulze
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students ...

- are capable to specify different manufacturing processes and to differentiate against each other.
- are able to classify the manufacturing processes by their structure and functionality according to the specific main groups.
- are able to explain the characteristics, function and field of application of different manufacturing processes.
- are qualified to evaluate different processes regarding specific applications based on technical aspects.

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 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 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

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Basics in Material Handling and Logistics Systems [2150653]

Coordinators: M. Schwab, P. Linsel
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral examination, 20 minutes, 1 x year (after lecture period)

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- describe material flow processes qualitativ and quantitativ,
- plan material flow systems, illustrate them in simple models and analyse them regarding their performance,
- use methods to determine performance indicators like throughput, utilization, etc.,
- Describe logistical tasks,
- Design logistical systems suitable to the respective task,
- Determine essential influencing parameters on the bullwhip effect and
- Use optimizing solution methods.

Content
Conveyor Systems

- Basic elements of conveyor systems
- Key figures
- Branching elements
  - continuous/partially-continuous
  - deterministic/stochastic switch
- Integration elements
  - continuous/partially-continuous
  - dispatching rules

Queueing Theory and Production Logistics

- Basic queueing systems
- Distributions
- M|M|1 and M|G|1 model
- Application on production logistics

Distribution Centers and Order Picking

- The location problem

- Distribution centers
- Inventory management
- Order picking

Vehicle Routing

- Types of vehicle routing problems
- Linear programming model and graph theoretic model
- Heuristics
- Supporting technologies

Optimization of Logistical Networks

- Objectives
- Cooperative strategies
- Supply chain management
- Implementation

Media
presentations, blackboard, book

Literature
Literature: Arnold, Dieter; Furmans, Kai : Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009

Remarks
none

Course: Basics of Liberalised Energy Markets [2581998]

Coordinators: W. Fichtner
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/1	Winter term	en

Learning Control / Examinations
The assessment consists of a written exam according to Section 4(2), 1 of the examination regulation.

Conditions
None.

Learning Outcomes

Content
1. The European liberalisation process
1.1 The concept of a competitive market
1.2 The regulated market
1.3 Deregulation in Europe
2. Pricing and investments in a liberalised power market
2.1 Merit order
2.2 Prices and investments
2.3 Market flaws and market failure
2.4 Regulation in liberalised markets
2.5 Additional regulation mechanisms
3. The power market and the corresponding submarkets
3.1 List of submarkets
3.2 Types of submarkets
3.3 Market rules
4. Risk management
4.1 Uncertainties in a liberalised market
4.2 Investment decisions under uncertainty
4.3 Estimating future electricity prices
4.4 Portfolio management
5. Market power
5.1 Defining market power
5.2 Indicators of market power
5.3 Reducing market power
6. Market structures in the value chain of the power sector

Media
Media will likely be provided on the e-learning platform ILIAS.

Literature
Elective literature:
Power System Economics; Steven Stoft, IEEE Press/Wiley-Interscience Press, 0-471-15040-1

Course: Production Operations Management [2110085]

Coordinators: K. Furmans, G. Lanza, F. Schultmann, B. Deml
Part of the modules: Production Operations Management (p. 39)[BSc-Modul 08, BPW]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are able to describe the connections between production science work scheduling and –design, material flow and basics of economics,
- are able to differentiate between production systems and rate their characteristics,
- are capable of designing workplaces according to the requirements,
- can create material flow systems depending on the production system to ensure supply,
- are able to evaluate systems financially by having the economical knowledge.

Content
The lecture is given in cooperation by the Institute for Conveying Technologies and Logistics (IFL), the Institute of Human and Industrial Engineering (IFAB), the Institute of Production Science (wbk) and the Institute for Industrial Production (IIP). Basic knowledge about the planning and operation of a production business is provided. Subject areas are production science (production techniques, manufacturing and assembly systems), work scheduling, work control, work design, material flow as well as basics of economics (accounting, reinvestment analyses, legal forms).

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: CAE-Workshop [2147175]

Coordinators: A. Albers, Assistenten
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	de

Learning Control / Examinations
Depending on the manner in which the CAE-Workshop will be credited.

Conditions
compulsory attendance

Recommendations
We suggest this Workshop after 2 years of classes.

Learning Outcomes
The students are able to ...

- name the purposes and limits of numerical simulation and optimization of the virtual product development.
- solve simple realistic tasks in the field of finite element analysis, multi-body-simulation and structure optimization with industrial common software (the content in winter and summer term is different).
- evaluate and to question the results of a simulation.
- identify and improve the mistakes of a simulation or optimization.

Content
Content in the summer semester:

- introduction to the finite element analysis (FEA)
- stess 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 optimization package TOSCA and the Abaqus solver

Content in the winter semester:

- 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 multi-body simulation (MBS)
- preparation and running of multi-body simulation models. Coupling of the MBS and FEA to calculate hyprid multi-body simulation problems.

Literature
The workshop script will be allocated at Ilias.

Course: CFD for Power Engineering [2130910]

Coordinators: I. Otic
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
Oral exam, length: 30 minutes

Conditions
None.

Learning Outcomes
After completing the course students are able:

- to understand the fundamentals of computational fluid dynamics (CFD)
- to simulate turbulent flow with heat transfer using CFD
- to present, analyse and evaluate the simulation results.

Content
This course is specified for both Bachelor and Master students, Power and Nuclear Engineering.
The course is aimed of 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.

Course: Chemical Fuels [2199115]

Coordinators: G. Schaub
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral/written examination

Conditions
basics in chemistry, reaction kinetics, chemical thermodynamics

Learning Outcomes
Understanding of (i) principles of production and upgrading of fuels, (ii) fuel conversion processes,
(iii) criteria for assessing different fuels and fuel conversion processes.

Content
Introduction to global reserves and production, environmental aspects, photosynthesis, fossil fuel formation; characteristic properties of raw materials and fuels; process overview of fuel upgrading, conversion, cleaning; examples liquid fuels: liquid fuels from petroleum and biomass, chemical upgrading processes in petroleum refining, non-conventional liquid fuels from fossil feedstocks and biomass feedstocks, fuel gas from coal and biomass.

Course: Service Operations Management [2110031]

Coordinators: P. Stock
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Elective Subject: oral exam (ca. 30 min)
Compulsory Optional Subject: oral exam (ca. 30 min)
Optional Subject: oral exam (ca. 30 min)

Conditions
None.

Recommendations

- Depened understanding of industrial engineering
- Some knowledge about service organisations
- Basics of mathematical statistics

Learning Outcomes
After completion this lecture, the students are able

- *to describe impact and goals of a service enterprise,*
- *to describe actual requirements of the market and the working world to service enterprises,*
- *to distinguish between service processes and production processes and to evaluate the service process according to its performance,*
- *to describe and to apply fundamental theories, methods and tools for the planning and control of services,*
- *to evaluate the methods and tools used within a service enterprise, to identify problems in a production system and to organise and configure a service enterprise.*

Content

1. Significance of services and administration
2. Definition and general model
3. Strategic roles and objectives
4. Analysis of service operations
5. Design of service operations
6. Control of service workload
7. Quality planning and control
8. Assessing and improving services

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Introduction to Ergonomics [2110033]

Coordinators:
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language

Learning Control / Examinations

Oral exam, length: 30 minutes
(only in English)

Allowed resource materials: none

Conditions

None.

Recommendations

- Basic understanding of human physiology
- Some knowledge about manufacturing processes
- Basics of mathematical statistics

Learning Outcomes

- Knowledge about prerequisites of human performance
- Stress and strain
- Initial knowledge about human-centered work organisation
- Basic knowledge about the management of occupational health and safety

Content

1. Introduction to the course
2. Basic concepts
3. Physiological issues of humans at work
4. Psychological issues of work design
5. Environmental conditions
6. Methods of work analysis
7. Workplace design and man models
8. Work structuring and personnel-oriented simulation
9. Ergonomic product design and virtual reality
10. Occupational health and safety

Literature

Learning material:
Handout online on: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html

Literature:

- BRIDGER, Robert S.: Introduction to Ergonomics. Boca Raton FL, London: CRC press, 3rd ed. 2008.

- DUL, Jan; WEERDMEESTER, Bernard: Ergonomics For Beginners. Boca Raton FL, London: CRC press, 2nd ed. 2001.
- KROEMER, Karl; KROEMER, Henrike; KROEMER-ELBERT, Katrin: Ergonomics. Upper Saddle River NJ: Prentice Hall, 2nd ed. 1998.
- SALVENDY, Gavriel: Handbook of Human Factors and Ergonomics. Hoboken NJ: Wiley, 3rd ed. 2006.

Please refer to the latest edition.

Course: Introduction into Mechatronics [2105011]

Coordinators: G. Bretthauer, A. Albers
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
Written examination, oral examination or certification of participation depending on the “Studienplan” resp. “Prüfungs- und Studienordnung (SPO)”.

Conditions
none

Learning Outcomes
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.

Content
Part I: Modeling and optimization (Prof. Bretthauer)

Introduction
Architecture of mechatronic systems
Modeling of mechatronic systems
Optimization of mechatronic systems
Perspective

Part II: Development and design (Prof. Albers)

Introduction
Development method for mechatronic products
Examples

Literature
Heimann, B.; Gerth, W.; Popp, K.: Mechatronik. Leipzig: Hanser, 1998
Isermann, R.: Mechatronische Systeme - Grundlagen. Berlin: Springer, 1999
Roddeck, W.: Einführung in die Mechatronik. Stuttgart: B. G. Teubner, 1997
Töpfer, H.; Kriesel, W.: Funktionseinheiten der Automatisierungstechnik. Berlin: Verlag Technik, 1988
Föllinger, O.: Regelungstechnik. Einführung in die Methoden und ihre Anwendung. Heidelberg: Hüthig, 1994
Bretthauer, G.: Modellierung dynamischer Systeme. Vorlesungsskript. Freiberg: TU Bergakademie, 1997

Course: Introduction into the multi-body dynamics [2162235]

Coordinators: W. Seemann
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Written exam

Optional subject: oral, 30 min.
Major Subject: oral, 20 min.

Conditions
None.

Learning Outcomes
The students know different possibilities to describe the position und orientation of rigid bodies. They realize that during numerical integration of the kinematic differential equations singularities may arise which may be avoided if for examle Euler-parameters are used. Holonomic as well as nonholonomic constraints and their effect on the structure of the differential equations are known. The description of the kinematic quantities in different reference systems can be done. The formulation of the moment of momentum using different reference frames for rotational velocity and inertia tensor is not a problem. Several methods for the derivation of equations of motion can be applied, especially for nonholonomic systems. The solution of equations of motion by numerical integration is understood in principle.

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 virtuel power, Lagrange's equations, Kane's equations, structure of the equations of motion

Literature
Wittenburg, J.: Dynamics of Systems of Rigid Bodies, Teubner Verlag, 1977
Roberson, R. E., Schwertassek, R.: Dynamics of Multibody Systems, Springer-Verlag, 1988
de Jal'on, J. G., Bayo, E.: Kinematik and Dynamic Simulation of Multibody System.
Kane, T.: Dynamics of rigid bodies.

Course: Electric Power Generation and Power Grid [2300002]

Coordinators: B. Hoferer
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
oral examination

Conditions
none

Recommendations
none

Learning Outcomes
Alfter completing the course, the students have theoretical fundamentals and solid understanding of electrical power engineering. The students are able to analyse problems in the field of power generation and power grid and to develop approaches to these problems.

Content
Power generation fundamental lecture. The lecture covers the entire topic of power generation from conversion of primary energy resources in coal fired power plants and nuclear power plants to utilisation of renewable energy. The lecture gives a review of the physical fundamentals, technical-economical aspects and potential for development of power generation both conventional generation and renewable generation. The lecture covers basics in power grids.

Literature
Material is available at the beginning of the lecture. Literature: Schwab; Elektroenergiesysteme.

Course: Electrical Machines [23315]

Coordinators: M. Doppelbauer
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2	Summer term	en

Learning Control / Examinations
oral examination;
duration: 20-30 minutes

Conditions
None

Recommendations
Candidates should have attended lectures and exercises.

Learning Outcomes
After completing the course the students are able to:

- understand the basic processes of mechanical and electrical energy conversion,
- specify and calculate electrical transformers,
- understand the basic processes of the generation of rotating magnetic fields,
- describe the operating principles and characteristics of asynchronous and synchronous electrical machines,
- identify the sources of torque and noise related problems of electric machines,
- understand the behavior of mechanical transmission elements and typical machines loads like fans, compressors and conveyors and specify a suitable electric machines accordingly,
- understand the mechanisms of losses and energy efficiency of electric machines.

Content

- Electrical machine basics
- Magnetic circuit basics
- Permanent magnets
- Rotating field windings
- DC (commutator) machines
- Synchronous machines
- Asynchronous machines

Media
Blackboard and powerpoint presentation. Practical examples as needed.

Literature
Course note packet

- H. A. Toliyat, G. B. Kliman: **Handbook of Electric Motors,** CRC Press, Taylor&Francis Group, 2004
- T. Wildi: **Electrical Machines, Drives and Power Systems,** Prentice Hall, 2005
- J.R. Hendershot, T. Miller: **Design of Brushless Permanent-Magnet Motors,** Magna Physics Publishing and Oxford University Press, 1994

- P.L. Alger: **The Nature of Polyphase Induction Machines,** John Wiley&Sons, Inc. and Chapmann&Hall, Ltd., 1951
- Rolf Fischer: **Elektrische Maschinen** (German language only), Carl Hanser Verlag, 2009

Remarks
None

Course: Electrical Power Transmission and Grid Control [2199120]

Coordinators: T. Leibfried
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	en

Learning Control / Examinations
Power Point Presentation worked out and presented by the student about special topics presented in the lecture, each student will get his own topic for presentation
Duration: 15-20 minutes plus discussion

Conditions
none

Recommendations
none

Learning Outcomes
After completing the course students

- can design an AC transmission system and describe its limitations
- can do the basic design an HVDC power transmission system and are able to describe the functional components, their necessity and working principle.
- can design an appropriate FACTS system and are able to describe different alternatives and know their working principle

They understand the basic working principle oft he power grid control system.

Content
Characteristic and limitations of the AC power transmission in the HV and MV grid. HVDC transmission system using LCC technology, FACTS (Flexible AC transmission Systems), Grid control principle and system.

Media
Blackboard and Powerpoint presentation

Literature
Course note packet
P. Kundur
“Power System Stability and Control“
McGraw-Hill Inc., 1994, ISBN 0-07-035958-X
N. G. Hingorani, L. I. Gyugyi
“Understanding FACTS“
Institute of Electrical and Electronics Engineers Inc., 2000, ISBN 0-7803-3455-8

Course: Electrical Engineering and Electronics for Mechanical Engineers [23339]

Coordinators: K. Becker
Part of the modules: Electrical Engineering (p. 41)[BSc-Modul 10, ET]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Winter term	de

Learning Control / Examinations
written examination with duration of 3h

Conditions
none

Learning Outcomes
The students have an overview of the physical basics of electrical engineering (electrical field, magnetic field, resistor, capacitor, inductor), know methods for the calculation of electrical DC- and AC-circuits, and understand the construction and steady-state performance of the basic electrical machines (transformer, DC-, induction- and synchronous machine).
The students have an overview of the most important semicon-ductor devices and their functionality, understand the basic principles of power electronic circuits and their arrangements to more complex structures (for semiconductor devices which can be switched off or can not be switched off as well), and know the basics of the operation mode of operational amplifiers.

Content
Fundamental terms, ohmic resistor, electrical field, magnetic field, oscillations, complex calculation of alternating current circuits, three phase current, measurement technique, drive engineering, DC machine, transformer, induction machine, synchronous machine, semiconductor devices, transistors and thyristors, power electronics, operational amplifiers

Literature
see homepage
download:
script (ca. 600 pages)
powerpoint sheets

Course: Experimental Lab Course in Material Science, mach, IP-M, part A of class, in groups [2174597]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	

Learning Control / Examinations
Oral colloquium at the beginning of each topic; certificate of successful attendance.

Conditions
Materials Science and Engineering I & II

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name standard materials characterization methods and can describe the execution of the tests as well as the evaluation of the results. The students are able to asses materials on base of the data obtained by these methods.
The students are capable to select appropriate experiments to clarify probelms regarding the materials behaviour. They can describe the experimental procedures and can carry out experiments. They can derive material properties from data gained in experiments. They can interpret these properties regarding microstructure-propety-relations.

Content
Performing and evaluating of two laboratory experiments in each of the following topics:

Mechanical testing of materials
Nonmetallic materials
Microstructure and properties
Cyclic loading / fatigue
Influence of manufacturing technique on materials

Literature
Laboratory script;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Experimental Lab Course in Material Science, mach, IP-M, part B of class, in groups [2174587]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral colloquium at the beginning of each topic; certificate of successful attendance.

Conditions
Materials Science and Engineering I & II

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name standard materials characterization methods and can describe the execution of the tests as well as the evaluation of the results. The students are able to asses materials on base of the data obtained by these methods.
The students are capable to select appropriate experiments to clarify probelms regarding the materials behaviour. They can describe the experimental procedures and can carry out experiments. They can derive material properties from data gained in experiments. They can interpret these properties regarding microstructure-propety-relations.

Content
Performing and evaluating of two laboratory experiments in each of the following topics:

Mechanical testing of materials
Nonmetallic materials
Microstructure and properties
Cyclic loading / fatigue
Influence of manufacturing technique on materials

Literature
Laboratory script;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Industrial Management Case Study [3109033]

Coordinators: P. Stock
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
Oral exam, length: 30 minutes
(only in English)

Allowed resource materials: none

Conditions

- Compact course (one week full-time)
- Limited number of participants
- Registration via ILIAS necessary
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge in Production Management (resp. Industrial Engineering) is necessary
- Knowledge of Informatics is not required, but usefull

Learning Outcomes
After completion this lecture, the students are able

- to describe the goals of production and production planning and control,
- to describe and to apply fundamental theories and methods of production planning and control (especially order planning, planning of demand and purchase, planning of resources, planning of lot sizes, Kanban),
- to describe and to apply fundamental methods for the configuration of assembly systems (especially group work, planning and balancing of an assembly line),
- to describe the approach of a simulation study, to identify needed input data for a simulation study for a specific example and to evaluate the results of a simulation study,
- to evaluate macro work systems within production, to identify occuring problems and to drive alternatives for organising and configuration for a specific work system.

Content
Within the week-long compact seminar the participants are required to solve various production management scenarios in a group format. They will thereby have the opportunity to influence the solution process from various perspectives and to recognize the effects of individual actions on the entire relationship.
The seminar contains a planning game based on the re-arrangement of a production company and thereby gives the participants the chance to put the studied methods into practice. With the simulation, the solution is quantitatively assessed and the effects of decisions will be highlighted.
The structure of the lecture is:

1. Introductory lecture
2. Organisational issues
3. Planning scenario of a bicycle factory

4. Basics of operations planning and control (OPC)
5. Basics of operations structuring (OST)
6. Introduction of the simulation package
7. Instructions for OPC
8. Instructions for OST
9. Instructions for the final presentation
10. Final presentation

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Fluid Technology [2114093]

Coordinators: M. Geimer
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2+2	Winter term	de

Learning Control / Examinations
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.

Conditions
None.

Learning Outcomes
The students will be able to

-
- know and understand physical principles of fluid power systems
- know the current components and their operating mode
- know the advantages and disadvantages of different components
- dimension the components for a given purpose
- calculate simple systems

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.

Literature
Scritum for the lecture *Fluidtechnik*
Institute of Vehicle System Technology
downloadable

Course: Combined Cycle Power Plants [2170490]

Coordinators: T. Schulenberg
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
Oral Examination 30 min

Conditions
Knowlegde in thermodynamics, heat and mass transfer, instrumentation and control, and turbomachines is presumed.

Recommendations
We recommend to combine the lecture with the Simulator Exercises for Combined Cycle Power Plants (2710491)

Learning Outcomes
The students know the design and operation principles of major components of advanced combined cycle power plants including their control, as well as the dynamic response of combined cycle power plants to grid requirements.

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 challinging grids, protection systems, water make-up and water chemistry. Design concepts of different power plant manufacturers, innovative power plant concepts.

Media
Lecture with English Power Point Presentation

Literature
Power point slides and other lecture material will be provided.
Recommended additional literature:
C. Lechner, J. Seume, Stationäre Gasturbinen, Springer Verlag, 2. Auflage 2010

Course: Fundamentals of Chemistry [5408]

Coordinators: O. Deutschmann
Part of the modules: Principles of Natural Science (p. 31)[BSc-Modul 02, NG]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
written test, 3 hours

Conditions
None

Learning Outcomes
The students are able to name basic ideas concerning the structure of mater and they are able to name physical-chemical laws and to correctly explain their influence on the proceeding of chemical reactions. The students are able to name important inorganic compounds and their properties as well as correctly indicate the equations of the reactions important for manufacturing. The students are able to correctly indicate the processes and chemical reactions used to manufacture important industrially used metals and they are able to correlate properties of the metals with technical applications. The students are able to indicate the structure of organic compounds, especially that of important polymers and to name the significance of important functional groups; they are able to correlate the process of combustion in motors with the methods of exhaust after treatment and to give reasons for the correlations.

Content
Structure of matter: Definition of Chemistry, Basic terms, Element, Atom, Molecule, Ions, Avogadro-constant, Atomic mass, Coulomb's law, Mass spectrometer, Electron, Proton, Neutron, Mass number, Order number, Isotopes, Energy levels of electrons, Spectral lines, Ionization energies, Wave- particle- Dualism, Wave function/Orbital, Hydrogen atom, Quantum numbers, Energy level scheme, Electron configuration, Structure of the periodic system, Main properties of the groups, Ionic bonds, Valence electrons, Atomic unions, Atomic bond, Lewis-Formulae, Multiple bonds, Bonding enthalpies, Electronegativity, Ionic bonds, Metallic bonds, Molecule grids, Water, Dipole, van der Waals-forces, Hydrogen bridges, Ion grids, Metal grids, Phase diagrams, Eutectics, Solid state compounds, Crystals, Crystal systems, Gaseous state, Liquids, Solutions, Osmosis, Chromatography, Phase transitions.
Chemical Reactions: Stoiciometric calculations, Molar amounts, Concentrations, Solutions, State variables, Energy, Enthalpy, Entropy, Gibbs, chemical equilibrium, law of mass action, Equilibrium constant, Solubility product, Enthalpy and entropy of solutions, Reaction rate, Arrhenius- equation, Transition state, Radical reactions, Catalysis, Acids, Bases, Bronstedt, Acid/Base-couples, ph-Value, pKs, pKB, Indicators, Buffer solutions, Neutralisation, Oxidation/Reduction, Oxidation number, Electron transfer, Redox potentials, Standard potential, Nernst- equation, Galvanic cell, Batteries (Led-Accumulator, Ni/Cd, Li-Ions), Fuel cells (PEM, SOFC), Corrosion, Electrolysis.
Inorganic Chemistry: Non metals: Nobel gases, Halogens, Hydrogen, Oxygen and Ozone, Sulfur and sulfur compounds, Nitrogen and nitrogen compounds, Carbon and Silicon.
Metals: Sources, Winning, Properties, Winning and use of important industrially used metals, Metallurgy of selected metals (Iron, Aluminium), 4. Main group, Transition metals, Corrosion, Corrosion protection.
Organic Chemistry: Types of bonds, Formulae, Spectroscopy, Separation and distillation, Alkanes, Alkenes, Alkynes, Aromatic hydrocarbons, Coal, Crude oil, Composition of fuel, Motoric combustion, Gas turbines, Basics of polymers, Reactions of polymer formation (Polymerization, Poly condensation, Poly addition, cross linking), important polymers.

Course: Measurement and Control Systems [2137301]

Coordinators: C. Stiller
Part of the modules: Measurement and control systems (p. 42)[BSc-Modul 11, MRT]

ECTS Credits	Hours per week	Term	Instruction language
7	3	Winter term	de

Learning Control / Examinations
written exam; duration 2,5 h; paper reference materials only (no calculator)

Conditions
Fundamentals in physics and electrical engineering; ordinary linear differential equations; Laplace transform

Learning Outcomes
Measurement and control of physical entities is a vital requirement in most technical applications. Such entities may comprise e.g. pressure, temperature, flow, rotational speed, power, voltage and electrical current, etc.. From a general perspective, the objective of measurement is to obtain information about the state of a system while control aims to influence the state of a system in a desired manner. This lecture provides an introduction to this field and general systems theory. The control part of the lecture presents classical linear control theory. The measurement part discusses electrical measurement of non-electrical entities.

Content
1 Dynamic systems
2 Properties of important systems and modeling
3 Transfer characteristics and stability
4 Controller design
5 Fundamentals of measurement
6 Estimation
7 Sensors
8 Introduction to digital measurement

Literature

- Measurement and Control Systems:

R.H. Cannon: Dynamics of Physical Systems, McGraw-Hill Book Comp., New York,1967
G.F. Franklin: Feedback Control of Dynamic Systems, Addison-Wesley Publishing Company, USA, 1988
R. Dorf and R. Bishop: Modern Control Systems, Addison-Wesley
C. Phillips and R. Harbor: Feedback Control Systems, Prentice-Hall

- Regelungstechnische Bücher:

J. Lunze: Regelungstechnik 1 & 2, Springer-Verlag
R. Unbehauen: Regelungstechnik 1 & 2, Vieweg-Verlag
O. Föllinger: Regelungstechnik, Hüthig-Verlag
W. Leonhard: Einführung in die Regelungstechnik, Teubner-Verlag
Schmidt, G.: Grundlagen der Regelungstechnik, Springer-Verlag, 2. Aufl., 1989

- Messtechnische Bücher:

E. Schrüfer: Elektrische Meßtechnik, Hanser-Verlag, München, 5. Aufl., 1992
U. Kiencke, H. Kronmüller, R. Eger: Meßtechnik, Springer-Verlag, 5. Aufl., 2001
H.-R. Tränkler: Taschenbuch der Messtechnik, Verlag Oldenbourg München, 1996
W. Pfeiffer: Elektrische Messtechnik, VDE Verlag Berlin 1999
Kronmüller, H.: Prinzipien der Prozeßmeßtechnik 2, Schnäcker-Verlag, Karlsruhe, 1. Aufl., 1980

Course: Basics of Technical Logistics [2117095]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe processes and machines of technical logistics,
- Model the fundamental structures and the impacts of material handling machines with mathematical models,
- Refer to industrially used machines and
- Model real machines applying knowledge from lessons and calculate their dimensions.

Content
Bases effect model of conveyor machines made 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

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Course: Fundmentals of Combustion I [2165515]

Coordinators: U. Maas
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory elective subject: Written exam.
In SP 45: oral exam.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students are able to:

- explain the chemical and physical processes gorverning combustion.
- discuss diagnostic methods apllied in combustion science.
- describe laminar and turbulent flames in a mathematical way.
- analyse the working principle of various technical combustion systems (e. g. piston engines, gas turbines, furnaces).

Content
Fundamental concepts ans phenomena
Experimental analysis of flames
Conservation equations for laminar flat flames
Thermodynamics of combustion processes
Transport phenomena
Chemical reactions
Chemical kinetics mechanisms
Laminar premixed flames
Laminar diffusion flames

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes,
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, authors: U. Maas, J. Warnatz, R.W. Dibble, Springer-Lehrbuch, Heidelberg 1996

Remarks
Compulsory elective subject: 2+1 SWS and 5 LP.

Course: Advanced Mathematics I [0131000]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 30)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
non graded (precondition for the admission to the examination): certificate of homeworks graded: written examination

Conditions
Homework is mandatory and a precondition to take part at the exam “AM I”.

Learning Outcomes
The students know the basic facts and tools of one dimensional analysis.

Content
Basic concepts, sequences and convergence, functions and continuity, series, differntial calculus of one variable, integral calculus

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Advanced Mathematics II [0180800]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 30)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Summer term	de

Learning Control / Examinations
precondition for the admission to the examination: certificate of homeworks (non graded)
written examination (graded)

Conditions
Homework is mandatory and a precondition to take part at the exam “AM 2”.

Recommendations
cours of 1st semester

Learning Outcomes
The students know the basics on vector spaces and multi-dimensional calculus and the basic techniques to solve differential equations.

Content
vector spaces, differential equations, Laplace transform, vector-valued functions of several variables

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Advanced Mathematics III [0131400]

Coordinators: A. Kirsch, T. Arens, F. Hettlich
Part of the modules: Advanced Mathematics (p. 30)[BSc-Modul 01, HM]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
precondition for the admission to the examination: certificate for homeworks (non graded)
written examination (graded)

Conditions
Homework is mandatory and a precondition to take part at the exam “AM 3”.

Recommendations
courses of 1st and 2nd semester

Learning Outcomes
The students know techniques and applications of the multi-dimensional calculus (vector calculus) and have basic knowledge on partial differential equations and stochastics.

Content
Applications of multi-dimensional calculus, domain integral, vector analysis, partial differential equations, Fourier theory, stochastics

Literature
Burg, Haf, Wille: Höhere Mathematik für Ingenieure,
Merziger, Wirth: Repetitorium der höheren Mathematik,
Arens, Hettlich et al: Mathematik

Course: Computer Science for Engineers [2121390]

Coordinators: J. Ovtcharova, S. Rogalski
Part of the modules: Computer Science (p. 40)[BSc-Modul 09, Inf]

ECTS Credits	Hours per week	Term	Instruction language
8	2	Winter term	de

Learning Control / Examinations
Written examination

Duration: 3 hours (compulsory subject)

Auxiliary means: none

Examination prerequisite: passed Lab Course [2121392]

Conditions
Examination prerequisite: passed Lab Course [2121392]

Recommendations
None.

Learning Outcomes
The students can identify, explain and assign the repective context to the fundamental terms of information technology, such as data, signals, information, numeral systems, propositional logic, computer architectures, data structures, algorithms, database managements systems as well as the related concepts and theories.
In addition, they can efficiently implement the underlying theorys and concepts in form of procedural and object-oriented (Java) programs as well as analyze the source code and its corresponding function.

Content
Basics: Information representation- and processing, terms and definitions: alphabet, data, signals, information, numeral systems, propositional logic and Boolean algebra, computer architectures, programming paradigms.
Object Orientation: Definition and important characteristics of object orientation, Object-oriented modeling with UML.
Data Structures: Definition, properties and application of graphs, trees, linked lists, queues and stacks.
Algorithms: Characteristics of algorithms, complexity analysis, design methods, important examples.
Database management systems: Relational data model, relational algebra, declarative language SQL

Literature
Lecture notes
Robert Sedgewick: Algorithms in Java, Part 1-4, 3. Auflage, Addison Wesley, 2002, ISBN 0201361205.
Robert Sedgewick: Algorithms in Java, Part 5, 3. Auflage. Addison Wesley, 2003, ISBN 0201361213.
Gerhard Goos: Informatik 1. Eine einführende Übersicht, 4. Auflage, Springer Lehrbuch, 1992, ISBN 3540527907
Gerhard Goos: Informatik 2. Eine einführende Übersicht, 4. Auflage, Springer Lehrbuch, 1992, ISBN 3540555676
Sebastian Abeck: Kursbuch Informatik (Broschiert), Universitätsverlag Karlsruhe, 2005, ISBN-10: 3937300686
Russ Miles, Kim Hamilton: Learning UML 2.0, 1. Auflage, O'Reilly, 2006, ISBN 0596009828
Craig Larman: Applying UML and Patterns: An Introduction to Object-Oriented Analysis and Design and Iterative Development, 3. Auflage. Prentice Hall, 2004, ISBN 0131489062
Peter Drake: Data Structures and Algorithms in Java. 1. Auflage. Prentice Hall, 2005, ISBN 0131469142
Thomas Rießinger: Informatik für Ingenieure und Naturwissenschaftler: Eine anschauliche Einführung in das Programmieren mit C und Java, Springer, 2005, ISBN-10: 3540262431
Raghu Ramakrishnan, Johannes Gehrke: Database Management Systems, 3. Auflage, McGraw-Hill, 2003, ISBN 0072465638

Course: Innovation Management [2146203]

Coordinators: N. Burkardt
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral exam
Duration: 30 minutes
Auxiliaries: none

Conditions
None.

Learning Outcomes
The students are able to:
- use the term innovation
- classify innovation in companies and know about its meaning
- evaluate the influencing parameters on product innovation
- describe strategies to promote innovation
- use methods of innovation promotion
- initiate patent research
- describe the importance and principle strategies of an open innovation.

Content
Basics of Innovation Management
Success factors in innovation competition
Strategic analysis of branches, companies an markets
Innovation traps
Informationmanagement
Pre-studies and feasibility studies
Risk analysis

Course: Introduction to Neutron Cross Section Theory and Nuclear Data Generation [2190490]

Coordinators: R. Dagan
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Coal fired power plants [2169461]

Coordinators: P. Fritz, T. Schulenberg
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
Knowledge in thermodynamics, heat and mass transfer, instrumentation and control, and turbomachines is presumed.

Recommendations
None.

Learning Outcomes
After completion, the students know the layout of different coal fired power plants, the design of their major components, as well as the operational conditions and their limits.

Content
The lecture presents the technology of coal fired power plants, which are conventional steam turbine plants as well as advanced combined cycle power plants with integrated coal gasification. It includes combustion systems, steam generators, a short overview over steam turbine technologies, the cooling system and the water supply system as well as the off gas treatment. Coal gasification will be explained with fixed bed, fluidized bed and entrained flow gasifiers. The integrated coal gasification combined cycle includes also the raw gas purification system. In addition, a visit to a coal fired power plant will be offered.

Media
power point presentation

Literature
Everett B. Woodruff, Herbert B. Lammers, Thomas F. Lammers, Steam Plant Operation, 9th Edition, McGraw Hill, New York 2012

Course: Power Plant Digital Control Systems with Emphasis on Safety and Availability [2400104]

Coordinators: A. Konnov
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
20 min oral exam (in the last class); ungraded

Conditions
Basic knowledge of precalculus recommended

Recommendations
Basic knowledge of precalculus recommended

Learning Outcomes

- General understanding of the structure and operating principal of digital control systems;
- Understanding the importance of availability and safety in modern technical systems (e.g. DCS);
- Essential definitions and terms of power plant digital control systems;
- To understand and be able to use the fundamental concepts of availability and safety analysis;
- To be aware of the necessity of finding an optimum balance between safety and availability in a technical plant;
- To practice using appropriate terminology in English;

Content

- This module should provide an introduction to the theoretical and practical aspects of the availability and safety analysis for power plant digital control systems (DCS).
- The module contains the necessary basics of the probability and dependability theory, and also the general introduction to the digital control systems.
- In the next step, the principal approach of the availability and safety analysis of complex systems (e.g. power plant DCS) will be explained.
- The main point of the module is “balance between safety and process related functions” and their influence on the economic effectiveness of the plant.

Literature
[1] Birolini, Alessandro *Zuverlässigkeit von Geräten und Systemen,* ISBN 3-540-60997-0
[2] Pham, Hoang *Handbook of reliability engineering*, ISBN 1-85233-453-3

Course: Light and Display Engineering [23747 + 23749]

Coordinators: R. Kling
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes

Content
Overview of lecture:
1. Motivation: Light & Display Engineering
2. Light, the Eye and the Visual System
3. Light in non - visual Processes
4. Fundamentals in Light Engineering
5. Color and Brightness
6. Light Sources
7. Displays
8. Luminaries
9. Optical Design

Remarks
You will find the newest Information online on https://studium.kit.edu/

Course: Management Training [2145200]

Coordinators: N. Burkardt
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3		Winter term	en

Learning Control / Examinations
oral/written examination

Conditions
None.

Learning Outcomes

Content
A computer based simulation allow participants to exercise their skills and judge their impact over time and on multiple decisions.
Topics:

- focusing upon various company objectives and strategies
- product life cycles, including product launch, entry into a new market and relaunch. The fundamental management techniques of competition analysis, portfolio analysis, marketing mix and pricing of special com-mercial operations are acquired in order to ensure product success. Participants will also become acquainted with and make use of break-even analysis and market re-search reports as a way of making marketing decisions.
- Research and development is another key area in which participants will expand their knowledge; this includes value analysis and the research and development into technological and environmental issues. In addition, participants learn about supply and stock keeping, particularly covering optimal order quantities. With regard to the important theme of production, participants will be taught about investment, disin-vestments, utilization planning, ecological production and rationalization and learn-ing curves, as well as the important decision of whether in-house production or third party supply would be most beneficial.
- Finance and accounting also plays a vital role in the education of future managers, therefore a great deal of attention is paid to this subject. Participants are taught about income and financial statements, cash flow, share prices and shareholder value. Furthermore, they benefit from learning the important skills of cost element, cost center and product cost accounting, progressive break-even analysis and financial budgeting.
- Participants are also trained in the field of staff management. The crucial topics of personnel planning, qualifications, productivity as well as employee turnover and absences are particularly dealt with, as knowledge of these aspects is key for future managers.

Course: Machinery and Processes [2185000]

Coordinators: H. Kubach, M. Gabi, H. Bauer, U. Maas
Part of the modules: Machines and Processes (p. 44)[BSc-Modul 13, MuP]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter / Summer Term	

Learning Control / Examinations
successful lab course and written exam (2 h)
Taking part at the exam is possible only when lab course has been successfully completed

Conditions
Successful lab course is a precondition to take part at the exam.

Learning Outcomes
The students can name and describe basic energy conversion processes and energy converting machines. They can explain the application of these energy conversion processes in various machines. They can analyze and evaluate the processes and machines in terms of functionality and efficiency and they are able to solve basic technical problems in terms of operating the machines.

Content
basics of thermodynamics
thermal fluid machines

- steam turbunes
- gas turbines
- combined-cycle plants
- turbines and compressors
- aircraft engines

hydraulic fluid machines

- oerating performance
- characterization
- control
- cavitation
- wind turbines, propellers

internal combustion engines

- characteristic parameters
- engine parts
- kinematics
- engine processes
- emissions

Media
slides to download
Documentation of the labcourse

Remarks
Lab course and lecture take place in summer and winter semester.
In the SS the lecture is held in English. The lab course is always bilingual.

Course: Machine Dynamics [2161224]

Coordinators: C. Proppe
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF], Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	en

Learning Control / Examinations
Written examination (compulsory subject), auxiliary means: own manuscripts
Oral examination (optional subject) , no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to apply engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery. This includes the investigation of runup, stationary operation of rigid rotors including balancing, transient and stationary behavior of flexible rotors, critical speeds, dynamics of slider-crank mechanisms, torsional oscillations.

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

Literature
Biezeno, Grammel: Technische Dynamik, 2. Edition, 1953

Holzweißig, Dresig: Lehrbuch der Maschinendynamik, 1979

Dresig, Vulfson: Dynamik der Mechanismen, 1989

Course: Mechanical Design I [2145178]

Coordinators: A. Albers, Burkardt
Part of the modules: Mechanical Design (p. 35)[BSc-Modul 06, MKL]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
Successful participation in the turorial mechanical design I.

Conditions
none

Learning Outcomes
The students are able to ...

- describe complex systems using the system technique.
- identify and formulate functional connections of a technical system.
- use the contact and channel approach (C&C²A).
- chose a spring and to calculate it.
- identify different bearings and bearing arrangements and to select a suitable one for the particular situation.
- dimension bearing arrangements for different load cases.
- use the basic rules and pincipales of visualization and to create a technical drawing.
- describe the functional connections of a technical system using the C&C²A approach and sytem theorie.

Furthermore the students can describe as a team technical solutions with a gear and draw chosen components in different technical expositions.

Content
Introduction in product development
Tools for visualization (technical drawing)
Product generation as a problem solving process
Technical systems for Product generation

- systems theory
- Elementary model C&CM

Basics of selected technical components

- springs
- bearings

Concommitant to the lectures tutorials take place with the following contents:
Gear workshop
Tutorial "tools of visualization (technical drawing)"
Tutorial "technical systems product development, sytem theory, element model C&CM"
Tutorial "springs"
Tutorial "bearing and bearing arrangements"

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
or per full text access provided by university library
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design II [2146178]

Coordinators: A. Albers, Burkardt
Part of the modules: Mechanical Design (p. 35)[BSc-Modul 06, MKL]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Summer term	de

Learning Control / Examinations
Successful participation in the tutorial mechanical design II.

Conditions
Participation in mechanical design I.

Learning Outcomes
The students are able to ...

- evaluate different bearing arrangements according their particular application and characteristics and to describe system specific phenomena.
- dimension a bearing arrangement and to chose, evaluate and dimension suitable bearings.
- name and describe the function principals of different sealing's as well as evaluate and use special sealing's under consideration of particular boundary condition and choosing criteria's.
- use the basic rules of designing on concrete problems. They understand the different designing stages and are able to name and take into account the requirements of designing.
- to describe manufacturing processes and their caracteristics, as well as deriving and using the resulting boundary conditions of designing.
- to understand the importance of the micro structure of a working surface for the required function. They have knowledge about surface measuring principals, can interpret measurement scribes and assign to a value to describe the surface. They can choose a process to manufacture the required surface and estimate their manufacturing costs.

The students know about the sense of standardization, their types and are able to classify and use standardization values in regard on product engineering.
They understand ...

- different types of tolerances, the ISO tolerance system and are able to interpret different geometric tolerances.
- the different effects of component connections and their dimensioning. They are able to choose and calculate a suitable connection and to illustrate their advantages and disadvantages.

Content
Bearings
Sealings
Design
Tolerances and fittings
Shaft-hub connections
Tutorials take place in concomitant to the lectures.

Media
Beamer
Visualizer
Mechanical components

Literature
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von

Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X,
also available as electronic paper at the KIT catalogue.
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8)

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design III [2145151]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Mechanical Design (p. 35)[BSc-Modul 06, MKL]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter term	de

Learning Control / Examinations
Successful participation in the tutorial and workshop MKL III.

Conditions
Participation in mechanical design I and II.

Learning Outcomes
The students are able to ...

- identify different component connections and their application and to use them for particular problems.
- chose and dimension bolt connections for different boundary conditions.
- list different types of gears and their advantages and disadvantages.
- develop technical solutions in a team, evaluate the principal feasibility, implement their ideas in technical solutions and illustrate, plan and evaluate their own working- and decision process by using protocols and diagrams.

Content
Tolerances and Fittings
Bearings
Dimensioning
Joints

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
or per full text access provided by university library
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3 (für Fortgeschrittene)

Remarks
Lecture notes:
The Productdevelopment knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Mechanical Design IV [2146177]

Coordinators: A. Albers, N. Burkardt
Part of the modules: Mechanical Design (p. 35)[BSc-Modul 06, MKL]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Successful participation in the tutorial and workshop in mechanical design IV.

Conditions
Participation in mechanical design I, mechanical design II and mechanical design III.

Learning Outcomes
The students are able to ...

- differentiate different clutch systems, name their functions, explain system specific phenomena's und use the dimensioning basics for clutches.
- use different clutch systems depending on the particular application.
- name different types of dimensioning and relevant influencing parameters of load.
- name and use independently strength hypothesizes.
- perfom and use independently strength calculations.
- name the fundamental characteristics of hydraulic systems, fundamental symbols of fluid technic and to interpret function diagrams.
- design and dimension simple hydraulic facilities by using circuit diagrams.
- develop unconventional technical solutions in team work, evaluate their principal feasibility, implement their ideas in technical solutions and illustrate, plan and evaluate their own working- and decision process by using protocols and diagrams.
- create technical drawings according common standardization regulations.
- create a CAD model of technical systems by using the top down method.

Content
Basic connections - part 2
Coupling fundamentals
Function and working principles
Significant characteristics and classification
Non-shiftable shaft couplings
Shiftable shaft couplings
Elastic couplings
Gear transmission fundamentals
Function and working principles
Fundamentals of gear transmissions
Significant characteristics and classification
Selection criteria
Fundamentals of further gear drives
Fundamentals of lubrication and lubricants
Tooth system fundamentals
Function and working principles
Tooth pitch characters
Cycloid as slope curve
Evolvent as slope curve

Manufacturing technologies
Transverse contact ratio
Profile offset
Application limits and technical defects
Dimensioning
Root bearing
Flank bearing
Hydraulic fundamentals
Basic functions and working principles
Significant characteristics and classification
Model types and characteristics
Selection criteria
Application
Dimensioning

Media
Beamer
Visualizer
Mechanical components

Literature
Lecture notes:
The lecture notes can be downloaded via the eLearning platform Ilias.
Literature:
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
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Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3 (für Fortgeschrittene)

Remarks
Lecture notes:
The product development knowledge base PKB will be provided in digital form for registered students. All lecture notes and additional slides will be provided in Ilias.

Course: Materials and Devices in Electrical Engineering [23211]

Coordinators: A. Weber
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	en

Learning Control / Examinations
Written Exam

Conditions
None.

Learning Outcomes
The lecture provides fundamental knowledge about Materials and Devices applied in Electrical Engineering.
The lecture of "Materials and Devices in Electrical Engineering" concerns the fundamental ideas of the electrical materials. It contains the minimum subject matter which can be recommended to the studying of "Electrical Engineering".

Content
Materials play a central role for the progress of technology and economy. Their applications determine the innovation degree of modern technologies like the information-, energy-, traffic-, manufacturing-, environmental and medical technology. Many innovations in electrical engineering could only be realized on the basis of new material and production engineering. Therefore the development of materials and their applications in systems become one of the key fields of the industrial technology in the 21st century with outstandingly high strategic meaning.
The lecture of "Materials and Devices in Electrical Engineering" concerns the fundamental ideas of the electrical materials.
Topics covered: Structure of Atoms and Solids, Electrical Conductors, Dielectric Materials, Magnetic Materials

Literature
William D. Callister, Materials Science and Engineering, John Wiley & Sons, Inc.,ISBN No. 0-471-32013-7

Remarks
Copies of the slides are available at http://www.iwe.kit.edu/.

Course: Mathématiques appliquées aux sciences de l'ingénieur [2161230]

Coordinators: J. Dantan
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Summer term	fr

Learning Control / Examinations
oral/written

Conditions
HM I-III

Learning Outcomes
The students have a good command of the basics of probability theory and Laplace transformation. The lecture then introduces into the application of the basics in the following fields of mechanics: functional safety of structural components, reliability of components and systems, vibrations and control systems.

Content
Courses are taught in French.
First block course at the KIT:
Basics of probability theory and Laplace transformation
Second block course at the Arts et Métiers ParisTech, centre Metz, France
Application of mathematics in the fields of functional safety of structural components, reliability of components and systems, vibrations and control systems.
A visit to an industry partner in the vicinity of Metz will be planned.

Remarks
The second block course will probably take place 1-2 days in Metz. KIT-DeFI will be responsible for the organisation and bear the expenses for the students interested.
Further information: www.itm.kit.edu/dynamik und www.defi.kit.edu.

Course: Mathematical Methods in Dynamics [2161206]

Coordinators: C. Proppe
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Winter term	de

Learning Control / Examinations
written examination (compulsory subject), auxiliary means: own manuscripts allowed
oral examination (optional subject) no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
The students know the mathematical methods of dynamics precisely. They are able to use the basic mathematical methods for modelling the dynamical behaviour of elastic and rigid bodies.
The students have a basic understanding of the description of kinematics and kinetics of bodies. They also master the alternative formulations based on weak formulations and variational methods and the approximate solution methods for numerical calculations of the moving behaviour of elastic bodies.

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:
Priniciple of virtual work, variational calculations, Principle of Hamilto

Approximate solution methods:
Methods of weighted residuals, method of Ritz

Applications

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

K. Willner: Kontinuums- und Kontaktmechanik : synthetische und analytische Darstellung, Berlin, Heidelberg, 2003

J.N. Reddy: Energy Principles and Variational Methods in applied mechanics, New York, 2002

A. Boresi, K.P. Chong, S. Saigal: Approximate solution methods in engineering mechanics, New York, 2003

Course: Mathematical Methods in Strength of Materials [2161254]

Coordinators: T. Böhlke
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	2+1	Winter term	de

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites are met by solution of homework problems

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can

-
- perform the most important tensor operatons in example problems
- classify tensors of second order according to their properties
- apply elements of tensoranalysis
- describe the kinematics of infinitesimal and finite deformations in tensorial notation
- derive balance laws of mechanics
- solve problems of elasticity and thermoelasticity using tensor notation
- apply the theoretical concepts of the lecture to special problems

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
- theory of elasticity
- thermo-elasticity

Literature
lecture notes
Bertram, A.: Elasticity and Plasticity of Large Deformations - an Introduction. Springer 2005.
Liu, I-S.: Continuum Mechanics. Springer, 2002.
Schade, H.: Tensoranalysis.Walter de Gruyter, New York, 1997.
Wriggers, P.: Nichtlineare Finite-Element-Methoden. Springer, 2001.

Course: Mathematical methods of vibration theory [2162241]

Coordinators: W. Seemann
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
written (compulsory subject), oral (optional subject)

Duration: 3 hours (compulsory subject), 30 minutes (optional subject), 20 minutes (major subject)

Allowed during exam: own scripts, literature (compulsory subject), none (optional subject or major subject)

Conditions
Technische Mechanik III, IV / Engineering Mechanics III, IV

Learning Outcomes
The students know to solve single differential equations with constant coefficients by various methods. For inhomogenious differential equations the inhomogenity may be arbitrary. They realize the relations between the different methods. For matrix-differential equations the students may derive the eigenvalue problem for free vibration and may obtain solutions for eigenvalues and eigenvectors. They know the modal transformation which is helpful to solve forced vibration. They may decide about stability of time-independent steady state solutions of nonlinear systems. They can derive boundary value problems by variational methods and know in principle how to solve them. For simple one-dimensional continua they may get analytical solutions. They can apply perturbation methods to derive analytical solutions for problems with small parameters.

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

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik

Course: Mathematical Methods in Fluid Mechanics [2154432]

Coordinators: A. Class, B. Frohnapfel
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written

Duration: 3 hours

Aux. means: formules, pocket calculator

Conditions
None.

Recommendations
Basic Knowledge about Fluid Mechanics

Learning Outcomes
The students can apply the mathematical methods of fluid mechanics effectively and precisely. They are able to use the basic mathematical methods for analytical and numerical modelling of the non-linear behaviour moving fluids. The students can apply the achieved understanding of the procedures to describe, simplify and solve the Navier-Stokes equations in order to calculate the flow behaviour.

Content
The lecture will cover a selection of the following topics

- numerical solution of the governing equation (finite difference methods)
- boundary layer flows (high Reynolds numbers)
- creeping flows (low Reynolds numbers)
- self similar solutions
- analogy shallow water theory and gas dynamics
- laminar-turbulent transitions
- turbulent flows (Reynolds-Averaged Navier Stokes Equations)

Media
Blackboard, Power Point

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Durst, F.: Fluid Mechanics: An Introduction to the Theory of Fluid Flows, Springer 2008
Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library
H. Ferziger, M. Peric, *Computational Methods for Fluid Dynamics*, Springer, 2008

Remarks
The lecture is accompanied by a tutorial where the application of the methods can be trained.

Course: Methods of Product Development [2146202]

Coordinators: N. Burkardt
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	2	Summer term	en

Learning Control / Examinations
oral exam
Duration: 30 minutes

Conditions
None.

Learning Outcomes
The students are able to ...

- 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 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 differents methods of design of experiment.
- explain the costs in development process.

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

Literature
Lecture documents
Pahl, Beitz: Konstruktionslehre, Springer-Verlag 1997
Hering, Triemel, Blank: Qualitätssicherung für Ingenieure; VDI-Verlag, 1993

Remarks
This lecture is the basis for the main subject Integrated Product Development, which is offered as a specialisation.

Course: Microoptics and Lithography [2142884]

Coordinators: T. Mappes
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral, duration 20 minutes, aids: none

Conditions
Basics in optics

Learning Outcomes
The course serves as an introduction for master students in optics and photonics to micro and nano components and systems including their fabrication. Microoptical devices are indispensable a for a variety of applications ranging from data handling, transmission and processing of light to optical detection and analysis. Lithography is a key technology for semiconductor manufacturing but also for pattering of any small structure by UV-light, X-rays and electron or ion beams.

Content

- - Concepts in micro and nano fabrication and applications in optics and photonics
- - Electron lithography
- - Optical lithography
- - X-ray lithography
- - EUV-, immersion and interference lithography
- - Microoptical devices and systems

Literature
W. Menz, J. Mohr, O. Paul: Microsystem Technology. Wiley-VCH, 1st ed. Weinheim, 2000. ISBN: 3527296344
S. Sinzinger, J. Jahns: Microoptics. Wiley-VCH, 2nd ed. Weinheim, 2003. ISBN: 9783527403554
M.J. Madou: Fundamentals of Microfabrication. Taylor & Francis Ltd., 2nd ed., Boca Raton 2002. ISBN: 9780849308260

Course: Modelling of Microstructures [2183702]

Coordinators: A. August, B. Nestler, D. Weygand
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
We regularly hand out exercise sheets. The individual solutions will be corrected.
Exam: oral 30 minutes or written.

Conditions
None.

Recommendations
materials science
fundamental mathematics

Learning Outcomes
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.

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

Media
Black board and slides.

Literature

1. Gottstein, G. (2007) Physikalische Grundlagen der Materialkunde. Springer Verlag Berlin Heidelberg
2. Kurz, W. and Fischer, D. (1998) Fundamentals of Solidification. Trans Tech Publications ltd, Switzerland Germany UK USA

3. Porter, D.A. Eastering, K.E. and Sherif, M.Y. (2009) Phase transformation in metals and alloys (third edition). CRC Press, Taylor & Francis Group, Boca Raton, London, New York

4. Gaskell, D.R., Introduction to the thermodynamics of materials

5. Problem sheets

Course: MD - Team Orientated Mechanical Design (3 + 4) [2145154]

Coordinators: A. Albers, diverse
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL], Mechanical Design (p. 35)[BSc-Modul 06, MKL]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter / Summer Term	de

Learning Control / Examinations
MD III and MD IV Workshops:
In every workshop session the knowledge of the students will be reviewed. The knowledge and the handling of the workshop tasks are required to pass the MD III and MD IV workshops.

Conditions
Workshop MD III:
Attendance on mechanical design I - II.
Workshop MD IV:
Attendance on mechanical design I - III.
A prosperous participation at the MD III and MD IV is compulsory to attend the exam.

Learning Outcomes
The students are able to develop technical solutions in a team, to implement their ideas in technical solutions and to illustrate their own working- and decision process by using protocols and diagrams.

Content
Interrogation of the purchased knowledge in mechanical design by means of the workshop task.

Literature
Konstruktionselemente des Maschinenbaus - 1 und 2
Grundlagen der Berechnung und Gestaltung von
Maschinenelementen;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-22033-X
Grundlagen von Maschinenelementen für Antriebsaufgaben;
Steinhilper, Sauer, Springer Verlag, ISBN 3-540-29629-8
CAD:
3D-Konstruktion mit Pro/Engineer - Wildfire, Paul Wyndorps, Europa Lehrmittel, ISBN: 978-3-8085-8948-9
Pro/Engineer Tipps und Techniken, Wolfgang Berg, Hanser Verlag, ISBN: 3-446-22711-3 (für Fortgeschrittene)

Remarks
Bonus
The student can achieve an extra bonus for the mechanical design exam.
The bonus amounts to 0,3 exam points and it can only be achieved in case of passed MD-exam (lowest passing grade 4,0).
More details will announce in mechanical design III and IV.

Course: Modelling and Simulation [2183703]

Coordinators: B. Nestler, P. Gumbsch
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter / Summer Term	de

Learning Control / Examinations
We regularly hand out exercise sheets. In addition, the course will be accompanied by practical exercises at the computer.
written examination: 90 minutes

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
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.

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

Media
Slides and black board. The slides will be provided as a manuscript for the course.

Literature

1. Scientific Computing, G. Golub and J.M. Ortega (B.G.Teubner Stuttgart 1996)

Course: Modern Radio Systems Engineering [23430 + 23431]

Coordinators: T. Zwick
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Summer term	en

Learning Control / Examinations
Oral Exam

Conditions
Basic knowledge of microwave and communications engineering

Learning Outcomes
At the end of this lecture the students will understand how to design an analogue frontend for a radio system on a block diagram level. Especially the non-idealities of typical radio frequency (RF) building blocks and their effects on the overall system performance will be part of the acquired knowledge.
The course gives a general overview of radio systems with their components. Thereby the focus is on the analogue parts of the system with their non-idealities. Based on the physical functionality of the various building blocks parameters are derived, which allow the consideration of their influence on the overall radio system performance.

Content
1. Introduction to radio systems
- Overview over wireless communication systems
- Modulation and detection
- Typical system performance parameters
- System components
2. Radio channel fundamentals and antennas
- Wireless radio channel
- Antenna parameters
3. Noise
- Noise sources
- Noise temperature, noise figure, signal-to-noise ratio
- Noise figure of cascaded stages
- Mixer noise calculation
- Noise calculation in base band
4. Non-linearity and time variance
- Effects of non-linearity: gain compression, inter-modulation
- Cascaded nonlinear stages
5. Sensitivity and dynamic range
6. Transceiver Architectures
- Transmitter architectures: heterodyne/homodyne
- Receiver architectures: heterodyne/homodyne, image-reject, digital-IF, sub-sampling
- Oscillators: phase noise, oscillator pulling and pushing
7. Case studies
- Generic PSK system
- UMTS receiver
- FMCW Radar

Literature
Material to the lecture can be found online at www.ihe.kit.edu.

Remarks
Current information can be found at the webpage of the IHE (www.ihe.kit.edu).

Course: Modern Software Tools in Power Engineering [2199119]

Coordinators: T. Leibfried
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	en

Learning Control / Examinations
Oral test at the beginning of the internship
Duration: 15-20 minutes plus discussion
Written report about the results of the experiments performed during the internship

Conditions
none

Recommendations
none

Learning Outcomes
After completing the course students can:

- apply commercial software for calculating magnetic and electric field.
- apply commercial software for power grid calculations.

Content
During this practical course students will be able to work with three power engineering software tools. Participants should individually solve three typical engineering tasks:

- · **Modelling a high voltage bushing using finite element software "Maxwell".**
  In this module students will design a high voltage transformer bushing which resists high electric field stress. Using a finite element software it is possible to determine critical values already during the design phase, before producing costly models or prototypes.
- · **Development and Validation of an elevator control system based on a Siemens Simatic S7 PLC**

The PLC software Simatic S7 is a standard system for all kinds of industrial automation and control tasks. It consists of several programs which can be individually configured. During this course module students will be able to develop a control system which can be tested on a physical elevator model.
· **Load Flow Calculation of an industrial distribution grid using grid simulation software „DIgSILENT Powerfactory"**
The intention of this network analysis module is to understand the theory of load flow and short circuit calculation and to get familiar with its usage in practice. Further, an insight in real network calculation software shall be imparted.

Media
Blackboard and Powerpoint presentation

Literature
Course note packet
P. Kundur
"Power System Stability and Control"
McGraw-Hill Inc., 1994, ISBN 0-07-035958-X
N. G. Hingorani, L. I. Gyugyi
"Understanding FACTS"
Institute of Electrical and Electronics Engineers Inc., 2000, ISBN 0-7803-3455-8

Course: Modern Physics for Engineers [4040311]

Coordinators: B. Pilawa
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Summer term	de

Learning Control / Examinations
Written exam. The written exam is scheduled in the beginning of each semester.
Duration of Examination: 180 min.

Conditions
Solid mathematical background, basic knowledge in physics.

Learning Outcomes
The students

- are familiar with the basic experimental results leading to relativistic physics
- understand the principles of relativity
- comprehend the coherence of the particle and wave description of light and matter
- understand the basic principles leading to the Dirac- and Schrödinger-equation
- are able the apply the Schrödinger-equation to basic problems in quantum mechanics
- comprehend the limits of wave mechanics
- have a good understanding of the hydrogen atom
- understand the basic properties of nuclei
- know the fundamental particles and interactions

Content
I. Introduction
II. Special relativity
III. Wave-particle duality
IV. Mater waves
V. The hydrogen atom VI. Nuclei and particles

Literature
Paul A. Tipler: Physics for engineers and scientists
Paul A. Tipler: Modern Physics

Course: Nuclear Fusion Technology [2189920]

Coordinators: A. Badea
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations

Conditions

good level of knowledge in physics and mathematics

Learning Outcomes

The students know about the physics of fusion, the components of a fusion reactor and their functions. Also they know the technological requirements for using fusion technology for future production of electricity. The environmental impact of using commercial fusion is also addressed.

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
vacuum technology
materials for fusion reactors
plasma physics, confinement
plasma heating
timeline of the fusion technology
ITER, DEMO
safety and waste management

Course: Nuclear Power and Reactor Technology [2189921]

Coordinators: A. Badea
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	en

Learning Control / Examinations
oral/written examination

Conditions
numerical methods, partial differential equations, special functions, orthogonal polynomials

Learning Outcomes
The students will learn fundamental reactor physics, thermal-hydraulics, control, and safety.
They will also learn about future reactor systems and technological requirements of the front-end and back-end of the fuel cycle.

Content
nuclear fission & fusion,
chain reactions,
moderation,
light-water reactors,
transport- and diffusion-equation,
power distributions in reactor,
reactor safety,
reactor dynamics,
design of nuclear reactors,
breeding processes,
nuclear power systems of generation IV

Course: Nuclear Thermal-Hydraulics [2189908]

Coordinators: X. Cheng
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral examination; duration: 30 minutes

Conditions
None.

Learning Outcomes
This lecture is focused on students of mechanical engineering and chemical engineering in bachelor or master degree courses. It gives a further insight of fundamentals in nuclear engineering. The students know and understand important processes and methods of the thermal hydraulic design in nuclear systems.

Content

1. criteria and tasks in thermal hydraulic design
2. heat release and heat transfer in nuclear facilities
3. heat transfer in nuclear systems
4. fluid dynamics in nuclear systems
5. thermal hydraulic core design
6. nuclear hydraulic savety aspects

Literature

1. W. Oldekop, Einführung in die Kernreaktor und Kernkraftwerkstechnik, Verlag Karl Thiemig, München, 1975
2. L.S. Tong, J. Weisman, Thermal-hydraulics of pressurized water reactors, American Nuclear Society, La Grande Park, Illinois, USA
3. R.T. Lahey, F.J. Moody, The Thermal-Hydraulics of a Boiling Water Nuclear Reactor, 2nd edition, ANS, La Grande Park, Illinois, USA, 1993

Course: Optical Engineering [23629 + 23631]

Coordinators: W. Stork
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4,5	3	Winter term	en

Learning Control / Examinations
Oral exam

Conditions
None.

Learning Outcomes
By the end of this lecture, a student will be able to understand an optical system specification, explain the meaning of the specified properties, and develop possible solutions for a simple design problem.
Foci of the lecture are the methodical and physical fundamentals that are needed for the design and the development of simple optical systems. Using examples from practical experience the applications and limitations of the introduced techniques are presented.

Content
Lecture
The course teaches the practical aspects of designing optical components and instruments such as lenses, microscopes, optical sensors and measurement systems, and optical storage systems (e.g. CD, DVD, HVD). During the course, the layout of modern optical systems is explained and an overview is given over available technology, materials, costs, design methods, as well as optical design software.
At first the phenomena of light refraction and reflection are introduced to the students using the concepts of ray-optics. Based on these fundamentals, the functionality of optical elements like lenses and parabolic mirrors, as well as of multi-element imaging systems like telescopes, microscopes or the human eye are explained and methods like the ray-transfer matrices are presented that can be used to calculate the properties of these multi-element systems and to describe the light propagation inside of these systems.
After a ray-optical introduction of imaging errors (aberrations), the transition from the ray- to the wave-optical representation of light is made and the aberrations are alternatively described as wavefront deviations. Applying these concepts, the phenomenon of diffraction is introduced and it is shown that even an error-free imaging system has only a limited resolution because of the always present diffractive effects. This then leads to the topics of Fourier optics and the representation of optical systems as LSI-systems (linear, shift-invariant systems) with the transfer function MTF and the "point response" PSF.
In the concluding chapters, the field of diffractive optics is discussed thoroughly, starting from the different types of diffraction gratings, to the functionality of diffractive lenses, to the basic principles of holography.
Exercises
To accompany the lecture material, assignments will be given out and partly discussed during the bi-weekly exercises, partly the students will be supported in finding a solution to the assignments during the exercise hours using standard mathematical software like Maple or Matlab to give them a first introduction to the use of this software and to also show them its strengths and weaknesses.

Literature

-
- Online material is available on ILIAS
- E. Hecht: "Optics", Addison Wesley, 1987.
- Meschede, D.: "Optics, Light and Lasers", Wiley-VCH, 2007

Remarks
The course comprises of the interleaved lecture blocks and exercises. Current information can be found on the ITIV (www.itiv.kit.edu) webpage and within ILIAS.

Course: Physics for Engineers [2142890]

Coordinators: P. Gumbsch, A. Nesterov-Müller, D. Weygand
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written exam, 90 min

Conditions
none

Learning Outcomes
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

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

Literature

- Tipler und Mosca: Physik für Wissenschaftler und Ingenieure, Elsevier, 2004
- Haken und Wolf: Atom- und Quantenphysik. Einführung in die experimentellen und theoretischen Grundlagen, 7. Aufl., Springer, 2000

Course: Physical basics of laser technology [2181612]

Coordinators: J. Schneider
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
Basic knowledge of physics, chemistry and material science is assumed.
It is not possible, to combine this lecture with the lecture *Laser Application in Automotive Engineering* [2182642]

Recommendations
None.

Learning Outcomes
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.

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.

Media
lecture notes via ILIAS

Literature
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

W. M. Steen: Laser Material Processing, 2010, Springer

Remarks
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.

Course: Power Electronics [2199102]

Coordinators: Prof. Dr. Alfons Kloenne
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
written examination

Conditions
Fundamentals of Electrical Engineering,
Fundamentals of Electronics

Learning Outcomes

- have profound knowledge about power electronic switches, their application and protection
- possess key skills in of generic power electronic circuits
- be able to analyse and calculate fundamental switched-power supplies
- understand Line-Frequency Phase Controlled Rectifiers and Inverters
- be endued with practical converter design considerations
- be able to implement the basic control strategies in power electronic systems

Content
- Introduction to Power Electronics
- Overview of Power Semiconductor Switches (Diodes, Thyristors, GTO, BJT, Mosfet)
- Drive and Snubber Circuits
- Structure of Power Module Packages
- Heat Transfer of Power Semiconductors
- DC-DC Switch-Mode Converters (Step-Down Converter, Step-Up Converter, Buck-Boost Converter, Flyback Converter)
- Line-Frequency Phase-Controlled Rectifiers and Inverters (Single-Phase, Three-Phase)
- High Voltage DC Transmission
- Switch-Mode Inverters (Single Phase, Three Phase)
- Concepts of Current Control in Swicht-Mode Inverters
- Variable Freqency Inverters

Literature
Prof. Kloenne, Lecture Notes, Summer Semester 2013
Mohan, N.; Undeland, T.M.; Robbins, W.P.: Power Electronics, Converters, Applications and Design; Wiley, 1989

Course: Product Lifecycle Management [2121350]

Coordinators: J. Ovtcharova
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
written examination
Duration:
1,5 hours

Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can:

- clarify the management concept of PLM, its objectives and highlight the economic benefits of the PLM concept.
- illustrate the need for an integrated and cross-departmental business process - from planning, portfolio construction and return of customer information, from the use phase to maintenance and recycling of products.
- reason the processes and functions needed to support the entire product life cycle and discuss the main operating software systems (PDM, ERP, SCM, CRM) and their functions for supporting PLM.
- argue a method to successfully introduce the concept of Management PLM in companys.

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

Literature
Lecture slides.

V. Arnold et al: Product Lifecycle Management beherrschen, Springer-Verlag, Heidelberg, 2005.

J. Stark: Product Lifecycle Management, 21st Century Paradigm for Product Realisation, Springer-Verlag, London, 2006.

A. W. Scheer et al: Prozessorientiertes Product Lifecycle Management, Springer-Verlag, Berlin, 2006.

J. Schöttner: Produktdatenmanagement in der Fertigungsindustrie, Hanser-Verlag, München, 1999.

M.Eigner, R. Stelzer: Produktdaten Management-Systeme, Springer-Verlag, Berlin, 2001.

G. Hartmann: Product Lifecycle Management with SAP, Galileo press, 2007.

K. Obermann: CAD/CAM/PLM-Handbuch, 2004.

Course: Range Extender [2146440]

Coordinators: H. Bauer
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	2	Winter term	en

Learning Control / Examinations
oral/written examination

Conditions
a subset of: thermodynamics, fluid mechanics, turbo machinery, combustion, rotor dynamics, power electronics, electric machines, machine elements, mechanical design and project management

Learning Outcomes
The students will be trained to work in an interdisciplinary team. Besides technical knowledge they will learn how to organise and run a project in a controlled manner within a given time frame and to a certain degree also within a limited budget.

Content
In a range extender an internal combustion engine (e.g. an SI/Diesel engine or a micro gas turbine) significantly extends the range of a normally electrically driven vehicle such as a car, a van, a truck or a bus. The internal combustion engine charges the battery of the electric vehicle only rather than to drive the vehicle directly. Hence the range extender additionally comprises an electric generator and some power electronics components.
The envisaged project focuses on a micro gas turbine as the internal combustion engine which drives an ultra-high-speed electric generator. Micro gas turbine and generator will be optimised for the design point only. As two completely different engines mechanically connected to each other will be subject of the course, i.e. a micro gas turbine and an electric generator, the task to preliminarily design a range extender will be strongly interdisciplinary. It will be solved by establishing a team consisting of students having specialised knowledge from different disciplines such as turbomachinery, combustion, rotor dynamics, electric engines and power electronics.
In an introductionary lesson the boundary conditions for the range extender will be given, such as size of the vehicle and its typical operational range and profile. A team will be formed with specific roles such as project manager, team leader(s) and specialists based on the needs of the project and the individual skills of the team members. Regular internal meetings as well as external review meetings will be agreed.
The expected result of the project will be a preliminary design of the major components of the range extender in terms of 3D CAD models, a cost estimate as well as a potential market share taking into account competing concepts. The range extender design will be presented to an external audience including the lecturers as well as industrial representatives.

Course: Nuclear Safety II: Safety Assessment of Nuclear Power Plants [2190464]

Coordinators: V. Sánchez-Espinoza
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral examination; duration: 20-30 minutes

Conditions
Nuclear Safety I: Fundamentals, Nuclear power plants, Nuclear thermal hydraulics

Recommendations
none

Learning Outcomes

- gain understanding for safety analysis and its methods
- get familiar with the mathematical-physical basis of numerical safety analysis codes used for the safety demonstration as well as with the role of code validation
- get familiar with the methodology to analyse design basis accidents of Light Water Reactors and with the step-by-step of the modelling of nuclear power plants with simulation tools

Content
The goal of this lecture is to impart the main elements and newest methods applied in the industry and by regulators that are needed to perform a safety assessment of nuclear power plants of generation 2 and 3 using numerical simulation tools. This lecture is focused on the deterministic safety analysis methodology; the mathematical and physical bases of numerical simulation tools used for safety demonstration and last but not least the safety criteria. The methodology and the prediction capability of Safety Analysis Tools (TRACE/PARCS, RELAP5/PARCS) widely used in industry, regulators and R&D institutions is exemplary demonstrated by analyzing selected transients and accidents of Light Water Reactors (LWR). The examples will describe the practical steps developing integral nuclear power plant models for the analysis of the normal and off-normal operation conditions. This lecture will be concentrated on the following topics:

- Safety analysis- an introduction
- Mathematical-physical basis of coupled neutronic-thermal hydraulic Best-Estimate codes
- Characterization of the plant conditions (start-up, operation, shutdown)
- Design basis accidents
- Methodologies fort he accident analysis of Pressurized and Boiling Water Reactors (PWR, BWR)
- Analysis of selected transients and accidents of PWR and BWR (RIA, LOCA, MSLB, TUSA)
- Beyond design basis accidents (physical phenomena and simulation tools)

Course: Computer Lab for Computer Science in Mechanical Engineering [2121392]

Coordinators: J. Ovtcharova
Part of the modules: Computer Science (p. 40)[BSc-Modul 09, Inf]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Winter term	de

Learning Control / Examinations
Programming assignments, that are to be implemented at the computer, are given every two weeks. The students are supervised by tutors while they work on the assignments. Therefore online tests must be solved by the students to assess the understanding of the tasks and the lecture material. All assignments have to be handed in, before they can take part in the exam.

Conditions
None

Recommendations
None

Learning Outcomes
In the computer science workshop for the lecture Computer Science in Engineering, students are given several practical assignments, through which they develop a program containing the subject areas covered in the tutorial.

Content
Introduction to programming using JAVA

Course: Renewable Energy - Resources, Technologies and Economics [2581012]

Coordinators: R. McKenna
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2	Winter term	en

Learning Control / Examinations
oral/written examination

Conditions
none

Learning Outcomes
After completing this course the students

- have an overview of the key economic aspects relating to renewable energies
- understand the technical and economic interdependencies of these technologies
- are able to judge the economical, ecological and social impacts renewable energies

Content
This lecture presents an overview of some of the most prevalent economic aspects of renewable energy technologies, whilst also considering the most pertinent technical aspects. Hence all renewable technologies are considered from an economic perspective, including the concept of levelized electricity generation costs and their determination with several examples. The need for and types of political support mechanisms for renewable energy technologies will also be discussed, and the diverging experience within Europe in this regard detailed. Other economic aspects of these technologies to be considered in the lecture include:

- determination of cost-potential curves
- logistics and associated requirements,
- marketing of renewable energy,
- investors and financing structures in renewable energy,
- short term forecasting of e.g. wind feed-in, and
- markets for renewable energy technologies
- externalities of renewable energies

Course: Risk Management in Industrial Planning and Decision-Making [2581993]

Coordinators: F. Schultmann
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3,5	2/0	Summer term	en

Learning Control / Examinations
The assessment consists of an oral (30 minutes) or a written (60 minutes) exam (following §4(2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Recommendations
None.

Learning Outcomes
This class is an introduction to risk management and decision support. Students will learn the concepts and methods of risk analysis and management and procedures that help to make decisions about risk management strategies. This course will focus on techniques to manage complexity and uncertainty, for instance by taking into account different value systems resulting from multiple objectives and the involvement of multiple experts and stakeholders. The students will also learn how to apply risk analysis and management in real world settings, and many examples from industrial production and crisis management will be used.
Topics include the identification of relevant risks, the modelling of uncertainty, methods and tools for risk assessment, decision analysis (single and multiple criteria), risk mitigation and management.

Content
This course covers the following topics:

- Introduction to the basic concepts of risk analysis
- Risk Identification: core concepts and tools
- Relationship between probability theory and modelling, risk analysis, and decision analysis
- Using probability theory, probabilistic modeling and probabilistic simulation for risk analysis
- Using basic tools of risk analysis – fault trees, event trees, simulation models, and influence diagrams
- Eliciting and using expert judgment in risk analysis
- Risk analysis in decision making, especially in regulatory settings
- Core concepts to support decision making under uncertainty
- Frameworks for decision problem structuring, preference modelling and choice under risk, along with their characteristics, techniques, tools and applicability for risk management in organisations and industrial companies.
- Understand risk management, including risk communication, implementation, and monitoring of risk management strategies
- Relation of all concepts to practice and modelling of real-world problems in a structured way that supports efficient and effective risk management and rational decision making

Media
Media will be provided on the e-learning platform.

Literature

- Ayyub, Bilal M. (2003) Risk analysis in engineering and economics, Chapman & Hall.

- Belton, Valerie and Stewart, Theodor J. (2002) Multiple criteria decision analysis: an integrated approach, Kluwer Academic Publishers.
- Clemen, Robert T. and Reilly, Terence (2001) Making hard decisions with Decision Tools, Duxbury/Thomson Learning.
- Skipper, Harold D., Kwon, W. Jean, (2007) Risk Management and Insurance: Perspectives In A Global Economy, Blackwell Publishing.

Further reading will be announced in the course

Remarks
This lecture will not be held in winter term any more but in summer term.

Course: Simulation of production systems and processes [2149605]

Coordinators: K. Furmans, V. Schulze, P. Stock
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam.
The successful participation of the related exercises is required for the approval to the exam.

Conditions
Regular attendance in the exercises.

Recommendations
None

Learning Outcomes
The students . . .

- can explain the procedure of a simulation study and the respective steps.
- are able to explain the different modeling approaches that are available to describe production systems in matters of production technology, systems of work and material flow, to analyze and evaluate the results.
- are able to define the different modeling approaches for the description of machining processes and their advantages and disadvantages.
- are able to specify methods for simulation of plants and factories and classify them according to their capabilities.
- are able to define basics in statistics.
- are able to both calculate performance indicators of material flow systems and evaluate real systems according to these performance indicators.
- are able to use the basic tools of a discrete-event simulation software and can evaluate simulation results.
- are able to describe how real systems can be modeled as well as how models can be used and their results can be evaluated.
- are able to perform a personnel-oriented simulation study and can evaluate its results concerning different key figures.
- are able to apply common techniques for verification and simulation and can evaluate the validity of a simulation study with these techniques.

Content
The aim of the lecture is to present the different aspects and possibilities of application of simulation technologies in the field of production systems and processes. Various simulations methods in the fields of production und manufacturing technology, work systems and the material flow for the production systems will be presented.
The following topics will be covered:

- Statistical basics (probability distribution and random numbers and their applications in the Monte Carlo simulation)
- Simulation of factories, machinery and processes (analysis of single manufacturing processes, machine tools and a digital plant)
- Simulation of work systems (personnel and oriented simulation of the digital plant)
- Design and validation of the simulations study (the procedure of a simulations study with the preparation work, the selection of the tools, the validation and the analysis/evaluation)

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Fluid Mechanics (german language) [2153412]

Coordinators: B. Frohnapfel
Part of the modules: Fluid mechanics (p. 43)[BSc-Modul 12, SL]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Winter term	de

Learning Control / Examinations
written

duration: 3 hours

Aux. Means: tables and formulas, electronic calculator

Conditions
None.

Recommendations
Successfully completed Advanced Mathematics I-III
basic knowledge about physics and ordinary linear differential equations

Learning Outcomes
After having completed this module the student is capable of deriving the mathematical equations that describe the motion of fluids and can determine flow quantities for generic problems.

Content
Introduction to the fundamentals of fluid mechanics for students of mechanical engineering and related fields, physics and mathematics. The lecture is complemented by a tutorial.

-
- Introduction
- Flows in Nature and Technologie
- Fundamentals of Fluid Mechanics
- Properties of Fluids and Characteristic Fluid Regimes
- Fundamental Equations of Fluid Mechanics (Conservation of Mass, Momentum and Energy)
  -
  - Continuity equation
  - Navier-Stokes equations (Euler Equations)
  - Energy equation
- Hydro- und Aerostatics
- Flows without dissipation (lossless)
- Technical Flows with Losses
- Introduction to Similarity Analysis
- Two-Dimensional Viscous Flows
- Integral Form of the Governing Equations
- Introduction to Gas Dynamics

Media
Blackboard, Power Point, Experiments

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Durst, F.: Fluid Mechanics: An Introduction to the Theory of Fluid Flows, Springer 2008
Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library

Course: Superconducting Materials for Energy Applications [23682]

Coordinators: M. Noe, Dr. F. Grilli
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	en

Learning Control / Examinations
Oral exam, about 25 min.

Conditions
None.

Learning Outcomes
After attending this course, the students will have

- Received an introduction to superconductivity, with an overview of its main features and of the theories developed to explain it;
- Learned about superconducting materials and their properties, especially those currently employed in energy applications (niobium-based superconductors, cuprates, MgB2) and promising recently discovered ones (pnictides);
- Familiarized with the wide range of superconducting energy applications (magnets, cables, fault current limiters, motors, transformers, etc.), and learned about the advantages they offer with respect to their conventional counterparts.

Content

- Introduction of the course
- Basics of superconductivity
- Materials I (low-T_c superconductors)
- Materials II (high-T_c superconductors)
- Stability
- AC losses
- Simulation and modeling
- Cables
- Fault current limiters
- Magnets, motors, transformers
- Smart-grids
- Lab tour

Media
Blackboard, PowerPoint slides, script written by the teacher (100+ pages)

Literature
Various. It will be provided on a lecture-by-lecture basis.

Remarks
Current information can be found on the IMS (www.ims.kit.edu) webpage. At the end of the course an excursion is planned to KIT Campus North (ITEP).

Course: Systematic Materials Selection [2174576]

Coordinators: J. Hoffmeister
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
oral; 20 - 30 Minutes

Conditions
Basic knowledge in materials science and engineering, mechanics and mechanical design

Learning Outcomes
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.

Content
Important aspects and criteria of materials selection are examined and guidelines for a systematic approach to materials selection are deeloped. The following topics are covered: the status of materials selection in mechanical design and product development
The most important classes of materials and their property profiles
Use of material selection charts
Consideration of to the cross-sectional shape
Consideration of to the manufacture processes
Alloying and material aspects
Industrial design and material character
Material database
Case studies of different areas of mechanical engineering

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: Integrated Information Systems for engineers [2121001]

Coordinators: J. Ovtcharova
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations

Conditions
None

Recommendations
None

Learning Outcomes
Students can:

- illustrate the structure and operating mode of information systems
- explain different goals of specific IT systems in product development (CAD, CAP, CAM, PPS, ERP, PDM) and assign product development processes
- describe the fundamentals of knowledge management and its application in engineering and deploy ontology as knowledge representation
- describe different types of process modelling and their application and illustrate and execute simple work flows and processes with selected tools

Content

- Information systems, information management
- CAD, CAP and CAM systems
- PPS, ERP and PDM systems
- Knowledge management and ontology
- Process modeling

Literature
Lecture slides

Course: Engineering Mechanics I [2161245]

Coordinators: T. Böhlke
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
6	3+2	Winter term	de

Learning Control / Examinations
written, 90 min. Additives as announced
Prerequisites by solving homework problems and attestations during the associated lab course.

Conditions
Mandatory participation in the assciated lab course.

Recommendations
None.

Learning Outcomes
The students can

-
- analyse different equilibrium systems based on the notion of forces and moments, e.g. plane and spatial force systems on a rigid body
- compute internal forces and moments for linear structures and as a result analyse and evaluate the internal load
- compute systems under the influence of friction
- determine the center of lines, areas, masses and volumes
- apply the principal of virtual displacements
- evaluate the stability of equilibrium positions
- compute and evaluate the load of straight bars in the framework of thermoelasticity
- list elastic-plastic material laws
- solve worksheet problems about topics of the lecture using the computer algebra system MAPLE

Content

-
- basics of vector calculus
- force systems
- statics of rigid bodies
- internal forces and moments in bars and beams
- friction
- centre of gravity, centre of mass
- work, energy, principle of virtual work
- statics of inextensible ropes
- elastostatics of tension-compression- bars

Literature

lecture notes
Hibbeler, R.C: Technische Mechanik 1 - Statik. Prentice Hall. Pearson Studium 2005.
Gross, D. et al.: Technische Mechanik 1 - Statik. Springer 2006.
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Parkus, H.: Mechanik der festen Körper. Springer 1988.

Course: Engineering Mechanics II [2162250]

Coordinators: T. Böhlke
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
5	2+2	Summer term	de

Learning Control / Examinations
written, 90 min. Additives as announced
Prerequisites by solving homework problems and attestations during the associated lab course.

Conditions
Mandatory participation in the assciated lab course.

Recommendations
None.

Learning Outcomes
The students can

-
- compute stresses and strains in beams in case of straight and unsymmetric bending
- compute stresses and strains in bodies under torsional load
- compute stresses and strains in beams in case of shear force loading
- compute and evaluate 3D stress and strain states
- apply energy methods for computing
- compute approximate solutions using the methods of Ritz and Galerkin
- analyse the stability of straight bars under compressive loads and evaluate on the basis of the buckling forces
- can solve worksheet problems to topics of the lecture using the computer algebra system MAPLE

Content

-
- bending
- shear
- torsion
- stress and strain state in 3D
- Hooke's law in 3D
- elasticity theors in 3D
- energy methods in elastostatics
- approximation methods
- stability
- inelastic material behaviour

Literature
lecture notes
Hibbeler, R.C: Technische Mechanik 2 - Festigkeitslehre. Prentice Hall. Pearson Studium 2005.
Gross, D. et al.: Technische Mechanik 2 - Elastostatik. Springer 2006.
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Parkus, H.: Mechanik der festen Körper. Springer 1988.

Course: Engineering Mechanics III [2161203]

Coordinators: W. Seemann
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
written exam

Duration: 3h (including TM III and TM IV) for engineering mechanics and for Techno-mathematics
1,5 h (only TM III) for mechatronics und information technicians
Resources allowed during exam: onw lecture notes and notes from tutorial, books in 'Engineering Mechanics'

Conditions
Homework is mandatory and a precondition for participation in the exam “Engineering Mechanics III/IV” (Engineering mechanics, techno-mathematics) and for participation in the exam “Engineering Mechanics III” (Mechatronics and information technicians)

Recommendations
None.

Learning Outcomes
The students are able to derive models of systems for a plain motion. This includes both kinematics as well as dynamics. They know how to describe the motion of particles in reference systems and may derive kinematic quantities like velocity or acceleration. The derivation of equations of motion for systems of particles and rigid bodies with Newton-Euler's axioms can be done. The students know the dependence of the kinetic energy on the kinematic quantities and the inertia parameters of the system and can apply the principle of work or the principle of the conservation of mechanical energy for conservative systems. Applications include impact problems as well as systems with increasing or decreasing mass.

Content
Kinematics: Cartesian, cylindrical and natural coordinates. Time derivatives in moving reference frames, angular velocities of reference frames.

Kinetics of a particle:
Newton's axiom, Principle of d'Alembert, work of a force, kinetic and potential energies, principle of linear momentum, principle of moment of momentum, kinetics in moving reference systems

Systems of particles:
Principle of center of mass, Principle of moment of momentum, impacts between particles, systems with variable mass, applications.

Plain motion of rigid bodies:
Pure translation, pure rotation, general plain motion. Instantaneous center of rotation, Kinetics, moment of momentum, principle of work and principle of energy conservation for a rotation around a space-fixed axis. Mass moment of inertia, parallel-axis-theorem.Principle of linear momentum and principle of moment of momentum for arbitrary plain motion. Principle of d'Alembert for plain motion. Principles of linear and moment of momentum in integral form. Applications for impact problems.

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006

Gross, Hauger, Schnell: Technische Mechanik Bd. 3, Heidelberg, 1983

Lehmann: Elemente der Mechanik III, Kinetik, Braunschweig, 1975

Göldner, Holzweissig: Leitfaden der Technischen Mechanik.

Hagedorn: Technische Mechanik III.

Course: Engineering Mechanics IV [2162231]

Coordinators: W. Seemann
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
written exam: 3h (together with TM III)

Conditions
Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics III/IV".

Learning Outcomes
The students know some possibilities to describe the position and orientation of a rigid body for an arbitrary 3D motion. They realize that the rotational velocity is a vector which may change both magnitude and orientation. They can apply the principle of linear momentum and the principle of moment of momentum to a spatial motion of a rigid body and notice that this is much more complicated compared to a plain motion. The students can calculate the coordinates of the inertia tensor. They see that many effects which may be seen with gyroscopes can be explained by the principle of moment of momentum. For systems with many particles or bodies but only few degrees of freedom the students know that the application of analytical methods like the principle of D'Alembert in Lagrangian form or the Lagrange equations may be advantageous. They can apply these principles to simple problems. For vibration problems the students can interprete the most important expressions like eigenfrequency, resonance or eigenvalue problem. Forced vibration of systems with one degree of freedom can be investigated by the students.

Content
Spatial kinematics of a rigid body, Euler angles, angular velocity using Euler angles, Euler's equations, inertia tensor, kinetic energy of a rigid body, free gyroscopes, forced gyroscopes, systems of rigid bodies, principle of d'Alembert, Lagrange's equations of the first and second kind, generalized coordinates, free and forced vibration of one degree of freedom systems, frequency response, vibration of multi degree of freedom systems, vibration absorption

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006
Marguerre: Technische Mechanik III, Heidelberger Taschenbücher, 1968
Magnus: Kreisel, Theorie und Anwendung, Springer-Verlag, Berlin,
1971 Klotter: Technische Schwingungslehre, 1. Bd. Teil A, Heidelberg

Course: Vibration Theory [2161212]

Coordinators: A. Fidlin
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
Written exam
If course is chosen as optional subject or part of major subject:
Oral exam, 30 minutes (optional subject), 20 minutes (major subject), no means

Conditions
None.

Recommendations
Examen in Engineering Mechanics 3 + 4

Learning Outcomes
The course gives an introduction into the vibration theory of linear systems. First, general vibration in form of harmonic signals is considered. One degree of freedom systems are treated in detail for free and forced vibration, especially for harmonic, periodic and arbitrary excitation. This is the foundation for systems with many degrees of freedom as these may be transformed with the help of modal coordinates. For multiple dof systems the eigenvalue problem is solved. Then forced vibration is treated. Finally, wave propagation problems and eigenvalue problems for systems with distributed parameters are discussed. As an application an introduction into rotor dynamics is given.

Goal of the course is to see the similarities for systems with one dof and with multiple dof. Besides typical phenomena like resonance a systematic mathematical approach to vibration problems and an interpretation of the mathematical results should be obtained.

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.

Systems with many degrees of freedom: Eigenvalue problem for undamped vibration, orthogonality of eigenvectors, modal decoupling, approximation methods, eigenvalue problem for damped vibration. Forced vibration for harmonic excitation, modal decomposition for arbitrary forced vibration, vibration absorber.

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.

Literature
Klotter: Technische Schwingungslehre, Bd. 1 Teil A, Heidelberg, 1978

Hagedorn, Otterbein: Technische Schwingungslehre, Bd 1 and Bd 2, Berlin, 1987

Wittenburg: Schwingungslehre, Springer-Verlag, Berlin, 1995

Course: Engineering Thermodynamics and Heat Transfer I [2165501]

Coordinators: U. Maas
Part of the modules: Engineering Thermodynamics (p. 34)[BSc-Modul 05, TTD]

ECTS Credits	Hours per week	Term	Instruction language
6,5	3	Winter term	de

Learning Control / Examinations
Written
Duration: 2 hours

Conditions
None

Recommendations
None

Learning Outcomes
After completing the course students can:

- describe the correlations between the thermodynamic properties of pure substances.
- setup the balance equations for mass and energy for different processes.
- determine the direction of a process.
- understand the fundamental processes in phase transitions.
- explain the basics of ideal thermodynamic cycles.

Content
System, properties of state
Absolute temperature, model systems
1st law of thermodynamics for resting and moved systems
Entropy and 2nd law of thermodynamics
Behavior of real substances described by tables, diagrams and equations of state
Machine processes

Media
Blackboard and Powerpoint presentation

Literature
Course note packet
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Technical Thermodynamics and Heat Transfer II [2166526]

Coordinators: U. Maas
Part of the modules: Engineering Thermodynamics (p. 34)[BSc-Modul 05, TTD]

ECTS Credits	Hours per week	Term	Instruction language
6,5	3	Summer term	de

Learning Control / Examinations
Written
Duration: 2 hours

Conditions
None

Recommendations
None

Learning Outcomes
After attending the course students are able to:

-
- describe the correlation between the thermodynamic properties in mixtures of different substances.
- explain the characteristics of real substances.
- define the major concepts in gas kinetics.
- determine the composition of a reacting mixture in the thermodynamic equilibrium.
- discuss the various influences on the reaction equilibrium.
- describe the fundamental laws of heat transfer.

Content
Repetition of the topics of "Thermodynamics and Heat Transfer I"
Mixtures of ideal gases
Moist air
Behaviour of real substances described by equations of state
Applications of the laws of thermodynamics to chemical reactions

Media
Blackboard and Powerpoint presentation

Literature
Course notes
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Ten lectures on turbulence [2189904]

Coordinators: I. Otic
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral examination; **duration**: 20 minutes

Conditions
None.

Recommendations

- Fundamentals of fluid dynamics

Learning Outcomes
After completing the course students should be able to establish a connection between theory and numerical modeling of turbulent flows.

Content
This course is specified for Master students of Mechanical, Power and Nuclear Engineering. The problem of turbulence is of key importance in many fields of science and engineering. It is an area which is vigorously researched across a diverse range of disciplines. This course is aimed of giving the fundamentals of turbulence theory and modelling. Starting from the basic physical phenomena and governing equations the quantitative and statistical description of turbulence is introduced. An overview on computational methods for turbulent flows and turbulence modelling is given.

Course: Thermal Turbomachines I [2169453]

Coordinators: H. Bauer
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	en

Learning Control / Examinations
oral
Duration: approximately 1 hour

no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
It is a recommended lecture combination with 'Thermal Turbomachines II'.

Learning Outcomes
The students are able to explain and comment on the design and operation of thermal turbomachines in detail. Moreover, they can evaluate the range of applications for turbomachinery. Therefore, students are able to to describe and analyse not only the individual components but also entire assemblies. The students can asses and evaluate the effects of physical, economical and ecological boundary conditions.

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

Literature
Lecture notes (available via Internet)

Bohl, W.: Strömungsmaschinen, Bd. I, II; Vogel Verlag, 1990, 1991

Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

Traupel, W.: Thermische Turbomaschinen Bd. I, II, Springer-Verlag, 1977, 1982

Course: Thermal Turbomachines II [2170476]

Coordinators: H. Bauer
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	en

Learning Control / Examinations
oral (can only be taken in conjunction with 'Thermal Turbomachines I')
Duration:approximately 60 minutes (including Thermal Turbomachines I)

Auxiliary:no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
Recommended as lecture combination with 'Thermal Turbomachines I'.

Learning Outcomes
Based on the fundamental skills learned in 'Thermal Turbomachines I' the students have the ability to design turbines and compressors and to analyse the operational behavior of these machines.

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

Literature
Course not packet
Bohl, W.: Strömungsmaschinen, Bd. I,II, Vogel Verlag 1990, 1991
Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993
Traupel, W.: Thermische Turbomaschinen, Bd. I,II, Springer-Verlag, 1977, 1982

Course: Exercises Computer Science for Engineers [2121391]

Coordinators: J. Ovtcharova
Part of the modules: Computer Science (p. 40)[BSc-Modul 09, Inf]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Winter term	de

Learning Control / Examinations
None

Conditions
None

Recommendations
None

Learning Outcomes
The tutorial provides insight into object-oriented programming with Java. An object-oriented way of thinking is practically communicated, based on the basic language elements that are also dealt with. Programming is taught from scratch, in order to communicate the essential skills for successfully participating in the computer science workshop.

After successfully completing the tutorial, students should be able to develop simple object-oriented programs in Java. They should know enough of the basics, in order to be capable of familiarizing themselves with further object-oriented languages within a limited period of time.

Besides programming, which is the main focus of the tutorial, subjects from the lecture will be implemented in programs.

Content
Basics and language elements of Java
Classes, attributes, methods
Constructors and objects
Loops and conditions
Inheritance, polymorphism
Interfaces, abstract classes
Collections, exceptions
Parallelism, threads

Literature
See lecture

Course: Engineering Mechanics III (Tutorial) [2161204]

Coordinators: W. Seemann, Assistenten
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter term	de

Learning Control / Examinations
Homework is mandatory and a precondition to take part in the exam TM III.

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know how to apply the methods which are derived in the corresponding lecture. They train to solve theoretical and industrial problems to which the methods must be applied in order to get more insight or in order to see what is the philosophy on which the methods shown in the lecture are based.

Content
In the Tutorial excercises for the corresponding subjects of the lecture are presented. During the tutorial part of the tutorial excercises are presented and instructions for those excercises are given which have to be done as homework.

The homework is mandatory and is corrected by the tutors. A successful elaboration of the homework is necessary to take part in the final exam.

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006

Gross, Hauger, Schnell: Technische Mechanik Bd. 3, Heidelberg, 1983

Lehmann: Elemente der Mechanik III, Kinetik, Braunschweig, 1975

Göldner, Holzweissig: Leitfaden der Technischen Mechanik.

Hagedorn: Technische Mechanik III.

Course: Engineering Mechanics IV (Tutorial) [2162232]

Coordinators: W. Seemann
Part of the modules: Engineering Mechanics (p. 32)[BSc-Modul 03, TM]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Summer term	de

Learning Control / Examinations
Homework is mandatory and a precondition to take part in the exam.

Conditions
None.

Learning Outcomes
The students know how to apply the methods which are derived in the corresponding lecture. They train to solve theoretical and industrial problems to which the methods must be applied in order to get more insight or in order to see what is the philosophy on which the methods shown in the lecture are based.

Content
In the Tutorial excercises for the corresponding subjects of the lecture are presented. During the tutorial part of the excercises are presented and instructions are given for those excercises which have to be done as homework.

The homework is mandatory and is corrected by the tutors. A successful elaboration of the homework is necessary to take part in the final exam.

Literature
Hibbeler: Technische Mechanik 3, Dynamik, München, 2006
Marguerre: Technische Mechanik III, Heidelberger Taschenbücher, 1968
Magnus: Kreisel, Theorie und Anwendung, Springer-Verlag, Berlin,
1971 Klotter: Technische Schwingungslehre, 1. Bd. Teil A, Heidelberg

Course: Tutorial: Engineering Thermodynamics I [2165527]

Coordinators: U. Maas, Assistenten
Part of the modules: Engineering Thermodynamics (p. 34)[BSc-Modul 05, TTD]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Winter term	de

Learning Control / Examinations
Written
Duration: 4 x 30 min hours

Conditions
None

Recommendations
Attendance of the lecture

Learning Outcomes
After completing the course students are able to:

-
- apply the knowledge gained in the course 2166526, “Technical Thermodynamics and Heat Transfer II” on specific thermodynamic problems.

Content
Calculation of thermodynamical problems

Literature
Course notes;
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Excercises in Technical Thermodynamics and Heat Transfer II [2166527]

Coordinators: U. Maas
Part of the modules: Engineering Thermodynamics (p. 34)[BSc-Modul 05, TTD]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Summer term	de

Learning Control / Examinations
Written
Duration: 4 x 30 min hours

Conditions
None

Recommendations
Attendance of the lecture

Learning Outcomes
After completing the course students are able to:

- apply the knowledge gained in the course 2166526, "Technical Thermodynamics and Heat Transfer II" on specific thermodynamic problems.

Content
Calculation of thermodynamical problems

Literature
Course notes
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Tutorial: Engineering Thermodynamics II - Repetition [2165530]

Coordinators: U. Maas, Halmer
Part of the modules: Engineering Thermodynamics (p. 34)[BSc-Modul 05, TTD]

ECTS Credits	Hours per week	Term	Instruction language
0	2	Winter term	de

Learning Control / Examinations
written;
Duration: 4 x 30 min hours

Conditions
Failed performance test in Engineering Thermodynamics II

Learning Outcomes
Application and consolidating of the lecture matter

Content
Calculation of thermodynamical problems

Literature
Course note packet
Elsner, N.; Dittmann, A.: Energielehre und Stoffverhalten (Grundlagen der technischen Thermodynamik Bd. 1 und 2), 8. Aufl., Akademie-Verlag, 680 S. 1993.
Baehr, H.D.: Thermodynamik: eine Einführung in die Grundlagen und ihre technischen Anwendungen, 9. Aufl., Springer-Verlag, 460 S., 1996.

Course: Virtual Engineering (Specific Topics) [3122031]

Coordinators: J. Ovtcharova
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Summer term	en

Learning Control / Examinations
Oral examination
Duration: 20 min

Auxiliary Means: none

Conditions
None

Recommendations
None

Learning Outcomes
The students will acquire an introduction in Product Lifecycle Management (PLM) and understand the application of PLM in Virtual Engineering.
Furthermore, they will have an extensive knowledge of the data models, the specific modules and functions of CAD systems. They will have an awareness of the IT background of CAx systems, as well as the integration problems and possible approaches.
Students will receive an overview of various CAE analysis methods along with the application possibilities, basic conditions and limitations. They will know the different function of preprocessor, solver and postprocessor of CAE systems.
The students will get to know the definition of virtual reality how the stereoscopic effect occurs and which technologies can be used to simulate this effect.
Moreover, they will know which validation tests can be carried through in the product development process with the aid of a virtual mock-up (VMU) and what's the difference between a VMU, a physical mock-up (PMU) and a virtual prototype (VP).

Content
The lecture presents the informational interrelationship required for understanding the virtual product development process. For this purpose, an emphasis and focus will be placed on IT-systems used in the industrial sector as support for the process chain of virtual engineering:

- Product Lifecycle Management refers to the entire lifecycle of the product, beginning with the concept phase up through disassembling and recycling.
- CAx-systems for the virtual product development allow the modeling of a digital product in regards to design, construction, manufacturing and maintenance.
- Validation Systems allow the checking of the product in regard to static, dynamics, safety and build ability.
- The corresponding models can be visualized in Virtual Reality Systems, from single parts up through a complete assembly.
- Virtual Prototypes combine CAD-data as well as information about the remaining characteristics of the components and assembly groups for immersive visualisation, functionality tests and functional validations in the VR/AR/MR environment.
- Integrated Virtual Product Development explains exemplified the product development process from the point of view of Virtual Engineering.

The goal of the lecture is to clarify the relationship between construction and validation operations through the usage of virtual prototypes and VR/AR/MR visualisation techniques in connection with PDM/PLM-systems.

Literature
Lecture slides

Course: Heat and mass transfer [22512]

Coordinators: H. Bockhorn, U. Maas
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
written (in winter- or summerterm)
duration: 3 hours
additives: non-progammable calculator, 2 DIN-A4-pages individual formulary

Conditions
None.

Recommendations

- Basic studies in Mechanical Engineering or Chemical Engineering with completed intermediate diploma
- Lectures in Thermodynamics, Fluid Dynamics and Higher Mathematics

Learning Outcomes
Students know about the contents of Heat and mass transfer.

Content

- Stationäre und instationäre Wärmeleitung in homogenen und Verbund-Körpern; Platten, Rohrschalen und Kugelschalen
- Molekulare, äquimolare und einseitige Diffusion in Gasen; Analogie der Stoffdiffusion zur Wärmeleitung
- Konvektiver, erzwungener Wärmeübergang in durchströmten Rohren/Kanälen sowie bei überströmten Platten und umströmten Profilen
- Konvektiver Stoffübergang, Stoff-/Wärmeübergangs-Analogie
- Mehrphasiger konvektiver Wärmeübergang (Kondensation, Verdampfung)
- Strahlungswärmeaustausch von Festkörpern und Gasen

Literature

- Bockhorn, H.; Vorlesungsskript "Wärme- und Stoffübertragung"
- Baehr, H.-D., Stephan, K.: "Wärme- und Stoffübertragung" , Springer Verlag, 1993
- Incropera, F., DeWitt, F.: "Fundamentals of Heat and Mass Transfer" , John Wiley & Sons, 1996
- Bird, R., Stewart, W., Lightfoot, E.: "Transport Phenomena" , John Wiley & Sons, 1960

Course: Wave Phenomena in Physics [2400411]

Coordinators: B. Pilawa
Part of the modules: Principles of Natural Science (p. 31)[BSc-Modul 02, NG]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written examination

Conditions
None

Learning Outcomes
Two basic concepts are known in classical physics. The concept of particles according to Newton and the concept of waves. The student realize that the dynamics of solids, liquids and gases are well described by waves in the frame of Newtonian physics. The students also realize that the concept of waves is an inherent feature of the classical electrodynamics and that electromagnetic waves open the door to the modern description of the world in terms of relativity and quantum mechanics.

Content
Mechanics: transversal and longitudinal waves, harmonic waves, wave length and frequency, phase velocity, wave equation, wave equation of a string, superposition of waves, reflection and transmission of waves on a string, standing waves, transport of energy on strings, impedance, sound waves, standing sound waves, wave equation of sound waves, energy and intensity of sound waves, loudness, plane waves, wave vector, reflection of waves, refraction of waves, dispersion, beats, group velocity
Electrodynamics: electrostatics, electric charge, Coulomb law, electric field, voltage, Gauss's law, capacitor, energy density of the electric field, magnetostatics, Lorentz force, law of Biot-Savart, Ampere's law, Faraday's law, inductivity, LR- and LC-circuit, energy density of the magnetic field, electric waves on a cable, impedance of a wave, reflection and transmission, displacement current of Maxwell, electromagnetic waves in vacuum, plane electromagnetic waves, dipole antenna, polarization, birefringence, polarization by scattering, Brewster's angle, reflection coefficient of the electric field, interference on thin layers, Michelson-Interferometer, Lorentz-Transformation, time dilation and length contraction, photo effect
Matter waves: de Broglie wave length, Davisson-Germer experiment

Course: Materials Science and Engineering I for mach, IP-M, phys; Part 1 of class: Letters A-K [2173550]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
7	5	Winter term	de

Learning Control / Examinations
Combined with 'Materials Science and Engineering II'; oral; about 30 minutes

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can describe the typical property profies and can name applications for the most important engineering materials.

The students are able to describe standard materials characterization methods and can explain the evaluation of these methods. They can judge materials on base of the data obtained by these methods.

Content
Atomic structure and atomic bonds

Structures of crystalline solids

Defects in crystalline solids

Structure of amorphous and semi-crystalline solids

Alloys

Transport and transformation phenomena in the solid state

Microscopy methods

Characterization by means of X-rays, Neutrons and Electrons

Nondestructive testing of materials

Mechanical testing of materials

Literature
Lecture Notes; Problem Sheets;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Materials Science and Engineering I for mach, IP-M, phys; Part 2 of class: Letters L-Z [2173551]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
7	5	Winter term	de

Learning Control / Examinations
Combined with “Materials Science and Engineering II”; oral; about 30 minutes

Conditions
none

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can describe the typical property profies and can name applications for the most important engineering materials.

The students are able to describe standard materials characterization methods and can explain the evaluation of these methods. They can judge materials on base of the data obtained by these methods.

Content
Atomic structure and atomic bonds

Structures of crystalline solids

Defects in crystalline solids

Structure of amorphous and semi-crystalline solids

Alloys

Transport and transformation phenomena in the solid state

Microscopy methods

Characterization by means of X-rays, Neutrons and Electrons

Nondestructive testing of materials

Mechanical testing of materials

Literature
Lecture Notes; Problem Sheets;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Materials Science and Engineering II for mach, IP-M, phys; Part 1 of class: Letters A-K [2174560]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
Combined with 'Materials Science and Engineering I'; oral; about 30 minutes

Conditions
Materials Science and Engineering I

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name representative materials for different material classes and can describe the differences.
The students are able to describe the basic mechanisms of hardening for ferrous and non-ferrous materials and reflect these mechanisms using phase and TTT diagrams.
The students can interpret given phase, TTT or other diagrams relevant for materials science, gather information from them and can correlate them regarding the microstructure evolution.
The students can describe the phenomena correlated with materials science in polymers, metals and ceramics and depict differences.
The students know about standard materials characterization methods and are able to asses materials on base of the data obtained by these methods.

Content
Ferrous materials

Non-ferrous metals and alloys

Engineering ceramics

Glasses

Polymers

Composites

Literature
Lecture Notes; Problem Sheets;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Materials Science and Engineering II for mach, IP-M, phys; Part 2 of class: Letters L-Z [2174561]

Coordinators: H. Seifert, K. Weidenmann, M. Heilmaier
Part of the modules: Materials Science and Engineering (p. 33)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Summer term	de

Learning Control / Examinations
Combined with "Materials Science and Engineering I"; oral; about 30 minutes

Conditions
Materials Science and Engineering I

Learning Outcomes
The students are able to describe the relationship between atomic structure, microscopical observations, and properties of solid materials.

The students can name representative materials for different material classes and can describe the differences.
The students are able to describe the basic mechanisms of hardening for ferrous and non-ferrous materials and reflect these mechanisms using phase and TTT diagrams.
The students can interpret given phase, TTT or other diagrams relevant for materials science, gather information from them and can correlate them regarding the microstructure evolution.
The students can describe the phenomena correlated with materials science in polymers, metals and ceramics and depict differences.

Content
Ferrous materials

Non-ferrous metals and alloys

Engineering ceramics

Glasses

Polymers

Composites

Literature
Lecture Notes; Problem Sheets;

Shackelford, J.F.
Werkstofftechnologie für Ingenieure
Verlag Pearson Studium, 2005

Course: Wind and Hydropower [2157451]

Coordinators: M. Gabi, N. Lewald
Part of the modules: Lectures in English (p. 49)[Englischsprachige Veranstaltungen]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
Oral exam, 30 minutes, no means

Conditions
None

Recommendations
Fluid Mechanics

Learning Outcomes
The students know basic fundamentals for the use of wind- and waterpower.

Content
Wind- and waterpower fundamental lecture. Introduction in the basics of fluid machinery.
Windpower:
Basic knowledge for the use of wind power for electricity, complemented by historical development, basic knowledge on wind systems and alternative renewable energies. Global and local wind systems as well as their measurement and energy content are dedicated. Aerodynamic basics and connections of wind-power plants and/or their profiles, as well as electrical system of the wind-power plants are described. Fundamental generator technology over control and controlling of the energy transfer.
Finally the current economic, ecological and legislations boundary conditions for operating wind-power plants are examined.An overview of current developments like super-grids and visions of the future of the wind power utilization will be given.
Waterpower:
Basic knowledge for the use of water power for electricity, complemented by historical development. Description of typical hydropower systems.
Introduction in the technology and different types of water turbines. Calculation of the energy conversion of typical hydropower systems.

Literature

-
- Erich Hau, Windkraftanlagen, Springer Verlag.
- J. F. Douglas er al., Fluid Mechanics, Pearson Education.
- Pfleiderer, Petermann, Strömungsmaschinen, Springer Verlag.

Course: Scientific computing for Engineers [2181738]

Coordinators: D. Weygand, P. Gumbsch
Part of the modules: Compulsory Elective Subject (BSc) (p. 46)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Learning Outcomes
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

Content
1. Introduction: why scientific computing
2. computer architectures
3. Introduction to Unix/Linux
4. Foundations of C++
* progamm 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.

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 Moleküldynamik, Griebel, Knapek, Zumbusch, Caglar, Springer Verlag

Course: Workshop 'Working Methods in Mechanical Engineering' (AIA) [2106984]

Coordinators: G. Bretthauer
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
Strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop 'Working Methods in Mechanical Engineering' (FAST - Bahnsystemtechnik) [2114990]

Coordinators: P. Gratzfeld
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations

- The attendance and active collaboration is required for all workshops.
- There will be no exam.

Conditions

- Attendance at the lecture “Arbeitstechniken für den Maschinenbau (2110969)” mandatory
- Registration via internet on http://www.mach.kit.edu required
- Mandatory attendance in all workshops

Learning Outcomes

The students should be able:
1. To plan a definite task under the consideration of specific regulations in a goal- and resource-oriented way.
2. To find and chose scientific information according to pre-defined quality criteria.
3. To write a precise and conclusive scientific abstract and to evaluate scientific papers.
4. To prepare a poster and an oral presentation in order to present scientific information.
5. To work in a team in a motivating and team-oriented way.

Content

Workshop 1: literature research, teamwork rules & roles , work organisation
Workshop 2: creativity techniques, decision making methods
Workshop 3: feedback rules, to get to know two types of scientific presentations - poster and oral presentation
Workshop 4: scientific presentations

Media

Handout online available for download

Course: Workshop 'Working Methods in Mechanical Engineering' (FAST - Fahrzeugtechnik) [2114989]

Coordinators: F. Gauterin, El-Haji, Unrau
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The performance is evaluated according to the degree of participation during the course. Furthermore, the quality of the periodically submitted worksheets and the final presentation are taken into account.

Conditions
None.

Learning Outcomes
After the course, the students are able to:
- conduct internet and literature research of topics regarding vehicle technology,
- express their knowledge and technical information with SysML,
- design and model systems with SysML,
- participate in and lead technical discussions based on SysML diagrams,
- present and communicate design results to a group of people.

Content
The students assume the role of an innovate automobile manufacturer and have the task to conceptualise different vehicles that can compete with current models.
The conceptualisation begins with the components of the vehicle which are then merged to the complete vehicle.

Literature
- Skript „Grundlagen der Fahrzeugtechnik I + II“
- „Systems Engineering mit SysML/UML“, Tim Weilkiens

Course: Workshop 'Working Methods in Mechanical Engineering' (FAST-Leichtbautechnologie) [2114450]

Coordinators: F. Henning
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop 'Working Methods in Mechanical Engineering' (FAST-MOBIMA) [2114979]

Coordinators: M. Geimer
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Abstract, oral presentations, documented research.

Conditions

- active participation in all four workshop sessions (mandatory attendance)
- participation in the lecture " Arbeitstechniken für den Maschinenbau (2110969)" required
- registration required on http://www.mach.kit.edu
- bring your own laptop if possible

Learning Outcomes
the student is able to:

1. plan and schedule specific tasks under specified boundary conditions such as ölimited resources.
2. work task-oriented an motivatig in a team
3. Discuss, explain and apply strategies for (literature-)research.
4. present technical information in text, oraly and with assitance of different media.
5. take into account principles of the scientific working in his own project work.

Content
Develop a new mobile machine with the steps:

- research state of the art
- develop performance specification
- frame out machine concept
- present results

The following scientific methods and tools are tought alongside:

- research techniques
- feedback
- presentation Media
- review processes
- abstracts

Media

- projector (Powerpoint)
- chart wall
- books/papers
- internet

Course: Workshop 'Working Methods in Mechanical Engineering' (FSM) [2158978]

Coordinators: M. Gabi
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

- Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2110969)" mandatory
- Limited number of participants
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes
The student should be able

- To plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- To find and chose scientific information according to pre-defined quality criteria.
- To write a precise and conclusive scientific abstract and to evaluate scientific papers.
- To present scientific information.
- To work in a team in a motivating and team-oriented way.

Content
Workshop 1: Self management, Problem solving, Work organisation

Workshop 2: Structuring of problems, Scientific research

Workshop 3: Scientific use of information

Workshop 4: Scientific presentations

Literature
Learning material:
Handout online on: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_7815.html

Literature:

- SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.
- BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.
- KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
- FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.

- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.

- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.

- KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
- ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.

Please refer to the latest edition.

Course: Workshop 'Working Methods in Mechanical Engineering' (IAM-AWP) [2174987]

Coordinators: H. Seifert, R. Kohler
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration in all four workshops is required.
There will be no exam.

Conditions

- Attendance at the lecture „Arbeitstechniken für den Maschinenbau (2110969)“ mandatory
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes
The participants should be able to

- plan a concrete task under the consideration of specific regulations in a goal- and resource-oriented way.
- find and chose scientific information according to redefined quality criteria.
- write a precise and conclusive scientific abstract and to evaluate scientific papers.
- present scientific information conclusively.
- work in a team in a motivating and team-oriented way.

Content
Workshop 1: literature research
Workshop 2: literature review
Workshop 3: preparation for presentation
Workshop 4: presentation

Literature

- T. Reddy, Linden's Handbook of Batteries, McGraw-Hill Professional (2010)
- M. Winter, R.J. Brodd, What Are Batteries, Fuel Cells, and Supercapacitors? Chem. Rev. 104 (2004) 4245-4269
- J.L. Li, C. Daniel, D. Wood, Materials processing for lithium-ion batteries, J. Power Sources 196 (2011) 2452–2460

Course: Workshop 'Working Methods in Mechanical Engineering' (IAM-KM) [2126980]

Coordinators: M. Hoffmann
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions
Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2174970)" mandatory
Registration via internet onhttp://www.mach.kit.edu/atm
Mandatory attendance in all workshops

Learning Outcomes
The student should be able
To plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
To find and chose scientific information according to pre-defined quality criteria.
To write a precise and conclusive scientific abstract and to evaluate scientific papers.
To present scientific information.
To work in a team in a motivating and team-oriented way.

Content
Workshop 1: Self management, Problem solving, Work organisation

Workshop 2: Structuring of problems, Scientific research

Workshop 3: Scientific use of information

Workshop 4: Scientific presentations

Course: Workshop ’Working Methods in Mechanical Engineering’ (IAM-WBM) [2178981]

Coordinators: O. Kraft, P. Gruber
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

- Attendance at the lecture “Arbeitstechniken für den Maschinenbau” mandatory
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes

- To treat a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- To find and chose scientific information according to pre-defined quality criteria.
- To write a precise and conclusive scientific abstract and to evaluate scientific papers.
- To present scientific information.
- To work in a team in a motivating and team-oriented way.

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Content
Workshop 1: Literature research
Workshop 2: Writing of an abstact, Preparation of a poster
Workshop 3: Poster presentation, Preparation of a talk
Workshop 4: Presentation of the talk

Literature
Lecture notes

Course: Workshop 'Working Methods in Mechanical Engineering' (IAM-ZBS, Nestler) [2182982]

Coordinators: B. Nestler, A. August
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

-
- Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2110969)" mandatory
- Limited number of participants
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes
The student should be able

-
- to plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- to find and chose scientific information according to pre-defined quality criteria.
- to write a precise and conclusive scientific abstract and to evaluate scientific papers.
- to present scientific information.
- to work in a team in a motivating and goal-oriented way.

Content
application of the lecture:
* project work in groups
* study of a particular given topic
* selection of material for presentation
* preparation of a presentation by poster or talk
* depending on the topic: Composition of a documentation

Media
books, research articles, web

Literature
lecture notes
on-topic research paper
further literature

-
- SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.

- BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.
- KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
- FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
- ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.

Please refer to the latest edition.

Course: Workshop 'Working Methods in Mechanical Engineering' (IFAB) [2110968]

Coordinators: P. Stock
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

- Attendance at the lecture “Arbeitstechniken für den Maschinenbau (2110969)” mandatory
- Limited number of participants
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes
After completion this workshop, the students are able

- to plan projects task- and resource-orientated,
- to apply creative techniques within a team,
- to find and evaluate scientific data sources and to achieve needed information,
- to summarize researched information and work results in written form in a structured and concise style,
- to present scientific problems or results,
- to work task-oriented and constructive within a team.

Content
Workshop 1: Self management, Problem solving, Work organisation

Workshop 2: Structuring of problems, Scientific research

Workshop 3: Scientific use of information

Workshop 4: Scientific presentations

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Workshop 'Working Methods in Mechanical Engineering' (IFKM) [2134996]

Coordinators: T. Koch
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
Strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop 'Working Methods in Mechanical Engineering' (IFL) [2118973]

Coordinators: Baur
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The successful participation is certified after active participation in all four Workshops and in the conclusion meeting .

Conditions
None.

Recommendations
None.

Learning Outcomes
The control of different work technics belongs to the key qualifications of a prospective mechanical engineer and the vocational practice. In the lecture some particular important aspects are treated: Scientific-technologic writing, investigating and quoting, time management, teamwork as well as presentation and communication technics . In four Workshops for this on the basis by setting of tasks from different areas of mechanical engineering practical experiences are gained.

Content
In four Workshops working technologies like scientific-technical writing, investigating and quoting, time management, teamwork as well as presentation and communication technologies are practiced and deepened.

Literature
None.

Course: Workshop 'Working Methods in Mechanical Engineering' (IMI) [2128998]

Coordinators: J. Ovtcharova, Mitarbeiter
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Team reports of the work packages and final team presentation will be estimated

Conditions
None.

Recommendations
None.

Learning Outcomes
Students become acquainted with working in a team and as well as gain experience in scientific research. They are able to analyze, to evaluate and to structure new information, as well as to abstract it within scientific reporting. Students develop independent concepts and case-based solutions and are able to present professionally the results, which have been worked out in the team. The students get a first insight into the approaches and ways of Product Lifecycle Management (PLM).

Content
Creativity techniques, presentation skills, communication techniques

Remarks
None.

Course: Workshop 'Working Methods in Mechanical Engineering' (IMT) [2142975]

Coordinators: M. Worgull
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations

- Participation in all workshops
- Deliverables
- Active Cooperation

Conditions
Participation of Lesson "Arbeitstechniken im Maschinenbau"

Learning Outcomes
Competences in

- Teamwork
- Working with limitation of time
- Scientific investigation
- Scientific citation
- Scientific writing
- Presentation

Content
Within the frame of a scientific conference the contents from the corresponding lesson will be implemented in a practical way.
The students have to organise a scientific conference by themself. The contributions have to prepared by the students and will be presented within the frame of abstracts, conference articles, posters, and presentations.
1. part of the workshop - Organisation of a conference

- Structure of a conference
- Generation of workgroups - Committees
- Exchange of Informations between workgroups
- Decision-making based on the information available
- Decision-making based under limitation of time
- Gerartion of technical progam, budget, flyer etc. of the conference
- Definition of critera for abstracts - communication of criteria

2. partl of the workshop - Investigation and writing of abstracts

- Investigation in Literatur / Patent Database
- Citation of scientific literature
- Writing of abstracts
- Evaluation of abstracts

3. part of the workshop - Writing of scientific conference contributions

- Structure of a scientific article
- Rules for scientific writing - style
- Citation - Sources and their citation
- Design of scientifi posters
- Design of a scientific presentation

4. part of the workshop - Moderation and presentation

- Presentation of the results of the workshop - oral presentations
- Presentation of posters
- Moderation of the confernce

Media
Computer with internet access

Literature
Script for the Workshop - Fundamentals of scientific writing, poster design, moderation and presentation were summerized in a kind of workshop guide.

Course: Workshop 'Working Methods in Mechanical Engineering' (ITS) [2170972]

Coordinators: H. Bauer
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
The students are able to:

-
- analyse scientific-technical articles
- conduct literature research
- correclty cite articles
- work together in a team
- manage a project within a given time frame
- present relations in a clear and comprehensible way

Content

Course: Workshop 'Working Methods in Mechanical Engineering' (ITT) [2166991]

Coordinators: U. Maas
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

-
- Attendance at the lecture “Arbeitstechniken für den Maschinenbau (2110969)” mandatory
- Limited number of participants
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Recommendations
None

Learning Outcomes
The student should be able

-
- To plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- To find and chose scientific information according to pre-defined quality criteria.
- To write a precise and conclusive scientific abstract and to evaluate scientific papers.
- To present scientific information.
- To work in a team in a motivating and team-oriented way.

Content

-
- Self management, Problem solving, Work organisation
- Structuring of problems, Scientific research
- Scientific use of information
- Scientific presentations

Media
None

Literature
Learning material:
Handout online on: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_7815.html

Literature:

-

- SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.
- BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.
- KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
- FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
- ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.

Please refer to the latest edition.

Remarks
None

Course: Workshop 'Working Methods in Mechanical Engineering' (MRT) [2138997]

Coordinators: C. Stiller
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
Strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop I 'Working Methods in Mechanical Engineering' (IAM-WK) [2174976]

Coordinators: M. Heilmaier
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
certificate after active participation in all four workshops

Conditions
none

Learning Outcomes
strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
On four afternoons at intervals of 2 weeks the students have to work on a project task in teams of 4. In the last workshop the teams have to present their results orally (presentation) and written (abstract, poster) and get feedback from the teching staff and the students from the other teams.

Course: Workshop I 'Working Methods in Mechanical Engineering' (IAM-ZBS, Gumbsch) [2182974]

Coordinators: P. Gumbsch, K. Schulz
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions

-
- Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2110969)" mandatory
- Limited number of participants
- Registration via internet on http://www.mach.kit.edu
- Mandatory attendance in all workshops

Learning Outcomes
The student should be able

-
- to plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- to find and chose scientific information according to pre-defined quality criteria.
- to write a precise and conclusive scientific abstract and to evaluate scientific papers.
- to present scientific information.
- to work in a team in a motivating and goal-oriented way.

Content
application of the lecture:
* project work in groups
* study of a particular given topic
* selection of material for presentation
* preparation of a presentation by poster or talk
* depending on the topic: Composition of a documentation

Literature
lecture notes
on-topic research paper
further literature

-
- SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.
- BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.

- KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
- FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
- KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
- ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.

Please refer to the latest edition.

Course: Workshop I ’Working Methods in Mechanical Engineering’ (IFRT) [2190497]

Coordinators: V. Sánchez-Espinoza
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
- Literature review (evaluation, comparison)
- Work out of solution and elaboration of short technical reports
- Final product: Poster or lecture about the main findings

Conditions
None.

Recommendations
Knowledge in energy technology, mechanical engineering, thermal hydraulic, fluid dynamics is welcomed

Learning Outcomes
The students know:
- main principles for the design optimization of fission reactors
- importance of economics, safety and environmental aspects in the optimization of energy generation facilities

Content

- Energy generation options
- Nuclear power plants construction and operation
- Heat removal from reactor core
- Heat transfer mechanism in nuclear power plants
- Optimization potentials in nuclear power plants

Course: Workshop I ’Working Methods in Mechanical Engineering’ (IPEK) [2146971]

Coordinators: A. Albers
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions
Registration via internet on http://www.mach.kit.edu
Mandatory attendance in all workshops

Learning Outcomes
The student should be able to ...

- plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- find and chose scientific information according to pre-defined quality criteria.
- write a precise and conclusive scientific abstract and to evaluate scientific papers.
- present scientific information.
- work in a team in a motivating and team-oriented way.

Content
1st Workshop:
Self- Organisation of the research task, division of labor within the team

2nd Workshop:
Introduction to creativity and application of these techniques in the team, hosted by appropriate experts.

3rd Workshop:
Introduction to methods for making and applying this as a team, hosted by appropriate experts.

4th Workshop:
Present scientific information and develop a presentation of the concept.

Literature
SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.
BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.
KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.
KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.
Please refer to the latest edition.

Course: Workshop I ’Working Methods in Mechanical Engineering’ (ITM) [2162983]

Coordinators: T. Böhlke, Mitarbeiter
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can

-
- apply the theoretical concepts of stress concentrations in elastic components
- perform a finite-element-analysis for computing the stresses within an elastic component
- write an abstract of the problem and their solution
- write a short report about the problem and their solution using the document preparing system LaTeX and they can use LaTeX-Templates
- give a short presentation about their problem and solution

Content
Solving a problem of approximation methods applied to stress concentration in elastic components

Course: Workshop I 'Working Methods in Mechanical Engineering' (WBK) [2150987]

Coordinators: V. Schulze
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops. There will be no exam.

Conditions
Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2110969)" mandatory, limited number of participants, Registration via internet on http://www.mach.kit.edu.

Recommendations
None

Learning Outcomes
The students are able to...

- find appropriate data sources, evaluate and extract information.
- apply a predetermined citation style correctly.
- summarize information and results shortly and concisely in a written form.
- to design visual preparations of scientific problems or results and to make an oral presentation.
- to work in task-oriented cooperation as a team.

Content
1. Workshop: Literature research, citation styles
2. Workshop: Poster presentation, Project management, Production technology related content
3. Workshop: Scientific publication, production aspects in a practical manner
4. Workshop: Presentation, including video analysis

Media
The slides will be provided after each workshop.

Literature
Lecture Slides

Remarks
None

Course: Workshop II 'Working Methods in Mechanical Engineering' (IAM-WK) [2174986]

Coordinators: P. Elsner
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
none

Learning Outcomes
The students are able to work target- and resources-oriented on a scientific and technical subject under specified conditions. They are able to research and select scientifical and technical informations according to set criteria. The students are able to present scientifical and technical informations in a clear, readable and convincing manner in a proposal. They can present scientifical and technical informations in a lecture-type form. They learn to work motivating and task-oriented in a team.

Content
Self-management, problem solving skills, work organization
Structuring problems, Research
Prepare and Present scientific information

Course: Workshop II 'Working Methods in Mechanical Engineering' (IFRT) [2190498]

Coordinators: F. Arbeiter
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
- Literature review, getting familiar with codes and standards
- Dimensioning and proof of stability of exemplary components, elaboration of short technical report
- Final product: Poster or lecture about the main findings

Conditions
None.

Recommendations
- Knowledge in engineering design, materials technology, mechanics

Learning Outcomes
The students:
- get know-how on the work with codes and standards
- have competences for self-reliant access to new fields of knowledge and scientific literature research
- have first experiences with the design of pressure components

Content
- Basic lectures (repetition) on mechanics and materials
- Introduction to the application of pressure vessel design codes: Safety classification, materials/products, technologies, proof of stability
- Presentation of practical application: Gas cooled irradiation experiment

Course: Workshop II 'Working Methods in Mechanical Engineering' (IPEK) [2146972]

Coordinators: S. Matthiesen
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops.
There will be no exam.

Conditions
Registration via internet on http://www.mach.kit.edu
Mandatory attendance in all workshops

Learning Outcomes
The student is able to ...

- plan a concrete task under the considertion of specific regulations in a goal- and resource-oriented way.
- find and chose scientific information according to pre-defined quality criteria.
- write a precise and conclusive scientific abstract and to evaluate scientific papers.
- present scientific information.
- work in a team in a motivating and team-oriented way.

Content
1st Workshop:
Self- Organisation of the research task, division of labor within the team

2nd Workshop:
Introduction to creativity and application of these techniques in the team, hosted by appropriate experts.

3rd Workshop:
Introduction to methods for making and applying this as a team, hosted by appropriate experts.

4th Workshop:
Present scientific information and develop a presentation of the concept.

Media
Computer
Beamer
Flipchart

Literature
SEIWERT, Lothar J.: Mehr Zeit für das Wesentliche: besseres Zeitmanagement mit der Seiwert-Methode konsequente Zeitplanung und effektive Arbeitsmethodik. Landsberg, Lech: Verlag Moderne Industrie, 12. Auflage, 1991.
BECHER, Stephan: Schnell und erfolgreich studieren: Organisation – Zeitmanagement – Arbeitstechniken. Würzburg: Lexika Verlag / Krick Fachmedien GmbH + Co, 1998.
KOEDER, Kurt W.: Studienmethodik: Selbstmanagement für Studienanfänger. München: Vahlen, 3. Auflage, 1998.
FRANCK, Norbert; STARY, Joachim: Die Technik wissenschaftlichen Arbeitens. Paderborn u.a.:Verlag Ferdinand Schöningh, 15. Auflage, 2009.
KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.
KARMASIN, Matthias; RIBING, Rainer: Die Gestaltung wissenschaftlicher Arbeiten. Wien: Facultas Verlags- und Buchhandels AG, 4. Auflage, 2009.

KRUSE, Otto: Keine Angst vor dem leeren Blatt. Frankfurt a.M.; New York: Campus Verlag, 12. Auflage, 2007.
ROSSIG, Wolfram; PRÄTSCH, Joachim: Wissenschaftliche Arbeiten. Leitfaden für Haus- und Seminararbeiten, Bachelor- und Masterthesis, Diplom- und Magisterarbeiten, Dissertationen. Achim: BerlinDruck, 7. Auflage, 2008.
Please refer to the latest edition.

Course: Workshop II ’Working Methods for Mechanical Engineering’ (ITM) [2162994]

Coordinators: C. Proppe
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops

Active participation

Processing of all homework

Conditions
None

Learning Outcomes
Strengthening of students’ skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
1. Teamwork - Literature Research - Time and Project Management

2. Communication and Feedback - Writing Skills

3. Self-management - Presentation Skills

Course: Workshop II ’Working Methods in Mechanical Engineering’ (WBK) [2150988]

Coordinators: G. Lanza
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	en

Learning Control / Examinations
The attendance and active collaboration is required for all workshops. There will be no exam.

Conditions
Attendance at the lecture “Arbeitstechniken für den Maschinenbau (2110969)” mandatory, limited number of participants, Registration via internet on http://www.mach.kit.edu.

Recommendations
None

Learning Outcomes
The students are able to. . .

- find appropriate data sources, evaluate and extract information.
- apply a predetermined citation style correctly.
- summarize information and results shortly and concisely in a written form.
- to design visual preparations of scientific problems or results and to make an oral presentation.
- to work in task-oriented cooperation as a team.

Content
1. Workshop: Literature research, citation styles
2. Workshop: Poster presentation, Project management, Production technology related content
3. Workshop: Scientific publication, production aspects in a practical manner
4. Workshop: Presentation, including video analysis

Media
The slides will be provided after each workshop.

Literature
Lecture Slides

Remarks
None

Course: Workshop III 'Working Methods in Mechanical Engineering' (IFRT) [2190975]

Coordinators: X. Cheng
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The successful participation is certified after active participation in all four Workshops.

Conditions
None.

Learning Outcomes
Strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop III 'Working Methods in Mechanical Engineering' (ITM) [2162995]

Coordinators: W. Seemann
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
Strengthening of students' skills and abilities in
- scientific writing
- literature research and citation techniques
- time management
- teamwork
- presentation and communication skills

Content
- Scientific working techniques
- Literature research
- Project management
- Time management
- Scientific elaborations
- Presentation techniques
- Communication skills

Course: Workshop III 'Working Methods in Mechanical Engineering' (WBK) [2150989]

Coordinators: J. Fleischer
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
The attendance and active collaboration is required for all workshops. There will be no exam.

Conditions
Attendance at the lecture "Arbeitstechniken für den Maschinenbau (2110969)" mandatory, limited number of participants, Registration via internet on http://www.mach.kit.edu.

Recommendations
None

Learning Outcomes
The students are able to...

- find appropriate data sources, evaluate and extract information.
- apply a predetermined citation style correctly.
- summarize information and results shortly and concisely in a written form.
- to design visual preparations of scientific problems or results and to give an oral presentation.
- to work in task-oriented cooperation as a team.

Content
1. Workshop: Literature research, presentation media, brainstorming techniques
2. Workshop: Presentations, Project management, Production technology related content
3. Workshop: Scientific publication, creativity techniques for production engineering aspects
4. Workshop: Presentation and discussion of scientific publications

Media
The slides will be provided after each workshop.

Literature
Lecture Slides

Remarks
None

Course: Workshop 'Working Methods in Mechanical Engineering' Heilmeier (IAM-WK) [2174975]

Coordinators: M. Heilmaier
Part of the modules: Key Competences (p. 36)[BSc-Modul 07, SQL]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Attendance at all four workshops
Active participation
Processing of all problems

Conditions
None.

Learning Outcomes
The students are able to work target- and resources-oriented on a scientific and technical subject under specified conditions. They are able to research and select scientifical and technical informations according to set criteria. The students are able to present scientifical and technical informations in a clear, readable and convincing manner in a proposal. They can present scientifical and technical informations in a lecture-type form. They learn to work motivating and task-oriented in a team.

Content
Self-management, problem solving skills, work organization
Structuring problems, Research
Prepare and Present scientific information

5 Major Fields

SP 02: Powertrain Systems

ID	Cat	Course	Lecturer	h	CP	Term
2113077	K	Drive Train of Mobile Machines (p. 234)	M. Geimer	3	4	W
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 236)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 237)	A. Albers, S. Ott	2	4	W
2163111	K	Dynamics of the Automotive Drive Train (p. 276)	A. Fidlin	4	5	W
2105012	E	Adaptive Control Systems (p. 230)	G. Bretthauer	2	4	W
2145181	E	Applied Tribology in Industrial Product Development (p. 233)	A. Albers, W. Burger	2	4	W
2162235	E	Introduction into the multi-body dynamics (p. 284)	W. Seemann	3	5	S
2117500	E	Energy efficient intralogistic systems (p. 292)	F. Schönung	2	4	W
2118083	E	IT for facility logistics (p. 347)	F. Thomas	4	6	S
2145184	E	Leadership and Product Development (p. 359)	A. Ploch	2	4	W
2161224	E	Machine Dynamics (p. 366)	C. Proppe	3	5	S
2162220	E	Machine Dynamics II (p. 367)	C. Proppe	2	4	W
2145180	E	Methodic Development of Mechatronic systems (p. 383)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 394)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 397)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2150683	E	Control Technology (p. 446)	C. Gönnheimer	2	4	S
2146193	E	Strategic Product Planing (p. 448)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2181711	E	Failure of structural materials: deformation and fracture (p. 474)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 482)	J. Hoffmeister	2	4	W
2133103	E	Fundamentals of Combustion Engines I (p. 325)	H. Kubach, T. Koch	3	4	W
2134131	E	Fundamentals of Combustion Engines II (p. 326)	H. Kubach, T. Koch	3	4	S
2181113	E	Tribology A (p. 468)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 469)	M. Scherge, M. Dienwiebel	2	4	S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 417)	G. Geerling	2	4	W
23321	E	Hybrid and Electric Vehicles (p. 335)	M. Doppelbauer, M. Schiefer	3	4	W

Conditions:
Recommendations: Recommended Courses:
2147175 CAE-Workshop
Learning Outcomes: 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.
Remarks:

SP 05: Calculation Methods in Mechanical Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2154446	K	Experimental Fluid Mechanics (p. 298)	B. Frohnapfel, J. Kriegseis	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 284)	W. Seemann	3	5	S
2161252	K	Advanced Methods in Strength of Materials (p. 334)	T. Böhlke	2+2	4	W
2157441	K	Computational Methods in Fluid Mechanics (p. 395)	F. Magagnato	2	4	W
2181740	E	Atomistic simulations and molecular dynamics (p. 243)	P. Gumbsch	2	4	S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2106004	E	Computational Intelligence I (p. 269)	G. Bretthauer, R. Mikut	2	4	S
2105015	E	Computational Intelligence II (p. 270)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 271)	R. Mikut	2	4	S
2162282	E	Introduction to the Finite Element Method (p. 280)	T. Böhlke	2+2	5	S
2146190	E	Lightweight Engineering Design (p. 352)	A. Albers, N. Burkardt	2	4	S
2161214	E	Vibration of continuous systems (p. 353)	H. Hetzler	2	4	S
2161224	E	Machine Dynamics (p. 366)	C. Proppe	3	5	S
2162220	E	Machine Dynamics II (p. 367)	C. Proppe	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 370)	C. Proppe	2	5	W
2161254	E	Mathematical Methods in Strength of Materials (p. 371)	T. Böhlke	2+1	5	W
2162241	E	Mathematical methods of vibration theory (p. 373)	W. Seemann	3	5	S
2162280	E	Mathematical Methods in Structural Mechanics (p. 375)	T. Böhlke	2+1	5	S
2134134	E	Analysis tools for combustion diagnostics (p. 382)	U. Wagner	2	4	S
2183702	E	Modelling of Microstructures (p. 385)	A. August, B. Nestler, D. Weygand	3	5	W
2183703	E	Modelling and Simulation (p. 390)	B. Nestler, P. Gumbsch	3	5	W/S
2162244	E	Plasticity Theory (p. 400)	T. Böhlke	2	5	S
2161250	E	Computational Mechanics I (p. 427)	T. Böhlke, T. Langhoff	2+2	6	W
2162296	E	Computational Mechanics II (p. 428)	T. Böhlke, T. Langhoff	2+2	6	S
2114095	E	Simulation of Coupled Systems (p. 440)	M. Geimer	4	4	S
2161217	E (P)	Mechatronic Softwaretools (p. 443)	C. Proppe	2	4	W
2117095	E	Basics of Technical Logistics (p. 322)	M. Mittwollen, Madzharov	4	6	W
2161212	E	Vibration Theory (p. 456)	A. Fidlin	3	5	W
2117060	EM	Analytical methods in material flow methodology (mach and wiwi) (p. 231)	J. Stoll, E. Özden	4	6	W
2163111	E	Dynamics of the Automotive Drive Train (p. 276)	A. Fidlin	4	5	W
2163113	E	Theory of Stability (p. 445)	A. Fidlin	4	6	W
2162247	E	Introduction to Nonlinear Vibrations (p. 287)	A. Fidlin	4	7	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 436)	H. Hetzler, A. Fidlin	3	3	S
2117096	E	Elements of Technical Logistics (p. 290)	M. Mittwollen, Madzharov	3	4	W

ID	Cat	Course	Lecturer	h	CP	Term
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 275)	H. Hetzler	2	4	W
2154432	E	Mathematical Methods in Fluid Mechanics (p. 374)	A. Class, B. Frohnapfel	2	4	S
2154430	E	Introduction to modeling of aerospace systems (p. 285)	G. Schlöffel	2	4	S
2117097	E	Elements of Technical Logistics and Project (p. 291)	M. Mittwollen, Madzharov	4	6	W
2157445	E	Computational methods for the heat protection of a full vehicle (p. 461)	H. Reister	2	4	W
2162225	E	Experimental Dynamics (p. 297)	A. Fidlin, Hetzler, Hartmut	3	5	S
2157444	E (P)	Introduction to numerical fluid dynamics (p. 286)	B. Pritz	2	4	W

Conditions:
Recommendations:
Learning Outcomes: Goal of this unit is to understand several methods in different disciplines to derive mathematical models. The students can do this exemplarily for some disciplines and apply the corresponding methods. The aim is not to be able use special software packages but to understand the principles on which these methods are based.
Remarks:

SP 07: Dimensioning and Validation of Mechanical Constructions

ID	Cat	Course	Lecturer	h	CP	Term
2161252	KP	Advanced Methods in Strength of Materials (p. 334)	T. Böhlke	2+2	4	W
2181745	K	Design of highly stresses components (p. 250)	J. Aktaa	2	4	W
2162282	K	Introduction to the Finite Element Method (p. 280)	T. Böhlke	2+2	5	S
2173585	K	Fatigue of Metallic Materials (p. 435)	K. Lang	2	4	W
2174574	K	Materials for Lightweight Construction (p. 481)	K. Weidenmann	2	4	S
2123358	E (P)	CATIA CAD training course (p. 263)	J. Ovtcharova	2	2	W/S
2123357	E (P)	CAD-NX training course (p. 264)	J. Ovtcharova	2	2	W/S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2161229	E	Designing with numerical methods in product development (p. 273)	E. Schnack	2	4	W
2175590	E (P)	Metallographic Lab Class (p. 299)	K. von Klinski-Wetzel	3	4	W/S
2173560	E (P)	Welding Lab Course, in groupes (p. 300)	J. Hoffmeister	3	4	W
2146190	E	Lightweight Engineering Design (p. 352)	A. Albers, N. Burkardt	2	4	S
2161224	E	Machine Dynamics (p. 366)	C. Proppe	3	5	S
2162220	E	Machine Dynamics II (p. 367)	C. Proppe	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 370)	C. Proppe	2	5	W
2161254	E	Mathematical Methods in Strength of Materials (p. 371)	T. Böhlke	2+1	5	W
2173590	E	Polymer Engineering I (p. 403)	P. Elsner	2	4	W
2162275	E (P)	Lab course experimental solid mechanics (p. 406)	T. Böhlke, Mitarbeiter	3	2	S
2174579	E	Technology of steel components (p. 458)	V. Schulze, J. Hoffmeister	2	4	S

Conditions: The courses *CAD-Praktikum CATIA V5* [2123356] and *CAD-Praktikum Unigraphics NX5* [2123355] can not be combined within this major field

Recommendations: Recommended compulsory elective subject: 2174576 Systematic Materials Selection

Learning Outcomes: After having finished this major field the students can

- list most important concepts of dimensioning and validation of technical systems
- apply these concepts to special situations
- evaluate a technical system with respect to dimensioning and validtion

Remarks:

SP 09: Dynamic Machine Models

ID	Cat	Course	Lecturer	h	CP	Term
2162235	K	Introduction into the multi-body dynamics (p. 284)	W. Seemann	3	5	S
2118078	K	Logistics - organisation, design and control of logistic systems (p. 361)	K. Furmans	4	6	S
2105012	E	Adaptive Control Systems (p. 230)	G. Bretthauer	2	4	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 236)	A. Albers, S. Ott	2	4	S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2117500	E	Energy efficient intralogistic systems (p. 292)	F. Schönung	2	4	W
2113807	E	Handling Characteristics of Motor Vehicles I (p. 301)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 302)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 303)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 304)	F. Gauterin	2	4	S
2146190	E	Lightweight Engineering Design (p. 352)	A. Albers, N. Burkardt	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 370)	C. Proppe	2	5	W
2114095	E	Simulation of Coupled Systems (p. 440)	M. Geimer	4	4	S
2138336	E	Behaviour Generation for Vehicles (p. 472)	C. Stiller, T. Dang	2	4	S
2122378	E	Virtual Engineering II (p. 478)	J. Ovtcharova	3	4	S
2118087	EM	Selected Applications of Technical Logistics (p. 246)	M. Mittwollen, Madzharov	3	4	S
2118088	EM	Selected Applications of Technical Logistics and Project (p. 247)	M. Mittwollen, Madzharov	4	6	S
2163111	E	Dynamics of the Automotive Drive Train (p. 276)	A. Fidlin	4	5	W
2163113	E	Theory of Stability (p. 445)	A. Fidlin	4	6	W
2162247	E	Introduction to Nonlinear Vibrations (p. 287)	A. Fidlin	4	7	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 436)	H. Hetzler, A. Fidlin	3	3	S
2161212	E	Vibration Theory (p. 456)	A. Fidlin	3	5	W
2162241	E	Mathematical methods of vibration theory (p. 373)	W. Seemann	3	5	S
2161214	E	Vibration of continuous systems (p. 353)	H. Hetzler	2	4	S
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 275)	H. Hetzler	2	4	W
24152	E	Robotics I – Introduction to robotics (p. 429)	R. Dillmann, S. Schmidt-Rohr	2	3	W
2162225	E	Experimental Dynamics (p. 297)	A. Fidlin, Hetzler, Hartmut	3	5	S

Conditions:
Recommendations:
Learning Outcomes: The students know the methods to derive physical and mathematical models in different disciplines. They know that such models are necessary to investigate such systems theoretically and to simulate their behaviour prior to a physical realization.
Remarks:

SP 10: Engineering Design

ID	Cat	Course	Lecturer	h	CP	Term
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 236)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 237)	A. Albers, S. Ott	2	4	W
2146190	K	Lightweight Engineering Design (p. 352)	A. Albers, N. Burkardt	2	4	S
2114073	K	Mobile Machines (p. 387)	M. Geimer	4	8	S
2145181	E	Applied Tribology in Industrial Product Development (p. 233)	A. Albers, W. Burger	2	4	W
2117064	E	Application of technical logistics in modern crane systems (p. 238)	M. Golder	2	4	W
2113079	E	Design and Development of Mobile Machines (p. 251)	M. Geimer	2	4	W
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2149657	E	Manufacturing Technology (p. 308)	V. Schulze, F. Zanger	6	8	W
2113805	E	Automotive Engineering I (p. 317)	F. Gauterin, H. Unrau	4	8	W
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 328)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 329)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 330)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 331)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 332)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 333)	R. Frech	1	2	S
2174571	E	Design with Plastics (p. 351)	M. Liedel	2	4	S
2145184	E	Leadership and Product Development (p. 359)	A. Ploch	2	4	W
2110017	E	Leadership and Conflict Management (in German) (p. 364)	H. Hatzl	2	4	S
2105014	E (P)	Laboratory mechatronics (p. 379)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2145180	E	Methodic Development of Mechatronic systems (p. 383)	A. Albers, W. Burger	2	4	W
2109028	E	Production Management I (p. 411)	P. Stock	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2149667	E	Quality Management (p. 422)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 438)	H. Kany	2	4	W
2146193	E	Strategic Product Planing (p. 448)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2158107	E	Technical Acoustics (p. 453)	M. Gabi	2	4	S
2146179	E	Technical Design in Product Development (p. 457)	M. Schmid, Dr. -Ing. Markus Schmid	2	4	S
2174574	E	Materials for Lightweight Construction (p. 481)	K. Weidenmann	2	4	S
2149902	E	Machine Tools and Industrial Handling (p. 485)	J. Fleischer	6	8	W
2161229	E	Designing with numerical methods in product development (p. 273)	E. Schnack	2	4	W

ID	Cat	Course	Lecturer	h	CP	Term
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 417)	G. Geerling	2	4	W

Conditions:
Recommendations: 2147175 CAE-Workshop
2105014 Mechatronik - Workshop
Learning Outcomes: The students are able to transfer their knowledge und abilities in product engineering to mechanical systems in research and industrial practice.
Remarks:

SP 12: Automotive Technology

ID	Cat	Course	Lecturer	h	CP	Term
2113805	KP	Automotive Engineering I (p. 317)	F. Gauterin, H. Unrau	4	8	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 236)	A. Albers, S. Ott	2	4	S
2114850	E	Global vehicle evaluation within virtual road test (p. 313)	B. Schick	2	4	S
2113807	E	Handling Characteristics of Motor Vehicles I (p. 301)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 302)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 303)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 304)	F. Gauterin	2	4	S
2113816	E	Vehicle Mechatronics I (p. 305)	D. Ammon	2	4	W
2138340	E	Automotive Vision (p. 306)	C. Stiller, M. Lauer	2	4	S
2114835	E	Automotive Engineering II (p. 318)	F. Gauterin, H. Unrau	2	4	S
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 320)	E. Lox	2	4	S
2114843	E	Basics and Methods for Integration of Tires and Vehicles (p. 327)	G. Leister	2	4	S
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 328)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 329)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 330)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 331)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 332)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 333)	R. Frech	1	2	S
2146190	E	Lightweight Engineering Design (p. 352)	A. Albers, N. Burkardt	2	4	S
2115808	E (P)	Motor Vehicle Laboratory (p. 355)	M. Frey, M. El-Haji	2	4	W/S
2182642	E	Laser in automotive engineering (p. 358)	J. Schneider	2	4	S
2149669	E	Materials and Processes for Body Lightweight Construction in the Automotive Industry (p. 369)	D. Steegmüller, S. Kienzle	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 397)	F. Zacharias	2	4	W/S
2123364	E	Product, Process and Resource Integration in the Automotive Industry (p. 410)	S. Mbang	3	4	S
2149001	E	Production Technology and Management in Automotive (p. 414)	V. Stauch, S. Peters	2	4	W
2115817	E	Project Workshop: Automotive Engineering (p. 416)	F. Gauterin	3	6	W/S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 417)	G. Geerling	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2162256	E	Computational Vehicle Dynamics (p. 425)	C. Proppe	2	4	S
2146193	E	Strategic Product Planing (p. 448)	A. Siebe	2	4	S

ID	Cat	Course	Lecturer	h	CP	Term
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 472)	C. Stiller, T. Dang	2	4	S
2149655	E	Gear Cutting Technology (p. 476)	M. Klaiber	2	4	W
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 482)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 481)	K. Weidenmann	2	4	S
2153425	E	Industrial aerodynamics (p. 339)	T. Breitling	2	4	W
2133103	E	Fundamentals of Combustion Engines I (p. 325)	H. Kubach, T. Koch	3	4	W
2134131	E	Fundamentals of Combustion Engines II (p. 326)	H. Kubach, T. Koch	3	4	S
2150904	E	Automated Manufacturing Systems (p. 252)	J. Fleischer	6	8	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 279)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 307)	F. Henning	2	4	S
2157445	E	Computational methods for the heat protection of a full vehicle (p. 461)	H. Reister	2	4	W
23321	E	Hybrid and Electric Vehicles (p. 335)	M. Doppelbauer, M. Schiefer	3	4	W

Conditions:
Recommendations:
Learning Outcomes: 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.
Remarks:

SP 13: Strength of Materials/ Continuum Mechanics

ID	Cat	Course	Lecturer	h	CP	Term
2161252	KP	Advanced Methods in Strength of Materials (p. 334)	T. Böhlke	2+2	4	W
2162282	K	Introduction to the Finite Element Method (p. 280)	T. Böhlke	2+2	5	S
2161254	K	Mathematical Methods in Strength of Materials (p. 371)	T. Böhlke	2+1	5	W
2162280	K	Mathematical Methods in Structural Mechanics (p. 375)	T. Böhlke	2+1	5	S
2181711	K	Failure of structural materials: deformation and fracture (p. 474)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2181740	E	Atomistic simulations and molecular dynamics (p. 243)	P. Gumbsch	2	4	S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2162255	E	Designing with composites (p. 274)	E. Schnack	2	4	S
2182732	E	Introduction to Theory of Materials (p. 281)	M. Kamlah	2	4	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 321)	M. Kamlah	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 370)	C. Proppe	2	5	W
2183702	E	Modelling of Microstructures (p. 385)	A. August, B. Nestler, D. Weygand	3	5	W
2183703	E	Modelling and Simulation (p. 390)	B. Nestler, P. Gumbsch	3	5	W/S
2162244	E	Plasticity Theory (p. 400)	T. Böhlke	2	5	S
2162275	E (P)	Lab course experimental solid mechanics (p. 406)	T. Böhlke, Mitarbeiter	3	2	S
2161501	E	Process Simulation in Forming Operations (p. 420)	D. Helm	2	4	W
2162246	E	Computational Dynamics (p. 424)	C. Proppe	2	4	S
2161250	E	Computational Mechanics I (p. 427)	T. Böhlke, T. Langhoff	2+2	6	W
2162296	E	Computational Mechanics II (p. 428)	T. Böhlke, T. Langhoff	2+2	6	S
2182740	E	Materials modelling: dislocation based plasticy (p. 484)	D. Weygand	2	4	S
2161251	E	Microstructure characterization and modelling (p. 384)	T. Böhlke, F. Fritzen	2	5	W

Conditions:
Recommendations: Recommended compulsory elective subjects:

- 2161206 Mathematical Methods in Dynamics
- 2161254 Mathematical Methods in Strength of Materials

Learning Outcomes: After having finished this major field the students can

- list mportant concepts and models of continuum mechanics
- analyse and evaluate models for describing the material behaviour
- apply these models in given problems

Remarks:

SP 15: Fundamentals of Energy Technology

ID	Cat	Course	Lecturer	h	CP	Term
2130927	KP	Fundamentals of Energy Technology (p. 316)	A. Badea	4	8	S
2130921	K	Energy Systems II: Nuclear Power Technology (p. 294)	A. Badea	3	4	S
2166538	K	Fundamentals of combustion II (p. 324)	U. Maas	2	4	S
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 337)	M. Gabi	4	8	W
2169453	K	Thermal Turbomachines I (p. 464)	H. Bauer	3	6	W
2117500	E	Energy efficient intralogistic systems (p. 292)	F. Schönung	2	4	W
2171486	E (P)	Integrated measurement systems for fluid mechanics applications (p. 343)	H. Bauer, Mitarbeiter	5	4	W/S
2171487	E (P)	Laboratory Exercise in Energy Technology (p. 360)	H. Bauer, U. Maas, H. Wirbser	4	4	W/S
23737	E	Photovoltaics (p. 398)	M. Powalla	3	6	S
2189910	E	Flows and Heat Transfer in Energy Technology (p. 449)	X. Cheng	2	4	W
2169472	E	Thermal Solar Energy (p. 462)	R. Stieglitz	2	4	W
2133108	EM	Fuels and Lubricants for Combustion Engines (p. 259)	B. Kehrwald, J. Volz	2	4	W
2169459	EM (P)	CFD-Lab using Open Foam (p. 267)	R. Koch	3	4	W
2158105	EM	Hydraulic Fluid Machinery II (p. 338)	S. Caglar, M. Gabi, Martin Gabi	2	4	S
2134134	EM	Analysis tools for combustion diagnostics (p. 382)	U. Wagner	2	4	S
2157441	EM	Computational Methods in Fluid Mechanics (p. 395)	F. Magagnato	2	4	W
2169458	EM	Numerical simulation of reacting two phase flows (p. 396)	R. Koch	2	4	W
2146192	EM	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2158107	EM	Technical Acoustics (p. 453)	M. Gabi	2	4	S
2158106	EM	Technologies for energy efficient buildings (p. 459)	F. Schmidt, Dipl. Phys. Emmerich Tempfli	4	4	S
2133103	EM	Fundamentals of Combustion Engines I (p. 325)	H. Kubach, T. Koch	3	4	W
23381	E	Windpower (p. 488)	N. Lewald	2	4	W
2129901	E	Energy Systems I: Renewable Energy (p. 293)	R. Dagan	3	6	W
2157444	EM (P)	Introduction to numerical fluid dynamics (p. 286)	B. Pritz	2	4	W

Conditions: None.
Recommendations: Recommended Course:

- 22512 Heat- and Mass transfer

Learning Outcomes: 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.

Remarks:

SP 17: Information Management

ID	Cat	Course	Lecturer	h	CP	Term
2121001	KP	Integrated Information Systems for engineers (p. 455)	J. Ovtcharova	3	5	S
2123358	E/P (P)	CATIA CAD training course (p. 263)	J. Ovtcharova	2	2	W/S
2123357	EM (P)	CAD-NX training course (p. 264)	J. Ovtcharova	2	2	W/S
2123380	E/P	CATIA advanced (p. 266)	J. Ovtcharova	2	2	S
2123357	E (P)	PLM-CAD workshop (p. 402)	J. Ovtcharova	4	4	W
2123370	E/P	Pro/ENGINEER advanced (p. 407)	J. Ovtcharova	2	2	W
2121350	K	Product Lifecycle Management (p. 408)	J. Ovtcharova	4	6	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 239)	J. Föller	2	4	S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 340)	C. Kilger	2	4	S
2118083	E	IT for facility logistics (p. 347)	F. Thomas	4	6	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 397)	F. Zacharias	2	4	W/S
2122376	E	PLM for Product Development in Mechatronics (p. 401)	M. Eigner	2	4	S
2123364	E	Product, Process and Resource Integration in the Automotive Industry (p. 410)	S. Mbang	3	4	S
2110678	E (P)	Production Techniques Laboratory (p. 412)	K. Furmans, J. Ovtcharova, V. Schulze, B. Deml, Research assistants of wbk, ifab und IFL	3	4	S
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2122387	K	Computer Integrated Planning of New Products (p. 426)	R. Kläger	2	4	S
2117062	E	Supply chain management (p. 451)	K. Alicke	4	6	W
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 479)	J. Ovtcharova	3	4	W/S

Conditions:
Recommendations: Attendance of the course Product Lifecycle Management [2121350] as elective module is recommended.
Learning Outcomes: The students should:
Understand the relevance of information management in product development in consideration of increasing product and process complexity.
Gain basic knowledge in handling information, which is generated by product development activities along the lifecycle.
Remarks:

SP 18: Information Technology

ID	Cat	Course	Lecturer	h	CP	Term
2106004	K	Computational Intelligence I (p. 269)	G. Bretthauer, R. Mikut	2	4	S
2105015	K	Computational Intelligence II (p. 270)	G. Bretthauer, MIkut	2	4	W
2137309	K	Digital Control (p. 272)	M. Knoop	2	4	W
2137308	K	Machine Vision (p. 363)	C. Stiller, M. Lauer	4	8	W
2138326	K	Measurement II (p. 381)	C. Stiller	2	4	S
2106002	K	Computer Engineering (p. 454)	G. Bretthauer	3	4	S
2105012	E	Adaptive Control Systems (p. 230)	G. Bretthauer	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 239)	J. Föller	2	4	S
2114092	E	BUS-Controls (p. 262)	M. Geimer	2	4	S
2106020	E	Computational Intelligence III (p. 271)	R. Mikut	2	4	S
2138340	E	Automotive Vision (p. 306)	C. Stiller, M. Lauer	2	4	S
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 340)	C. Kilger	2	4	S
2105022	E	Information Processing in Mechatronic Systems (p. 341)	M. Kaufmann	2	4	W
2118083	E	IT for facility logistics (p. 347)	F. Thomas	4	6	S
2137304	E	Correlation Methods in Measurement and Control (p. 354)	F. Mesch	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 379)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2134137	E	Engine measurement techniques (p. 393)	S. Bernhardt	2	4	S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 405)	C. Stiller, P. Lenz	3	4	W
2150683	E	Control Technology (p. 446)	C. Gönnheimer	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 472)	C. Stiller, T. Dang	2	4	S
24102	E	Information Processing in Sensor Networks (p. 342)	U. Hanebeck, F. Beutler	3	4	W

Conditions:
Recommendations:
Learning Outcomes: Students are able to

- explain fundamentals of information technology for given problems in mechanical engineering an 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.

Remarks:

SP 24: Energy Converting Engines

ID	Cat	Course	Lecturer	h	CP	Term
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 337)	M. Gabi	4	8	W
2169453	K	Thermal Turbomachines I (p. 464)	H. Bauer	3	6	W
2133103	K	Fundamentals of Combustion Engines I (p. 325)	H. Kubach, T. Koch	3	4	W
2158112	E	Low Temperature Technology (p. 232)	F. Haug	2	4	S
22509	E	Design of combustion chamber in gas turbines (Project) (p. 249)	N. Zarzalis	2	4	S
2133108	E	Fuels and Lubricants for Combustion Engines (p. 259)	B. Kehrwald, J. Volz	2	4	W
2114093	E	Fluid Technology (p. 311)	M. Geimer	2+2	4	W
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 320)	E. Lox	2	4	S
2165515	E	Fundmentals of Combustion I (p. 323)	U. Maas	2	4	W
2166538	E	Fundamentals of combustion II (p. 324)	U. Maas	2	4	S
2158105	E	Hydraulic Fluid Machinery II (p. 338)	S. Caglar, M. Gabi, Martin Gabi	2	4	S
2157441	E	Computational Methods in Fluid Mechanics (p. 395)	F. Magagnato	2	4	W
2158107	E	Technical Acoustics (p. 453)	M. Gabi	2	4	S
2170476	E	Thermal Turbomachines II (p. 465)	H. Bauer	3	6	S
2169462	E	Turbine and compressor Design (p. 470)	H. Bauer, A. Schulz	2	4	W
2170478	E	Turbo Jet Engines (p. 471)	H. Bauer, A. Schulz	2	4	S
2134131	E	Fundamentals of Combustion Engines II (p. 326)	H. Kubach, T. Koch	3	4	S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 417)	G. Geerling	2	4	W
2157445	E	Computational methods for the heat protection of a full vehicle (p. 461)	H. Reister	2	4	W
2157451	E	Wind and Hydropower (p. 487)	M. Gabi, N. Lewald	2	4	W
23381	E	Windpower (p. 488)	N. Lewald	2	4	W
2157444	E (P)	Introduction to numerical fluid dynamics (p. 286)	B. Pritz	2	4	W

Conditions:
Recommendations: Recommended compulsory optional subject
22512 Heat and mass transfer
Learning Outcomes: 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.

Remarks:

SP 26: Materials Science and Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2173553	K	Materials Science and Engineering III (p. 483)	M. Heilmaier	5	8	W
2193002	K	Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria (with exercises) (p. 467)	H. Seifert	2	4	W
2193003	K	Solid State Reactions and Kinetics of Phase Transformations (with exercises) (p. 310)	D. Cupid, P. Franke	2	4	W
2174579	E	Technology of steel components (p. 458)	V. Schulze, J. Hoffmeister	2	4	S
2125757	E	Introduction to Ceramics (p. 349)	M. Hoffmann	4	6	W
2193010	E	Grundlagen der Herstellungsverfahren der Keramik und Pulvermetallurgie (p. 319)	R. Oberacker	2	4	W
2194643	E	Constitution and Properties of Wear resistant materials (p. 244)	S. Ulrich	2	4	S
2174586	E	Material Analysis (p. 480)	J. Gibmeier	2	4	S
2175590	E (P)	Metallographic Lab Class (p. 299)	K. von Klinski-Wetzel	3	4	W/S
2174575	E	Foundry Technology (p. 314)	C. Wilhelm	2	4	S
2173565	E	Welding Technology I (p. 431)	B. Spies	1	2	W
2174570	E	Welding Technology II (p. 433)	B. Spies	1	2	S
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 482)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 481)	K. Weidenmann	2	4	S
2182642	E	Laser in automotive engineering (p. 358)	J. Schneider	2	4	S
2174571	E	Design with Plastics (p. 351)	M. Liedel	2	4	S
2178734	E	Introduction to the Mechanics of Composite Materials (p. 282)	Y. Yang	2	4	S
2161983	E	Mechanics of laminated composites (p. 376)	E. Schnack	2	4	W
2162255	E	Designing with composites (p. 274)	E. Schnack	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 243)	P. Gumbsch	2	4	S
2173580	E	Mechanics and Strengths of Polymers (p. 377)	B. von Bernstorff (Graf), von Bernstorff	2	4	W
2183702	E	Modelling of Microstructures (p. 385)	A. August, B. Nestler, D. Weygand	3	5	W
2183703	E	Modelling and Simulation (p. 390)	B. Nestler, P. Gumbsch	3	5	W/S
2173590	E	Polymer Engineering I (p. 403)	P. Elsner	2	4	W
2183640	E (P)	Laboratory “Laser Materials Processing” (p. 404)	J. Schneider, W. Pfleging	3	4	W/S
2173577	E	Failure Analysis Seminar (p. 437)	K. Poser	2	2	W
2181715	E	Failure of Structural Materials: Fatigue and Creep (p. 473)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 474)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2173585	E	Fatigue of Metallic Materials (p. 435)	K. Lang	2	4	W
2177601	EM	Constitution and Properties of Protective Coatings (p. 245)	S. Ulrich	2	4	W
2181744	EM	Size effects in micro and nanostructures materials (p. 315)	P. Gumbsch, D. Weygand, P. Gruber, M. Dienwiebel	2	4	W

ID	Cat	Course	Lecturer	h	CP	Term
2126749	EM	Advanced powder metals (p. 421)	R. Oberacker	2	4	S
2162280	EM	Mathematical Methods in Structural Mechanics (p. 375)	T. Böhlke	2+1	5	S
2162244	EM	Plasticity Theory (p. 400)	T. Böhlke	2	5	S
2126775	EM	Structural Ceramics (p. 450)	M. Hoffmann	2	4	S
2182740	EM	Materials modelling: dislocation based plasticy (p. 484)	D. Weygand	2	4	S
2181730	EM	Evaluation of welded joints (p. 261)	P. Gumbsch, M. Farajian, Farajian, Majid	2	4	W
2181750	EM	Multi-scale Plasticity (p. 399)	K. Schulz, C. Greiner	2	4	W

Conditions: Basic knowledge in materials science and engineering (Werkstoffkunde I/II)
Recommendations: suggested optional compulsory subject:

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- 2174576 Systematic Materials Selection

Learning Outcomes: In this key area the students gain competence in selecting metallic materials for mechanical engineering applications by deliberately adjusting their properties via appropriate mechanical and thermal treatments.
Besides the core curse in materials science and engineering III, they select a further topic within this key area.
Remarks:

SP 31: Mechatronics

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 230)	G. Bretthauer	2	4	W
2106004	K	Computational Intelligence I (p. 269)	G. Bretthauer, R. Mikut	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 284)	W. Seemann	3	5	S
2138340	K	Automotive Vision (p. 306)	C. Stiller, M. Lauer	2	4	S
2105024	K	Modern Concepts of Control (p. 391)	L. Gröll, Groell	2	4	W
2138336	K	Behaviour Generation for Vehicles (p. 472)	C. Stiller, T. Dang	2	4	S
2106005	E	Automation Systems (p. 254)	M. Kaufmann	2	4	S
2114092	E	BUS-Controls (p. 262)	M. Geimer	2	4	S
2147175	E (P)	CAE-Workshop (p. 265)	A. Albers, Assistenten	3	4	W/S
2105015	E	Computational Intelligence II (p. 270)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 271)	R. Mikut	2	4	S
2137309	E	Digital Control (p. 272)	M. Knoop	2	4	W
2118083	E	IT for facility logistics (p. 347)	F. Thomas	4	6	S
2161224	E	Machine Dynamics (p. 366)	C. Proppe	3	5	S
2162220	E	Machine Dynamics II (p. 367)	C. Proppe	2	4	W
2181710	E	Mechanics in Microtechnology (p. 378)	P. Gruber, C. Greiner	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 379)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2138326	E	Measurement II (p. 381)	C. Stiller	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 383)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 394)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 397)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 443)	C. Proppe	2	4	W
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 479)	J. Ovtcharova	3	4	W/S
2150904	E	Automated Manufacturing Systems (p. 252)	J. Fleischer	6	8	S
24152	E	Robotics I – Introduction to robotics (p. 429)	R. Dillmann, S. Schmidt-Rohr	2	3	W
24659	E	Human-Machine-Interaction (p. 380)	M. Beigl, Takashi Miyaki	2	3	S
23109	E	Signals and Systems (p. 439)	F. Puente, F. Puente León	2	3	W
23321	E	Hybrid and Electric Vehicles (p. 335)	M. Doppelbauer, M. Schiefer	3	4	W
2105011	E	Introduction into Mechatronics (p. 283)	G. Bretthauer, A. Albers	3	6	W

Conditions:
Recommendations:
Learning Outcomes: 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.
Remarks:

SP 38: Production Systems

ID	Cat	Course	Lecturer	h	CP	Term
2149657	K	Manufacturing Technology (p. 308)	V. Schulze, F. Zanger	6	8	W
2149902	K	Machine Tools and Industrial Handling (p. 485)	J. Fleischer	6	8	W
2150660	K	Integrated production planning (p. 344)	G. Lanza	6	8	S
2109035	K	Human Factors Engineering I (p. 240)	B. Deml	2	4	W
2109036	K	Human Factors Engineering II (p. 242)	B. Deml	2	4	W
2117051	K	Material flow in logistic systems (p. 368)	K. Furmans	4	6	W
2149605	K	Simulation of production systems and processes (p. 441)	K. Furmans, V. Schulze, P. Stock	4	5	W
2118085	E	Automotive Logistics (p. 362)	K. Furmans	2	4	S
2121350	E	Product Lifecycle Management (p. 408)	J. Ovtcharova	4	6	W
2149667	E	Quality Management (p. 422)	G. Lanza	2	4	W
2150683	E	Control Technology (p. 446)	C. Gönnheimer	2	4	S
2121001	E	Integrated Information Systems for engineers (p. 455)	J. Ovtcharova	3	5	S
2150904	E	Automated Manufacturing Systems (p. 252)	J. Fleischer	6	8	S
2149903	E	Design Project Machine Tools and Industrial Handling (p. 295)	J. Fleischer	2	4	W

Conditions: None
Recommendations: Recommended Compulsory Elective Subject:
2149605 Simulation of production systems and processes
Learning Outcomes: The students...

- are able to choose methods of production science target-oriented in familiar situations and are able to justify their selection.
- are able to describe and compare production processes exemplarily.
- are able to transfer known solutions to given problems 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 results of others at the solution of given problems.
- have the ability to present their own results in written form and are able to interpret them.
- 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.

Remarks: None

SP 44: Technical Logistics

ID	Cat	Course	Lecturer	h	CP	Term
2117095	KP	Basics of Technical Logistics (p. 322)	M. Mittwollen, Madzharov	4	6	W
2117096	K	Elements of Technical Logistics (p. 290)	M. Mittwollen, Madzharov	3	4	W
2118087	K	Selected Applications of Technical Logistics (p. 246)	M. Mittwollen, Madzharov	3	4	S
2118088	K	Selected Applications of Technical Logistics and Project (p. 247)	M. Mittwollen, Madzharov	4	6	S
2117064	E	Application of technical logistics in modern crane systems (p. 238)	M. Golder	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 239)	J. Föller	2	4	S
2117500	E	Energy efficient intralogistic systems (p. 292)	F. Schönung	2	4	W
2138341	E	Cogitive Automobiles - Laboratory (p. 350)	C. Stiller, M. Lauer, B. Kitt	2	4	S
2118097	E	Warehousing and distribution systems (p. 356)	M. Schwab, J. Weiblen	2	4	S
2117051	E	Material flow in logistic systems (p. 368)	K. Furmans	4	6	W
2149667	E	Quality Management (p. 422)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 438)	H. Kany	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 472)	C. Stiller, T. Dang	2	4	S
2118083	EM	IT for facility logistics (p. 347)	F. Thomas	4	6	S
2150904	E	Automated Manufacturing Systems (p. 252)	J. Fleischer	6	8	S
2117097	E	Elements of Technical Logistics and Project (p. 291)	M. Mittwollen, Madzharov	4	6	W

Conditions: none
Recommendations: Recommended compulsory optional subjects:

- Mathematical Methods in Dynamics
- Simulation of production systems and processes
- Stochastics in Mecanical Engineering
- Modelling and Simulation
- Technical Logistics I

Learning Outcomes: Students are able to:

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

Remarks: none

SP 48: Internal Combustion Engines

ID	Cat	Course	Lecturer	h	CP	Term
2133103	KP	Fundamentals of Combustion Engines I (p. 325)	H. Kubach, T. Koch	3	4	W
2133120	KP	Thermodynamics and Energy Conversion in Internal Combustion Engines (p. 466)	T. Koch, H. Kubach	2	4	W
2134131	K	Fundamentals of Combustion Engines II (p. 326)	H. Kubach, T. Koch	3	4	S
2134138	K	Fundamentals of catalytic exhaust gas aftertreatment (p. 320)	E. Lox	2	4	S
2134134	K	Analysis tools for combustion diagnostics (p. 382)	U. Wagner	2	4	S
2134137	K	Engine measurement techniques (p. 393)	S. Bernhardt	2	4	S
2133108	E	Fuels and Lubricants for Combustion Engines (p. 259)	B. Kehrwald, J. Volz	2	4	W
2134141	E	Gas Engines (p. 312)	R. Golloch	2	4	S
2134150	E	Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines (p. 229)	M. Gohl	2	4	S
2134139	E	Model based Application Methods (p. 389)	F. Kirschbaum	3	4	S
2134001	E	Engine Laboratory (p. 392)	U. Wagner	2	4	S
2133112	E	Drive Systems and Possibilities to Increase Efficiency (p. 235)	H. Kollmeier	1	2	W
2166538	E	Fundamentals of combustion II (p. 324)	U. Maas	2	4	S
2113805	E	Automotive Engineering I (p. 317)	F. Gauterin, H. Unrau	4	8	W
2114835	E	Automotive Engineering II (p. 318)	F. Gauterin, H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 303)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 304)	F. Gauterin	2	4	S
2158107	E	Technical Acoustics (p. 453)	M. Gabi	2	4	S
2161224	E	Machine Dynamics (p. 366)	C. Proppe	3	5	S
2162220	E	Machine Dynamics II (p. 367)	C. Proppe	2	4	W
2181113	E	Tribology A (p. 468)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 469)	M. Scherge, M. Dienwiebel	2	4	S
2181745	E	Design of highly stresses components (p. 250)	J. Aktaa	2	4	W
2150904	E	Automated Manufacturing Systems (p. 252)	J. Fleischer	6	8	S
2146192	E	Sustainable Product Engineering (p. 452)	K. Ziegahn	2	4	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 397)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 419)	P. Gutzmer	2	4	W
2157445	E	Computational methods for the heat protection of a full vehicle (p. 461)	H. Reister	2	4	W

Conditions: None.
Recommendations: Recommended Courses:

- 22512 Heat and Mass Transfer
- 2165515 Fundamentals of combustion I

Learning Outcomes: 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

Remarks:

SP 50: Rail System Technology

ID	Cat	Course	Lecturer	h	CP	Term
2115919	KP	Rail System Technology (p. 255)	P. Gratzfeld	2	4	W/S
2115996	KP	Rail Vehicle Technology (p. 430)	P. Gratzfeld	2	4	W/S
2115995	E	Project Management in Rail Industry (p. 418)	P. Gratzfeld	2	4	W
2114916	E	Intermodal Transport and Cross-Border Rail Traffic (p. 346)	P. Gratzfeld, R. Grube	2	4	S
2115915	E	Mobility Concepts of Rail Transportation in 2030 (p. 388)	P. Gratzfeld	2	4	W/S
2114346	E	Electric Rail Vehicles (p. 289)	P. Gratzfeld	2	4	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 279)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 307)	F. Henning	2	4	S
2105011	E	Introduction into Mechatronics (p. 283)	G. Bretthauer, A. Albers	3	6	W
2138340	E	Automotive Vision (p. 306)	C. Stiller, M. Lauer	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 425)	C. Proppe	2	4	S
2161217	E (P)	Mechatronic Softwaretools (p. 443)	C. Proppe	2	4	W
6234801	E	Operation (p. 258)	E. Hohnecker, P. Gratzfeld	2	3	S
6234804	E	Operation Systems and Track Guided Infrastructure Capacity (p. 260)	E. Hohnecker, P. Gratzfeld	2	3	S
6234701 / 6234702	E	Track Guided Transport Systems - Technical Design and Components (p. 444)	E. Hohnecker, P. Gratzfeld	3/1	6	W

Conditions:
Recommendations: none
Learning Outcomes:

- The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
- They deduct the fundamental requirements for rail vehicles out of it and assess concepts of rail vehicles.
- They know about major systems in a rail vehicle and evaluate their fitness in specific fields of application.
- Supplementary lectures present further major aspects of a rail system.

Remarks:

SP 52: Production Engineering

ID	Cat	Course	Lecturer	h	CP	Term
3110040	KP	Introduction to Industrial Engineering (p. 277)	B. Deml	2	4	S
2118092	KP	Selected Topics in Manufacturing Technologies (p. 248)	V. Schulze	2	4	S
2150653	E	Basics in Material Handling and Logistics Systems (p. 256)	M. Schwab, P. Linsel	2	4	S

Conditions:
Recommendations: Recommended Compulsory Elective Subject:

3109033 Industrial Management Case Study

3122031 Virtual Engineering (specific Topics)

Learning Outcomes: The students acquire in the compulsory core subjects 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 module, the students are able

- to analyse and solve planning and layout problems on the level of the enterprise, production, processes and work tasks,
- to plan and control a production,
- to evaluate and configure the quality and efficiency of production, processes and products.

Remarks:

6 Courses of the Major Fields

6.1 All Courses

Course: Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines [2134150]

Coordinators: M. Gohl
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Letter of attendance or oral exam (30 minutes, no testing aids)

Conditions
none

Recommendations
Knowledge in the field of engine technology and measurement techniques is advantageous

Learning Outcomes
The Students can point out the challenges concerning the current emission standards in engine development. They can name and explain the basic principles of measurement techniques and methods to analyse exhaust gas components and components of engine oil. Hence, the students have the ability to choose the right methods for a given Problem and to interpret the results.

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.

Media
Lecture with Powerpoint slides

Literature
The lecture documents are distributed during the courses.

Course: Adaptive Control Systems [2105012]

Coordinators: G. Bretthauer
Part of the modules: SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
Measuring and Automatic Control

Learning Outcomes
The students know different types, structures and operation of adaptive control systems. They are capable of setting up system equations theoretically and experimentally. By experimenting with examples students are prepared to apply adaptive control systems in practice.

Content
Introduction: definitions, classification of adaptive control systems, objectives

Structures of adaptive control systems: overview, parameter-, structure- and signal-adaptive control systems, open-loop and closed loop ARS, ARS with reference/identification model, application

Modeling: methods, experimental conditions, experimental modeling, identifcation methods for single input single output systems and multi input multi output systems

Parameter adaptive control systems: definitions, design methods

Literature
W. Weber. Adaptive Regelungssysteme, volume I, II. R. Oldenbourg, München, 1971.

Course: Analytical methods in material flow methodology (mach and wiwi) [2117060]

Coordinators: J. Stoll, E. Özden
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
oral

30min (electives), 60min (main subject)

examination aids: none

Conditions
none

Recommendations
Basic knowledge of statistic
recommended compusory optional subject:

- Stochastics in Mecanical Engineering

recommended lecture:

- Material flow in logistic systems (also parallel)

Learning Outcomes
Students are able to:

- Describe material flow systems with analytical solvable stochastic models,
- Derive Approches for control systems (KANBAN) based on easy models of queueing theory,
- Execute practical exercised on workstations and
- Use simulation and exakt methods.

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

Media
black board, lecture notes, presentations

Literature
Wolff: Stochastic Modeling and the Theory of Queues, Prentice Hall, 1989

Shanthikumar, Buzacott: Stochastic Models of Manufacturing Systems

Remarks
none

Course: Low Temperature Technology [2158112]

Coordinators: F. Haug
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination
duration: 30 minutes
no tools or reference materials may be used during the exam

Conditions
none

Recommendations
Knowledge in Thermodynamics I is of advantage (however, no prerequisite)

Learning Outcomes
The lecture gives an introduction to the interdisciplinary field of low temperature technology (cryogenics) with emphasis on thermodynamics and process engineering. Fundamentals are explained followed by exercises and practical examples comprising industrial cryoplants. Where useful reference is made to cryogenic systems at CERN, the European Organization for high energy physics. Low temperature technology is a comparatively young engineering branch with future potential and is indispensible for basic research, space technology, some medical technologies, industry, superconductivity, research centres.

Content

1. Introduction to low temperature technology
2. The research centre CERN
3. Fundamentals (thermo-physical)
4. Low temperature properties of materials
5. Cryogens
6. Thermal insulation, storage, transfer of cryogenic fluids
7. Fundamentals (laws of thermodynamics)
8. Cycles and processes
9. Refrigerators and components
10. Instrumentation, automation
11. Examples of cryoplants (among others at CERN)
12. Cryocoolers
13. Production of extremely low temperatures

Literature

1. Technische Thermodynamik, beliebig
2. Tieftemperaturtechnologie, H. Frey und R. Haefer, VDI-Verlag, 1981
3. Handbook of Cryogenic Engineering, J. Weisend II, Verlag Taylor&Francis, 1998

Course: Applied Tribology in Industrial Product Development [2145181]

Coordinators: A. Albers, W. Burger
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The goal of the lecture is to discuss tribological problems, tribological features and the tribological variety on examples of the automobile 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.
- show the limits of a tribological system.

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

Literature
The lecture script will be allocated at Ilias.

Course: Drive Train of Mobile Machines [2113077]

Coordinators: M. Geimer
Part of the modules: SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations

- general basics of mechanical engineering
- basic knowledge in hydraulics
- interest in mobile machines

Learning Outcomes
Get to know all relevant aspects and components of a drive train of a mobile machine and also the construction of various drive trains. Knowing and understandung interactions and independancies of components on a besic level.

Content
In this course will be discussed the different drive train of mobile machinerys. The fokus of this course is:
- improve knowledge of fundamentals
- mechanical gears
- torque converter
- hydrostatic drives
- continuous variable transmission
- eletrical drives
- hybrid drives
- axles
- terra mechanic

Media
projector presentation

Literature
download of scriptum via ILIAS

Course: Drive Systems and Possibilities to Increase Efficiency [2133112]

Coordinators: H. Kollmeier
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Oral examination, time duration 30 min., no aids

Conditions
none

Recommendations
Verbrennungsmotoren A

Learning Outcomes
The student has an overview about possibilities for increasing the efficiency of propulsion systems. He understands the basics of waste heat recovery and knows the required technology therefore. He has an overview about systems for storage electrical energy, heat energy and mechanical energy. The student understands the technical contexts of combined propulsions systems of internal combustion engine and electric motor/generator. The student understands the necessary of lightweight construction systems and knows the material basics therefore.

Content
The students attend to propulsion systems and possibilities for increasing efficiency and get an overview about the demand of energy of stationary and mobile propulsion systems. Furthermore they get an overview about possibilities for increasing efficiency by the use of storage systems, systems of waste heat recovery and lightweight construction systems. There is also a view on complete systems for increasing efficiency as combined heat and power plant and hybrid propulsion systems.

Media
Lecture with powerpoint slides

Literature
Download of powerpoint slides

Remarks
none

Course: Powertrain Systems Technology A: Automotive Systems [2146180]

Coordinators: A. Albers, S. Ott

Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination

Conditions
none

Recommendations
Power Train Systems Technology B: Stationary Machinery

Learning Outcomes
The student acquires the basic skills which are necessary to design energy-efficient and comfortable automotive powertrain solutions.

Content
Powertrain System
Driver System
Environment System
System Components
Development Process

Literature
Kirchner, E.; "Leistungsübertragung in Fahrzeuggetrieben: Grundlagen der Auslegung, Entwicklung und Validierung von Fahrzeuggetrieben und deren Komponenten", Springer Verlag Berlin Heidelberg 2007
Naunheimer, H.; "Fahrzeuggetriebe: Grundlagen, Auswahl, Auslegung und Konstruktion", Springer Verlag Berlin Heidelberg 2007

Course: Powertrain Systems Technology B: Stationary Machinery [2145150]

Coordinators: A. Albers, S. Ott
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Conditions
none

Recommendations
Powertrain Systems Technology A: Automotive Systems

Learning Outcomes
The student acquires the basic skills which are necessary to design energy-efficient and secure solutions for the design of stationary powertrain applications.

Content
Powertrain System
Operator System
Environment System
System Components
Development Process

Literature
VDI-2241: "Schaltare fremdbetätigte Reibkupplungen und -bremsen", VDI Verlag GmbH, Düsseldorf
Geilker, U.: "Industriekupplungen - Funktion, Auslegung, Anwendung", Die Bibliothek der Technik, Band 178, verlag moderne industrie, 1999

Course: Application of technical logistics in modern crane systems [2117064]

Coordinators: M. Golder
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral, approx. 20min, appointment after acknowledgement

Conditions
none

Recommendations
technical interest; Beneficial: Knowledge of the lecture 'Technical logistics I, basics'

Learning Outcomes
Students are able to:

- Dimension modern crane installations and transfer this approach to other material handling installations and
- Judge about the confirmity of the system by using relevant standards and set of rules.

Content

- Basics of modern crane construction
- Characteristics of application, classification
- Configuration, dimensioning, consideration of costs
- Relevant rules and standards
- Modern concepts of crane control and drives

Media
presentations, black board

Literature
None.

Remarks
none

Course: Application of technical logistics in sorting- and distribution technology [2118089]

Coordinators: J. Föller
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral 30 min

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and classify basics and characteristics of application of sorting and distribution of goods,
- Solve drive and control tasks with appropriate concept selection,
- Design systems with appropriate calculation methods and evaluate them financially, and
- Judge about the confirmity of the system by using relevant standards and set of rules.

Content
Basics of goods sorting and distribution technology, employment characteristics, classification, interpretation, dimensioning, costs considerations. Relevant control, modern sets of rules and propulsion principles

Media
presentations, black board

Literature
None.

Remarks
none

Course: Human Factors Engineering I [2109035]

Coordinators: B. Deml
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory Core Subject: oral exam
Elective Subject: oral exam (ca. 30 min)
Compulsory Optional Subject: written exam (60 min)
Optional Subject: oral exam (ca. 30 min)
The exams are only offered in German!

Conditions

- **The exams "Arbeitswissenschaft I (2109035)" and "Ergonomie und Arbeitswirtschaft (2109029)" are mutually exclusive.**
- **The exams "Arbeitswissenschaft I (2109035)" and "Arbeitsschutz und Arbeitsrecht (2109024)" are mutually exclusive.**
- **The exams "Arbeitswissenschaft I (2109035)" and "Arbeitswissenschaft (2109026)" are mutually exclusive.**

Recommendations

- Willingness to learn interdisciplinarily (Product design, Legal regulations Work physiology, Work psychology . . .)
- Basic knowledge of Production Management is usefull

Learning Outcomes
After completion the lecture, the students are able

- to classify basics of human work and to apply basic research methods of Human Factors Engineering,
- to evaluate and design work places following the goals of Human Factors Engineering under consideration of psychological, physiological, anthropometric, safety-related, organisational as well as technological aspects,
- evaluate and configure work environments following the goals of Human Factors Engineering under consideration of noise, illumination, climate and mechanical vibrations,
- to classify and apply basic theories and methods of Human Factors Engineering. They are able to evaluate a work place and to derive corresponding wage concepts,
- to rate problems of labor-law and to describe the organisation of the representation of interests in the German working world.

Content

1. Introduction
2. Basics of human performance
3. Research methods of Human Factors Engineering
4. Design of workplaces
5. Design of working environment

6. Industrial Engineering
7. Labour legislation and Representation of interest groups

Literature
Learning material:
Handout online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html
Literature:

- SCHLICK, Christopher; BRUDER, Ralph; LUCZAK, Holger: Arbeitswissenschaft. Heidelberg u.a.: Springer, 3rd edition 2010.

Please refer to the latest edition.

Course: Human Factors Engineering II [2109036]

Coordinators: B. Deml
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory Core Subject: oral exam
Elective Subject: oral exam (ca. 30 min)
Optional Subject Economics/Law: written exam (60 min)
Optional Subject: oral exam (ca. 30 min)
The exams are only offered in German!

Conditions

- **The exams "Arbeitswissenschaft II (2109036)" and "Arbeitsschutz und Arbeitsrecht (2109024)" are mutually exclusive.**
- **The exams "Arbeitswissenschaft II (2109036)" and "Arbeitswissenschaft (2109026)" are mutually exclusive.**

Learning Outcomes
After completion the lecture, the students are able

- to classify basics of the research within work organisation and to apply basic research methods of Human Factors Engineering. They know actual trends of work organisation.
- to apply fundamental methods of employee selection, personnel development and employee appraisal. They know basic theories of work satisfaction and motivation.
- to consider important psychological aspects of teams (e.g. interaction, communication). They know fundamental theories about leadership.
- to apply and evaluate methods of human-resource allocation and the fundamental basics of departmental, process and production organisation.

Content

1. Introduction
2. Basics of work organisation
3. Research methods of work organisation
4. Individual person
5. Group
6. Organisation

Literature
Learning material:
Handout online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html
Literature:

- SCHLICK, Christopher; BRUDER, Ralph; LUCZAK, Holger: Arbeitswissenschaft. Heidelberg u.a.: Springer, 3rd edition 2010.

Please refer to the latest edition.

Course: Atomistic simulations and molecular dynamics [2181740]

Coordinators: P. Gumbsch
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
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

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. static, dynamic, thermodynamic
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

Literature

1. Understanding Molecular Simulation: From Algorithms to Applications, Daan Frenkel and Berend Smit (Academic Press, 2001)
2. Computer simulation of liquids, M. P. Allen and Dominic J. Tildesley (Clarendon Press, Oxford, 1996)

Course: Constitution and Properties of Wear resistant materials [2194643]

Coordinators: S. Ulrich
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
None

Recommendations
None

Learning Outcomes
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.

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

Literature
Laska, R. Felsch, C.: Werkstoffkunde für Ingenieure, Vieweg Verlag, Braunschweig, 1981

Schedler, W.: Hartmetall für den Praktiker, VDI-Verlage, Düsseldorf, 1988

Schneider, J.: Schneidkeramik, Verlag moderne Industrie, Landsberg am Lech, 1995

Copies with figures and tables will be distributed

Course: Constitution and Properties of Protective Coatings [2177601]

Coordinators: S. Ulrich
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
None

Recommendations
None

Learning Outcomes
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.

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

Literature
Bach, F.-W.: Modern Surface Technology, Wiley-VCH, Weinheim, 2006

Copies with figures and tables will be distributed

Course: Selected Applications of Technical Logistics [2118087]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
look at Empfehlungen (en)

Recommendations
GTL/ESTL should be visited in advance, knowledge out of GTL/ESTL preconditioned

Learning Outcomes
Students are able to:

- Model the dynamic behaviour of material handling systems and based on this calculate the dynamical behaviour and
- Transfer this approach autonomous to further, different material handling installations and
- Discuss the knowledge with subject related persons.

Content
design and dimension of machines from intralogistics // static and dynamic behaviour // operation properties and specifics // visit of real intralogistic system
Inside practical lectures: sample applications and calculations in addition to the lectures

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Remarks
-

Course: Selected Applications of Technical Logistics and Project [2118088]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
Lesson: after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau"); (counts two-thirds);
Project: presentation, marked (counts one third)

Conditions
none

Recommendations
GTL/ESTL should be visited in advance, knowledge out of GTL/ESTL preconditioned

Learning Outcomes
Students are able to:

- Model the dynamic behaviour of material handling systems and based on this calculate the dynamical behaviour and
- Transfer this approach autonomous to further, different material handling installations,
- Discuss the knowledge with subject related persons and
- Judge about systems in place and justify it in front of subject related persons.

Content
design and dimension of machines from intralogistics // static and dynamic behaviour // operation properties and specifics // visit of real intralogistic system // self manufactured project report
Inside practical lectures: sample applications and calculations in addition to the lectures
Self manufacturing of a project report to recesses the topic.

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Course: Selected Topics in Manufacturing Technologies [2118092]

Coordinators: V. Schulze
Part of the modules: SP 52: Production Engineering (p. 228)[SP_52_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to specify different manufacturing processes and to differentiate against each other.
- are able to classify the manufacturing processes by their structure and functionality according to the specific main groups.
- are able to explain the characteristics, function and field of application of different manufacturing processes.
- are qualified to evaluate different processes regarding specific applications based on technical aspects.

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 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 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

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Design of combustion chamber in gas turbines (Project) [22509]

Coordinators: N. Zarzalis
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations

Conditions
Engineering Thermodynamics, Fluid Mechanics, Heat and Mass Transfer, Construction

Recommendations
None.

Learning Outcomes

Content

Remarks
None.

Course: Design of highly stresses components [2181745]

Coordinators: J. Aktaa
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam: 30 minutes

Conditions
material science
solid mechanics II

Learning Outcomes
The students know about the rules of established design codes for the assessment of components which under operation are subjected to high thermo-mechanical and/or irradiation loadings. They understnd which constitutive equations are used according to state-of-the-art of technology and research to estimate deformation and damage appearing under these loadings and to predict expected lifetime. They gained insight into the application of these generally non-linear constitutive equations in finite element codes and can judge the major issues which shall be thereby taken into account.

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

Literature

- R. Viswanathan, Damage Mechanisms and Life Assessment of High-Temperature Components, ASM International, 1989.
- Lemaitre, J.; Chaboche J.L.: Mechanics of Solid Materials, Cambridge University Press, Cambridge, 1990.

Course: Design and Development of Mobile Machines [2113079]

Coordinators: M. Geimer
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
homework in small groups during the semester + oral examination

Conditions
None.

Recommendations
Knowledge in Fluid Technology (SoSe, LV 21093)

Learning Outcomes
Students will learn:
1. How to develop a mobile working machine
2. How to apply existing knowledge on a specific problem
3. How to break down and structure a complex task
4. How knowledge of different courses can be brought together

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 beeing 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.

Literature
None.

Course: Automated Manufacturing Systems [2150904]

Coordinators: J. Fleischer

Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

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.

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

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.

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Automation Systems [2106005]

Coordinators: M. Kaufmann
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of measuring and control engineering

Learning Outcomes
Students have fundamental knowledge about functionality, composition, components and development of industrial automation systems.

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

Literature

- Gevatter, H.-J., Grünhaupt, U.: Handbuch der Mess- und Regelungstechnik in der Produktion. 2. Auflage, Berlin, Heidelberg: Springer-Verlag, 2006.
- Langmann, R.: Taschenbuch der Automatisierung. München: Fachbuchverlag Leipzig, 2010.
- Strohrmann, G.: Automatisierung verfahrenstechnischer Prozesse: eine Einführung für Ingenieure und Techniker. München, Wien: Oldenbourg-Industrieverlag, 2002.
- Wellenreuther, G., Zastrow, D.: Automatisieren mit SPS: Theorie und Praxis. 4. Auflage, Wiesbaden: Vieweg+Teubner, 2009.

Course: Rail System Technology [2115919]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
They can assess the suitability of existing elements in the overall system.
They deduct the fundamental requirements for rail vehicles out of it.

Content
Introduction: railyway as system, history, networks, traffic development, economic impact
Vehicle dynamics: driving resistance, tractive effort diagram, load cycles
Wheel-rail-contact: carrying of vehicle mass, adhesion, wheel guidance
Train protection: succession of trains, guideway
Traction power supply: power networks, power distribution, substations
Vehicles: definitions, compositions
Enviromental aspekt: energy consumption, traffic area, noise

Media
All slides are available for download (Ilias-platform).

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

Remarks
none

Course: Basics in Material Handling and Logistics Systems [2150653]

Coordinators: M. Schwab, P. Linsel
Part of the modules: SP 52: Production Engineering (p. 228)[SP_52_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
oral examination, 20 minutes, 1 x year (after lecture period)

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- describe material flow processes qualitativ and quantitativ,
- plan material flow systems, illustrate them in simple models and analyse them regarding their performance,
- use methods to determine performance indicators like throughput, utilization, etc.,
- Describe logistical tasks,
- Design logistical systems suitable to the respective task,
- Determine essential influencing parameters on the bullwhip effect and
- Use optimizing solution methods.

Content
Conveyor Systems

- Basic elements of conveyor systems
- Key figures
- Branching elements
  - continuous/partially-continuous
  - deterministic/stochastic switch
- Integration elements
  - continuous/partially-continuous
  - dispatching rules

Queueing Theory and Production Logistics

- Basic queueing systems
- Distributions
- M|M|1 and M|G|1 model
- Application on production logistics

Distribution Centers and Order Picking

- The location problem

- Distribution centers
- Inventory management
- Order picking

Vehicle Routing

- Types of vehicle routing problems
- Linear programming model and graph theoretic model
- Heuristics
- Supporting technologies

Optimization of Logistical Networks

- Objectives
- Cooperative strategies
- Supply chain management
- Implementation

Media
presentations, blackboard, book

Literature
Literature: Arnold, Dieter; Furmans, Kai : Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009

Remarks
none

Course: Operation [6234801]

Coordinators: E. Hohnecker, P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Operation systems, signalling systems, operation schedule and timetable construction

Literature
Elective literature:
Fiedler: Grundlagen der Bahntechnik, Werner Verlag Düsseldorf
Pachl: Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

Remarks
See German version.

Course: Fuels and Lubricants for Combustion Engines [2133108]

Coordinators: B. Kehrwald, J. Volz
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination, Duration: ca. 30 min., no auxiliary means

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can name and explain composition and meaning of fuels, lubricants and coolants as important components in the system of todays Otto and Diesel engines as well as definition and chemical composition of fuels and lubricants, the meanig of crude oil as basic primary product, production processes, major properties, standards and specifications, testing methods.
They can point out future worldwide trends in the field of conventional and alternative fuels regarding emission standards and energy conservation

Content
Introduction and basics

Fuels for Gasoline and Diesel engines

Hydrogen

Lubricants for Gasoline and Diesel engines

Coolants for combustion engines

Literature
Lecturer notes

Course: Operation Systems and Track Guided Infrastructure Capacity [6234804]

Coordinators: E. Hohnecker, P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
See module description.

Learning Outcomes
See German version.

Content
Special signalling equipments, automatic driving, safety case, capacity of railway equipiments, dimensioning of marshaling yards.

Literature
Elective literature:
Fiedler: Grundlagen der Bahntechnik, Werner Verlag Düsseldorf
Pachl: Systemtechnik des Schienenverkehrs, Teubner-Verlag, Stuttgart

Remarks
See German version.

Course: Evaluation of welded joints [2181730]

Coordinators: P. Gumbsch, M. Farajian, Farajian, Majid
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Exercise sheets are handed out regularly.
oral examination (30 min)

no tools or reference materials

Conditions
None.

Recommendations
preliminary knowlegde materials science and mechanics

Learning Outcomes
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

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

Media
Black board and slides (beamer).

Literature

1. D. Radaj, C.M. Sonsino and W. Fricke, Fatigue assessment of welded joints by local approaches, Second edition.Woodhead Publishing, Cambridge 2006.
2. FKM-Richtlinie, Bruchmechanischer Festigkeitsnachweis, Forschungskuratorium Maschinenbau, VDMA Verlag, 2009

Course: BUS-Controls [2114092]

Coordinators: M. Geimer
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
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.

Conditions
Basic knowledge of electrical engineering is recommended. Programming skills are also helpful.

Learning Outcomes
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.

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
Elective literature:

- Etschberger, K.: Controller Area Network, Grundlagen, Protokolle, Bausteine, Anwendungen; München, Wien: Carl Hanser Verlag, 2002.
- Engels, H.: CAN-Bus - CAN-Bus-Technik einfach, anschaulich und praxisnah dargestellt; Poing: Franzis Verlag, 2002.

Remarks
The course will be replenished by interesting lectures of professionals.

Course: CATIA CAD training course [2123358]

Coordinators: J. Ovtcharova
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter / Summer Term	de

Learning Control / Examinations
Practical examination, duration: 60 min., auxiliary means: script

Conditions
None

Recommendations
Dealing with technical drawings is required.

Learning Outcomes
Students are able to:

- create their own 3D geometric models in the CAD system CATIA and generate drawings due to the created geometry
- carry out FE-studies and kinematic simulations using the integrated CAE tools
- use advanced, knowledge-based functionalities of CATIA to automate the creation of geometry and thus to ensure the reusability of the models.

Content
The participant will learn the following knowledge:

- Basics of CATIA such as user interface, handling etc.
- Production and processing of different model types
- Production of basic geometries and parts
- Generation of detailed drawings
- Integration of partial solutions in modules
- Working with constrains
- Strength analysis with FEM
- Kinematic simulation with DMU
- Dealing with CATIA Knowledgeware

Literature
practical course skript

Remarks
For the practical course attendance is compulsory.

Course: CAD-NX training course [2123357]

Coordinators: J. Ovtcharova
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter / Summer Term	de

Learning Control / Examinations
Practical examination, duration: 60 min., auxiliary means: script

Conditions
None

Recommendations
Dealing with technical drawings is required.

Learning Outcomes
Students are able to:

- create their own 3D geometric models in the CAD system NX and generate drawings due to the created geometry
- carry out FE-studies and kinematic simulations using the integrated CAE tools
- use advanced, knowledge-based functionalities of NX to automate the creation of geometry and thus to ensure the reusability of the models.

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

Literature
Practical course skript

Remarks
For the practical course compulsory attendance exists.

Course: CAE-Workshop [2147175]

Coordinators: A. Albers, Assistenten
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 17: Information Management (p. 216)[SP_17_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	de

Learning Control / Examinations
Depending on the manner in which the CAE-Workshop will be credited.

Conditions
compulsory attendance

Recommendations
We suggest this Workshop after 2 years of classes.

Learning Outcomes
The students are able to ...

- name the purposes and limits of numerical simulation and optimization of the virtual product development.
- solve simple realistic tasks in the field of finite element analysis, multi-body-simulation and structure optimization with industrial common software (the content in winter and summer term is different).
- evaluate and to question the results of a simulation.
- identify and improve the mistakes of a simulation or optimization.

Content
Content in the summer semester:

- introduction to the finite element analysis (FEA)
- stess 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 optimization package TOSCA and the Abaqus solver

Content in the winter semester:

- 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 multi-body simulation (MBS)
- preparation and running of multi-body simulation models. Coupling of the MBS and FEA to calculate hyprid multi-body simulation problems.

Literature
The workshop script will be allocated at Ilias.

Course: CATIA advanced [2123380]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Summer term	de

Learning Control / Examinations
Presentation of the results at the end of semester
and oral examination, duration: 10 min.

Conditions
None

Recommendations
Very good knowledge of Machine Design and an excellently passed CAD practical course CATIA at the IMI are required.

Learning Outcomes
At the workshop, a complete CAD model of a transmission is developed.
The design problem is worked out in small groups. Using a basic sketch the participants have to design partial solutions independently, test and then integrate them into the overall solution. The advanced capabilities of CATIA are dealt with. The design process should be simulated from idea to finished model.
The focus is on independent solution finding, teamwork, functional performance, production and design.

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

Remarks
For the workshop compulsory attendance exists.

Course: CFD-Lab using Open Foam [2169459]

Coordinators: R. Koch
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations

- Successful solution of problems

Conditions

- Fluid Dynamics
- Course on numerical fluid mechanics

Recommendations

- Basic knowledge in LINUX

Learning Outcomes

The students are able to:

- use OpenFOAM
- generate simple grids or import grids into OpenFOAM
- choose and define appropriate boundary conditions
- estimate numerical errors and asses them
- judge turbulence models and select an appropriate model
- simulate 2-phase flows using suitable models

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

Media

- A CD containing the course material will be handed out to the students

Literature

- Documentation of Open Foam

- www.open foam.com/docs

Remarks

- Number of participants is limited
- Priority for students of the lecture “Numerische Simulation reagierender Zweiphasenströmungen” (Vorl.-Nr. 2169458)

Course: Computational Intelligence I [2106004]

Coordinators: G. Bretthauer, R. Mikut
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of fuzzy logic and fuzzy control efficiently. They know the basic mathematical foundations for the model design using fuzzy logic (membership functions, inference methods, defuzzification). In addition, they are able to design fuzzy controllers (Mamdani controllers and hybrid controllers with fuzzy-adaptive components) for practical applications.

Content
Terms and definitions Computational Intelligence, application fields and examples

Fuzzy logic and fuzzy sets

Fuzzification and membership functions

Inference: T-norms and -conorms, operators, aggregation, activation, accumulation

Defuzzification methods

Structures for fuzzy control

Software practice (fuzzyTECH) and applications (crane control)

Literature
Kiendl, H.: Fuzzy Control. Methodenorientiert. Oldenbourg-Verlag, München, 1997

Bandemer, H.; Gottwald, S.: Einführung in Fuzzy Methoden. Akademie-Verlag, Berlin, 1993

Zadeh, L.A.: Fuzzy Sets. Information and Control, 8, 338-353, 1965

Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe, Kapitel 5.5; 2008 (Internet)

Software: FuzzyTech (für die Übung)

Course: Computational Intelligence II [2105015]

Coordinators: G. Bretthauer, MIkut
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of Artificial Neural Networks and Evolutionary Algorithms efficiently. They know the basic mathematical foundations and the goal-oriented design and the problem formulation for technical applications (selection of net structures for Artificial Neural Networks, optimization using Evolutionary Algorithms with coding of potential solutions for real-world applications as individuals).

Content
Terms and definitions, application fields and examples

Biological foundations of neural nets

Artificial Neural Nets: neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps,
training strategies (Backpropagation, Levenberg-Marquardt)

Evolutionary Algorithms: Genetic Algorithms and Evolution Strategies, mutation, recombination, evaluation, selection, integration of local search strategies

Software practice (Gait-CAD, GLEAMKIT) and applications

Literature
S. Haykin: Neural Networks: A Comprehensive Foundation. Prentice Hall, 1999

T. Kohonen: Self-Organizing Maps. Berlin: Springer-Verlag, 1995

R. Rojas: Theorie der Neuronalen Netze. Berlin: Springer-Verlag, 1995

W. Jakob: Eine neue Methodik zur Erhöhung der Leistungsfähigkeit Evolutionärer Algorithmen
durch die Integration lokaler Suchverfahren. Forschungszentrum Karlsruhe, 2004

H.-P. Schwefel: Evolution and Optimum Seeking. New York: John Wiley, 1995

H.J. Holland: Adaptation in Natural and Artificial Systems. Ann Arbor, 1975

R. Mikut: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe, 2008 (Internet, Kapitel 5.6)

Course: Computational Intelligence III [2106020]

Coordinators: R. Mikut
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of data analysis efficiently. They know the basic mathematical 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.

Content
Introduction and motivation

Terms and definitions (types of multidimensional features - time series and images, problem classes)

Application scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation

Application (Software practice with Gait-CAD): Control of hand prostheses, energy prediction

Literature
Lecture notes (Internet)

Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe.
2008 (Internet)

Backhaus, K.; Erichson, B.; Plinke, W.; Weiber, R.: Multivariate Analysemethoden: Eine anwendungsorientierte Einführung. Berlin u.a.: Springer. 2000

Burges, C.: A Tutorial on Support Vector Machines for Pattern Recognition. Knowledge
Discovery and Data Mining 2(2) (1998), S. 121–167

Tatsuoka, M. M.: Multivariate Analysis. Macmillan. 1988

Mikut, R.; Loose, T.; Burmeister, O.; Braun, S.; Reischl, M.: Dokumentation der MATLAB-Toolbox Gait-CAD. Techn. Ber., Forschungszentrum Karlsruhe GmbH. 2006 (Internet)

Course: Digital Control [2137309]

Coordinators: M. Knoop
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination; duration: 30 minutes; no tools or reference materials may be used during the exam.

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
The lecture intoduces 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.

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

Literature

- Lunze, J.: Regelungstechnik 2, 3. Auflage, Springer Verlag, Berlin Heidelberg 2005
- Unbehauen, H.: Regelungstechnik, Band 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme. 8. Auflage, Vieweg Verlag, Braunschweig 2000
- Föllinger, O.: Lineare Abtastsysteme. 4. Auflage, R. Oldenbourg Verlag, München Wien 1990
- Ogata, K.: Discrete-Time Control Systems. 2nd edition, Prentice-Hall, Englewood Cliffs 1994
- Ackermann, J.: Abtastregelung, Band I, Analyse und Synthese. 3. Auflage, Springer Verlag, Berlin Heidelberg 1988

Course: Designing with numerical methods in product development [2161229]

Coordinators: E. Schnack
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are provided with a detailed overview of the numerical methods for product development in mechanical engineering. Account is taken of the fact that a modern development of products in mechanical engineering generally involves a multi-field approach: knowledge of thermodynamics, fluid mechanics, solid mechanics, electronics / electrics and magnetism are required. In addition, problems can be steady but are very often unsteady, i.e. time-dependent. All these aspects are incorporated into modern industrial software. In the lectures the fundamental methods used in the development of the software are introduced and discussed in detail. Students are provided with the tools to carry out the design process on a computer using existing industrial software. It is also worth noting that beside the finite element and the boundary element methods, structural optimisation with shape and topological optimisation must be taken into account. Structural optimisation will play an increasingly important role in the future.

Content
Overview of the numeric process: finite difference methods, finite volume methods. Finite element methods. Boundary element method (BEM). Thermodynamic processes. Flow dynamic processes. Solid dynamics. Nonlinear field behaviour. These methods are summarised at the end of the course, and a holistic concept for design processes is developed.

Literature
Lecture notes (available in the administration office, building 10.91, rm. 310)

Course: Designing with composites [2162255]

Coordinators: E. Schnack
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
None.

Recommendations
None.

Learning Outcomes
The aim is to gain understanding of laminated composite materials with a wide variety of applications in the aerospace and automotive industries. The terminology used for modern composites will be introduced and the students will gain an understanding of lamina, laminae and laminate. In addition they will gain understanding of the transformation properties between a single-layer and a multi-layer coordinate system. They will understand new aspects of composites such as the piezo-electric monitoring of composite materials.

Content
Short overview of the definition of modern composite materials. Fundamental structure of industrial composites. Definition of the mixture rules for fibre and matrix materials. Calculation of a wide variety of transformations between lamina, laminae and laminate for different coordinate systems. Derivation of the relevant differential equations for composites.

Literature
Lecture notes available in the administration office, building 10.91, rm. 310

Course: Dynamics of mechanical Systems with tribological Contacts [2162207]

Coordinators: H. Hetzler
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam., 30min

Conditions
None.

Learning Outcomes
This lectures gives an introduction in to basic aspects of mechanical systems with contacts. Here, the tribological contact properties must be respected as well, since it affects the contact behaviour.
The course begins with the phyisical-mathematical description and adresses common solution strategies. By several example problems typcial dynamic phenomena are discussed.

Content
* Introduction into contact kinematics
* kinetics of mechanical systems with frictional unilateral contacts
* mathematical solution strategies
* introduction into contact mechanics
* normal contact (Hertzian contact, rough surfaces, constitutive contact laws)
* impacts (Newton's Impact law, wave effects)
* friction induced vibrations (stick-slip, squeal, ...)
* lubricated contacts: Reynold's Equation, rotors in fluid film bearings, EHD-contacts

Literature
list of literature will be handed out

Course: Dynamics of the Automotive Drive Train [2163111]

Coordinators: A. Fidlin
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Powertrain Systems Technology A: Automotive Systems
Machine Dynamics
Vibration theory

Learning Outcomes

- To obtain the basic skills in dynamic modelling of the vehicle powertrain including the most important components, driving situations and requirements

Content

- Main components of the vehicle powertrain and their modelling
- Typical driving situations
- Problemoriented models for particular driving situations
- System analysis and optimization with respect to dynamic behavior

Literature

- Dresig H. Schwingungen mechanischer Antriebssysteme, 2. Auflage, Springer, 2006
- Pfeiffer F., Mechanical System Dynamics, Springer, 2008
- Laschet A., Simulation von Antriebssystemen:Modellbildung der Schwingungssysteme und Beispiele aus der Antriebstechnik, Springer, 1988

Course: Introduction to Industrial Engineering [3110040]

Coordinators: B. Deml
Part of the modules: SP 52: Production Engineering (p. 228)[SP_52_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	en

Learning Control / Examinations
Compulsory Core Subject: oral exam
Optional Subject: oral exam (ca. 30 min)

Conditions
None.

Recommendations

- Willingness to learn interdisciplinarily (Technique, Economy, Legal regulations, Informatics . . .)
- Basic understanding of technical products
- Some knowledge about manufacturing techniques
- Basics of mathematical statistics

Learning Outcomes
After completion the lecture, the students are able

- to describe goals and fundamentals of Industrial Engineering,
- to apply basic methods of the configuration of work places and work environment,
- to apply fundamental methods of work organisation, e.g. employee selection or leadership. They can describe the theoretical basics of work satisfaction and motivation as well as the departmental und process organisation.
- to describe and apply the basics of production management, e.g. enterprise strategies, product development and planning, production systems, management of resources, work planning and controlling.

Content

1. Objectives and Goals of Industrial Engineering
2. Design of workplace andworking environment
3. Work Organisation
4. Staff selection
5. Job satisfaction/motivation
6. Human Resources Management
7. Structural Organisation
8. Process Organisation
9. Production Management
10. Business Strategy
11. Product Development and Program Planning
12. Production System

13. Management of Resources
14. Production Planning
15. Production Control
16. Business Controlling

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Introduction to Automotive Lightweight Technology [2113101]

Coordinators: F. Henning
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
verbally
duration: 20 - 30 min
auxiliary means: none

Conditions
none

Recommendations
none

Learning Outcomes
Students learn that lightweight design is a process of realizing a demanded function by using the smallest possible mass. They understand lightweight construction as a complex optimization problem with multiple boundary conditions, involving competences from methods, materials and production.
Students learn the established lightweight strategies and ways of construction. They know the metallic materials used in lightweight construction and understand the relation between material and vehicle body.

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
metalic materials
steal, aluminium, magnesium, titan

Course: Introduction to the Finite Element Method [2162282]

Coordinators: T. Böhlke

Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2+2	Summer term	de

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites are met by attestations during the associated lab course.

Conditions
The institute decides about registration for the lab course (restricted number of participants).

Recommendations
None.

Learning Outcomes
The students can

- apply the most important tensorial operations in the framework of linear elasticity
- analyse the initial-boundary-value problem of linear thermal conductivity
- analyse the boundary-value problem of linear elasticity
- assess the spatial discretization for 3D problems
- derive the weak form for solving a boundary value problem
- evalutae solution methods for linear systems of equations
- choose an appropriate element-type for performing a finite-element-analysis for a given problem
- evaluate error estimations for the results of a finite-element-analysis
- autonomously perform a finite-element-analysis using the software ABAQUS

Content

- introduction and motivation
- elements of tensor calculus
- the initial-boundary-value-problem of linear thermoconductivity
- the boundary-value-problem of linear elastostatic
- spatial discretization for 3D problems
- solution of the boundary-value-problem of elastostatic
- numerical solution of linear systems
- element types
- error estimation

Literature
lecture notes
Fish, J., Belytschko, T.: A First Course in Finite Elements, Wiley 2007 (includes an introduction into ABAQUS)

Course: Introduction to Theory of Materials [2182732]

Coordinators: M. Kamlah
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
Engineering Mechanics; Advanced Mathematics

Learning Outcomes
The student can judge for a problem to be computed, which constitutive model should be selected depending on choice of material and loading. For computation tools such as commercial finite element codes, the students can understand the documentation with respect to the implemented constitutive models, and they can make their choice based on their knowledge. The students have basic knowledge for the development of constitutive laws.

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.

Literature
[1] Peter Haupt: Continuum Mechanics and Theory of Materials, Springer
[2] Lecture Notes

Course: Introduction to the Mechanics of Composite Materials [2178734]

Coordinators: Y. Yang
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
Solid Mechanics

Learning Outcomes
The students understand the fundamentals of the mechanical properties of composite materials. Based on this they can apply design rules for composite materials. They are able to analyze lightweight structures with respect to their mechanical properties.

Content

- Introduction to composite materials, applied examples in the industry
- Micromechanical behaviour of a lamina
- Macromechanical behaviour of a lamina
- Macromechanical behaviour of a laminate (I):
  classical lamination theory
- Macromechanical behaviour of a laminate (II):
  stiffness / stress analysis
- Strength of laminates, failure criteria in laminates
- Optimization and Design of fiber reinforced composite materials

Literature
[1] Robert M. Jones (1999), Mechanics of Composite Materials
[2] Valery V. Vasiliev & Evgeny V. Morozov (2001), Mechanics and Analysis of Composite Materials, ISBN: 0-08-042702-2
[3] Helmut Schürmann (2007), Konstruieren mit Faser-Kunststoffverbunden, Springer, ISBN: 978-3-540-72189-5 .

Course: Introduction into Mechatronics [2105011]

Coordinators: G. Bretthauer, A. Albers
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
Written examination, oral examination or certification of participation depending on the "Studienplan" resp. "Prüfungs- und Studienordnung (SPO)".

Conditions
none

Learning Outcomes
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.

Content
Part I: Modeling and optimization (Prof. Bretthauer)

Introduction
Architecture of mechatronic systems
Modeling of mechatronic systems
Optimization of mechatronic systems
Perspective

Part II: Development and design (Prof. Albers)

Introduction
Development method for mechatronic products
Examples

Literature
Heimann, B.; Gerth, W.; Popp, K.: Mechatronik. Leipzig: Hanser, 1998
Isermann, R.: Mechatronische Systeme - Grundlagen. Berlin: Springer, 1999
Roddeck, W.: Einführung in die Mechatronik. Stuttgart: B. G. Teubner, 1997
Töpfer, H.; Kriesel, W.: Funktionseinheiten der Automatisierungstechnik. Berlin: Verlag Technik, 1988
Föllinger, O.: Regelungstechnik. Einführung in die Methoden und ihre Anwendung. Heidelberg: Hüthig, 1994
Bretthauer, G.: Modellierung dynamischer Systeme. Vorlesungsskript. Freiberg: TU Bergakademie, 1997

Course: Introduction into the multi-body dynamics [2162235]

Coordinators: W. Seemann
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Written exam

Optional subject: oral, 30 min.
Major Subject: oral, 20 min.

Conditions
None.

Learning Outcomes
The students know different possibilities to describe the position und orientation of rigid bodies. They realize that during numerical integration of the kinematic differential equations singularities may arise which may be avoided if for examle Euler-parameters are used. Holonomic as well as nonholonomic constraints and their effect on the structure of the differential equations are known. The description of the kinematic quantities in different reference systems can be done. The formulation of the moment of momentum using different reference frames for rotational velocity and inertia tensor is not a problem. Several methods for the derivation of equations of motion can be applied, especially for nonholonomic systems. The solution of equations of motion by numerical integration is understood in principle.

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 virtuel power, Lagrange's equations, Kane's equations, structure of the equations of motion

Literature
Wittenburg, J.: Dynamics of Systems of Rigid Bodies, Teubner Verlag, 1977
Roberson, R. E., Schwertassek, R.: Dynamics of Multibody Systems, Springer-Verlag, 1988
de Jal'on, J. G., Bayo, E.: Kinematik and Dynamic Simulation of Multibody System.
Kane, T.: Dynamics of rigid bodies.

Course: Introduction to modeling of aerospace systems [2154430]

Coordinators: G. Schlöffel
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min
no auxiliary means

Conditions
none

Recommendations
basic skills in mathematics, physics and fluid dynamics

Learning Outcomes
Students attending this lecture will be able to,

- give an outline of the common methods of modeling the flight of aerospace systems,
- describe the different phases of flight of an aerospace system launching from earth,
- handle and compute the physics and its particular impact on the aerospace system during the different phases of flight,
- discriminate and treat in particular the effects of gravitation, propulsion and aerodynamics,
- characterize and describe possible flight paths and orbits,
- implement in Matlab/Simulink the fundamental equations of motion with respect to the simulation of an aerospace system

Content
This lecture covers the following topics:

- Reference and coordinate systems and their transformations
- Newton-Euler-Equations of motion
- Gravitation
- Propulsion of aerospace systems
- Aerodynamics
- Trajectories and Orbits
- Re-entry

Implementation of a Matlab/Simulink simulation

Literature

- P. H. Zipfel: Modeling and Simulation of Aerospace Vehicle Dynamics. American Institute of Aeronautics and Astronautics (AIAA), Reston 2007. ISBN 978-1563478758
- A. Tewari: Atmospheric and Space Flight Dynamics. Birkhäuser, Boston 2007. ISBN 978-0-8176-4373-7
- W. Ley, K. Wittmann, W. Hallmann (Hrsg.): Handbuch der Raumfahrttechnik. Hanser, München 2011. ISBN 978-3446424067
- W. Büdeler: Geschichte der Raumfahrt. Edition Helmut Sigloch, Künzelsau 1999. ISBN 978-3893931941

Course: Introduction to numerical fluid dynamics [2157444]

Coordinators: B. Pritz
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Certificate of participation

Conditions
Fluid Mechanics (german language) [2153412]

Recommendations
Computational Methods in Fluid Mechanics [2157441]

Learning Outcomes
Students

- know the three components of CFD: mesh generation, calculation and evaluation.
- will be able to create simple geometries and generate mesh.
- can set up and carry out simulations.
- know the ways of evaluating the results and the possibilities of flow visualization.
- know how to analyze flow situations.

Content

1. Brief introduction into Linux
2. Mesh generation for an example geometry
3. Data visualisation and interpretation of preset calculation results
4. Handling of the flow solver
5. Full calculation cycle: Flat plate
6. Introduction to unsteady calculations: flow around a circular cylinder

Literature
Lecture notes/handout

Remarks
In winter term 2012/2013:
Course: Computational Methods in Fluid Mechanics (Exercise) [2157442]

Course: Introduction to Nonlinear Vibrations [2162247]

Coordinators: A. Fidlin
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
7	4	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory, dynamic stability

Learning Outcomes

- to learn the most usual nonlinear effects
- to learn the minimal models for these effects
- to be able to apply perturbation methods for the analysis of nonlinear systems
- to learn basics of the bifurcation theory
- to be able to identify dynamic chaos

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

Literature

- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Nayfeh A.H., Mook D.T. Nonlinear Oscillation. Wiley, 1979.
- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.

- Fidlin A. Nonlinear Oscillations in Mechanical Engigeering. Springer, 2005.
- Bogoliubov N.N., Mitropolskii Y.A. Asymptotic Methods in the Theory of Nonlinear Oscillations. Gordon and Breach, 1961.
- Nayfeh A.H. Perturbation Methods. Wiley, 1973.
- Sanders J.A., Verhulst F. Averaging methods in nonlinear dynamical systems. Springer-Verlag, 1985.
- Blekhman I.I. Vibrational Mechanics. World Scientific, 2000.
- Moon F.C. Chaotic Vibrations – an Introduction for applied Scientists and Engineers. John Wiley & Sons, 1987.

Course: Electric Rail Vehicles [2114346]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students know the history of electric traction in railway transportation from the very beginning to modern vehicles with three-phase traction drives.
They know the basics of railway transportation, vehicle dynamics and wheel-rail-contact and can deduct the requirements for electric rail vehicles out of it.
They understand purpose, design and functionality of electric traction drives.
They learn about the different systems of traction power supply with its advantages and disadvantages.
They are informed about actual concepts and new developments in the field of electric railway vehicles.

Content
History of electric traction with railway vehicles, economic impact
Vehicle dynamics: running resistance, tractive effort diagram, running cycles
Wheel-rail-contact
Electric drives: traction motors, power conversion, drives for vehicles at dc and ac lines, dieselelectric vehicles, multi system vehicles, axle drives, transmission of tractive effort to the rails
Traction power supply: networks, substations, inductive power supply, energy management
Modern vehicle concepts for mass transit and main line

Media
All slides are available for download (Ilias-platform).

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

Course: Elements of Technical Logistics [2117096]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at “Studienplan Maschinenbau”, latest version)

Conditions
None.

Recommendations
previous / parallel visit of LV 21177095 “Grundlagen der Technischen Logistik”

Learning Outcomes
Students are able to:

- Describe elements and systems of technical logistics,
- Model and calculate structures and functions of special conveying machines,
- Describe interdependence of material flow systems and technique quantitatively and qualitatively and
- Equip material flow systems with appropriate machines.

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

Media
supplementary sheets,projector, blackboard

Literature
recommendations during lectures

Course: Elements of Technical Logistics and Project [2117097]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Lesson: after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau"); (counts two-thirds);
Project: presentation, marked (counts one third)

Conditions
None.

Recommendations
previous / parallel visit of LV 21177095 "Grundlagen der Technischen Logistik"

Learning Outcomes
Students are able to:

- Describe elements and systems of technical logistics,
- Model and calculate structures and functions of special conveying machines,
- Describe interdependence of material flow systems and technique quantitatively and qualitatively,
- Equip material flow systems with appropriate machines and
- Judge about systems in place and justify it in front of subject related persons.

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.

Media
supplementary sheets,projector, blackboard

Literature
recommendations during lectures

Course: Energy efficient intralogistic systems [2117500]

Coordinators: F. Schönung

Part of the modules: SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral,30 min, examination dates after the end of each lesson period

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and choose basic measures to enhance energy efficency,
- Specify this measures considering material handling processes like
  - steady conveyors,
  - unsteady conveyors,
  - as well as the necassary drives,
- Model based on this material handling systems and calculate their energy efficiency and
- Choose ressource efficient material handling systems.

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.

Media
presentations, black board

Literature
None.

Remarks
none

Course: Energy Systems I: Renewable Energy [2129901]

Coordinators: R. Dagan
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	de

Learning Control / Examinations
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

Conditions
None.

Learning Outcomes
The student knows the principles of the feasibility of energy gain by means of renewable energies, in particular the solar energy.

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.

Course: Energy Systems II: Nuclear Power Technology [2130921]

Coordinators: A. Badea
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations

Conditions
none

Learning Outcomes
The goal is to get experienced with nuclear, cooling and control engineering calculation methods for the design of nuclear power plants with nuclear fission reactors and with the safety standards in the nuclear industry.

Content
nuclear fission & fusion,
chain reactions,
moderation,
light-water reactors,
reactor safety,
reactor dynamics,
design of nuclear reactors,
breeding processes,
nuclear power systems of generation IV

Course: Design Project Machine Tools and Industrial Handling [2149903]

Coordinators: J. Fleischer
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
The Design Project Machine Tools an Industrial Handling can only be combined with the lecture Machine Tools and Industrial Handling (Lecture-No. 2149902). The number of students is limited to five.

Recommendations
None

Learning Outcomes
The students . . .

- are able to solve a specified task in a team.
- have the ability to analyze a given work piece, to select the necessary manufacturing process and to deduce a suitable manufacturing strategy.
- are qualified to identify the required movements of work piece and tool.
- are enabled to select the essential components and assemblies as well as execute the necessary design and calculations of dimensions.
- have the ability to interpret and present their designs and calculations.
- are capable of performing FEA analysis regarding dynamic and static behavior of the machine tool.
- are qualified to perform the essential methods for design at optimal cost, detect potentials for cost reduction and solve the given task within target costs.
- are enabled to practice the learned knowledge and methods of Machine Tools and Industrial Handling on an actual example.

Content
The tutorial Design Project Machine Tools and Industrial Handling provides an inside view of machine tool development. Within the project the students are enabled to design a machine tool for a specified work piece selected by a corporate partner.
First a machining strategy is deduced. With this strategy the students are enabled to calculate the relevant technological specifications and to dimension the necessary components such as feed axes, frame, bed and main spindle. In the end the machine tool is designed and optimized with FEA methods. Aside a target costing approach is executed for remaining within the specified costs.
The Project is executed by the students under the instruction and in cooperation with the corporate partner.
It offers

- a unique opportunity to implement the learned knowledge interdisciplinary and creatively.
- inside views into manifold development and design work.
- Co-operation with first-grade cooperate partners.
- work within a student team and professional support by research associates.

Media
SharePoint, wiki, Catia V5R20

Literature
None

Remarks
None

Course: Experimental Dynamics [2162225]

Coordinators: A. Fidlin, Hetzler, Hartmut
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory, dynamic stability, nonlinear vibrations

Learning Outcomes

- To learn the basic principles for dynamic measurements
- To learn the basics of the experimental model validation
- To get the first experience in the digital data analysis
- To learn the limits of the minimal models
- To be able to perform simple measurements

Content

1. Introduction
2. Measurement principles
3. Sensors as coopled 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

Remarks
The lectures will be accompanied by the laboratory experiments

Course: Experimental Fluid Mechanics [2154446]

Coordinators: B. Frohnapfel, J. Kriegseis
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
Fundamental Knowledge about Fluid Mechanics

Learning Outcomes
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 measurment signal and data obtained with the common fluid mechanical measuring techniques.

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 in groups.
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

Media
Slides, blackboard, overhead

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Schlichting, H., Gersten, K.: Boundary Layer Theory, Springer 2000

Tropea, Yarin, Foss: Springer Handbook of Experimental Fluid Mechanics, Springer 2007

Course: Metallographic Lab Class [2175590]

Coordinators: K. von Klinski-Wetzel
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	

Learning Control / Examinations
Colloquium with every experiment, Laborjournal

Conditions
basic knowledge in materials science (e.g. lecture materials science I and II)

Learning Outcomes
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.

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
(e. g. copper-, aluminium-, nickel-, titanium-and tin-based alloys)

Literature
E. Macherauch: Praktikum in Werkstoffkunde, 10th edition, 1992

H. Schumann: Metallographie, 13th edition, Deutscher Verlag für Grundstoffindustrie, 1991

Literature List will be handed out with each experiment

Course: Welding Lab Course, in groupes [2173560]

Coordinators: J. Hoffmeister
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
Certificate to be issued after evaluation of the lab class report

Conditions
Certtificate of attendance for Welding technique I

Learning Outcomes
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.

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

Literature
distributed during the lab attendance

Remarks
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!

Course: Handling Characteristics of Motor Vehicles I [2113807]

Coordinators: H. Unrau
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Verbally

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know the basic connections between drivers, vehicles and environment. They can build up a vehicle simulation model, with which forces of inertia, aerodynamic forces and tyre forces as well as the appropriate moments are considered. They have proper knowledge in the area of tyre characteristics, since a special meaning comes to the tire behavior during driving dynamics simulation. Consequently they are ready to analyze the most importent influencing factors on the driving behaviour and to contribute to the optimization of the handling characteristics.

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

Literature
1. Willumeit, H.-P.: Modelle und Modellierungsverfahren in der Fahrzeugdynamik,
B. G. Teubner Verlag, 1998

2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R.; Unrau, H.-J.: Reprint collection to the lecture Handling Characteristics of Motor Vehicles I

Course: Handling Characteristics of Motor Vehicles II [2114838]

Coordinators: H. Unrau
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of common test methods, with which the handling of vehicles is gauged. They are able to interpret results of different stationary and transient testing methods. Apart from the methods, with which e.g. the driveability in curves or the transient behaviour from vehicles can be registered, also the influences from cross-wind and from uneven roadways on the handling characteristics are well known. They are familiar with the stability behavior from single vehicles and from vehicles with trailer. Consequently they are ready to judge the driving behaviour of vehicles and to change it by specific vehicle modifications.

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

Literature
1. Zomotor, A.: Fahrwerktechnik: Fahrverhalten, Vogel Verlag, 1991
2. Mitschke, M./Wallentowitz, H.: Dynamik von Kraftfahrzeugen, Springer-Verlag, Berlin, 2004

3. Gnadler, R. Unrau, H.-J.: Reprint collection to the lecture Handling Characteristics of Motor Vehicles II

Course: Vehicle Comfort and Acoustics I [2113806]

Coordinators: F. Gauterin
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know what noises and vibrations mean, how they are generated, and how they are perceived by human beings.
They have knowledge about the requirements given by users and the public. They know which components of the vehicle are participating in which way on noise and vibration phenomenon and how they could be improved. They are ready to apply different tools and methods to analyze relations and to judge them. They are able to develop the chasis regarding driving comfort and acoustic under consideration of goal conflicts.

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.

Literature
1. Michael Möser, Technische Akustik, Springer, Berlin, 2005

2. Russel C. Hibbeler, Technische Mechanik 3, Dynamik, Pearson Studium, München, 2006

3. Manfred Mitschke, Dynamik der Kraftfahrzeuge, Band B: Schwingungen, Springer, Berlin, 1997

The script will be supplied in the lectures

Course: Vehicle Comfort and Acoustics II [2114825]

Coordinators: F. Gauterin
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have knowledge about the noise and vibration properties of the chassis components and the drive train. They know what kind of noise and vibration phenomena do exist, what are the generation mechanisms behind, which components of the vehicle participate in which way and how could they be improved. They have knowledge in the subject area of noise emission of automobiles: Noise impact, legal requirements, sources and influencing parameters, component and system optimization, target conflicts and development methods. They are ready to analyze, to judge and to optimize the vehicle with its single components regarding acoustic and vibration phenomena. They are also able to contribute competently to the development of a vehicle regarding the noise emission.

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

Literature
The script will be supplied in the lectures.

Course: Vehicle Mechatronics I [2113816]

Coordinators: D. Ammon
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the system science field of mechatronics and its application in the area of vehicle conception, especially in the context of vehicle system dynamics. They know the tools and methods for a systemactical analysis, conception, and design of mechatronic systems, focussing on mechatronically extended suspension systems. They are ready to analyze, to judge and to optimize mechatronic systems.

Content
1. Introduction: Mechatronics in vehicle technology
2. Vehicle Control systems
Brake- and traction controls (ABS, ASR, automated power train controls)
Active and semiactive suspension systems, active stabilizor bars
Vehicle dynamics controls, driver assistence systems
3. Modelling technology
Mechanics - multi body dynamics
Electrical and electronical systems, control systems
Hydraulics
Interdisciplinary coupled systems
4. Computer simulation technology
Numerical integration methods
Quality (validation, operating areas, accuracy, performance)
Simulator-coupling (hardware-in-the-loop, software-in-the-loop)
5. Systemdesign (example: brake control)
Demands, requirements (funktion, safety, robustness)
Problem setup (analysis - modelling - model reduction)
Solution approaches
Evaluation (quality, efficiency, validation area, concept ripeness)

Literature
1. Ammon, D., Modellbildung und Systementwicklung in der Fahrzeugdynamik, Teubner, Stuttgart, 1997
2. Mitschke, M., Dynamik der Kraftfahrzeuge, Bände A-C, Springer, Berlin, 1984ff
3. Miu, D.K., Mechatronics - Electromechanics and Contromechanics, Springer, New York, 1992
4. Popp, K. u. Schiehlen, W., Fahrzeugdynamik - Eine Einführung in die Dynamik des Systems Fahrzeug-Fahrweg, Teubner, Stuttgart, 1993
5. Roddeck, W., Einführung in die Mechatronik, Teubner, Stuttgart, 1997
6. Zomotor, A., Fahrwerktechnik: Fahrverhalten, Vogel, Würzburg, 1987

Course: Automotive Vision [2138340]

Coordinators: C. Stiller, M. Lauer
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
Fundamentals in measurement, system and control theory, e.g. from the lecture “Measurement and Control Systems”

Learning Outcomes
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 ßeeing vehicles’. Application examples from cutting-edge and future driver
assistance systems illustrate the discussed subjects.

Content
1. Driver assistance systems
2. Image acquisition and discretization
3. Image signal processing
4. Stochastic image models
5. Stereo vision and image sequence processing
6. Tracking
7. Lane recognition
8. Obstacle recognition

Literature
TBA

Course: Composites for Lightweight Design [2114052]

Coordinators: F. Henning
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
verbally
duration: 20 - 30 min
auxiliary means: none

Conditions
none

Recommendations
none

Learning Outcomes
Students know different polymer resin materials and fiber materials and can deduce their character and use.
They understand the reinforcing effect of fibers in a matrix surrounding as well as the tasks of the single components in a compound. They know about the influence of the length of fibers, their mechanical characters and performance in a polymer matrix compound.
Student know the important industrial production processes for continuous and discontinuous reinforced polymer matrix compounds.

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

Course: Manufacturing Technology [2149657]

Coordinators: V. Schulze, F. Zanger
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

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.

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

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Solid State Reactions and Kinetics of Phase Transformations (with exercises) [2193003]

Coordinators: D. Cupid, P. Franke
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination (30 min)

Conditions

- Bacic course in materials science and engineering
- physical chemistry

Recommendations
none

Learning Outcomes
diffusion mechanisms, Fick's laws, basic solutions of the diffusion equation, evaluation of diffusion experiments, interdiffusion, thermodynamic factor, parabolic growth of layers, pearlite, transformations of microstructure according to Avrami and Johnson-Mehl

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

Literature
1. J. Crank, „The Mathematics of Diffusion“, 2nd Ed., Clarendon Press, Oxford, 1975.
2. J. Philibert, „Atom Movements“, Les Éditions de Physique, Les Ulis, 1991.
3. D.A. Porter, K.E. Easterling, M.Y. Sherif, „Phase Transformations in Metals and Alloys“, 3rd edition, CRS Press, 2009.
4. H. Mehrer, „Diffusion in Solids“, Springer, Berlin, 2007.

Course: Fluid Technology [2114093]

Coordinators: M. Geimer
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2+2	Winter term	de

Learning Control / Examinations
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.

Conditions
None.

Learning Outcomes
The students will be able to

-
- know and understand physical principles of fluid power systems
- know the current components and their operating mode
- know the advantages and disadvantages of different components
- dimension the components for a given purpose
- calculate simple systems

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.

Literature
Scritum for the lecture *Fluidtechnik*
Institute of Vehicle System Technology
downloadable

Course: Gas Engines [2134141]

Coordinators: R. Golloch
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral examination, duration 30 min., no aid allowed

Conditions
none

Recommendations
Knowledge about „Verbrennungsmotoren A und B“

Learning Outcomes
The student can name and explain the function, characteristics and application areas of gas and dual fuel engines. He is able to distinguish from engines using liquid fuels. The student describe and explain gaseous fuels, engine subsystems, combustion processes and exhaust gas aftertreatment technologies. He is capable to analyse and evaluate current development areas and technical challenges.

Content
Based on the basics of internal combustion engines the students learn about functions of modern gas and dual fuel engines. Core learning areas are gaseous fuels, combustion processes including abnormal combustion characteristics, subsystems like gas admission, ignition, safety and control systems. Further knowledge will be teached on emissions, exhaust gas aftertreatment, applications and operation characteristics.

Media
Lecture with PowerPoint slides

Literature
Lecture Script, prepared by the lecturer. Obtainable at the Institut für Kolbenmaschinen
Recommended:
- Merker, Schwarz, Teichmann: Grundlagen Verbrennungsmotoren, Vieweg + Teubner Verlag 2011;
- Zacharias: Gasmotoren, Vogel Fachbuch 2001

Course: Global vehicle evaluation within virtual road test [2114850]

Coordinators: B. Schick
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: CarMaker Simulation Environment

Conditions
none

Learning Outcomes
The students have an overview of the vehicle dynamics simulation, the model parametrization and the related data sources. They have good knowledge about vehicle dynamics test methods and related execution of virtual test driving (open loop, closed loop). They are able to evaluate driving behavior based on self-created results. They have achieved knowledge about influences and interactions of components such as tires, suspension, kinematics and compliance, roll bars, steering, brakes, mass distribution and powertrain and they have the qualification to analyze, to judge and to optimize components with regard to global vehicle behavior.

Content
1. Testing and evaluation methods
2. Fundamentals of vehicle dynamics simulation
3. Execution of virtual test driving and evaluation of the results
4. Influence of several components and optimization of global driving behavior

Literature
1. Reimpell, J.: Fahrwerktechnik: Grundlagen, Vogel Verlag, 1995
2. Unrau, H.-J.: Scriptum zur Vorlesung “Fahreigenschaften I”
3. Unrau, H.-J.: Scriptum zur Vorlesung “Fahreigenschaften II”
4. IPG: User Guide CarMaker

Course: Foundry Technology [2174575]

Coordinators: C. Wilhelm
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral

duration: 20 - 30 minutes

no notes

Conditions
Required: WK 1+2

Learning Outcomes
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 comparision, 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 detailled 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 desvcribe detailled.

Content
Moulding and casting processes
Solidifying of melts
Castability
Fe-Alloys
Non-Fe-Alloys
Moulding and additive materials
Core production
Sand reclamation
Feeding technology
Design in casting technology
Casting simulation
Foundry Processes

Literature
Reference to literature, documentation and partial lecture notes given in lecture

Course: Size effects in micro and nanostructures materials [2181744]

Coordinators: P. Gumbsch, D. Weygand, P. Gruber, M. Dienwiebel
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in materials science

Learning Outcomes
The student can

- describe the mechanical behavior of nano and micrometer sized structured materials and analyse and explain the origin for the differences compared to classical materials behavior.
- explain processing routes, experimetal characterization methods and adequate modelling schems for nano- and microstructred maetrials.

Content
Modern topics in the mechanics of materials are presented.

1. Nanotubes
* production routes, properties
* application
2. cermics
* defect statistics
3. size effect in metallic structures
* thin film mechanics
* micro pillar
* modelling:
discrete dislocation dynamic
4. nanocontact:
* gecko
* hierachical structures
5. nanotribology
* contact, friction: simple and multiple contacts
* radio nucleid technique

Literature
lecture slides

Course: Fundamentals of Energy Technology [2130927]

Coordinators: A. Badea
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Summer term	

Learning Control / Examinations

Conditions
none

Learning Outcomes
The students will receive state of the art knowledge about the very challenging field of energy industry and the permanent competition between the economical profitability and the long-term sustainability.

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

Course: Automotive Engineering I [2113805]

Coordinators: F. Gauterin, H. Unrau
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Verbally

Duration: 45 up to 60 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know the movements and the forces at the vehicle and are familiar with active and passive security. They have proper knowledge about operation of engines and alternative drives, the necessary transmission between engine and drive wheels and the power distribution. They have an overview of the components necessary for the drive and have the basic knowledge, to analyze, to judge and to develop the complex system “vehicle”.

Content
1. Driving mechanics: driving resistances and driving performances, mechanics of the longitudinal and transverse forces, collision mechanics

2. Engines: combustion engine, alternative drives (e.g. electric motor, fuel cell)

3. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)

4. Power transmission and distribution: drive shafts, cardon joints, differentials

Literature
1. Mitschke, M./ Wallentowitz, H.: Dynamik der Kraftfahrzeuge, Springer-Verlag, Berlin, 2004

2. Braes, H.-H.; Seiffert, U.: Handbuch Kraftfahrzeugtechnik, Vieweg&Sohn Verlag, 2005

3. Gnadler, R.: Script to the lecture ’Automotive Engineering I’

Course: Automotive Engineering II [2114835]

Coordinators: F. Gauterin, H. Unrau
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Written Examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the modules, which are necessary for the road holding of a motor vehicle and the power transmission between vehicle bodywork and roadway. They have knowledge of different wheel suspensions, the tyres, the steering elements and the brakes. They know different execution forms, the function and the influence on the driving or brake behavior. They are able to develop the appropriate components correctly. They are ready to analyze, to judge and to optimize the complex relationship of the different components under consideration of boundary conditions.

Content
1. Chassis: Wheel suspensions (rear axles, front axles, kinematics of axles), tyres, springs, damping devices
2. Steering elements: Steering elements of single vehicles and of trailers
3. Brakes: Disc brake, drum brake, retarder, comparison of the designs

Literature
1. Heißing, B./Ersoy, M.: Fahrwerkhandbuch: Grundlagen, Fahrdynamik, Komponenten, Systeme, Mechatronik, Perspektiven, Vieweg-Verlag, Wiesbaden, 2011

2. Breuer, B./Bill, K.-H.: Bremsenhandbuch: Grundlagen - Komponenten - Systeme - Fahrdynamik, Vieweg-Verlag, Wiesbaden, 2012

3. Gnadler, R.: Script to the lecture 'Automotive Engineering II'

Course: Grundlagen der Herstellungsverfahren der Keramik und Pulvermetallurgie [2193010]

Coordinators: R. Oberacker
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed

Learning Outcomes
The students know the basics of characterization of powders, pastes and suspensions. They have a fundamental understanding of the process technology for shaping of particulate systems. They are able to use these fundamentals to design selected wet- and dry forming processes.

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.

Literature

- R.J.Brook: Processing of Ceramics I+II, VCH Weinheim, 1996
- M.N. Rahaman: Cermamic Processing and Sintering, 2nd Ed., Marcel Dekker, 2003
- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Fundamentals of catalytic exhaust gas aftertreatment [2134138]

Coordinators: E. Lox
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 40 min., no auxiliary means

Conditions
none

Recommendations
Combustion Engines A or B or Fundamentals of Combustion engines I helpful

Learning Outcomes
The students can name and explain the scientific fundamentals of the catalytic exhaust gas aftertreatment, as well as the technical, political and economical parameters of its application in engines for passenger cars and HD vehicles.

The students are able to point out and explain which emissions are formed in combustion engines, why these emissions are helth-related critical and which measures the legislator has established to reduce the emissions.

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

Literature
Lecture notes available in the lectures

1. ”Environmental Catalysis” Edited by G.Ertl, H. Knötzinger, J. Weitkamp Wiley-VCH Verlag GmbH, Weinheim, 1999 ISBN 3-527-29827-4
2. ”Cleaner Cars- the history and technology of emission control since the 1960s” J. R. Mondt Society of Automotive Engineers, Inc., USA, 2000 Publication R-226, ISBN 0-7680-0222-2
3. ”Catalytic Air Pollution Control - commercial technology” R. M. Heck, R. J. Farrauto John Wiley & Sons, Inc., USA, 1995 ISBN 0-471-28614-1
4. ”Automobiles and Pollution” P. Degobert Editions Technic, Paris, 1995 ISBN 2-7108-0676-2
5. ”Reduced Emissions and Fuel Consumption in Automobile Engines” F. Schaeder, R. van Basshuysen, Springer Verlag Wien New York, 1995 ISBN 3-211-82718-8
6. ”Autoabgaskatalysatoren : Grudlagen - Herstellung - Entwicklung - Recycling - Ökologie” Ch. Hagelüken und 11 Mitautoren, Expert Verlag, Renningen, 2001 ISBN 3-8169-1932-4

Course: Foundations of nonlinear continuum mechanics [2181720]

Coordinators: M. Kamlah
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
Engineering Mechanics - Advanced Mathematics

Learning Outcomes
The students understand the fundamental structure of a continuum theory consisting of kinematics, balance laws and constitutive model. In particular, they recognize non-linear continuum mechanics as a common structure including all continuum theories of thermomechanics, which are obtained by adding a corresponding constitutive model. The students understand in detail the kinematics of finite deformation and know the transition to the geometrically linear theory they are familiar with. The students know the spatial and material representation of the theory and the different related tensors. The students take the balance laws as physical postulates and understand their respective physical motivation.

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 thrid 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.

Literature
lecture notes

Course: Basics of Technical Logistics [2117095]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau", latest version)

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe processes and machines of technical logistics,
- Model the fundamental structures and the impacts of material handling machines with mathematical models,
- Refer to industrially used machines and
- Model real machines applying knowledge from lessons and calculate their dimensions.

Content
Bases effect model of conveyor machines made 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

Media
supplementary sheets,projector, blackboard

Literature
Recommendations during lessons

Course: Fundmentals of Combustion I [2165515]

Coordinators: U. Maas
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory elective subject: Written exam.
In SP 45: oral exam.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students are able to:

- explain the chemical and physical processes gorverning combustion.
- discuss diagnostic methods apllied in combustion science.
- describe laminar and turbulent flames in a mathematical way.
- analyse the working principle of various technical combustion systems (e. g. piston engines, gas turbines, furnaces).

Content
Fundamental concepts ans phenomena
Experimental analysis of flames
Conservation equations for laminar flat flames
Thermodynamics of combustion processes
Transport phenomena
Chemical reactions
Chemical kinetics mechanisms
Laminar premixed flames
Laminar diffusion flames

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes,
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments, Pollutant Formation, authors: U. Maas, J. Warnatz, R.W. Dibble, Springer-Lehrbuch, Heidelberg 1996

Remarks
Compulsory elective subject: 2+1 SWS and 5 LP.

Course: Fundamentals of combustion II [2166538]

Coordinators: U. Maas
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing the course attendents are able to:

-
- explain the processes involved in ignition (auto-ignition and induced ignition).
- describe the governing mechanisms in combustion of liquid and solid fuels.
- understand the mechanisms governing pollutant formation.
- describe turbulent reacting flows by means of simple models.
- explain the occurence of engine knock.
- outline the basic numerical schemes applied in the simulation of reacting flows.

Content
Ignition processes
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

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes;
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation,Experiments, Pollutant Formation; Authors: U. Maas, J. Warnatz, R.W. Dibble, Springer; Heidelberg, Karlsruhe, Berkley 2006

Course: Fundamentals of Combustion Engines I [2133103]

Coordinators: H. Kubach, T. Koch

Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
oral examination, Duration: 40 min., no auxiliary means

Conditions
None.

Recommendations
None.

Learning Outcomes
The student can name and explain the working princile of combustion engines. He is able to analyse and evaluate the combustion process. He is able to evaluate influences of gas exchange, mixture formation, fuels and exhaust gas aftertreatment on the combustion performance. He can solve basic research problems in the field of engine development.

Content
Introduction, History, Concepts
Working Principle and Termodynamics
Characteristic Parameters
Air Path
Fuel Path
Energy Conversion
Fuels
Emissions
Exhaust Gas Aftertreatment

Literature
Lecturer notes available in the 'Studentenhaus'

Course: Fundamentals of Combustion Engines II [2134131]

Coordinators: H. Kubach, T. Koch
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
oral examination, Duration: 0,5 hours, no auxiliary means

Conditions
None.

Recommendations
Combustion Engines A helpful

Learning Outcomes
The students deepen and complement their knowledgement from the lecture combustion engines A. they can name and explain construction elements, development tools and latest development trends. They are be able to analyse and evaluate powertrain concepts which are subject of the lecture.

Content
Emissions
Fuels
Drive Train Dynamics
Engine Parts
Boosting
Alternative Powertrain Concepts

Special Engine Concepts

Power Transmission

Literature
Lecture notes available in the 'Studentenhaus'

Remarks
This lecture is not offered anymore. Students who attended the lecture in earlier semesters can still choose an oral exam in this subject.

Course: Basics and Methods for Integration of Tires and Vehicles [2114843]

Coordinators: G. Leister
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
Knowledge in automotive engineering

Learning Outcomes
The students are informed about the interactions of tires, chassis and road. They have an overview of the processes regarding the tire development. They have knowledge of the physical relationships. They are ready to analyze and to judge the mentioned interactions. They are able to participate competently in the chassis development.

Content
1. The role of the tire in a vehicle
2. Tire geometrie, Package and load capacity, 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: Forces and Moments
6. Tire modes and sound
7. Tire presssure: Indirect and direct measuring systems
8. Tire testing subjective and objective

Literature
Manuscript to the lecture

Course: Fundamentals for Design of Motor-Vehicles Bodies I [2113814]

Coordinators: H. Bardehle
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the fundamental possibilities for design and manufacture of motor-vehicle bodies. They know the complete process, from the first idea, through the concept to the dimensioned drawings (e.g. with FE-methods). They have knowledge about the fundamentals and their correlations, to be able to analyze and to judge relating components as well as to develop them accordingly.

Content
1. History and design

2. Aerodynamics

3. Design methods (CAD/CAM, FEM)

4. Manufacturing methods of body parts

5. Fastening technologie

6. Body in white / body production, body surface

Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH,
Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg

Course: Fundamentals for Design of Motor-Vehicles Bodies II [2114840]

Coordinators: H. Bardehle
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know that, often the design of seemingly simple detail components can result in the solution of complex problems. They have knowledge in testing procedures of body properties. They have an overview of body parts such as bumpers, window lift mechanism and seats. They understand, as well as, parallel to the normal electrical system, about the electronic side of a motor vehicle. Based on this they are ready to analyze and to judge the relation of these single components. They are also able to contribute competently to complex development tasks by imparted knowledge in project management.

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

Literature
1. Automobiltechnische Zeitschrift ATZ, Friedr. Vieweg & Sohn Verlagsges. mbH, Wiesbaden
2. Automobil Revue, Bern (Schweiz)
3. Automobil Produktion, Verlag Moderne Industrie, Landsberg

Course: Fundamentals in the Development of Commercial Vehicles I [2113812]

Coordinators: J. Zürn
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have proper knowledge about the process of commercial vehicle development starting from the concept and the underlying original idea to the real design. They know that the customer requirements, the technical realisability, the functionality and the economy are important drivers.
The students are able to develop parts and components. Furthermore they have knowledge about different cab concepts, the interior and the interior design process. Consequently they are ready to analyze and to judge concepts of commercial vehicles as well as to participate competently in the commercial vehicle development.

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

Literature
1. Marwitz, H., Zittel, S.: ACTROS – die neue schwere Lastwagenbaureihe von Mercedes-Benz, ATZ 98, 1996, Nr. 9

2. Alber, P., McKellip, S.: ACTROS – Optimierte passive Sicherheit, ATZ 98, 1996

3. Morschheuser, K.: Airbag im Rahmenfahrzeug, ATZ 97, 1995, S. 450 ff.

Course: Fundamentals in the Development of Commercial Vehicles II [2114844]

Coordinators: J. Zürn
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students know the advantages and disadvantages of different drives. Furthermore they are familiar with components, such as transfer box, propeller shaft, powered and non-powered frontaxle etc. Beside other mechanical components, such as chassis, axle suspension and braking system, also electric and electronic systems are known. Consequently the student are able to analyze and to judge the general concepts as well as to adjust them precisely with the area of application.

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

Literature
1. Schittler, M., Heinrich, R., Kerschbaum, W.: Mercedes-Benz Baureihe 500 – neue V-Motorengeneration für schwere Nutzfahrzeuge, MTZ 57 Nr. 9, S. 460 ff., 1996

2. Robert Bosch GmbH (Hrsg.): Bremsanlagen für Kraftfahrzeuge, VDI-Verlag, Düsseldorf, 1. Auflage, 1994

3. Rubi, V., Strifler, P. (Hrsg. Institut für Kraftfahrwesen RWTH Aachen): Industrielle Nutzfahrzeugentwicklung, Schriftenreihe Automobiltechnik, 1993

Course: Fundamentals of Automobile Development I [2113810]

Coordinators: R. Frech
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
Written examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the fundamentals of the development of automobiles. They know the development process, the national and the international legal requirements that are to be met. They have knowledge about the thermo-management, aerodynamics and the design of an automobile. They are ready to judge goal conflicts in the field of automobile development and to work out approaches to solving a problem.

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

Literature
The scriptum will be provided during the first lessons

Course: Fundamentals of Automobile Development II [2114842]

Coordinators: R. Frech
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
Written examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are familiar with the selection of appropriate materials and the choice of adequate production technology. They have knowledge of the acoustical properties of the automobiles, covering both the interior sound and exterior noise. They have an overview of the testing procedures of the automobiles. They know in detail the evaluation of the properties of the complete automobile. They are ready to participate competently in the development process of the complete vehicle.

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

Literature
The scriptum will be provided during the first lessons.

Course: Advanced Methods in Strength of Materials [2161252]

Coordinators: T. Böhlke
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2+2	Winter term	de

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites have to be met by attestations during the associated lab course

Conditions
The institutes decides about registration for the lab course (restricted number of participants).

Recommendations
None.

Learning Outcomes
The students can

-
- perform basic tensor operations
- apply solution concepts of elasticity theory to sample problems
- analyse and evaluate systems within the framework of linear elastic fracture mechanics
- know elements of elasto-plasticity theory
- evaluate systems according to known flow and failure hypotheses
- apply concepts of elasto-plasticity to sample problems
- solve independently small problems abot topics of lecture during the corresponding lab course using the FE-software ABAQUS

Content

-
- kinematics
- mechanical balance laws
- theory of elasticity
- linear elastic fracture mechanics
- linear and plane structures
- elasto-plasticity theory

Literature
lecture notes
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Gross, D.; Seelig, T.: Bruchmechanik. Springer 2002.
Hibbeler, R.C: Technische Mechanik 2 - Festigkeitslehre. Pearson Studium 2005.

Course: Hybrid and Electric Vehicles [23321]

Coordinators: M. Doppelbauer, M. Schiefer
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
written exam (2 h)

Conditions
none

Recommendations
none

Learning Outcomes
The students are able to understand the technical functionality of all drive components of hybrid and electric vehicles and their interaction in the drive train. They possess detailed knowledge about all drive components, in particular batteries and fuel cells, power electronics and electric machines including gears. Moreover they know the different drive train topologies and theirs specific advantages and disadvantages. The students can evaluate the technical, economical and ecological impact of alternative automotive drive technologies.

Content
Starting with the mobility needs of the modern industrialized society and the political goals concerning climate protection, the different drive and charge concepts of battery-electric and hybrid-electric vehicles are introduced and evaluated. The lecture gives a wide overview on all needed components such as electric drive trains, especially batteries, chargers, DC/DC-converters, DC/AC-converters, electrical machines and gear drives.
Structure:
Hybrid automotive drive trains
Electric automotive drive trains
Driving resistance and energy consumption
Control strategies
Energy storage systems
Fundamentals of electric machines
Induction machines
Synchronous machines
Special machines
Power electronics
Charging
Enviroment
Automotive examples
Requirements and specifications

Media
Slides

Literature

-
- Peter Hofmann: Hybridfahrzeuge – Ein alternatives Antriebskonzept für die Zukunft, Springer-Verlag, 2010
- L. Guzzella, A. Sciarretta: Vehicle Propulsion Systems – Introduction to Modeling and Optimization, Springer Verlag, 2010
- Konrad Reif: Konventioneller Antriebsstrang und Hybridantriebe – Bosch Fachinformation Automobil, Vieweg+Teubner Verlag, 2010
- Rolf Fischer: Elektrische Maschinen, Carl Hanser Verlag München, 2009

- Joachim Specovius: Grundkurs Leistungselektronik, Vieweg+Teubner Verlag, 2010

Remarks

The lecture slides can be downloaded from the institute's homepage at the beginning of the semester. Due to organizational reasons a certificate of attendance cannot be issued.

Course: Hydraulic Fluid Machinery I (Basics) [2157432]

Coordinators: M. Gabi
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Oral or written examination (see anouncement)
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
2153412 Fluid mechanics

Learning Outcomes
Students get to know the basics of hydraulic fluid machinery (pumps, fans, hydroturbines, windturbines, hydrodynamic transmissions) in general. Application of the knowledge in different fields of engineering.
The lecture introduces the basics of Hydraulic Fluid Machinery. The different types and shapes are presented. The basic equations for the preservation of mass, momentum and energy are discussed. Velocity schemes in typical cascades are shown, the Euler equation of fluid machinery and performance characteristics are deduced. Similarities and dimensionless parameters are discussed. Fundamental aspects of operation and cavitation are shown.
Students are able to understand the working principle of Hydraulic Fluid Machinery as well as the interaction with typical systems, in which they are integrated.

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

Literature

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Bohl, W.: Strömungsmaschinen I & II . Vogel-Verlag
3. Gülich, J.F.: Kreiselpumpen, Springer-Verlag
4. Pfleiderer, C.: Die Kreiselpumpen. Springer-Verlag
5. Carolus, T.: Ventilatoren. Teubner-Verlag
6. Kreiselpumpenlexikon. KSB Aktiengesellschaft
7. Zierep, J., Bühler, K.: Grundzüge der Strömungslehre. Teubner-Verlag

Course: Hydraulic Fluid Machinery II [2158105]

Coordinators: S. Caglar, M. Gabi, Martin Gabi
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: ca. 30 minutes
No tools or reference materials may be used during the exam.

Conditions
Hydraulic Fluid Machinery I (Basics)

Recommendations
2153412 Fluid mechanics

Learning Outcomes
Students get to know advanced basics of hydraulic fluid machinery (pumps, fans, hydroturbines, windturbines, hydrodynamic transmissions). Application of the knowledge in different fields of engineering.
The lecture introduces, based on the lecture Hydraulic Fluid Machinery I, advanced knowledge in the field of design and operation. The different types and shapes are discussed.
Students are able to understand the working and design principle of Hydraulic Fluid Machinery as well as the interaction with typical systems, in which they are integrated.

Content
Rotodynamic pumps and fans of different types of construction
Hydro turbines
Wind turbines
Hydrodynamic transmissions

Literature

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Siegloch, H.: Strömungsmaschinen, Hanser-Verlag
3. Pfleiderer, C.: Kreiselpumpen, Springer-Verlag
4. Carolus, T.: Ventilatoren, Teubner-Verlag
5. Bohl, W.: Ventilatoren, Vogel-Verlag
6. Raabe, J.: Hydraulische Maschinen, VDI-Verlag
7. Wolf, M.: Strömungskupplungen, Springer-Verlag
8. Hau, E.: Windkraftanlagen, Springer-Verlag

Course: Industrial aerodynamics [2153425]

Coordinators: T. Breitling
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Learning Outcomes
Students can describe the different challenges of aerdynamical 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.

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 combustation at direct injected Diesel engines
- Flow mixing and combustation at gasoline engine
- Vehicle aerodynamics
- HVAC-Systems and thermal comfort
- Aeroacoustics

Literature
Script

Remarks
Block course with limited number of participants, registration in the secretary's office required. See details at www.istm.kit.edu

Course: Information Systems in Logistics and Supply Chain Management [2118094]

Coordinators: C. Kilger
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- Describe requirements of logistical processes regarding IT systems,
- Choose information systems to support logistical processes and use them according to the requirements of a supply chain.

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

Media
presentations

Literature
Stadtler, Kilger: Supply Chain Management and Advanced Planning, Springer, 4. Auflage 2008

Remarks
none

Course: Information Processing in Mechatronic Systems [2105022]

Coordinators: M. Kaufmann
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Basic knowledge of computer science and programming

Learning Outcomes
Students have fundamental knowledge about selection, conceptual design and development of information processing components in mechatronic systems.

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

Literature

- Marwedel, P.: Eingebettete Systeme. Springer: 2007.
- Teich, J: Digitale Hard-, Software-Systeme. Springer: 2007.
- Wörn, H., Brinkschulte, U.: Echtzeitsysteme: Grundlagen, Funktionsweisen, Anwendungen. Springer, 2005.
- Zöbel, D.: Echtzeitsysteme: Grundlagen der Planung. Springer, 2008.

Course: Information Processing in Sensor Networks [24102]

Coordinators: U. Hanebeck, F. Beutler
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Knowledge of the lectures *Localization of Mobile Agents* [IN4INLMA] or *Stochastic Information Processing* [IN4INSIV] will be beneficial.

Learning Outcomes
The student understands the specific challenges of information processing in the area of sensor networks and become acquainted with the different levels of processing procedures for the sensor measurements. The student is able to analyze, compare, and evaluate different approaches towards information processing in sensor networks.

Content
In the lecture, relevant aspects of information processing in sensor networks are considered. First, the technical configuration of a single sensor node is presented. This includes the main components required for information processing, like sensor technology, analog signal processing, analog-to-digital conversion, and digital signal processing. In the second part, approaches for localization, time synchronization, routing, and sensor scheduling are presented. At the end of the lecture, approaches for sensor information fusion as well as the model-based reconstruction of distributed phenomena are discussed.

Media

- Handwritten lecture notes will be made available electronically.
- Figures and application examples on slides.

More information can be retrieved from the information brochure available on the ISAS website.

Literature
Elective literature:
Lecture notes.

Course: Integrated measurement systems for fluid mechanics applications [2171486]

Coordinators: H. Bauer, Mitarbeiter
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	5	Winter / Summer Term	de

Learning Control / Examinations
Group colloquia for each topic

Duration: approximately 10 minutes

no tools or reference materials may be used

Conditions
none

Learning Outcomes
The students are able to:

-
- theoretically describe and explain the fundamentals of computer aided measurements and and adopt them practically
- apply the basics learned during the lecture to a practical problem in the form of a PC excercise

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

Literature
Germer, H.; Wefers, N.: Meßelektronik, Bd. 1, 1985
LabView User Manual
Hoffmann, Jörg: Taschenbuch der Messtechnik, 6., aktualisierte. Aufl. , 2011

Remarks
Registration during the lecture period via the website.

Course: Integrated production planning [2150660]

Coordinators: G. Lanza
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
Attendance of the lecture 'Manufacturing Engineering' [21657] prior to attending this lecture is recommended.

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.

Content
As part of this lecture further engineering aspects of production technology are taught. This includes content from the manufacturing technology, machine tools and handling techniques as well as the organization and planning.
Planning factories within the context of value networks and integrated production systems (Toyota etc.) requires an integrated perspective for the consideration of all functions included in the "factory" system. This includes the planning of manufacturing systems including the product, the value network and factory production, and the examination of SOPs, the running of a factory and maintenance. Content and theory covered by this lecture are completed with many examples from industry and exercises based on real-life situations and conditions.
Main topics covered by the lecture:

- The basic principles of production planning
- Links between product planning and production planning
- Integrating a production site into a production network
- Steps and methods of factory planning
- Approach to the integrated planning of manufacturing and assembly plants
- Layout of production sites
- Maintenance
- Material flow
- Digital factory
- Process simulation for material flow optimisation
- Start-up

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Intermodal Transport and Cross-Border Rail Traffic [2114916]

Coordinators: P. Gratzfeld, R. Grube
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students learn about the entrepreneurial approach and viewpoint of railways. They comprehend key issues of the transport policy, regulatory as well as financial framework, and grasp strategic fields of action in international as well as intermodal market perspectives.

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 enviroment
Trends in the transportation market
Future of Deutsche Bahn, DB 2020
Integration of traffic carriers
International passenger and freight transportation

Media
All material is available for download (Ilias-platform).

Literature
none

Remarks
For the dates please see special announcement on the website www.bahnsystemtechnik.de

Course: IT for facility logistics [2118083]

Coordinators: F. Thomas
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe and classify automation technologie for material flow and the information technology necessary,
- Names and uses measures to handle risks of failure, and
- Transfer his knowledge to practical implementations.

Content
This lecture, with exercises, treats automation technology in material flow as well as the information technology that has a direct relationship with it. In the first few chapters, an overview is given of the motors and conveying technology elements used in materials handling, and the sensors required for the purpose are explained. The target control types as well as the topic of coding techniques (barcodes etc) are treated in detail. Material flow controls are defined based on
these chapters. Among other things, the functions of a stored-memory controller are explained in this section. Hierarchically classified control structures and
their integration in network structures are considered in detail. The principles of communications systems (bus systems etc.) are supplemented with information on
the use of the Internet as well as data warehousing strategies. An overview of modern logistics systems, especially in stores administration, illustrates new
problem solution strategies in the area of information technology for logistics systems. After an analysis of the causes for system failures, measures are worked
out for reducing the risks of failure. Furthermore, the objectives, task areas as well as various scheduling strategies in the area of transport management and
control are presented. Worthwhile information on Europe-wide logistics concepts round off this practice-oriented lecture series.
The presentation of the lectures will be multimedia-based. Exercises repeat and extend the knowledge principles imparted in the lectures and illustrate the
subject with practical examples.

- Electrical drives (DC, AC asynchronous, EC, linear motors)
- Contact-less proximity switches (inductive, capacitive, optical, acoustic)
- Coding technology (target controllers, codes, laser, CCD sensors, reading techniques, mobile data media)
- Material flow control (stored-program controllers, material flow controllers, flexible information systems)

- Communications systems (principles, bus systems, Internet, Data Warehouse)
- Material flow control and administration systems (stores administration, failure safety and data storage)
- Transport management (objectives, components, tasks, task areas, scheduling strategies, stacking management systems)
- Euro-logistics

Literature
Detailed script available from Script Sales, updated and enhanced annually.
CD-ROM with PowerPoint presentation of the lectures and exercises at the end of the semester available from the lecturer, updated and enhanced annually.

Remarks
none

Course: Introduction to Ceramics [2125757]

Coordinators: M. Hoffmann
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (30 min) taking place at the agreed date.
The re-examination is offered upon agreement.

Conditions
none

Recommendations
Fundamentals in natural science are recommended for students in mechanical and industrial engineering. The lecture requires the basics of the material science courses in mechanical or industrial engineering for bachelor students.

Learning Outcomes
The students know the most relevant crystal structures and defects of non metallic inorganic materials, are able to read binary and ternary phase diagrams and are familar with powdertechnological shaping techniques, sintering and grain growth. They know the basics of the linear elastic fracture mechanics, are familar with Weibull statistics, K-concept, subcritical crack growth, creep and the opportunities for microstructural reinforcement of ceramics. The students are able to explain the correlation among chemical bonding, crystal and defect structures and the electrical properties of ceramics.

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 siginificantly 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.

Media
Slides for the lecture:
available under http://www.iam.kit.edu/km

Literature

- H. Salmang, H. Scholze, "Keramik", Springer
- 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

Course: Cogitive Automobiles - Laboratory [2138341]

Coordinators: C. Stiller, M. Lauer, B. Kitt
Part of the modules: SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Colloquia, final race

Conditions
Lectures "Automotive Vision" and "Behaviour Generation for Vehicles" have to be attended in parallel. Basic knowledge of a programming language is a plus.

Learning Outcomes
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.

Content
1. Lane recognition
2. Object detection
3. Vehicle lateral control
4. Vehicle longitudinal control
5. Collision avoidance

Literature
TBA

Course: Design with Plastics [2174571]

Coordinators: M. Liedel
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral duration: 20 - 30 min. aids: none

Conditions
none, recomm. 'Polymer Engineering I'

Learning Outcomes
Students will be able to
• distinguish polymer compounds from other construction materials regarding chemical differences, thermal behaviour and solid conditions.
• discuss main plastics processes regarding advantages and disadvantages of materials selection and part geometry design and to make appropiate selections.
• analyze complex application requirements concerning material impacts on strength and to use the classic dimensioning method specific to the application to evalute the lifetime part strength limit.
• evaluate part tolerances and geometry by appropiate 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.

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.

Literature
Scriptum will be handed out during the lecture.
Recommended literature are provided in the lecture.

Course: Lightweight Engineering Design [2146190]

Coordinators: A. Albers, N. Burkardt
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination

Duration: 20 minutes (Bachelor/Master)
Auxiliary means: none

Conditions
none

Learning Outcomes
The students are able to ...

- name the central strategies of lightweight construction and their connections and to illustrate them on examples.
- list different stiffening methods in relation to computer-based design.
- evaluate the capacity of computer-based design as well as the related limits and influences on the manufacturing.
- reflect the basics of lightweight construction in the overall framework related to the product engineering process.

Content
General aspects of leightweight 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.

Media
Beamer

Literature
Klein, B.: Leichtbau-Konstruktion. Vieweg & Sohn Verlag, 2007
Wiedemann, J.: Leichtbau: Elemente und Konstruktion, Springer Verlag, 2006
Harzheim, L.: Strukturoptimierung. Grundlagen und Anwendungen. Verlag Harri Deutsch, 2008

Remarks
Lecture slides are available via eLearning-Platform ILIAS.

Course: Vibration of continuous systems [2161214]

Coordinators: H. Hetzler
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam., 30min

Conditions
None.

Learning Outcomes

Content
This lecture is on vibrations of continuous systems. After an introduction into the topic and a definition of basic concepts and calculation approaches, 1-parametric continua (strings, bars) and 2-parametric continua (membranes, plates) are discussed into detailed. Based on these basic models, a brief outlook to more complex geometries is given. Beyond these basis issues more advanced topics (like elastic rotors) are discussed as well.

Literature
Literature recommendations are given in the lecture.

Course: Correlation Methods in Measurement and Control [2137304]

Coordinators: F. Mesch
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions

- Fundamentals of the lecture "Measurement and Control Systems"
- Basic background in probability and statistics

Learning Outcomes
Description of temporal stochastic processes, correlation and spectral analysis and corresponding estimation methods.

Content
1. Introduction
2. Stochastic processes
3. Correlation functions and power density spectra of stationary processes
4. Stochastic processes in linear systems
5. Sampling and smoothing
6. Stochastic processes in non-linear systems
7. Estimation of stochastic parameters
8. Optimal linear systems
9. Signal detection
10. Applications in measurement

Literature

- Papoulis, A: Probability, Random Variables, and Stochastic Processes. McGraw-Hill Book

Comp. Newe York, 3. Aufl., 1991

- Brigham, E. O.: The Fast Fourier Transform and its Applications. Prentice-Hall Englewood

Cliffs, New Jersey, 1988

- Umdruck 'Zusammenstellung der wichtigsten Formeln'

Course: Motor Vehicle Laboratory [2115808]

Coordinators: M. Frey, M. El-Haji
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Colloquium before each experiment
After completion of the experiments: written examination
Duration: 90 minutes
Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have deepened their knowledge on motor vehicles acquired in lectures and can apply it practically. They have an overview of the applied measuring technique and can execute and analyse measurements for the handling of given problem definitions. They are ready to analyze and to judge measurement results.

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

Literature
1. Matschinsky, W: Radführungen der Straßenfahrzeuge, Verlag TÜV Rheinland, 1998

2. Reimpell, J.: Fahrwerktechnik: Fahrzeugmechanik, Vogel Verlag, 1992

3. Gnadler, R.: Documents to the Motor Vehicle Laboratory

Course: Warehousing and distribution systems [2118097]

Coordinators: M. Schwab, J. Weiblen
Part of the modules: SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version 29.06.2011)

Conditions
none

Recommendations
logistics lecture

Learning Outcomes
Students are able to:

- Describe the areas of typical warehouse and distribution systems with the respective processes and can illustrate it with sketches,
- Use and choose strategies of warehouse and distribution systems according to requirements,
- Classify typical systsems using criteria discussed in the lecture, and
- Reson about the choice of appropriate technical solutions.

Content

- Introduction
- Yard management
- Receiving
- Storage and picking
- Workshop on cycle times
- Consoldiation and packing
- Shipping
- Added Value
- Overhead
- Case Study: DCRM
- Planning of warehouses
- Case study: Planning of warehouses
- Distribution networks
- Lean Warehousing

Media
presentations, black board

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
BARTHOLDI III, John J., HACKMAN, Steven T. (2008)
Warehouse 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
WISSER, 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

Remarks
none

Course: Laser in automotive engineering [2182642]

Coordinators: J. Schneider
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
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].

Recommendations
None.

Learning Outcomes
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-, CO_2- 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.

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-, CO_2-, high power diode-laser)
- beam properties, guiding and shaping
- basics of materials processing with lasers
- laser applications in automotive engineering
- economical aspects
- savety aspects

Media
lecture notes via ILIAS

Literature
W. M. Steen: Laser Material Processing, 2010, Springer
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

Remarks
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.

Course: Leadership and Product Development [2145184]

Coordinators: A. Ploch
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The students are able to name, explain und discuss the main elements of leadership theories, methods and management development basics as well as the bordering topics of change management, intercultural competences, team work and corporate governance.

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

Course: Laboratory Exercise in Energy Technology [2171487]

Coordinators: H. Bauer, U. Maas, H. Wirbser
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter / Summer Term	de

Learning Control / Examinations
1 report, approx. 12 pages
Discussion of the documented results with the assistents

Duration: 30 minutes

no tools or reference materials may be used

Conditions
none

Recommendations
none

Learning Outcomes
Attending this course enables the students to:

- accomplish experimental and design related as well as theoretical tasks in a scientific background
- perform a correct evaluation of the obtained results
- adequately document and present their results in a scientific framework

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
- Heatcapacity
- Wood combustion

Remarks
Online registration within the first two weeks of the lecture periode at: http://www.its.kit.edu

Course: Logistics - organisation, design and control of logistic systems [2118078]

Coordinators: K. Furmans
Part of the modules: SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe logistical tasks,
- Design logistical systems suitable to the respective task,
- Dimension stocastical stock models,
- Determine essential influencing parameters on the bullwhip effect and
- Use optimizing solution methods.

Content
multistage logistic process chains
transport chain in logistic networks
distribution processes
distribution centers
logistics of production systems
dependencies between production and road traffic
information flow
cooperative strategies (like kanban, just-in-time, supply chain management)

Media
presentations, black board

Literature
None.

Remarks
none

Course: Automotive Logistics [2118085]

Coordinators: K. Furmans
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

Conditions
None.

Recommendations
None.

Learning Outcomes
Students are able to:

- Describe essential logistic questions, in a complex production network. As an example the automobile industry is used.
- Choose and apply solution possibilities for logistic problems in this area.

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

Media
presentations, black board

Literature
None.

Remarks
none

Course: Machine Vision [2137308]

Coordinators: C. Stiller, M. Lauer
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
Basic studies and preliminary examination; fundamentals in measurement, system and control theory, e.g. from the lecture “Measurement and Control Systems”

Learning Outcomes
Machine vision (or computer vision) describes the computer supported solution of visual tasks similar to a human. The technical domain machine vision incorporates numerous research areas like optics, digital image processing, 3D measurement technology and pattern recognition. One main focus is image understanding having the goal to gather the meaning of an image and draw conclusions from this semantic meaning. The subjects in the course machine vision are similar to the standard image processing procedure. The students shall acquire an overview on major Machine Vision methods and gather practical experience from computer exercises and experiments.

Content
1. Illumination
2. Image acquisition
3. Image preprocessing
4. Feature extraction
5. Stereo Vision
6. Robust parameter estimation
7. Classification and interpretation

Literature
Main results are summarized in pdf-file. Further recommendations will be presented in the lecture.

Course: Leadership and Conflict Management (in German) [2110017]

Coordinators: H. Hatzl
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Elective Subject: oral exam (ca. 30 min)
Optional Subject: oral exam (ca. 30 min)
Optional Subject Economics/Law: oral exam (ca. 30 min)

Conditions

- Compact course
- Limited number of participants
- Registration via ILIAS necessary
- Compulsory attendance during the whole lecture

Recommendations

- Knowledge of Work science and economics is usefull

Learning Outcomes

- Knowledge about techniques for management and leadership
- Preparation for the management and leadership in the job

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

Literature
Learning material:
Handout online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Literature:

- ALLHOFF, D.-W.; ALLHOFF, W.: Rhetorik und Kommunikation. Regensburg: Bayerischer Verlag für Sprechwissenschaft, 2000.

- ARMSTRONG, M.: Führungsgrundlagen. Wien, Frankfurt/M.: Ueberreuter, 2000.
- BUCHHOLZ, G.: Erprobte Management-Techniken. Renningen-Malmsheim : expert-Verlag, 1996.
- RICHARDS, M. D.; GREENLAW, P. S.: Management Decision Making. Homewood: Irwin, 1966.
- SCHNECK, O.: Management-Techniken, Frankfurt/M., New York: Campus Verlag, 1996.

Please refer to the latest edition.

Course: Machine Dynamics [2161224]

Coordinators: C. Proppe

Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	en

Learning Control / Examinations
Written examination (compulsory subject), auxiliary means: own manuscripts
Oral examination (optional subject) , no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to apply engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery. This includes the investigation of runup, stationary operation of rigid rotors including balancing, transient and stationary behavior of flexible rotors, critical speeds, dynamics of slider-crank mechanisms, torsional oscillations.

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

Literature
Biezeno, Grammel: Technische Dynamik, 2. Edition, 1953

Holzweißig, Dresig: Lehrbuch der Maschinendynamik, 1979

Dresig, Vulfson: Dynamik der Mechanismen, 1989

Course: Machine Dynamics II [2162220]

Coordinators: C. Proppe
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
oral exam, no auxiliary means allowed

Conditions
none

Recommendations
Machine Dynamics

Learning Outcomes
Students are able to develop and analyze detailed models in machine dynamics that encompass continuum models, fluid structure interaction, and stability analyses.

Content
- hydrodynamic bearings
- rotating shafts in hydrodynamic bearings
- belt drives
- virbation of turbine blades

Literature
R. Gasch, R. Nordmann, H. Pfützner: Rotordynamik, Springer, 2006

Course: Material flow in logistic systems [2117051]

Coordinators: K. Furmans
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", current version)

Conditions
none

Recommendations
Recommended compulsory optional subject:
Stochastics in mechanical engineering

Learning Outcomes
Students are able to:

- describe material flow processes qualitativ and quantitativ,
- assign possibibilities of technical solutions to a open operational task,
- plan material flow systems, illustrate them in simple models and analyse them regarding their performance,
- use methods to determine performance indicators like throughput, utilization, etc., and
- evaluate material flow systems regarding performance and availability.

Content

- elements of material flow systems (conveyor elements, fork, join elements)
- models of material flow networks using graph theory and matrices
- queueing theory, calculation of waiting time, utilization
- warehouseing and order-picking
- shuttle systems
- sorting systems
- simulation
- calculation of availability and reliability
- value stream analysis

Media
presentations, black board, book

Literature
Arnold, Dieter; Furmans, Kai : Materialfluss in Logistiksystemen; Springer-Verlag Berlin Heidelberg, 2009

Remarks
none

Course: Materials and Processes for Body Lightweight Construction in the Automotive Industry [2149669]

Coordinators: D. Steegmüller, S. Kienzle
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- 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.
- are able to evaluate the different methods against lightweight applications on the basis of technical and economic aspects.

Content
The objective of the lecture is to build up an overview of the relevant materials and processes for the production of a lightweight body. This includes both the actual production and the joining for the body. The lecture covers the different lightweight approaches and possible fields of application in the automotive industry. The methods are discussed with practical examples from the automotive industry.
The following topics will be covered:

- lightweight designs
- aluminum and steel for lightweight construction
- fibre-reinforced plastics by the RTM and SMC process
- joining of steel and aluminum (clinching, riveting, welding)
- bonding
- coating
- finishing
- quality assurance
- virtual factory

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Mathematical Methods in Dynamics [2161206]

Coordinators: C. Proppe
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Winter term	de

Learning Control / Examinations
written examination (compulsory subject), auxiliary means: own manuscripts allowed
oral examination (optional subject) no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
The students know the mathematical methods of dynamics precisely. They are able to use the basic mathematical methods for modelling the dynamical behaviour of elastic and rigid bodies.
The students have a basic understanding of the description of kinematics and kinetics of bodies. They also master the alternative formulations based on weak formulations and variational methods and the approximate solution methods for numerical calculations of the moving behaviour of elastic bodies.

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:
Priniciple of virtual work, variational calculations, Principle of Hamilto

Approximate solution methods:
Methods of weighted residuals, method of Ritz

Applications

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

K. Willner: Kontinuums- und Kontaktmechanik : synthetische und analytische Darstellung, Berlin, Heidelberg, 2003

J.N. Reddy: Energy Principles and Variational Methods in applied mechanics, New York, 2002

A. Boresi, K.P. Chong, S. Saigal: Approximate solution methods in engineering mechanics, New York, 2003

Course: Mathematical Methods in Strength of Materials [2161254]

Coordinators: T. Böhlke
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2+1	Winter term	de

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites are met by solution of homework problems

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can

-
- perform the most important tensor operatons in example problems
- classify tensors of second order according to their properties
- apply elements of tensoranalysis
- describe the kinematics of infinitesimal and finite deformations in tensorial notation
- derive balance laws of mechanics
- solve problems of elasticity and thermoelasticity using tensor notation
- apply the theoretical concepts of the lecture to special problems

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

- theory of elasticity
- thermo-elasticity

Literature
lecture notes
Bertram, A.: Elasticity and Plasticity of Large Deformations - an Introduction. Springer 2005.
Liu, I-S.: Continuum Mechanics. Springer, 2002.
Schade, H.: Tensoranalysis.Walter de Gruyter, New York, 1997.
Wriggers, P.: Nichtlineare Finite-Element-Methoden. Springer, 2001.

Course: Mathematical methods of vibration theory [2162241]

Coordinators: W. Seemann
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
written (compulsory subject), oral (optional subject)

Duration: 3 hours (compulsory subject), 30 minutes (optional subject), 20 minutes (major subject)

Allowed during exam: own scripts, literature (compulsory subject), none (optional subject or major subject)

Conditions
Technische Mechanik III, IV / Engineering Mechanics III, IV

Learning Outcomes
The students know to solve single differential equations with constant coefficients by various methods. For inhomogenious differential equations the inhomogenity may be arbitrary. They realize the relations between the different methods. For matrix-differential equations the students may derive the eigenvalue problem for free vibration and may obtain solutions for eigenvalues and eigenvectors. They know the modal transformation which is helpful to solve forced vibration. They may decide about stability of time-independent steady state solutions of nonlinear systems. They can derive boundary value problems by variational methods and know in principle how to solve them. For simple one-dimensional continua they may get analytical solutions. They can apply perturbation methods to derive analytical solutions for problems with small parameters.

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

Literature
Riemer, Wedig, Wauer: Mathematische Methoden der Technischen Mechanik

Course: Mathematical Methods in Fluid Mechanics [2154432]

Coordinators: A. Class, B. Frohnapfel
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written

Duration: 3 hours

Aux. means: formules, pocket calculator

Conditions
None.

Recommendations
Basic Knowledge about Fluid Mechanics

Learning Outcomes
The students can apply the mathematical methods of fluid mechanics effectively and precisely. They are able to use the basic mathematical methods for analytical and numerical modelling of the non-linear behaviour moving fluids. The students can apply the achieved understanding of the procedures to describe, simplify and solve the Navier-Stokes equations in order to calculate the flow behaviour.

Content
The lecture will cover a selection of the following topics

- numerical solution of the governing equation (finite difference methods)
- boundary layer flows (high Reynolds numbers)
- creeping flows (low Reynolds numbers)
- self similar solutions
- analogy shallow water theory and gas dynamics
- laminar-turbulent transitions
- turbulent flows (Reynolds-Averaged Navier Stokes Equations)

Media
Blackboard, Power Point

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Durst, F.: Fluid Mechanics: An Introduction to the Theory of Fluid Flows, Springer 2008
Batchelor, G.K.: An Introduction to Fluid Dynamics, Cambridge Mathematical Library
H. Ferziger, M. Peric, *Computational Methods for Fluid Dynamics*, Springer, 2008

Remarks
The lecture is accompanied by a tutorial where the application of the methods can be trained.

Course: Mathematical Methods in Structural Mechanics [2162280]

Coordinators: T. Böhlke
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2+1	Summer term	de

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites are met by solving homework problems

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students can

- apply methods of variational calculus for solving problems of linear elasticity
- assess mesoscopic and macroscopic können mesoskopische und makroskopische Spannungs- und Dehnungsmaße beurteilen
- apply and evaluate the methods of homogenization of elastic and thermo-elastic properties
- list methods of homogenization of elastic-plastic properties
- solve worksheet problems to topics of the lecture using technical-mathematical software

Content
Basics of variational calculus

- functionals; Frechet-differential; Gateaux-differential; maximum or minimum problems
- lemma of variational calculus and Lagrange delta-process; Euler-Lagrange-equations

Applications: Principals of continuums mechanics

- variational principals in mechanics; variational formulierung of boundary value problem of elastostatic

Applications: Homogenization methods for materials with microstructure

- mesoscopic and macroskopic 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

Literature
Vorlesungsskript
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Gross, D., Seelig, T.: Bruchmechanik – Mit einer Einführung in die Mikromechanik.
Springer 2002.
Klingbeil, E.: Variationsrechnung, BI Wissenschaftsverlag, 1977
Torquato, S.: Random Heterogeneous Materials. Springer, 2002.

Course: Mechanics of laminated composites [2161983]

Coordinators: E. Schnack
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
none

Recommendations
none

Learning Outcomes
In the first part of the course the students are introduced to the definition of modern composites. The terms 'lamina', 'laminae' and 'laminate' are explained in detail with reference to examples. The students are then able to classify modern composites, particularly when they use these materials to design machine structures. As by definition the material data are directionally dependent, different transformations are discussed so that the students can understand the structural behaviour and participate in the design of the materials.

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.

Literature
Lecture notes (available in the administration office, building 10.91, rm. 310)

Course: Mechanics and Strengths of Polymers [2173580]

Coordinators: B. von Bernstorff (Graf), von Bernstorff
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Duration: 20 - 30 minutes

no notes

Conditions
basic knowledge in materials science (e.g. lecture materials science I and II)

Learning Outcomes
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 homogenuous polymers and composite materials therefrom.

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

Literature
A literature list, specific documents and partial lecture notes shall be handed out during the lecture.

Course: Mechanics in Microtechnology [2181710]

Coordinators: P. Gruber, C. Greiner
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

Learning Outcomes
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.

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 Mechnical Parameters such as Young'sModulus and YieldDtrength; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Elektrostatics,...
8. Aktuation: Inverse Piezo-electric Effect, Shape Memory, Elektromagnetic Actuation,. . .

Literature
Folien,
1. M. Ohring: „The Materials Science of Thin Films", Academic Press, 1992
2. L.B. Freund and S. Suresh: „Thin Film Materials"
3. M. Madou: Fundamentals of Microfabrication", CRC Press 1997
4. M. Elwenspoek and R. Wiegerink: „Mechanical Microsensors" Springer Verlag 2000
5. Chang Liu: Foundations of MEMS, Illinois ECE Series, 2006

Course: Laboratory mechatronics [2105014]

Coordinators: A. Albers, G. Bretthauer, C. Proppe, C. Stiller
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
Certification of participation or oral examination depending on the "Studienplan" resp. "Prüfungs- und Studienordnung (SPO)" / IPEK: partial exmanination with grade

Conditions
none

Learning Outcomes
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.

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

Literature
Manuals for the laboratory course on Mechatronics

Course: Human-Machine-Interaction [24659]

Coordinators: M. Beigl, Takashi Miyaki
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Summer term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
120h

Content

Literature
David Benyon: Designing Interactive Systems: A Comprehensive Guide to HCI and Interaction Design. Addison-Wesley Educational Publishers Inc; 2nd Revised edition edition; ISBN-13: 978-0321435330
Steven Heim: The Resonant Interface: HCI Foundations for Interaction Design. Addison Wesley; 1 edition (March 15, 2007) ISBN-13: 978-0321375964

Course: Measurement II [2138326]

Coordinators: C. Stiller
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach], SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination

Duration: 30 minutes

no reference material

Conditions
Fundamentals in measurement, system and control theory, e.g. from the lecture "Measurement and Control Systems"

Learning Outcomes
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.

Content
1. Amplifiers
2. Digital technology
3. Stochastic modeling for measurement applications
4. Estimation
5. Kalman Filter
6. Environmental perception

Literature
Various Scripts

Course: Analysis tools for combustion diagnostics [2134134]

Coordinators: U. Wagner
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 0,5 hours, no auxiliary means

Conditions
none

Recommendations
Combustion Engines A or Fundamentals of Combustion Engines helpful

Learning Outcomes
The students can name and explain state-of-the-art methods to analyse the process in combustion as well as special measuring techniques such as optical and laser analysis. They are able to thermodynamically model, analyse and evaluate the engine process.

Content
energy balance at the engine
energy conversion in the combustion chamber
thermodynamics of the combustion process

flow velocities

flame propagation

special measurement techniques

Literature
Lecture notes available in the lectures

Course: Methodic Development of Mechatronic systems [2145180]

Coordinators: A. Albers, W. Burger
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Conditions
none

Learning Outcomes
The students ...

- are able to work in an interdisciplinary team for mechatronic system development, to understand the problems of the other subject and to arbitrate in case of misunderstandings.
- have knowledge about the different ways of thinking of mechanical engineers, electrical engineers and computer scientists.
- know the most common technical terms of electrical – and software engineering.
- are able to illustrate typical technical- human- interfaces in the mechatronic field and to identify interactions between mechanical and electrical part systems.

Content
Introduction - from market to product
Typical activities during the development of electronic components, traps and problems
Interfaces between mechanics / electronics / software / human user
Typical activities during the development of software, traps and problems
Failure modes and mechanisms of electronic circuits
Failure modes and verification of software
Quality assurance of mechatronic systems
Human interfacing problems, team-management

Literature
Manuals for the lecture available

Course: Microstructure characterization and modelling [2161251]

Coordinators: T. Böhlke, F. Fritzen
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Winter term	de

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students can

-
- list, apply and evaluate basic measures to describe the geometry of microstructured materials
- choose appropriate distribution functions for describing fibre or particle reinforced or plycrystalline materials
- list and evaluate the basic steps of algorithms for generation of synthetic structures

Content
An introduction to the statistical description of geometric properties of microstructured materials is given. Typically, particle or fibre reinforced materials and polycrystalline materials are considered. The statistical description using n-point-correlation functions is described as well as characteristic measures and distribution functions (fibre or crystal orientation distribution functions) are discussed. Additionally, methods for generation of synthetic structures are considered which are typical input data for numerical multiscale simulations.

Literature
Torquato, S.: Random heterogeneous materials: microstructure and macroscopic properties, Springer, New York, 2002.
Ohser, J., Mücklich, F.: Statistical Analysis of Microstructures in Materials Science, Statistics in Practice, John Wiley & Sons, 2000.

Course: Modelling of Microstructures [2183702]

Coordinators: A. August, B. Nestler, D. Weygand
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
We regularly hand out exercise sheets. The individual solutions will be corrected.
Exam: oral 30 minutes or written.

Conditions
None.

Recommendations
materials science
fundamental mathematics

Learning Outcomes
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.

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

Media
Black board and slides.

Literature

1. Gottstein, G. (2007) Physikalische Grundlagen der Materialkunde. Springer Verlag Berlin Heidelberg

2. Kurz, W. and Fischer, D. (1998) Fundamentals of Solidification. Trans Tech Publications ltd, Switzerland Germany UK USA
3. Porter, D.A. Eastering, K.E. and Sherif, M.Y. (2009) Phase transformation in metals and alloys (third edition). CRC Press, Taylor & Francis Group, Boca Raton, London, New York
4. Gaskell, D.R., Introduction to the thermodynamics of materials
5. Problem sheets

Course: Mobile Machines [2114073]

Coordinators: M. Geimer
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Summer term	de

Learning Control / Examinations
oral examination.

Conditions
Knowledge in Fluid Power is required.

Recommendations
It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

Learning Outcomes
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 of the structure of the whole system
- Practical insight in the development techniques

Media
Lecture notes.

Course: Mobility Concepts of Rail Transportation in 2030 [2115915]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Written report and oral exam

Conditions
Attendance is mandatory during the whole seminar.

Recommendations
none

Learning Outcomes

- The students learn about the innovationprocess of an international company in rail industry.
- They exercise advanced creativity techniques.
- They learn and deepen key qualifications like communication skills, presentation skills, moderation techniques and team work.

Content

- Company presentation
- Long term development of society and environment (megatrends), impact on railways and rail industry
- Creating, elaborating and discussing innovative ideas by using the tool “Zukunftswerkstatt”
- Final presentations

Media
All material is available for download (Ilias-platform).

Literature
Literatur will be provided during the course.

Remarks

- This seminar is a 5-day block course.
- Number of participants is limited.
- A registration is necessary.
- For further information please look at the website www. bahnsystemtechnik.de .

Course: Model based Application Methods [2134139]

Coordinators: F. Kirschbaum
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	

Learning Control / Examinations
take-home exam, short presentation with oral examination

Conditions
none

Recommendations
Basics of combustion engines, vehicualr systems, control theorie and statistics.

Learning Outcomes
The student can name the most important methods for model-based calibration of powertrain ECUs. Particulary he can choose and apply the correct approach for empirical modeling for a given powertrain calibration task (fuel consumption, emissions, air path, driveability, etc.) and type of plant (linear-nonlinear, static-dynamic, etc.). He is capable to solve typical Problems of a calibration engineer of automotive OEMs or suppliers.

Content
The efforts for the calibration of automotive powertrain ECUs are increasing due to new engine or powertrain technologies and tightening emission laws. From a present view only model based calibration methods are capable to handle this situation. The lecture presents a selection of practice-proofed model-based calibration methods.

Media
Lecture notes, blackboard, presentations and life demonstrations via projector

Course: Modelling and Simulation [2183703]

Coordinators: B. Nestler, P. Gumbsch
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter / Summer Term	de

Learning Control / Examinations
We regularly hand out exercise sheets. In addition, the course will be accompanied by practical exercises at the computer.
written examination: 90 minutes

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
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.

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

Media
Slides and black board. The slides will be provided as a manuscript for the course.

Literature

1. Scientific Computing, G. Golub and J.M. Ortega (B.G.Teubner Stuttgart 1996)

Course: Modern Concepts of Control [2105024]

Coordinators: L. Gröll, Groell
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of measurement and control

Learning Outcomes
Students have enlarged knowledge about control theory and they implement controllers for different problems in Matlab.

Content

- Reference feedforward control (2-DOF control)
- Qualitative theory of ordinary differential equations
- PID control
- Augmented control structures
- State space and state feedback control
- Input-output linearization
- Lyapunov theory

Literature

- Aström, K.-J., Murray, R.M.: Feedback Systems. Princeton University Press, 2009.
- Khalil, H.K.: Nonlinear Systems. Prentice Hall, 2002.

Course: Engine Laboratory [2134001]

Coordinators: U. Wagner
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
written documentation of every experiment, certificate of successful attendance, no grading

Conditions
Combustion Engines A or Fundamentals of Combustion Engines I

Learning Outcomes
The students are abele to transfer their theoretical knowledge to practical problems and to perform engine tests on stat-of-the-art test benches.

Content
5 engine experiments in up-to-date development projects

Literature
Description of experiments

Course: Engine measurement techniques [2134137]

Coordinators: S. Bernhardt
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination, Duration: 0,5 hours, no auxiliary means

Conditions
None.

Recommendations
Combustion Engines A or Fundamentals of Combustion Engines I helpful

Learning Outcomes
The students are able to explain the principles of modern measuring devices and are able to determin the right device for a certain measuring problem. The are able to analyse and evaluate the results.

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 abberations are discussed.

Furthermore techniques for measuring exhaust emissions, air/fuel ratio, fuel consumption as well as pressure indication for thermodynamic analysis are covered.

Literature
Lecture notes available in the lectures or in the 'Studentenhaus'

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

Course: Novel actuators and sensors [2141865]

Coordinators: M. Kohl, M. Sommer
Part of the modules: SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature

- Sensoren: “Sensors Update”, Volumes 1 und 2, Edited by H. Baltes, W.Göpel, J.Hesse, VCH, 1996, ISBN 3-527-29432-5
- Nanofasern: “Nanowires and Nanobelts”, Volume 2: Nanowires and Nanobelts of Functional Materials, Zhong Lin Wang, 2006, Springer, ISBN 10 0-387-28706-X

Course: Computational Methods in Fluid Mechanics [2157441]

Coordinators: F. Magagnato
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 30 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Learning Outcomes
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).

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

Media
"Powerpoint presentation", Beamer

Literature
Ferziger, Peric: Computational Methods for Fluid Dynamics. Springer-Verlag, 1999.
Hirsch: Numerical Computation of Internal and External Flows. John Wiley & Sons Inc., 1997.
Versteg, Malalasekera: An introduction to computational fluid dynamics. The finite volume method. John Wiley & Sons Inc., 1995

Course: Numerical simulation of reacting two phase flows [2169458]

Coordinators: R. Koch
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral exam
Duration: approximately 30 minutes

no tools or reference materials are allowed

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have the ability to:

- describe and apply the governing equations of fluid mechanics
- select and judge appropriate methods for predicting turbulent flows
- explain the procedures of numerical solver algorithms
- judge the numerical methods, on which comon CFD software is based
- judge and apply different approaches to characterize sprays
- apply methods for predicting the break up of liquids
- analyse and evaluate methods and models for the calculation of mulitphase flows
- describe reactive flows and the corresponding models

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.
1. Single phase flow: Basic equations of fluid dynamics, Turbulence: DNS, LES, RANS; Finite volume methods, Numerical solvers.

2. Two phase flows: Basics of atomisation, Characterisation of sprays, Numerical prediction of droplet movement, Numerical methods for predicitng of liquid disintegration (VoF, SPH), Numerical methods for secondary atomisation; Droplet evaporation

3. Reacting flows: Combustion models; Single droplet combustion, Spray combustion.

Literature
Lecture notes

Course: Intellectual Property Rights and Strategies in Industrial Companies [2147161]

Coordinators: F. Zacharias

Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
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.

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

Course: Photovoltaics [23737]

Coordinators: M. Powalla
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	

Learning Control / Examinations
Turorials, written exams, alternatively oral exam.

Conditions
Basic knowledge of thermodynamics and solid state physics.

Recommendations
Complement to “Energy Systems” and “Fundamentals of Energy Technology”.

Learning Outcomes
After the course attendants can:

- understand energy conversion in semiconductors.
- discuss emerging technological and production relevant aspects.
- capture the interaction of photovoltaic energy sytems with different system components.
- quantify losses.

Content

- The significance of photovoltaics in national and global energy supply.
- Physical fundamentals of energy conversion.
- Photovoltaic cells (specific parameters, materials, loss assessment).
- Implementation concepts (Sillicon technology, thin layer cells, concentrator cells, dye cells and organic cells).
- Modular technique and production technology.
- Photovoltaic energy systems (Components, alternative current converter, solar tracking, system design).

Literature
P. Würfel, Physik der Solarzellen, 2. Auflage (Spektrum Akademischer Verlag, Heidelberg, 2000)
R. Sauer, Halbleiterphysik, (Oldenburg Wissenschaftsverlag, 2009)
H.J. Lewerenz, H. Jungblut, Photovoltaik (Springer, Berlin, 1995)
H.G. Wagemann, Photovototaik, (Vieweg, Wiebaden, 2010)
Tom Markvart, Luis Castaner, Photovoltaics Fundamentals and Applications, (Elsevier, Oxford, 2003)
Heinrich Häberlin, Photovoltaik, (AZ Verlag, Aarau, 2007)

Course: Multi-scale Plasticity [2181750]

Coordinators: K. Schulz, C. Greiner
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
presentation (40%), oral examination (30 min, 60%)

Conditions

- limited number of participants
- mandatory registration
- mandatory attendance

Recommendations
preliminary knowlegde in mathematics, physics, mechanics and materials science

Learning Outcomes
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.

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.

Media
black board, beamer, script

Remarks
The maximum number of students is 14 per semester.

Course: Plasticity Theory [2162244]

Coordinators: T. Böhlke
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	2	Summer term	de

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students can

-
- derive the kinematics of finite deformations
- derive the balance laws in regular and irregular points
- discuss the principles of material theory for given examples
- evaluate the basics of fihite elasticity
- discuss the basics of elasto-plasticity
- apply basic concepts of crystal plasticity to example problems

Content

-
- tensor calculus, kinematics, balance equations
- principles of material theory
- finite elasticity
- infinitesimal elasto(visco)plasticity
- exact solutions ov infinitesimal Platicity
- finite elasto(visco)plasticity
- infinitesimal and finite crystal(visco)plasticity
- hardening and failure
- strain localization

Literature
lecture notes
Bertram, A.: Elasticity and Plasticity of Large Deformations - an Introduction. Springer 2005.
Liu, I-S.: Continuum Mechanics. Springer 2002.
Schade, H.: Tensoranalysis.Walter de Gruyter 1997.
Wriggers, P.: Nichtlineare Finite-Element-Methoden. Springer 2001.

Course: PLM for Product Development in Mechatronics [2122376]

Coordinators: M. Eigner
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (30 min.).

Conditions
None.

Learning Outcomes
Students have a basic overview about product data management and product lifecycle management.
Students know components and core functions of PLM solutions
Students can describe trends in research and practice in the environment of PLM

Content
Product Data Management
Product Lifecycle Management

Course: PLM-CAD workshop [2123357]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Winter term	de

Learning Control / Examinations
Evaluation of Project Management, presentation of final results and demonstration of the vehicle in practice

Conditions
None

Recommendations
None

Learning Outcomes
The overall objective is to depict usage of collaborative product development in terms of product lifecycle management (PLM) and to accent additional benefit contrary to classic CAD driven development processes as well as comprehensive management of product and variant structures. Students will be presented in detail how product specific data like e.g. bill-of-materials or sketches can transparently and holisticly managed by the use of PLM and moreover, they will be taught how to automatize workflow management in product development.

Content
In the Workshop a LEGO vehicle will be conceived and developed within a project order through usage of modern PLM and CAD systems in the field of lifecycle engineering.
main topics are:

- Autonomous design in development teams with LEGO Mindstorms NXT
- 3D-CAD conceptual design of the vehicle using Siemens UGS NX
- Simulation of realistic product development by forming disjunct project teams extending cross locations
- Solving communication problems, inconsistencies of product models, unregulated data access a.s.o.
- Product Lifecycle oriented development using market-leading Siemens UGS Teamcenter Engineering PLM system

Literature
Script on-site only in german

Remarks
Conditions for participation are a short letter of motivation and a short CV covering information of previously performed studies resp. education as well as practical experience

Course: Polymer Engineering I [2173590]

Coordinators: P. Elsner
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 20-30 Minutes

Conditions
None.

Learning Outcomes
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 familiar
  to describe and classify polymers
  with the fundamental synthesis
  processing techniques
- learns practical applications of polymer parts
- are able to apply the processing techniques, the application of polymers and polymer composites regarding to the basic principles of material science
- has knowledge about the special mechanical, chemical and elctrical prooperties of polymers
- has knowledge about application areas and the limitation in the use of polymers

Content
1. Economical aspects of polymers
2. Introductiom of mechanical,
chemical end electrical properties
3. Processing of polymers
(introduction)
4. Material science of polymers
5. Synthesis

Literature
Recommended literature and selected official lecture notes are provided in the lecture

Course: Laboratory “Laser Materials Processing” [2183640]

Coordinators: J. Schneider, W. Pfleging
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	de

Learning Control / Examinations
The assessment consists of an colloquium for every single experiment and an overall final colloquium incl. an oral presentation of 20 min.

Conditions
Basic knowledge of physics, chemistry and material science is assumed.

Recommendations
The attendance to one of the courses Physical Basics of Laser Technology (2181612) or Laser Application in Automotive Engineering (2182642) is strongly recommended.

Learning Outcomes
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.

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 CO_2-, excimer-, Nd:YAG- and high power diode-laser sources within the laboratory.

Media
lecture notes via ILIAS

Literature
W.T. Silfvast: Laser Fundamentals, 2008, Cambrigde University Press
W.M. Steen: Laser Materials Processing, 2010, Springer

Remarks
The maximum number of students is 12 per semester.

Course: Lab Computer-aided methods for measurement and control [2137306]

Coordinators: C. Stiller, P. Lenz
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter term	de

Learning Control / Examinations
Colloquia

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
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.

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 lap comprises 9 experiments.

Literature
Instructions to the experiments are available on the institute's website

Course: Lab course experimental solid mechanics [2162275]

Coordinators: T. Böhlke, Mitarbeiter
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	3	Summer term	de

Learning Control / Examinations
attestation without grade

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can

-
- list basic measuring methods for thermoelasticity
- perform measurements for determining material parameters of thermoelasticity
- apply the concepts of parameter identification to experimentally obtained stress-strain-curves
- list and evalutate different forms of anisotropy

Content

-
- Anisotropic materials
- Experiments for determination of the five material constants of thermoelasticity
- Experiments for determination of parameters of the inelatic material behaviour

Literature
is announced during lab course

Course: Pro/ENGINEER advanced [2123370]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter term	de

Learning Control / Examinations
Presentation of the results at the end of semester
and oral examination, duration: 10 min.

Conditions
None

Recommendations
Very good knowledge of Machine Design and basic skills in ProEngineer are required.

Learning Outcomes
In the workshop, a complete CAD model of a transmission is developed.
The design problem is worked out in small groups. Using a basic sketch the participants should independently design partial solutions, test and then integrate them into the overall solution. The advanced capabilities of Pro/E are dealt with. The design process should be simulated from idea to finished model.
The focus is on independent solution finding, teamwork, functional performance, production and design.

Content

- Use of advanced CAD techniques and ProE functionalities
- Development of selection criteria for the design method
- Integration of partial solutions into the overall solution
- Ensure the reusability of CAD models through parameterization and cataloging
- Validation
- Sheet metal forming
- kinematic simulation
- Animation

Remarks
For the workshop compulsory attendance exists.

Course: Product Lifecycle Management [2121350]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
written examination
Duration:
1,5 hours

Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can:

- clarify the management concept of PLM, its objectives and highlight the economic benefits of the PLM concept.
- illustrate the need for an integrated and cross-departmental business process - from planning, portfolio construction and return of customer information, from the use phase to maintenance and recycling of products.
- reason the processes and functions needed to support the entire product life cycle and discuss the main operating software systems (PDM, ERP, SCM, CRM) and their functions for supporting PLM.
- argue a method to successfully introduce the concept of Management PLM in companys.

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

Literature
Lecture slides.

V. Arnold et al: Product Lifecycle Management beherrschen, Springer-Verlag, Heidelberg, 2005.

J. Stark: Product Lifecycle Management, 21st Century Paradigm for Product Realisation, Springer-Verlag, London, 2006.

A. W. Scheer et al: Prozessorientiertes Product Lifecycle Management, Springer-Verlag, Berlin, 2006.

J. Schöttner: Produktdatenmanagement in der Fertigungsindustrie, Hanser-Verlag, München, 1999.

M.Eigner, R. Stelzer: Produktdaten Management-Systeme, Springer-Verlag, Berlin, 2001.

G. Hartmann: Product Lifecycle Management with SAP, Galileo press, 2007.

K. Obermann: CAD/CAM/PLM-Handbuch, 2004.

Course: Product, Process and Resource Integration in the Automotive Industry [2123364]

Coordinators: S. Mbang
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Oral examination, Durations: 20 min, Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
A considerable aspect of this lecture is to combine engineering knowledge with the practical, real industrial problems and applications.
Thus, the objectives of the lecture are:

- collaborative drafting of industrial and academic state of the art regarding the basics.
- specification of exigencies, requirements and concepts for an integrated CAx-process chain,
- introduction in the paradigms of the integrated process-oriented product development
- to convey practical industrial knowledge about the integrated product development in the automotive sector

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: CAD/CAM modeling (CATIA V5), planning (CATIA/DELMIA), archiving – PDM (CATIA/SmarTeam).

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 word and distributed development.

Literature
Lecture slides

Remarks
Max. 20 students, registration necessary (ILIAS)

Course: Production Management I [2109028]

Coordinators: P. Stock
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Compulsory Core Subject: oral exam
Elective Subject: oral exam (ca. 30 min)
Optional Subject: oral exam (ca. 30 min)
The exams are only offered in German!

Conditions
None.

Recommendations

- Willingness to learn interdisciplinarily (Technique, Economy, Legal regulations, Informatics . . .)

Learning Outcomes
After completion this lecture, the students are able

- to describe the goals of production and production management,
- to describe the prevailing requirements of the working world and the thereof resulting fields of application of Production Management and to give examples,
- to describe and to apply basic theories, methods and tools for the different fields of application of Production Management on a strategical, tactical and operational level,
- to plan and control the industrial process of production and adding value,
- to evaluate the applied methods and tools of production management within a specific enterprise and to drive alternatives for organising and configuration a production system.

Content

1. Introduction
2. Strategy of enterprises
3. Product development and programme planning
4. Location planning
5. Enterprise system (Production system, fabric planning, departmental and process organisation)
6. Management of resources (personnel, machines, material)
7. Operations planning and control
8. Controlling
9. Management systems

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Course: Production Techniques Laboratory [2110678]

Coordinators: K. Furmans, J. Ovtcharova, V. Schulze, B. Deml, Research assitants of wbk, ifab und IFL
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Advanced Internship: Participate in practicle exercise courses and complete the colloquia successfully.
Elective Subject: oral exam (ca. 30 min)
Optional Subject: oral exam (ca. 30 min)

Conditions
None.

Recommendations
Participation in the following lectures:

- Informationssystems in logistics and supply chain management
- Material flow in logistic systems
- Manufacturing technology
- Human Factors Engineering

Learning Outcomes
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 assembly respective to processes and work places.*

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. Configuration of Display Work Stations (ifab)
10. Time study (ifab)
11. Workplace configuration (ifab)

Media
several

Literature
Handout and literature online on: https://ilias.studium.kit.edu/goto_produktiv_cat_29099.html

Remarks
none

Course: Production Technology and Management in Automotive [2149001]

Coordinators: V. Stauch, S. Peters
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to specify the current challenges in automotive industry and to explain approaches to solve them.
- are able to classify the main parts of an automotive plant and its key elements (production facilities).
- are qualified to identify interlinkages between development processes and production systems (such as lean production).
- have the ability to classify modern concepts of logistics and tasks in management and design of value added networks.
- are enabled to explain the importance of an integrated quality management in product development and production as well as related methods.
- are able to characterize methodical approaches of analytical assessment and optimization of production planning tasks.

Content
The lecture deals with the technical and organizational aspects of automotive production. The course starts with an introduction to the automotive industry, current trends in vehicle technology and integrated product development. A selection of manufacturing processes are subjects of the second lecture block. Experiences of the applications of the Mercedes Production System in production, logistics and maintenance are the subject of the third event. During the last block approaches to quality management, global networks and current analytical planning methods in research are discussed. The course is strongly oriented towards the practice and is provided with many current examples. Mr. Stauch was Head of Powertrain Production Mercedes Benz Cars and plant manager Untertürkheim until 2010.
The following topics will be covered:

- Introduction to Automotive Industry and Technology
- Basics of Product Development
- Selected Automotive Manufacturing Technologies
- Automotive Production Systems
- Logistics
- Quality Assurance
- Global Networks
- Analytical Approaches of Production Planning

Media
Lecture slides will be provided printed.

Literature
Lecture Slides

Remarks
None

Course: Project Workshop: Automotive Engineering [2115817]

Coordinators: F. Gauterin
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter / Summer Term	de

Learning Control / Examinations
Oral Examination

Duration: 30 up to 40 minutes

Auxiliary means: none

Conditions
None.

Learning Outcomes
The students are familiar with typical industrial development processes and working style. They are able to apply knowledge gained at the university to a practical task. They are able to analyze and to judge complex relations. They are ready to work self-dependently, to apply different development methods and to work on approaches to solve a problem, to develop practice-oriented products or processes.

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.

Literature
Steinle, Claus; Bruch, Heike; Lawa, Dieter (Hrsg.), Projektmanagement, Instrument moderner Innovation, FAZ Verlag, Frankfurt a. M., 2001, ISBN 978-3929368277

The scripts will be supplied in the start-up meeting.

Course: Development of Oil-Hydraulic Powertrain Systems [2113072]

Coordinators: G. Geerling
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination

Conditions
knowledge in the fluidics

Learning Outcomes
The students are able to understand hydraulic systems und to develop them independently. They apply their competences in a simulation of a development project with real hydraulic components within a laboratory tutorial.

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

Course: Project Management in Rail Industry [2115995]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
None

Recommendations
None

Learning Outcomes
The students learn the basic of project management.
They learn about the roles of project manager and project core team.
They understand the project phases and know about processes and tools.
They understand the governance process behind.

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 not only valid for rail vehicles but also other areas.
The following topics will be discussed:
Introduction: definition of project and project management
Project management system: project phases, main processes and supporting processes, governance
Organization: organizational structure within a company, project organization, roles in a project organization
Main processes: project start, project plan, work brake down structure, detailed project schedule, risk and opportunity management, change management, project closure
Governance

Media
All slides are available for download (Ilias-platform).

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

Remarks
None.

Course: Project management in Global Product Engineering Structures [2145182]

Coordinators: P. Gutzmer
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 17: Information Management (p. 216)[SP_17_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
Auxilary means: none

Conditions
none

Learning Outcomes
Project management is essential for successful companies.
The students are able to describe, explain and compare characteristics and attributes of product development processes based on practical examples of industry.
They are able to specify processes of product development, their necessary organization structures and important attributes.
The participants learn to identify and evaluate aspects of product management within international operating companies.

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

Literature
lecture notes

Course: Process Simulation in Forming Operations [2161501]

Coordinators: D. Helm
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral examination (30 min)

Conditions
None.

Learning Outcomes
The students can

- describe and classify the most important forming methods
- explain the reasons for the die Ursachen für die gute Umformbarkeit von Metallen in Bezug zu den stattfindenden Phänomenen in der Mikrostruktur erläutern und den Bezug zu den Abläufen in den unterschiedlichen Fertigungsverfahren herstellen
- describe the kinematics of infinitesimal and finite deformations
- explain the differences between different stress tensors in case of finite deformations
- apply simple material models of elasticity and plasticity and explain their operation
- derive the equation of the finite element method based on the balance laws
- describe why the material models are necessary and how they are applied in the whole algorithm
- sketch the process of a FEM-simulation and give the relation to the theoretical basis

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, aniostropy, hardening
- classification of forming operations and discussion of selected topics
- basics of tensor algebra and tensor analysis
- continuum mechanics: kinematics, finite deformations, balance laws, thermdydnamics
- 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 implicite formulations, types of elements, numerical integration of material models
- process simulation of selected problems of sheet metal forming

Course: Advanced powder metals [2126749]

Coordinators: R. Oberacker
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed.

Learning Outcomes
The students know the basics of powder metallurgy. They are able to asses the conditions for applying either powder metallurgy or competing production methods. They have knowledge on production, properties and application of the most important PM materials.

Content
The lecture gives an overview on production, properties and application structural and functional powder metallurgy material. The following groups of materials are presented: PM High Speed Steels, Cemented Carbides, PM Metal Matrix Composites, PM Secialities, PM Soft Magnetic and Hard Magnetic Materials.

Literature

- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Quality Management [2149667]

Coordinators: G. Lanza
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

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 specic problem.

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-specic elds 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 certication 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 denition
- 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

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Computational Dynamics [2162246]

Coordinators: C. Proppe
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
The lecture teaches the ability to compute solutions for problems in structure dynamics. For this purpose differential equations for the vibration of structure elements are presented and solved by means of numerical methods.

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

Literature
1. Lecture notes (in German) will be provided!
2. M. Géradin, B. Rixen: Mechanical Vibrations, Wiley, Chichester, 1997

Remarks
The course takes place every two years (in pair years).

Course: Computational Vehicle Dynamics [2162256]

Coordinators: C. Proppe
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
This course serves as an introduction to the computational modelling and simulation of the technical system road/vehicle. A method based perspective is taken, which allows for a unified treatment of various kinds of vehicles. The vehicle model is obtained by dividing the system into functional subsystems and defining interfaces between these subsystems. In the first part of the course, vehicle models will be developed based on models of the suspensions, the road, and the contact forces between road and vehicle. The focus of the second part of the course is on computational methods for linear and non-linear models of vehicle systems. The third part of the course discusses design criteria for stability, safety and ride comfort.The multi body dynamics software Simpack will be used.

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

Literature
1. K. Popp, W. Schiehlen: Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1993
2. H.-P. Willumeit: Modelle und Modellierungsverfahren in der Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1998
3. H. B. Pacejka: Tyre and Vehicle Dynamics. Butterworth Heinemann, Oxford, 2002
4. K. Knothe, S. Stichel: Schienenfahrzeugdynamik, Springer, Berlin, 2003

Remarks
The course takes place every two years (impair years only).

Course: Computer Integrated Planning of New Products [2122387]

Coordinators: R. Kläger
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination
Duration:
30 minutes

No tools or reference materials may be used during exam.

Conditions
None.

Recommendations
None.

Learning Outcomes
The students got a basic understanding of relations, procedures and structure elements of standard processes in product planning and are capable of using these as guidelines for planning of new products.
They acquired knowledge of requirements and options in choosing and applying the right methods and tools for an efficient and reasonable assistance for specific use cases.
The students are familiar with elements and methods of computer aided idea and innovation management. They acquired knowledge of simultaneous assistance to the product planning process by using the technologies of rapid prototyping during development phases.

Content
The increase in creativity and the strength of innovation for the planning and development of new products has become a key factor for the competitiveness of the industry. Shorter innovation cycles, an overwhelming flood of information and an increasing demand for information and communication makes the use of computer absolutely necessary. Against this background this lecture discusses the success factors for new products, and introduces a product innovation process in conjunction with planning of new products based on the concepts of system engineering. In the following the methodological assistance to this process is being discussed by introducing innovation management, idea management, problem solving strategies, creativity and rapid prototyping for instance.

Literature
Handouts during lecture

Course: Computational Mechanics I [2161250]

Coordinators: T. Böhlke, T. Langhoff
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	2+2	Winter term	de

Learning Control / Examinations
oral examination
Prerequisites by attestations during associated tutorials

Conditions
None.

Recommendations
Lectures “Mathematical Methods in Strength of Materials” and “Introduction to the Finite Element Method”
This course is geared to MSc students.

Learning Outcomes
The students can

- analyse and evaluate different methods for solving linear systems of equations
- list and assess basics and assumptions of the linear elasticity
- list methods for solving the boundary value problem of linear elasticity
- apply and evaluate the matrix displacement method
- list and analyse variational principles of linear elasticity
- analyse the different aspects and steps of the finite-element-method
- solve worksheet problems to topics of the lecture by writing own MATLAB code

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

Literature
Simó, J.C.; Hughes, T.J.R.: Computational Inelasticity. Springer 1998.
Haupt, P.: Continuum Mechanics and Theory of Materials. Springer 2002.
Belytschko, T.; Liu,W.K.; Moran, B.: Nonlinear FE for Continua and Structures. JWS 2000.
W. S. Slaughter: The linearized theory of elasticity. Birkhäuser, 2002.
J. Betten: Finite Elemente für Ingenieure 2, Springer, 2004.

Course: Computational Mechanics II [2162296]

Coordinators: T. Böhlke, T. Langhoff
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	2+2	Summer term	de

Learning Control / Examinations
oral examination

Conditions
Successful participation in lecture "Computational Mechanics I"

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students can

- apply and evaluate algorithms for solving a non-linear equation of systems of equations
- compute stresses and strains in the framework of linear elasticity and of infinitesimal plasticity
- apply and assess models of generalized standard materials
- list the basic equations of linear thermo-elasticity
- develop user-subroutines within FORTRAN for use within commercial FE-Codes
- perform a finite-element-analysis with ABAQUS for elastic-plastic materials using or developing user-subroutines

Content

- overview quasistatic nonlinear phenomena
- numerics of nonlinear systems
- foundations of nonlinear continuum mechanics
- balance equations of geometrically nonlinear solid mechanics
- finite elasticity
- infinitesimal plasicity
- linear and gemetrically nonlinear thermoelasticity

Literature
Simó, J.C.; Hughes, T.J.R.: Computational Inelasticity. Springer 1998.Haupt, P.: Continuum Mechanics and Theory of Materials. Springer 2002.Belytschko, T.; Liu,W.K.; Moran, B.: Nonlinear FE for Continua and Structures. JWS 2000.

Course: Robotics I – Introduction to robotics [24152]

Coordinators: R. Dillmann, S. Schmidt-Rohr
Part of the modules: SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
It is recommended to attend "Cognitive Systems" prior to this lecture. It is further recommended to attend "Robotik II" and „Robotik III" in conjunction with „Robotik I".

Learning Outcomes
This lecture gives an overview of basic methods and components for building and running a robotic platform. The lecture aims at the communication of methodical understanding regarding the organization of robot system architectures.

Content
The lecture gives an overview of the research field of robotics. Robotic systems in industrial manufacturing as well as service robots are covered. The key aspects consist in modelling of robots as well as methods for robot control.

First, the different system and control components of a robotic platform are discussed. Methods for robot modelling such as kinematics and dynamics modelling are covered. Based on these models, approaches for control, planning and collision avoidance are discussed. Finally, robot architectures are introduced which comprise the previously studied approaches and models.

Media
Slides

Literature
Elective literature:
Fu, Gonzalez,Lee: Robotics - Control, Sensing, Vision, and Intelligence
Russel, Norvig: Artificial Intelligenz - A Modern Approach, 2nd. Ed.

Course: Rail Vehicle Technology [2115996]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter / Summer Term	de

Learning Control / Examinations
Oral examination
Duration: 20 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
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 about the basics of running dynamics and bogies.
They define suitable vehicle concepts based on requirements for modern rail vehicles.

Content
Vehicle system technology: structure and main systems of rail vehicles
Drives: Electric and non-electric traction drives
Brakes: Tasks, basics, principles, brake control
Bogies: forces, running gears, axle configuration
Vehicle concepts: trams, metros, regional trains, double deck coaches, locomotives
Examples of existing rail vehicles were discussed.

Media
All slides are available for download (Ilias-platform).

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

Remarks
None.

Course: Welding Technology I [2173565]

Coordinators: B. Spies
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Winter term	de

Learning Control / Examinations
oral

Duration: 30 minutes
(Welding Technology I+II)

no auxiliary material

Conditions
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.

Learning Outcomes
knowledge and understanding of the most important welding processes and its industrial application.

recognition, understanding and handling of problems occuring during the application of different welding processes relating to design, material and production.

classification and importance of welding technonolgy within the scope of connecting processes (advantages/disadvantages, alternatives).

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.
seam preparation/design
welding positions
weldability
gas welding, thermal cutting

manual metal-arc welding
submerged arc welding
IV characteristics: arc/sources of energy
gas-shielded metal-arc welding

Literature
Handbuch der Schweißtechnik I bis III
Werkstoffe
Verfahren und Fertigung
Konstruktive Gestaltung der Bauteile
Jürgen Ruge
Springer-Verlag GmbH & Co, Berlin

Schweißtechnische Fertigungsverfahren 1 bis 3
Schweiß- und Schneidtechnologien
Verhalten der Werkstoffe beim Schweißen
Gestaltung und Festigkeit von Schweißkonstruktionen

Ulrich Dilthey (1-3), Annette Brandenburger(3)
Springer-Verlag GmbH & Co, Berlin

Fachbuchreihe Schweißtechnik Band 76/I und II
Killing, R.; Böhme, D.; Hermann, F.-H.
DVS-Verlag

DIN/DVS -TASCHENBÜCHER
Schweißtechnik 1,2 ff...
Beuth-Verlag GmbH, Berlin

Course: Welding Technology II [2174570]

Coordinators: B. Spies
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	1	Summer term	de

Learning Control / Examinations
oral

Duration: 30 minutes (Welding Technology I + II)

no auxiliary material

Conditions
lecture on Welding Technology I.
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.

Learning Outcomes
recognition, understanding and handling of problems occuring during the application of different welding processes relating to design, material and production.

consolidation of and amplification to the knowledge of Welding Technology I

consolidation of knowledge of material behaviour during welding
design and properties of welded constructions
quality assurance for welding processes

Content
narrow gap welding
TIG-welding
plasma arc welding
electron beam welding
laser welding

spot welding / projection welding
heat flow at welding

welding of low-alloy steel / time-temperature-transformation curve.
welding of high-alloy steel / austenite / Schaefflerdiagramm
low temperature steels
welding of cast iron

heat treatment for welding
welding of aluminium alloys
residual welding stress
methods of testing
design of welded constructions

Literature
Handbuch der Schweißtechnik I bis III
Werkstoffe
Verfahren und Fertigung
Konstruktive Gestaltung der Bauteile
Jürgen Ruge
Springer-Verlag GmbH & Co, Berlin

Schweißtechnische Fertigungsverfahren 1 bis 3

Schweiß- und Schneidtechnologien
Verhalten der Werkstoffe beim Schweißen
Gestaltung und Festigkeit von Schweißkonstruktionen
Ulrich Dilthey (1-3), Annette Brandenburger(3)
Springer-Verlag GmbH & Co, Berlin

Fachbuchreihe Schweißtechnik Band 76/I und II
Killing, R.; Böhme, D.; Hermann, F.-H.
DVS-Verlag

DIN/DVS -TASCHENBÜCHER
Schweißtechnik 1,2 ff...
Beuth-Verlag GmbH, Berlin

Course: Fatigue of Metallic Materials [2173585]

Coordinators: K. Lang
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: 30 minutes
none

Conditions
none, basic knowledge in Material Science will be helpful

Learning Outcomes
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.

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

Literature
Lecture notes that include a list of current literature
will be distributed.

Course: Schwingungstechnisches Praktikum [2161241]

Coordinators: H. Hetzler, A. Fidlin
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	3	Summer term	de

Learning Control / Examinations
Colloquium to each session.

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory, dynamic stability, nonlinear vibrations

Learning Outcomes
* Introduction to common measurement principles for mechanical vibrations
* selected vibrational problems are demonstrated from a theoretical and experimental aspect
* Measurement, evaluation and
comparison with analytical calculations.

Content
* Frequency response of a force-excited oscillator (1DoF)
* stochastically excited oscillator (1DoF)
* digital processing of measurement data
* forces vibrations of a Duffing oscillator
* isolation of acoustical waves by means of additional masses
* critical speeds of a rotor in elastic bearings
* stability of a parametrically excited oscillator
* experimental modal analysis
* friction induced vibrations

Literature
comprehensive instructions will be handed out

Course: Failure Analysis Seminar [2173577]

Coordinators: K. Poser
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	2	Winter term	de

Learning Control / Examinations
participation, report

Conditions
knowledge in 'failure analysis'

Learning Outcomes
The seminar deals with real failed parts. The students will carry out complete failure analyses incl. appropiate reporting. It starts with the basic failure mechanisms of machanically, chemically, and thermally induced failures and it failure appearances. After the failure mechanisms are known possible counters to measure are presented and discussed.

Content
analyse of real failed parts

failure appearances

mechanisms of failure

prevention of failure

writing a report

Course: Safety engineering [2117061]

Coordinators: H. Kany
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
Students are able to:

- Name and describe relevant safety conceps of safety engeneering,
- 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.

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.

Media
presentations

Literature
Defren/Wickert: Sicherheit für den Maschinen- und Anlagenbau, Druckerei und
Verlag: H. von Ameln, Ratingen, ISBN: 3-926069-06-6

Remarks
none

Course: Signals and Systems [23109]

Coordinators: F. Puente, F. Puente León
Part of the modules: SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2	Winter term	de

Learning Control / Examinations
The assessment consists of a written exam (approx. 120 minutes) according to sec. 4 subsec. 2 no. 1 study and examination regulations.
The grade of the course corresponds to the grade of the written exam.

Conditions
Knowledge of higher mathematics and probability theory (1305) is required.

Learning Outcomes

Content

Media
Slides
work sheets

Literature
Prof. Dr.-Ing. Kiencke: Signale und Systeme; Oldenbourg Verlag, 2008
Elective literature:
Will be announced in the lecture.

Course: Simulation of Coupled Systems [2114095]

Coordinators: M. Geimer
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Summer term	de

Learning Control / Examinations
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.

Conditions
It is recommended to have:

- Knowledge of ProE (ideally in current version)
- Basic knowledge of Matlab/Simulink
- Basic knowledge of dynamics of machines
- Basic knowledge of hydraulics

Learning Outcomes
After completion of the course, students are able to:

- building a coupled simulation
- parameterize models
- Perform simulations
- do Troubleshooting
- check results for plausibility

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

Literature
Elective literature:

- miscellaneous guides according the software-tools pdf-shaped
- information to the wheel-type loader

Course: Simulation of production systems and processes [2149605]

Coordinators: K. Furmans, V. Schulze, P. Stock
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	4	Winter term	de

Learning Control / Examinations
The assessment is carried out as a written exam.
The successful participation of the related exercises is required for the approval to the exam.

Conditions
Regular attendance in the exercises.

Recommendations
None

Learning Outcomes
The students . . .

- can explain the procedure of a simulation study and the respective steps.
- are able to explain the different modeling approaches that are available to describe production systems in matters of production technology, systems of work and material flow, to analyze and evaluate the results.
- are able to define the different modeling approaches for the description of machining processes and their advantages and disadvantages.
- are able to specify methods for simulation of plants and factories and classify them according to their capabilities.
- are able to define basics in statistics.
- are able to both calculate performance indicators of material flow systems and evaluate real systems according to these performance indicators.
- are able to use the basic tools of a discrete-event simulation software and can evaluate simulation results.
- are able to describe how real systems can be modeled as well as how models can be used and their results can be evaluated.
- are able to perform a personnel-oriented simulation study and can evaluate its results concerning different key figures.
- are able to apply common techniques for verification and simulation and can evaluate the validity of a simulation study with these techniques.

Content
The aim of the lecture is to present the different aspects and possibilities of application of simulation technologies in the field of production systems and processes. Various simulations methods in the fields of production und manufacturing technology, work systems and the material flow for the production systems will be presented.
The following topics will be covered:

- Statistical basics (probability distribution and random numbers and their applications in the Monte Carlo simulation)
- Simulation of factories, machinery and processes (analysis of single manufacturing processes, machine tools and a digital plant)
- Simulation of work systems (personnel and oriented simulation of the digital plant)
- Design and validation of the simulations study (the procedure of a simulations study with the preparation work, the selection of the tools, the validation and the analysis/evaluation)

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Mechatronic Softwaretools [2161217]

Coordinators: C. Proppe
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach], SP 31: Mechatronics (p. 221)[SP_31_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
certificate of attendance (no grade), oral (colloquium)

Conditions
none

Recommendations
none

Learning Outcomes
After an introduction to the commercial software packages Maple, Matlab, Simulink, and Adams, students are able to select a suitable software package for a given mechatronic problem and to implement a model for solving the problem.

Content
1. Introduction to Maple: Generating of the nonlinear equations of motion for a double pendulum. Stability and resonance investigation of a Laval-rotor.
2. Introduction to Matlab: Dynamic simulation of a basic vehicle model using the Runge-Kutta-method. Solution of the partial differential equation for a rod by a Galerkin approximation.
3. Introduction to Simulink: Block diagrams of one-mass- and two-mass-oscillators. PID-distance control of two vehicles.
4. Introduction to Adams: Modelling and dynamic simulation of a simple robotic manipulator.

Literature
Hörhager, M.: Maple in Technik und Wissenschaft, Addison-Wesley-Longman, Bonn, 1996

Hoffmann, J.: Matlab und Simulink, Addison-Wesley-Longman, Bonn, 1998

Programmbeschreibungen des Rechenzentrums Karlsruhe zu Maple, Matlab und Simulink

Course: Track Guided Transport Systems - Technical Design and Components [6234701 / 6234702]

Coordinators: E. Hohnecker, P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 227)[SP_50_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3/1	Winter term	de

Learning Control / Examinations
Oral examination
Duration: 30 minutes
No tools or reference materials may be used during the exam.

Conditions
See module description.

Learning Outcomes
See German Version.

Content
Law and Organisation of track guided transport systems, basics of driving dynamics, dimensioning and construction of railway tracks, basics of railway facilities, basics of signalling

Literature
Zilch, Diederichs, Katzenbach, Beckmann (Hrsg): Handbuch für Bauingenieure, Springer-Verlag 2012

Course: Theory of Stability [2163113]

Coordinators: A. Fidlin
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory

Learning Outcomes

- to learn the most important methods of the stability analysis
- to apply the stabiliy analysis for equilibria
- to apply the stabiliy analysis for periodic solution
- to apply the stabiliy analysis for systems with feedback control

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

Literature

- Pannovko Y.G., Gubanova I.I. Stability and Oscillations of Elastic Systems, Paradoxes, Fallacies and New Concepts. Consultants Bureau, 1965.
- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.

Course: Control Technology [2150683]

Coordinators: C. Gönnheimer
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester twice. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

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.

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
- Process control systems
- Field bus
- Trends in the area of control technology

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Strategic Product Planing [2146193]

Coordinators: A. Siebe
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam
duration: 20 minutes

Conditions
none

Learning Outcomes
After listening to this lecture the students is able to ...

- describe the importance and goals of future management in product planning.
- to evaluate the different approaches of strategic product planning under consideration of the particular application.
- describe the approaches of a strategic szenario-based product planning.
- illustrate the strategic szenario-based product planning based on examples.

Content
Introduction into future management, Development of scenarios, scenariobased strategy development, trendmanagement, strategic early detection, innovation- and technologymanagement, scenarios in product development, from profiles of requirements to new products, examples out of industrial praxis.

Course: Flows and Heat Transfer in Energy Technology [2189910]

Coordinators: X. Cheng
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination; duration: 20min

Conditions
None.

Learning Outcomes
This lecture is dedicated to students of mechanical engineering and other engineering Bachelor or Master degree courses. Goal of the lecture is the understanding of major processes in fluid dynamics and heat transfer in energy engineering. The corresponding phenomena and the methods to analyse are described and explained. In addition the lecture will be supplemented by convenient examples.

Content

1. collection of sample applications
2. heat transfer and its application
3. convective fluid dynamics and heat transfer
4. thermal radiation and its application
5. special cases

Literature

- Bahr, H.D., Stephan, K., Wärme- und Stoffübertragung, 3. Auflage Springer Verlag, 1998
- Mueller, U., Zweiphasenströmung, Vorlesungsmanuskript, Februar 2000, TH Karlsruhe
- Mueller, U., Freie Konvektion und Wärmeübertragung, Vorlesungsmanuskript, WS1993/1994, TH Karlsruhe
- W. Oldekop,„Einführung in die Kernreaktor und Kernkraftwerktechnik,“Verlag Karl Thiemig, München, 1975
- Cacuci, D.G., Badea, A.F., Energiesysteme I, Vorlesungsmanuskript, 2006, TH Karlsruhe
- Jones, O.C., Nuclear Reactor Safety Heat Transfer, Hemisphere Verlag, 1981
- Herwig, H., Moschallski, A., Wärmeübertragung, 2. Auflage, Vieweg + Teubner, 2009

Course: Structural Ceramics [2126775]

Coordinators: M. Hoffmann
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the agreed date.
Auxiliary means: none
The re-examination is offered upon agreement.

Conditions
none

Recommendations
Basics of the course “Introduction to Ceramics” should be known.

Learning Outcomes
The students know the most relevant structural ceramics (silicon carbide, silicon nitride, alumina, boron nitride, zirconia, fibre-reinforced ceramics) and their applications. They are familar with the microstructural features, fabrication methods, and mechanical properties.

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.

Media
Slides for the lecture:
available under http://www.iam.kit.edu/km

Literature
W.D. Kingery, H.K. Bowen, D.R. Uhlmann, “Introduction to Ceramics”, John Wiley & Sons, New York, (1976)

E. Dörre, H. Hübner, “Aluminia”, Springer Verlag Berlin, (1984)

M. Barsoum, “Fundamentals of Ceramics”, McGraw-Hill Series in Material Science and Enginewering (2003)

Remarks
The course will not take place every year.

Course: Supply chain management [2117062]

Coordinators: K. Alicke
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	4	Winter term	de

Learning Control / Examinations
oral examination

No tools or reference materials may be used during the exam.

Conditions
limited number: application necessary

Recommendations
none

Learning Outcomes
Students are able to:

- Discuss the requirements on modern supply chains,
- Use the basic concepts of demand forecast, stock optimization and supply in practical exercises,
- Analyse the typical questions of dimensioning a supply chain and evaluate a supply chain with the results.

Content

- Bullwhip-Effect, Demand Planning & Forecasting
- Conventional planning processes (MRP + MRPII)
- Stock keeping strategy
- Data acquisition and analysis
- Design for logistics (Postponement, Mass Customization, etc.)
- Logistic partnerships (VMI, etc.)
- Distribution structures (central vs. distributed, Hub&Spoke)
- SCM-metrics (performance measurement) e-business
- Special sectors as well as guest lectures

Media
presentations

Literature
Alicke, K.: Planung und Betrieb von Logistiknetzwerken

Simchi-Levi, D., Kaminsky, P.: Designing and Managing the Supply Chain

Goldratt, E., Cox, J.: The Goal

Remarks
this course is a block course

Course: Sustainable Product Engineering [2146192]

Coordinators: K. Ziegahn
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 17: Information Management (p. 216)[SP_17_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	

Learning Control / Examinations
oral exam

Conditions
none

Learning Outcomes
The goal of the lecture is to convey the main elements of sustainable product development in the economic, social and ecological context.
The students are able to ...

- identify und describe the 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.
- discuss the skills for life-cycle product design using the example of complex automotive components such as airbag systems and other current products.
- understand the 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 simulationduring the process of developement of technical products.
- develop skills such as team skills / project / self / presentation based on realistic projects.

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 simulationduring the process of developement of technical products
delivery of key skills such as team skills / project / self / presentation based on realistic projects

Course: Technical Acoustics [2158107]

Coordinators: M. Gabi
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 30 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
Students get to know the basics of technical acoustics in general. Application of the knowledge in different fields of engineering.
Students learn physical basics of acoustics and human perception. Physical-empirical laws for determination of sound and noise levels of various emission and immission situations will be worked out or derived. Furtheron general sound measurement methods of machinery will be taught.
Students are able to understand mechanisms of sound origin, propagation and reduction, as well as measuring technics

Content
Basics of acoustics
Perception and weighting of noise (human hearing)
Description of acoustic parameters, level notation
Noise propagation
Acoustical measurement techniques

Literature
1. Lecture notes (downloadable from institute's homepage).
2. Heckl, M.; Müller, H. A.: Taschenbuch der Technischen Akustik, Springer-Verlag.
3. Veit, Ivar: Technische Akustik. Vogel-Verlag (Kamprath-Reihe), Würzburg.
4. Henn, H. et al.: Ingenieurakustik. Vieweg-Verlag.

Course: Computer Engineering [2106002]

Coordinators: G. Bretthauer
Part of the modules: SP 18: Information Technology (p. 217)[SP_18_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Written examination

Duration: 2 hours (compulsory subject)

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
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 understand the importance of software quality in mechanical engineering and know basic concepts and important measures of quality assurance.

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 exercice course.

Literature
Vorlesungsskript (Internet)

Becker, B., Molitor, P.: Technische Informatik : eine einführende Darstellung. München, Wien : Oldenbourg, 2008.

Hoffmann, D. W.: Grundlagen der Technischen Informatik. München: Hanser, 2007.

Balzert, H.: Lehrbuch Grundlagen der Informatik : Konzepte und Notationen in UML, Java und C++, Algorithmik und Software-Technik, Anwendungen. Heidelberg, Berlin : Spektrum, Akad. Verl., 1999.

Trauboth, H.: Software-Qualitätssicherung : konstruktive und analytische Maßnahmen. München, Wien : Oldenbourg, 1993.

Course: Integrated Information Systems for engineers [2121001]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 38: Production Systems (p. 223)[SP_38_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations

Conditions
None

Recommendations
None

Learning Outcomes
Students can:

- illustrate the structure and operating mode of information systems
- explain different goals of specific IT systems in product development (CAD, CAP, CAM, PPS, ERP, PDM) and assign product development processes
- describe the fundamentals of knowledge management and its application in engineering and deploy ontology as knowledge representation
- describe different types of process modelling and their application and illustrate and execute simple work flows and processes with selected tools

Content

- Information systems, information management
- CAD, CAP and CAM systems
- PPS, ERP and PDM systems
- Knowledge management and ontology
- Process modeling

Literature
Lecture slides

Course: Vibration Theory [2161212]

Coordinators: A. Fidlin
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Winter term	de

Learning Control / Examinations
Written exam
If course is chosen as optional subject or part of major subject:
Oral exam, 30 minutes (optional subject), 20 minutes (major subject), no means

Conditions
None.

Recommendations
Examen in Engineering Mechanics 3 + 4

Learning Outcomes
The course gives an introduction into the vibration theory of linear systems. First, general vibration in form of harmonic signals is considered. One degree of freedom systems are treated in detail for free and forced vibration, especially for harmonic, periodic and arbitrary excitation. This is the foundation for systems with many degrees of freedom as these may be transformed with the help of modal coordinates. For multiple dof systems the eigenvalue problem is solved. Then forced vibration is treated. Finally, wave propagation problems and eigenvalue problems for systems with distributed parameters are discussed. As an application an introduction into rotor dynamics is given.

Goal of the course is to see the similarities for systems with one dof and with multiple dof. Besides typical phenomena like resonance a systematic mathematical approach to vibration problems and an interpretation of the mathematical results should be obtained.

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.

Systems with many degrees of freedom: Eigenvalue problem for undamped vibration, orthogonality of eigenvectors, modal decoupling, approximation methods, eigenvalue problem for damped vibration. Forced vibration for harmonic excitation, modal decomposition for arbitrary forced vibration, vibration absorber.

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.

Literature
Klotter: Technische Schwingungslehre, Bd. 1 Teil A, Heidelberg, 1978

Hagedorn, Otterbein: Technische Schwingungslehre, Bd 1 and Bd 2, Berlin, 1987

Wittenburg: Schwingungslehre, Springer-Verlag, Berlin, 1995

Course: Technical Design in Product Development [2146179]

Coordinators: M. Schmid, Dr. -Ing. Markus Schmid
Part of the modules: SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
For the reason of high sutdent number the exam is a written exam.
Only dictionnary is allowed.

Conditions
Authorisation by the Examination Office.

Recommendations
None

Learning Outcomes
After listening the module „technical design“ the students should have knowledge about the basics of technical oriented design as an integral part of the methodical product development
The students have knowledge about ...

- the interface between engineer and designer.
- all relevant human-product requirements as f. exp. demographic/ geographic and psychographic features, relevant perceptions, typical content recognition as well as ergonomic bases.
- the approaches concerning the design of a product, product program or product system with focus on structure, form-, color- and graphic design within the phases of the design process.
- the design of functions and supporting structures as well as the important interface between human and machine.
- relevant parameters of a good corporate design.

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

Literature
Hexact (R) Lehr- und Lernportal

Course: Technology of steel components [2174579]

Coordinators: V. Schulze, J. Hoffmeister
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
duration 20 minutes
No tools or reference materials may be used during the exam

Conditions
Materials Science and Engineering I & II

Learning Outcomes
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.

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

Literature
Script will be distributed within the lecture
VDEh: Werkstoffkunde Stahl, Bd. 1: Grundlagen, Springer-Verlag, 1984
H.-J. Eckstein: Technologie der Wärmebehandlung von Stahl, Deutscher Verlag Grundstoffindustrie, 1977
H.K.D.H. Badeshia, R.W.K. Honeycombe, Steels - Microstructure and Properties, CIMA Publishing, 3. Auflage, 2006
V. Schulze: Modern Mechanical Surface Treatments, Wiley, Weinheim, 2005

Course: Technologies for energy efficient buildings [2158106]

Coordinators: F. Schmidt, Dipl. Phys. Emmerich Tempfli
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	4	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 30 minutes
No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
Technische Thermodynamik und Wärmeübertragung I und II

Learning Outcomes
Students know the main factors influencing the final energy consumption of buildings; they know the criteria for indoor comfort as well as principles of energy efficient and solar building design.
Students acquire knowledge on the current state of technologies for the building envelope (including solar thermal energy utilisation) as well as technologies for heating, cooling and air-conditioning of energy efficient buildings.
Students are able to check building energy concepts for plausibility and can estimate how different technologies can be integrated into highly efficient complete systems.

Content
More than one third of the primary energy consumption in Europe can be directly related to the heating, cooling and climatisation of buildings. As a contribution to climate change mitigation, a reduction of greenhouse gas emissions to about one fifth of today's values is required over the next half century.
This course deals with the potentials for reducing the energy demand of buildings and for integrating utilisation of solar energy and environmental energy into building energy concepts. Available technologies and current development trends for efficient energy use in buildings are presented. The influence of various technology options and system concepts on energy demand is discussed referring to building simulation results for selected reference buildings.

- Terms and definitions: energy economics, climate change mitigation, energy use in buildings
- Factors influencing energy consumption in buildings and occupants' comfort
- Heat transfer through the building envelope, insulation technologies
- Windows and glazings
- Daylight use, glare protection, shadings
- Ventilation and air-conditioning, „passive house" concept
- Heating and cooling with low-exergy systems (LowEx); ground heat sources and sinks
- Solar thermal energy use in buildings
- Heat and cold storage
- Heat pumps (mechanically / thermally driven)
- Solar Cooling
- Cogeneration and Trigeneration
- Examples of realised system concepts
- Buildings within supply infrastructures; district heating

- Excursion

Media
Powerpoint, blackboard, computer (tutorial)

Literature
1. Voss, K.; Löhnert, G.; Herkel, S.; Wagner, A.; Wambsganß, M.: Bürogebäude mit Zukunft - Konzepte, Analysen, Erfahrungen. Solarpraxis Verlag,

2. Au. 2007. 2. Wagner, A.: Energieefziente Fenster und Verglasungen. Solarpraxis Verlag, 4. Au. 2013.

3. Henning, H.-M. (ed.): Solar Assisted Air-Conditioning in Buildings. Springer, 2nd ed. 2007.

Course: Computational methods for the heat protection of a full vehicle [2157445]

Coordinators: H. Reister
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 206)[SP_05_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral examination, 30 minutes, no aids

Conditions
basics in fluid mechanics and thermodynamics recommended

Recommendations
none

Learning Outcomes
Learn basic equations to understand thermal situation in vehicles.
Evaluate thermal situation in vehicles.
Utilize methods.

Content
In the lecture computational methods for the heat protection of the full vehicle are presented. For this the basic conservation equations are introduced and the applied computational programs are discussed in detail. The aspects concerning fluid mechanics are treated extensively. For this the underhood flow as well as the flow around the vehicle, at the underbody and at the rear of the car are considered. The computation of the temperature in the components of the vehicle is illustrated. For this mainly local approaches for the classical and electronic components are used. Finally a new overall approach for the heat protection is exlpained whre also detailed compuations at the engine, at the exhaust system and at the transmission are integrated.
Content
1. Introduction
2. Theoretical fundamentals
3. Computational methods
4. Numerical simulation of the flow in and around the vehicle
5. Computation of the temperature in components
6. Overall approach for the hat protection

Course: Thermal Solar Energy [2169472]

Coordinators: R. Stieglitz
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 25 minutes

no tools or reference materials may be used during the exam

Conditions
Basics in heat and mass transfer, material science and fluid mechanics

Recommendations
desirbale are reliable knowledge in physics in optics and thermodynamics

Learning Outcomes
The lecture elaborates the basics of the solar technology and the definition of the major wordings and its phyical 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 ende the ways for solar climatization 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.

Content
Baiscs of thermal solar energy (radiation, heat conduction, storage, efficiency ....) Active and passive use of solar energy. Solar collectors (design types, efficiency, system technology). Solar plants (heliostats etc.). Solar climatization.
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.

4 Passive solar mechanisms: heat conduction in solids and gases, radiation heat transfer in transparent and opaque bodies, selective absorber - typical materials and manufacturing processes.

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.

Literature

supply of lecture material in printed and electronic form

Stieglitz & Heinzel; Thermische Solarenergie -Grundlagen-Technologie- Anwendungen. Springer Vieweg Verlag. 711 Seiten. ISBN 978-3-642-29474-7

Course: Thermal Turbomachines I [2169453]

Coordinators: H. Bauer
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Winter term	en

Learning Control / Examinations
oral
Duration: approximately 1 hour

no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
It is a recommended lecture combination with 'Thermal Turbomachines II'.

Learning Outcomes
The students are able to explain and comment on the design and operation of thermal turbomachines in detail. Moreover, they can evaluate the range of applications for turbomachinery. Therefore, students are able to to describe and analyse not only the individual components but also entire assemblies. The students can asses and evaluate the effects of physical, economical and ecological boundary conditions.

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

Literature
Lecture notes (available via Internet)

Bohl, W.: Strömungsmaschinen, Bd. I, II; Vogel Verlag, 1990, 1991

Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993

Traupel, W.: Thermische Turbomaschinen Bd. I, II, Springer-Verlag, 1977, 1982

Course: Thermal Turbomachines II [2170476]

Coordinators: H. Bauer
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
6	3	Summer term	en

Learning Control / Examinations
oral (can only be taken in conjunction with 'Thermal Turbomachines I')
Duration:approximately 60 minutes (including Thermal Turbomachines I)

Auxiliary:no tools or reference materials may be used during the exam

Conditions
None.

Recommendations
Recommended as lecture combination with 'Thermal Turbomachines I'.

Learning Outcomes
Based on the fundamental skills learned in 'Thermal Turbomachines I' the students have the ability to design turbines and compressors and to analyse the operational behavior of these machines.

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

Literature
Course not packet
Bohl, W.: Strömungsmaschinen, Bd. I,II, Vogel Verlag 1990, 1991
Sigloch, H.: Strömungsmaschinen, Carl Hanser Verlag, 1993
Traupel, W.: Thermische Turbomaschinen, Bd. I,II, Springer-Verlag, 1977, 1982

Course: Thermodynamics and Energy Conversion in Internal Combustion Engines [2133120]

Coordinators: T. Koch, H. Kubach
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam, 30 minutes, no auxillary means

Conditions
None.

Recommendations
especially reasonable in combination with lecture “Fundamentals of Combustion Engines I”

Learning Outcomes
The students can name all important influences on the combustion process. They can analyse and evaluate the engine process considering efficiency, emissions and potential.

Content
reaction kinetics
fuels
gas exchange
ignition
flow field of gasoline engines
working process
pressure trace analysis
thermodynamic analysis of the high pressure process
exergy analysis and waste heat recuperation
aspects of sustainability

Course: Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria (with exercises) [2193002]

Coordinators: H. Seifert
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
Oral examination (30 min)

Conditions

- basic course in materials science and engineering
- physical chemistry

Recommendations
none

Learning Outcomes
This class deals with the heterogeneous phase equilibria of binary, ternary and multicomponent materials systems. The thermodynamic properties of multiphase engineering materials and their reactions with gas and liquid phases are analyzed.

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)

Literature
1. Phase Equilibria, Phase Diagrams and Phase Transformations, Their Thermodynamic Basis; M. Hillert, University Press, Cambridge (2007)
2. Introduction to the Thermodynamics of Materials; D.R. Gaskell, Taylor & Francis (2008)

Course: Tribology A [2181113]

Coordinators: M. Scherge, M. Dienwiebel
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
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.

Content

- Chapter 1: Friction Adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing, evironmental 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.

Literature

1. Fleischer, G. ; Gröger, H. ; Thum: Verschleiß und Zuverlässigkeit. 1. Auflage. Berlin : VEB-Verlag Technik, 1980
2. Persson, B.J.N.: Sliding Friction, Springer Verlag Berlin, 1998
3. M. Dienwiebel, and M. Scherge, Nanotribology in automotive industry, In:Fundamentals of Friction and Wear on the Nanoscale; Editors: E. Meyer and E. Gnecco, Springer, Berlin, 2007.
4. Scherge, M., Shakhvorostov, D., Pöhlmann, K.: Fundamental wear mechanism of metals. Wear 255, 395–400 (2003)
5. Shakhvorostov, D., Pöhlmann, K., Scherge, M.: An energetic approach to friction, wear and temperature. Wear 257, 124–130 (2004)

Course: Tribology B [2182139]

Coordinators: M. Scherge, M. Dienwiebel
Part of the modules: SP 48: Internal Combustion Engines (p. 225)[SP_48_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
None.

Recommendations
preliminary knowlegde about engines and materials science

Learning Outcomes
The student can

- 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

Content
Based on “tribology A” the lecture outlines various tribological measurement techniques as well as the fundamental principles of methods for the characterisation of topography and chemical composition of tribologically loaded surfaces.

1. measurement techniques
   - friction measurement, tribometer, sales performance,
   - conventional wear measurement,
   - continuous wear measurement(RNT)
2. roughness
   - profilometry, profile parameters, measuring ranges and filters
   - bearing ratio curve, measurement error
3. accompanying analysis
   - multi-scale topography measurement
   - chemical surface analysis
   - structural analysis
   - mechanical analysis

Literature
Lecture notes available in the lectures

Course: Turbine and compressor Design [2169462]

Coordinators: H. Bauer, A. Schulz
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
Thermal Turbomachines I+II

Learning Outcomes
The students have the ability to:

-
- describe special types of components, such as e.g. radial machines and transonic compressors
- explain and evaluate the operation of components and machines
- interpret and apply the the physical principles
- design individual components in a practical approach

Content
The lecture is intended to expand the knowledge from Thermal Turbomachines I+II.
Thermal Turbomaschines, general overview

Design of a turbomachine: Criteria and development

Radial machines

Transonic compressors

Combustion chambers

Multi-spool installations

Literature
Münzberg, H.G.: Gasturbinen - Betriebsverhalten und Optimierung, Springer Verlag, 1977

Traupel, W.: Thermische Turbomaschinen, Bd. I-II, Springer Verlang, 1977, 1982

Course: Turbo Jet Engines [2170478]

Coordinators: H. Bauer, A. Schulz
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The students have the ability to:

-
- compare the design concepts of modern jet engines
- analyse the operation of modern jet engines
- apply the thermodynamic and fluidmechanic basics of jet engines
- choose the main components intake, compressor, combustor, turbine and thrust nozzle based on given criteria
- comment on different methods for the reduction of pollutant emissions, noise and fuel consumption

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

Literature
Hagen, H.: Fluggasturbinen und ihre Leistungen, G. Braun Verlag, 1982
Hünnecke, K.: Flugtriebwerke, ihre Technik und Funktion, Motorbuch Verlag, 1993
Saravanamuttoo, H.; Rogers, G.; Cohen, H.: Gas Turbine Theory, 5th Ed., 04/2001
Rolls-Royce: The Jet Engine, ISBN:0902121235, 2005

Course: Behaviour Generation for Vehicles [2138336]

Coordinators: C. Stiller, T. Dang
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 09: Dynamic Machine Models (p. 209)[SP_09_mach], SP 44: Technical Logistics (p. 224)[SP_44_mach], SP 18: Information Technology (p. 217)[SP_18_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination

Duration: 30 minutes

no reference materials

Conditions
Fundamentals in measurement, system and control theory, e.g. from the lecture “Measurement and Control Systems”

Learning Outcomes
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.

Content
1. Driver assistance systems
2. Driving comfort and safety
3. Vehicle dynamics
4. Path and trajectory planning
5. Path control
6. Collision avoidance

Literature
TBA

Course: Failure of Structural Materials: Fatigue and Creep [2181715]

Coordinators: O. Kraft, P. Gumbsch, P. Gruber
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
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.

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

Literature

- Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); worth reading, relatively simple but comprehensive
- 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

Course: Failure of structural materials: deformation and fracture [2181711]

Coordinators: P. Gumbsch, O. Kraft, D. Weygand
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

Recommendations
preliminary knowlegde in mathematics, mechanics and materials science

Learning Outcomes
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 decribe the main empirical materials models for deformation and fracture and can apply them.
- has the physical understanding to describe and explain phenomena of failure.

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 elasic fracture mechanics
   - crack resitance
   - experimental measurement of fracture toughness
   - defect measurement
   - crack propagation
   - application of fracture mechanics
   - atomistics of fracture

Literature

- Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); worth reading, relatively simple but comprehensive
- 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

Course: Gear Cutting Technology [2149655]

Coordinators: M. Klaiber
Part of the modules: SP 12: Automotive Technology (p. 212)[SP_12_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral examination. The examination is offered every winter semester in agreement with the Lecturer.

Conditions
None

Recommendations
None

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.

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.
The following topics will be covered:

- Sample applications
- Basics of gearing geometry
- Need of gearboxes
- Soft machining processes
- Hardening processes
- Hard machining processes
- Bevel gear production
- Measurement and testing

- Manufacturing of gearbox components
- Special gearings

Media
Lecture slides will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Slides

Remarks
None

Course: Virtual Engineering II [2122378]

Coordinators: J. Ovtcharova
Part of the modules: SP 09: Dynamic Machine Models (p. 209)[SP_09_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Summer term	de

Learning Control / Examinations
Depending on choice according to acutal version of study regulations
Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students will be able to:

- describe virtual reality, how the stereoscopic effect occurs and compare the technologies to simulate this effect.
- describe how to model a scene in VR, store the VR graph on a computer and explain the inner workings of the VR pipeline for visualizing the scene.
- name various systems for interacting with the VR scene and assess the advantages and disadvantages of various manipulation and tracking devices.
- compare validation tests that can be carried through in the product development process with the aid of a virtual mock-up (VMU) and describe the difference between a VMU, a physical mock-up (PMU) and a virtual prototype (VP).
- point out the vision of an integrated virtual product development and which challenges need to be resolved towards that vision.

Content
The lecture presents the informational interrelationship required for understanding the virtual product development process. For this purpose, an emphasis and focus will be placed on IT-systems used in the industrial sector as support for the process chain of virtual engineering:

- The corresponding models can be visualized in Virtual Reality Systems, from single parts up through a complete assembly.
- Virtual Prototypes combine CAD-data as well as information about the remaining characteristics of the components and assembly groups for immersive visualisation, functionality tests and functional validations in the VR/AR/MR environment.
- Integrated Virtual Product Development explains exemplified the product development process from the point of view of Virtual Engineering.

The goal of the lecture is to clarify the relationship between construction and validation operations through the usage of virtual prototypes and VR/AR/MR visualisation techniques in connection with PDM/PLM-systems. This will be achieved through an introduction to each particular IT-system along with praxis-oriented exercises.

Literature
Lecture slides

Course: Virtual Reality Laboratory [2123375]

Coordinators: J. Ovtcharova
Part of the modules: SP 17: Information Management (p. 216)[SP_17_mach], SP 31: Mechatronics (p. 221)[SP_31_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	Winter / Summer Term	de

Learning Control / Examinations
Presentation of project work (40%)
Individual project participation (30%)
Written test (20%)
Soft skills (10%)

Conditions
None

Recommendations
Participation in the course Virtual Engineering 2 [2122378]

Learning Outcomes
The students are able to operate and use hardware and software for Virtual Reality applications in order to:

- design solutions for complex tasks in a team.
- solve subtasks within a specific work package in small groups, keeping the interfaces to other work packages in mind and
- merge this solution in the final product.

Content
The Virtual Reality lab course consists of following three overlapping parts:

- Basics: Introduction in Virtual Reality (hardware, software, applications)
- Tool Kit: Exercises in the task specific software systems
- Application: autonomous project work in the area of Virtual Reality in small groups

Soft Skills: Methodical approach to practical engineering problems, team and interdisciplinary work, time management.

Media
Stereoscopic projection in MR and VR at the Lifecycle Engineering Solutions Center (LESC), 15 computers, beamer

Literature
Presentations, Exercise documents, Tutorials, Books for individual work

Course: Material Analysis [2174586]

Coordinators: J. Gibmeier
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral examination
duration: 20 - 30 minutes
no auxillray resources

Conditions
obligation: Material Science I/II

Learning Outcomes
The students have basic knowledge about methods of material analysis. They have a basic understanding to transfer this nasic knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure

Content
The following methods will be introduced within this module:

microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy

material and microstructure analyses by means of X-ray, neutron and electron beams

spectroscopic methods

Literature
lecture notes (will be provided at the beginning of the lecture)

literature will be quoted at the beginning of the lecture

Course: Materials for Lightweight Construction [2174574]

Coordinators: K. Weidenmann
Part of the modules: SP 07: Dimensioning and Validation of Mechanical Constructions (p. 208)[SP_07_mach], SP 10: Engineering Design (p. 210)[SP_10_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
Oral examination
Duration: 20 - 30 Min
none

Conditions
Werkstoffkunde I/II (recommended)

Learning Outcomes
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.

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 and hardenable steels

Composites - mainly PMC
Matrices
Reinforcements

Literature
Presentation slides and additional lecture notes are handed out during the lecture, additional literature recommendations given

Course: Materials and mechanical loads in the power train: engines, gearboxes and drive sections [2173570]

Coordinators: J. Hoffmeister
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach], SP 12: Automotive Technology (p. 212)[SP_12_mach], SP 02: Powertrain Systems (p. 205)[SP_02_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
oral
duration: 20 - 30 minutes
none

Conditions
None.

Learning Outcomes
The students are capable to name the different main loads in engines, gearboxes and other drive units. The students can correlate the possible materials to the important compounds of the power train. The students can name the important casting materials, case hardened steels, quench and tempered steels and further structural materials in the power engine. The students can describe the important properties of these materials and can compare them. They can describe the significant hardening mechanisms of the materials of the power train and can transfer this knowledge to applied problems.

Content
Introduction

constructive, production-orientated and material aspects in the power train

engines

stress in the engines
cast aluminium alloys
cast magnesium alloy
cast irons
and other materials

gearboxes

stress in the gearboxes
case-hardened steel
and other materials

drive sections

stress in the drive sections
materials for the clutch
materials for the power train
materials in other elements of the drive sections

Literature
Reference, data and draft in the lecture

Course: Materials Science and Engineering III [2173553]

Coordinators: M. Heilmaier
Part of the modules: SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	5	Winter term	de

Learning Control / Examinations
oral; 30-40 minutes

Conditions
Basic knowledge in materials science and engineering (Werkstoffkunde I/II)

Learning Outcomes
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 treatmens 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 treatmens.

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.

Literature
Lecture Notes; Problem Sheets; Bhadeshia, H.K.D.H. & Honeycombe, R.W.K.
Steels – Microstructure and Properties
CIMA Publishing, 3. Auflage, 2006

Course: Materials modelling: dislocation based plasticy [2182740]

Coordinators: D. Weygand
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 214)[SP_13_mach], SP 26: Materials Science and Engineering (p. 219)[SP_26_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer term	de

Learning Control / Examinations
oral exam 30 minutes

Conditions
None.

Recommendations
preliminary knowlegde in mathematics, physics and materials science

Learning Outcomes
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.

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. discrete dislocation dynamics in two dimensions
7. discrete dislocation dynamics in three dimensions
8. continuum description of dislocations
9. microstructure evolution: grain growth
a) physical basis: small/large angle boundaries
b) interaction between dislocations and GBs
10) Monte Carlo methods in micro structure evolution

Literature

1. D. Hull and D.J. Bacon, Introduction to Dislocations, Oxford Pergamon 1994
2. J.P. Hirth and J. Lothe: Theory of dislocations, New York Wiley 1982. (oder 1968)
3. J. Friedel, Dislocations, Pergamon Oxford 1964.
4. V. Bulatov, W. Cai, Computer Simulations of Dislocations, Oxford University Press 2006
5. A.S. Argon, Strengthening mechanisms in crystal plasticity, Oxford materials.

Course: Machine Tools and Industrial Handling [2149902]

Coordinators: J. Fleischer
Part of the modules: SP 38: Production Systems (p. 223)[SP_38_mach], SP 10: Engineering Design (p. 210)[SP_10_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	6	Winter term	de

Learning Control / Examinations
The assessment is carried out as an oral exam. The examination is offered every semester. Reexaminations are offered at every ordinary examination date.

Conditions
None

Recommendations
None

Learning Outcomes
The students . . .

- are capable to explain the use and application of machine tools and handling devices as well as differentiate their characteristics and structure.
- are able to name and describe the essential components (frame, main spindles, feed axis, peripheral equipment, control) of machine tools.
- Are capable to distinguish and select and describe the essential components regarding structure, characteristics advantages and disadvantages.
- are enabled to dimension the main components of machine tools.
- are able to name and describe the control principles of machine tools.
- are capable to name examples of machine tools and industrial handling as well as to deduce compare the essential components. Additionally they can allocate manufacturing processes.
- are enabled to identify drawbacks as well as derive and asses measures for improvements.
- are qualified to apply methods for selection and evaluation of machine tools.
- are experienced to deduce the particular failure characteristics of a ball screw.

Content
The lecture provides an overview of machine tool and handling devices structures, use and application areas. Within the lecture based and industrially oriented knowledge for selection, dimensioning and evaluation is conveyed. First the components of machine tools are explained systematically. Here the distinctive features of dimensioning machine tools are deduced followed by the integral dimensioning of machine tools. Subsequently the use of machine tools is shown in exemplary application areas e.g. turning, milling, grinding, metal forming, sheet metal forming and gear cutting.
The lecture provides an inside view of industrial application and is illustrated with current examples.
The topics are as follows:

- Frame and frame components
- Main drives and main spindles
- Requirements for feed axes
- Electro-mechanical feed axis
- Fluidic feed axes

- Control technologies
- Peripheral components
- Metrological assessment
- Machine maintenance
- Process-diagnosis
- Machine tool examples

Media
Lecture notes will be provided in ilias (https://ilias.studium.kit.edu/).

Literature
Lecture Notes

Remarks
None

Course: Wind and Hydropower [2157451]

Coordinators: M. Gabi, N. Lewald
Part of the modules: SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	en

Learning Control / Examinations
Oral exam, 30 minutes, no means

Conditions
None

Recommendations
Fluid Mechanics

Learning Outcomes
The students know basic fundamentals for the use of wind- and waterpower.

Content
Wind- and waterpower fundamental lecture. Introduction in the basics of fluid machinery.
Windpower:
Basic knowledge for the use of wind power for electricity, complemented by historical development, basic knowledge on wind systems and alternative renewable energies. Global and local wind systems as well as their measurement and energy content are dedicated. Aerodynamic basics and connections of wind-power plants and/or their profiles, as well as electrical system of the wind-power plants are described. Fundamental generator technology over control and controlling of the energy transfer.
Finally the current economic, ecological and legislations boundary conditions for operating wind-power plants are examined.An overview of current developments like super-grids and visions of the future of the wind power utilization will be given.
Waterpower:
Basic knowledge for the use of water power for electricity, complemented by historical development. Description of typical hydropower systems.
Introduction in the technology and different types of water turbines. Calculation of the energy conversion of typical hydropower systems.

Literature

-
- Erich Hau, Windkraftanlagen, Springer Verlag.
- J. F. Douglas er al., Fluid Mechanics, Pearson Education.
- Pfleiderer, Petermann, Strömungsmaschinen, Springer Verlag.

Course: Windpower [23381]

Coordinators: N. Lewald
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 215)[SP_15_mach], SP 24: Energy Converting Engines (p. 218)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginning of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every winter semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
The students know basic fundamentals for the use of wind power.
Wind Power fundamental lecture. Focus of the lecture is basic knowledge for the use of wind power for electricity, complemented by historical development, basic knowledge on wind systems and alternative renewable energies.

Content
The lecture contacts due to the broadly basic knowledge to all listeners of all terms.
On the basis of an overview of alternative, renewable energy technologies as well as general energy data, the entrance is transacted into the wind energy by means of an overview of the historical development of the wind force.
Since the wind supplies the driving power as indirect solar energy, the global and the local wind systems as well as their
measurement and energy content are dedicated to its own chapter.
Whereupon constructing the aerodynamic bases and connections of wind-power plants and/or their profiles are described. The electrical system of the wind-power plants forms a further emphasis. Begun of fundamental generator technology over control and controlling of the energy transfer.
After the emphasis aerodynamics and electrical system the further components of wind-power plants and their characteristics in the connection are described.
Finally the current economic, ecological and legislations boundary conditions for operating wind-power plants are examined.
In addition to wind-power plants for electricity production, the lecture is also shortly aiming at alternative use possibilities such as pumping systems.
Finally an overview of current developments like super-grids and visions of the future of the wind power utilization will be
given.

Media
A scriptum that has to be overhault is available under www.ieh.kit.edu under “Studium und Lehre”. Further book titles or relevant websites will be announced in the lecture.

Universität Karlsruhe (TH)
Forschungsuniversität · gegründet 1825
Der Rektor

Amtliche Bekanntmachung

2008 **Ausgegeben Karlsruhe, den 09. September 2008** **Nr. 78**

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360

Studien- und Prüfungsordnung der Universität Karlsruhe (TH) für den Bachelorstudiengang Maschinenbau

Aufgrund von § 34 Abs. 1, Satz 1 des Landeshochschulgesetzes (LHG) vom 1. Januar 2005 hat die beschließende Senatskommission für Prüfungsordnungen der Universität Karlsruhe (TH) am 31. Januar 2008 die folgende Studien- und Prüfungsordnung für den Bachelorstudiengang Maschinenbau beschlossen.

Der Rektor hat seine Zustimmung am 28. Februar 2008 erteilt.

Inhaltsverzeichnis

In dieser Satzung wurde nur die weibliche Sprachform gewählt. Alle personenbezogenen Aussagen gelten jedoch stets für Frauen und Männer gleichermaßen.

Die Universität Karlsruhe (TH) hat sich im Rahmen der Umsetzung des Bolognaprozesses zum Aufbau eines Europäischen Hochschulraumes zum Ziel gesetzt, dass am Abschluss der Studierendenausbildung an der Universität Karlsruhe (TH) in der Regel der Mastergrad steht. Die Universität Karlsruhe (TH) sieht daher die an der Universität Karlsruhe (TH) angebotenen konsekutiven Bachelor- und Masterstudiengänge als Gesamtkonzept mit konsekutivem Curriculum.

I. Allgemeine Bestimmungen

§ 1 Geltungsbereich, Ziele

(1) Diese Bachelorprüfungsordnung regelt Studienablauf, Prüfungen und den Abschluss des Studiums im Bachelorstudiengang Maschinenbau an der Universität Karlsruhe (TH).

(2) Im Bachelorstudium sollen die wissenschaftlichen Grundlagen und die Methodenkompetenz der Fachwissenschaften vermittelt werden. Ziel des Studiums ist die Fähigkeit, einen konsekutiven Masterstudiengang erfolgreich absolvieren zu können sowie das erworbene Wissen berufsfeldbezogen anwenden zu können.

§ 2 Akademischer Grad

Aufgrund der bestandenen Bachelorprüfung wird der akademische Grad „Bachelor of Science“ (abgekürzt: „B.Sc.“) für den Bachelorstudiengang Maschinenbau verliehen.

§ 3 Regelstudienzeit, Studienaufbau, Leistungspunkte

(1) Die Regelstudienzeit beträgt sechs Semester. Sie umfasst ein Berufspraktikum, Prüfungen und die Bachelorarbeit.

(2) Die im Studium zu absolvierenden Lehrinhalte sind in Module gegliedert, die jeweils aus einer Lehrveranstaltung oder mehreren, thematisch und zeitlich aufeinander bezogenen Lehrveranstaltungen bestehen. Art, Umfang und Zuordnung der Lehrveranstaltungen zu einem Modul sowie die Möglichkeiten, Module und Lehrveranstaltungen untereinander zu kombinieren, beschreibt der Studienplan. Die Module und ihr Umfang werden in § 17 definiert.

(3) Der für das Absolvieren von Lehrveranstaltungen und Modulen vorgesehene Arbeitsaufwand wird in Leistungspunkten (Credits) ausgewiesen. Die Maßstäbe für die Zuordnung von Leistungs-punkten entsprechen dem ECTS (European Credit Transfer System). Ein Leistungspunkt entspricht einem Arbeitsaufwand von etwa 30 Stunden.

(4) Der Umfang der für den erfolgreichen Abschluss des Studiums erforderlichen Studienleistungen wird in Leistungspunkten gemessen und beträgt insgesamt 180 Leistungspunkte.

(5) Die Verteilung der Leistungspunkte im Studienplan auf die Semester hat in der Regel gleichmäßig zu erfolgen.

(6) Lehrveranstaltungen können auch in englischer Sprache angeboten werden.

§ 4 Aufbau der Prüfungen

(1) Die Bachelorprüfung besteht aus einer Bachelorarbeit und Modulprüfungen, jede Modulprüfung aus einer oder mehreren Modulteilprüfungen. Eine Modulteilprüfung besteht aus mindestens einer Erfolgskontrolle.

(2) Erfolgskontrollen sind:

1. schriftliche Prüfungen,
2. mündliche Prüfungen oder
3. Erfolgskontrollen anderer Art.

Erfolgskontrollen anderer Art sind z.B. Vorträge, Marktstudien, Projekte, Fallstudien, Experimente, schriftliche Arbeiten, Berichte, Seminararbeiten und Klausuren, sofern sie nicht als schriftliche oder mündliche Prüfung in der Modul- oder Lehrveranstaltungsbeschreibung im Studienplan ausgewiesen sind.

(3) In der Regel sind mindestens 50 % einer Modulprüfung in Form von schriftlichen oder mündlichen Prüfungen (Abs. 2, Nr. 1 und 2) abzulegen, die restlichen Prüfungen erfolgen durch Erfolgskontrollen anderer Art (Abs. 2, Nr. 3).

§ 5 Anmeldung und Zulassung zu den Prüfungen

(1) Um zu schriftlichen und/oder mündlichen Prüfungen (§ 4 Abs. 2, Nr. 1 und 2) in einem bestimmten Modul zugelassen zu werden, muss die Studentin vor der ersten schriftlichen oder mündlichen Prüfung in diesem Modul beim Studienbüro eine bindende Erklärung über die Wahl des betreffenden Moduls bzw. der Teilmodule, wenn diese Wahlmöglichkeit besteht, abgeben. Darüber hinaus muss sich die Studentin für jede einzelne Modulteilprüfung, die in Form einer schriftlichen oder mündlichen Prüfung (§ 4 Abs. 2, Nr. 1 und 2) durchgeführt wird, beim Studienbüro anmelden. Dies gilt auch für die Zulassung zur Bachelorarbeit.

(2) Um an den Modulprüfungen teilnehmen zu können, muss sich die Studentin schriftlich oder per Online-Anmeldung beim Studienbüro anmelden. Hierbei sind die gemäß dem Studienplan für die jeweilige Modulprüfung notwendigen Studienleistungen nachzuweisen.

(3) Die Zulassung darf nur abgelehnt werden, wenn

a. die Studentin in einem mit dem Maschinenbau vergleichbaren oder einem verwandten Studiengang bereits eine Diplomvorprüfung, Diplomprüfung, Bachelor- oder Masterprüfung nicht bestanden hat, sich in einem Prüfungsverfahren befindet oder den Prüfungsanspruch in einem solchen Studiengang verloren hat oder
b. die gemäß dem Studienplan für die jeweilige Modulprüfung notwendigen Studienleistungen nicht nachgewiesen werden können oder
c. die in § 18 genannte Voraussetzung nicht erfüllt ist.

In Zweifelsfällen entscheidet die jeweilige Prüfungskommission.

(4) Die Anmeldung zu einer ersten schriftlichen Modulprüfung gilt zugleich als bedingte Anmeldung für die Wiederholung der Modulprüfung bei nicht bestandener Prüfung.

§ 6 Durchführung von Prüfungen und 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) der einzelnen Lehrveranstaltungen wird von der Prüferin der betreffenden Lehrveranstaltung in Bezug auf die Lehrinhalte der Lehrveranstaltung und die Lehrziele des Moduls festgelegt. Die Prüferin sowie die Art der Erfolgskontrollen, ihre Häufigkeit, Reihenfolge und Gewichtung, die Bildung der Lehrveranstaltungsnote und der Modulnote müssen mindestens sechs Wochen vor Semesterbeginn bekannt gegeben werden. Im Einvernehmen von Prüferin und Studentin kann die Art der Erfolgskontrolle auch nachträglich geändert werden. Dabei ist jedoch § 4 Abs. 3 zu berücksichtigen. Für die jeweilige Modulprüfung notwendige Studien- und Prüfungsleistungen sind im Studienplan festgelegt.

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

(4) Macht eine Studentin glaubhaft, dass sie wegen länger andauernder oder ständiger körperlicher Behinderung nicht in der Lage ist, die Erfolgskontrollen ganz oder teilweise in der vorgeschriebenen Form abzulegen, kann die zuständige Prüfungskommission – in dringenden Angelegenheiten, deren Erledigung nicht bis zu einer Sitzung des Ausschusses aufgeschoben werden kann, deren Vorsitzende – gestatten, Erfolgskontrollen in einer anderen Form zu erbringen.

(5) Mit Zustimmung der Studentin kann die Prüferin die entsprechenden Erfolgskontrollen in einer anderen Sprache als Deutsch abnehmen.

(6) Schriftliche Prüfungen (§ 4 Abs. 2, Nr. 1) sind in der Regel von einer Prüferin nach § 15 Abs. 2 oder § 15 Abs. 3 zu bewerten. Die Note ergibt sich aus dem arithmetischen Mittel der Einzelbewertungen. Entspricht das arithmetische Mittel keiner der in § 7 Abs. 2, Satz 2 definierten Notenstufen, so ist auf die nächstliegende Notenstufe zu runden. Bei gleichem Abstand ist auf die nächstbessere Notenstufe zu runden. Das Bewertungsverfahren soll sechs Wochen nicht überschreiten. Schriftliche Einzelprüfungen dauern mindestens 60 und höchstens 300 Minuten.

(7) Mündliche Prüfungen (§ 4 Abs. 2, Nr. 2) sind von mehreren Prüferinnen (Kollegialprüfung) oder von einer Prüferin in Gegenwart einer Beisitzenden als Gruppen- oder Einzelprüfungen abzunehmen und zu bewerten. Vor der Festsetzung der Note hört die Prüferin die anderen an der Kollegialprüfung mitwirkenden Prüferinnen an. Mündliche Prüfungen dauern in der Regel mindestens 15 Minuten und maximal 60 Minuten pro Studentin.

(8) Die wesentlichen Gegenstände und Ergebnisse der mündlichen Prüfung in den einzelnen Fächern sind in einem Protokoll festzuhalten. Das Ergebnis der Prüfung ist der Studentin im Anschluss an die mündliche Prüfung bekannt zu geben.

(9) Bei Prüfungen nach § 4 Abs. 2 , Nr. 1 und Nr. 2 kann von der Prüferin ein Bonus von bis zu maximal 0.4 Notenpunkten für vorlesungsbegleitende Übungen oder Projektarbeiten des Pflichtbereichs, die mit der Note 1.0 bewertet werden, vergeben werden. Die Note wird in diesem Falle um den gewährten Bonus verbessert. Entspricht das so entstandene Ergebnis keiner der in § 7 Abs. 2, Satz 2 definierten Notenstufen, so ist auf die nächstliegende Notenstufe zu runden.

(10) Studentinnen, die sich in einem späteren Prüfungszeitraum der gleichen Prüfung unterziehen wollen, werden entsprechend den räumlichen Verhältnissen als Zuhörerinnen bei mündlichen Prüfungen zugelassen. Die Zulassung erstreckt sich nicht auf die Beratung und Bekanntgabe der Prüfungsergebnisse. Aus wichtigen Gründen oder auf Antrag der zu prüfenden Studentin ist die Zulassung zu versagen.

(11) Für Erfolgskontrollen anderer Art sind angemessene Bearbeitungsfristen einzuräumen und Abgabetermine festzulegen. Dabei ist durch die Art der Aufgabenstellung und durch entsprechende Dokumentation sicherzustellen, dass die erbrachte Studienleistung der Studentin zurechenbar ist. Die wesentlichen Gegenstände und Ergebnisse einer solchen Erfolgskontrolle sind in einem Protokoll festzuhalten.

(12) Schriftliche Arbeiten im Rahmen einer Erfolgskontrolle 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 diese Arbeit nicht angenommen. Die wesentlichen Gegenstände und Ergebnisse einer solchen Erfolgskontrolle sind in einem Protokoll festzuhalten.

(13) Bei mündlich durchgeführten Erfolgskontrollen anderer Art muss neben der Prüferin eine Beisitzerin anwesend sein, die zusätzlich zur Prüferin die Protokolle zeichnet.

§ 7 Bewertung von Prüfungen und Erfolgskontrollen

(1) Das Ergebnis einer Erfolgskontrolle wird von den jeweiligen Prüferinnen in Form einer Note festgesetzt.

(2) Im Bachelorzeugnis dürfen nur folgende Noten verwendet werden:

1	=	sehr gut (very good)	=	hervorragende Leistung,
2	=	gut (good)	=	eine Leistung, die erheblich über den durchschnittlichen Anforderungen liegt,
3	=	befriedigend (satisfactory)	=	eine Leistung, die durchschnittlichen Anforderungen entspricht,
4	=	ausreichend (sufficient)	=	eine Leistung, die trotz ihrer Mängel noch den Anforderungen genügt,
5	=	nicht ausreichend (failed)	=	eine Leistung, die wegen erheblicher Mängel nicht den Anforderungen genügt.

Für die Bachelorarbeit und die Modulteilprüfungen sind zur differenzierten Bewertung nur folgende Noten zugelassen:

1	:	1.0, 1.3	=	sehr gut
2	:	1.7, 2.0, 2.3	=	gut
3	:	2.7, 3.0, 3.3	=	befriedigend
4	:	3.7, 4.0	=	ausreichend
5	:	4.7, 5.0	=	nicht ausreichend

Diese Noten müssen in den Protokollen und in den Anlagen (Transcript of Records und Diploma Supplement) verwendet werden.

(3) Für Erfolgskontrollen anderer Art kann im Studienplan die Benotung mit „bestanden“ (passed) oder „nicht bestanden“ (failed) vorgesehen werden.

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

(5) Jedes Modul, jede Lehrveranstaltung und jede Erfolgskontrolle darf in demselben Studiengang bzw. einem darauf aufbauenden konsekutiven Masterstudiengang nur einmal angerechnet werden.

(6) Erfolgskontrollen anderer Art dürfen in Modulteilprüfungen oder Modulprüfungen nur eingerechnet werden, wenn die Benotung nicht nach Absatz 3 erfolgt ist. Die zu dokumentierenden Erfolgskontrollen und die daran geknüpften Bedingungen werden im Studienplan festgelegt.

(7) Eine Modulteilprüfung ist bestanden, wenn die Note mindestens „ausreichend“ (4.0) ist.

(8) Eine Modulprüfung ist dann bestanden, wenn die Modulnote mindestens „ausreichend“ (4.0) ist. Die Modulprüfung und die Bildung der Modulnote werden im Studienplan geregelt. Die differenzierten Modulteilnoten (Absatz 2) sind bei der Berechnung der Modulnoten als Ausgangsdaten zu verwenden.

(9) Enthält der Studienplan keine Regelung darüber, wann eine Modulprüfung bestanden ist, so ist diese Modulprüfung dann endgültig nicht bestanden, wenn eine dem Modul zugeordnete Modulteilprüfung endgültig nicht bestanden wurde.

(10) Die Ergebnisse der Bachelorarbeit, der Modulprüfungen bzw. der Modulteilprüfungen, der Erfolgskontrollen anderer Art sowie die erworbenen Leistungspunkte werden durch das Studienbüro der Universität erfasst.

(11) Die Noten der Teilmodule eines Moduls gehen in die Modulnote mit einem Gewicht proportional zu den ausgewiesenen Leistungspunkten der Module ein.

(12) Werden in dem Schwerpunkt-Modul mehr als die notwendigen Leistungspunkte erworben, werden bei der Festlegung der Modulnote alle Modulteilnoten gemäß ihrer Leistungspunkte gewichtet. Bei der Bildung der Gesamtnote werden nur die in § 17 vorgesehenen Leistungspunkte gewertet.

(13) Die Gesamtnote der Bachelorprüfung, die Modulnoten und die Modulteilnoten 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

(14) Zusätzlich zu den Noten nach Absatz 2 werden ECTS-Noten für Modulprüfungen und für die Bachelorprüfung nach folgender Skala vergeben:

ECTS-Note	Definition
A	gehört zu den besten 10 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
B	gehört zu den nächsten 25 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
C	gehört zu den nächsten 30 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
D	gehört zu den nächsten 25 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
E	gehört zu den letzten 10 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
FX	*nicht bestanden* (failed) - es sind Verbesserungen erforderlich, bevor die Leistungen anerkannt werden,
F	*nicht bestanden* (failed) - es sind erhebliche Verbesserungen erforderlich.

Die Quote ist als der Prozentsatz der erfolgreichen Studentinnen definiert, die diese Note in der Regel erhalten. Dabei ist von einer mindestens fünfjährigen Datenbasis über mindestens 30 Studentinnen auszugehen. Für die Ermittlung der Notenverteilungen, die für die ECTS-Noten erforderlich sind, ist das Studienbüro der Universität zuständig.

§ 8 Erlöschen des Prüfungsanspruchs, Orientierungsprüfungen, Wiederholung von Prüfungen und Erfolgskontrollen

(1) Die Modulteilprüfungen in Höherer Mathematik I, II sowie in Technischer Mechanik I, II sind bis zum Ende des Prüfungszeitraums des zweiten Fachsemesters abzulegen (Orientierungsprüfungen).

Wer die Orientierungsprüfungen einschließlich etwaiger Wiederholungen bis zum Ende des Prüfungszeitraums des dritten Fachsemesters nicht abgelegt hat, verliert den Prüfungsanspruch im Studiengang, es sei denn, dass sie die Fristüberschreitung nicht zu vertreten hat; hierüber entscheidet die jeweilige Prüfungskommission auf Antrag der Studentin. Eine zweite Wiederholung der Orientierungsprüfungen ist in höchstens einer Modulteilprüfung möglich.

(2) Studentinnen können eine nicht bestandene schriftliche Prüfung (§ 4 Abs. 2, Nr. 1) einmal wiederholen. Wird eine schriftliche Wiederholungsprüfung mit „nicht ausreichend“ 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.

(3) Studentinnen können eine nicht bestandene mündliche Prüfung (§ 4 Abs. 2, Nr. 2) einmal wiederholen.

(4) Wiederholungsprüfungen nach Absatz 2 und 3 sind grundsätzlich zum nächstmöglichen Prüfungstermin abzulegen, sie müssen jedoch spätestens binnen eines Jahres erfolgen. Bei Versäumnis dieser Wiederholungsfrist erlischt der Prüfungsanspruch, es sei denn, die Studentin hat das Versäumnis nicht zu vertreten.

Die Anmeldung erfolgt bei schriftlichen Prüfungen gemäß § 5 Abs. 3. Die Prüfungen müssen in Inhalt, Umfang und Form (mündlich oder schriftlich) der ersten entsprechen. Ausnahmen kann die zuständige Prüfungskommission auf Antrag zulassen. Fehlversuche an anderen Hochschulen sind anzurechnen.

(5) Die Wiederholung einer Erfolgskontrolle anderer Art (§ 4 Abs. 2, Nr. 3) wird im Studienplan geregelt.

(6) Eine zweite Wiederholung derselben schriftlichen oder mündlichen Prüfung ist nur in Ausnahmefällen zulässig. Einen Antrag auf Zweitwiederholung hat die Studentin schriftlich bei der jeweiligen Prüfungskommission zu stellen. Über den ersten Antrag einer Studentin auf Zweitwiederholung entscheidet die jeweilige Prüfungskommission, wenn sie den Antrag genehmigt. Wenn die jeweilige Prüfungskommission diesen Antrag ablehnt, entscheidet die Rektorin. Über weitere Anträge auf Zweitwiederholung entscheidet nach Stellungnahme der jeweiligen Prüfungskommission die Rektorin. Absatz 2, Satz 2 und 3 gilt entsprechend.

(7) Die Wiederholung einer bestandenen Erfolgskontrolle ist nicht zulässig.

(8) Eine Modulprüfung ist endgültig nicht bestanden, wenn mindestens ein Teilmodul des Moduls endgültig nicht bestanden ist.

(9) Die Bachelorarbeit kann bei einer Bewertung mit „nicht ausreichend“ einmal wiederholt werden. Eine zweite Wiederholung der Bachelorarbeit ist ausgeschlossen.

(10) Ist gemäß § 34 Abs. 2, Satz 3 LHG die Bachelorprüfung bis zum Beginn der Vorlesungszeit des zehnten Fachsemesters einschließlich etwaiger Wiederholungen nicht vollständig abgelegt, so erlischt der Prüfungsanspruch im Studiengang, es sei denn, dass die Studentin die Fristüberschreitung nicht zu vertreten hat. Die Entscheidung darüber trifft die jeweilige Prüfungskommission.

§ 9 Versäumnis, Rücktritt, Täuschung, Ordnungsverstoß

(1) Die Studentin kann bei schriftlichen Modulteilprüfungen ohne Angabe von Gründen bis zur Ausgabe der Prüfungsaufgaben zurücktreten. Bei mündlichen Modulteilprüfungen muss der Rücktritt spätestens drei Werktage vor dem betreffenden Prüfungstermin erklärt werden. Die Abmeldung kann schriftlich bei der Prüferin oder per Online-Abmeldung beim Studienbüro erfolgen. Eine durch Widerruf abgemeldete Prüfung gilt als nicht angemeldet.

(2) Eine Modulteilprüfung gilt als mit „nicht ausreichend“ bewertet, wenn die Studentin einen Prüfungstermin ohne triftigen Grund versäumt oder wenn sie nach Beginn der Prüfung ohne triftigen Grund von der Prüfung zurücktritt. Dasselbe gilt, wenn die Bachelorarbeit nicht innerhalb der vorgesehenen Bearbeitungszeit erbracht wird, es sei denn, die Studentin hat die Fristüberschreitung nicht zu vertreten.

(3) Der für den Rücktritt nach Beginn der Prüfung oder das Versäumnis geltend gemachte Grund muss der jeweiligen Prüfungskommission unverzüglich schriftlich angezeigt und glaubhaft gemacht werden. Bei Krankheit der Studentin oder eines von ihr allein zu versorgenden Kindes oder pflegebedürftigen Angehörigen kann die Vorlage eines ärztlichen Attestes und in Zweifelsfällen ein amtsärztliches Attest verlangt werden. Die Anerkennung des Rücktritts ist ausgeschlossen, wenn bis zum Eintritt des Hinderungsgrundes bereits Prüfungsleistungen erbracht worden sind und nach deren Ergebnis die Prüfung nicht bestanden werden kann. Wird der Grund anerkannt, wird ein neuer Termin anberaumt. Die bereits vorliegenden Prüfungsergebnisse sind in diesem Fall anzurechnen.

(4) Versucht die Studentin das Ergebnis ihrer Modulteilprüfung durch Täuschung oder Benutzung nicht zugelassener Hilfsmittel zu beeinflussen, gilt die betreffende Modulteilprüfung als mit „nicht ausreichend“ (5.0) bewertet. Bei Modulprüfungen, die aus mehreren Modulteilprüfungen bestehen, werden die Prüfungsleistungen dieses Moduls, die bis zu einem anerkannten Rücktritt bzw. einem anerkannten Versäumnis einer Prüfungsleistung dieses Moduls erbracht worden sind, angerechnet.

(5) Eine Studentin, die den ordnungsgemäßen Ablauf der Prüfung stört, kann von der jeweiligen Prüferin oder der Aufsicht führenden Person von der Fortsetzung der Modulteilprüfung ausgeschlossen werden. In diesem Fall gilt die betreffende Prüfungsleistung als mit „nicht ausreichend“ (5.0) bewertet. In schwerwiegenden Fällen kann die jeweilige Prüfungskommission die Studentin von der Erbringung weiterer Prüfungsleistungen ausschließen.

(6) Die Studentin kann innerhalb einer Frist von einem Monat verlangen, dass Entscheidungen gemäß Absatz 4 und 5 von der jeweiligen Prüfungskommission überprüft werden. Belastende Entscheidungen der jeweiligen Prüfungskommission sind unverzüglich schriftlich mitzuteilen. Sie sind zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen. Vor einer Entscheidung ist Gelegenheit zur Äußerung zu geben.

(7) Näheres regelt die Allgemeine Satzung der Universität Karlsruhe (TH) zur Redlichkeit bei Prüfungen und Praktika.

§ 10 Mutterschutz, Elternzeit

(1) Auf Antrag sind die Mutterschutzfristen, wie sie im jeweils gültigen Gesetz zum Schutz der erwerbstätigen Mutter (MuSchG) festgelegt sind, entsprechend zu berücksichtigen. Dem Antrag sind die erforderlichen Nachweise beizufügen. Die Mutterschutzfristen unterbrechen jede Frist nach dieser Prüfungsordnung. Die Dauer des Mutterschutzes wird nicht in die Frist eingerechnet.

(2) Gleichfalls sind die Fristen der Elternzeit nach Maßgabe des jeweiligen gültigen Gesetzes (BErzGG) auf Antrag zu berücksichtigen. Die Studentin muss bis spätestens vier Wochen vor dem Zeitpunkt, von dem an sie die Elternzeit antreten will, der jeweiligen Prüfungskommission unter Beifügung der erforderlichen Nachweise schriftlich mitteilen, in welchem Zeitraum sie die Elternzeit in Anspruch nehmen will. Die jeweilige Prüfungskommission hat zu prüfen, ob die gesetzlichen Voraussetzungen vorliegen, die bei einer Arbeitnehmerin den Anspruch auf Elternzeit auslösen würden, und teilt der Studentin das Ergebnis sowie die neu festgesetzten Prüfungszeiten unverzüglich mit. Die Bearbeitungszeit einer Bachelorarbeit kann nicht durch eine Elternzeit unterbrochen werden. Die gestellte Arbeit gilt in diesem Fall als nicht vergeben. Nach Ablauf der Elternzeit erhält die Studentin ein neues Thema.

§ 11 Bachelorarbeit

(1) Voraussetzung für die Zulassung zur Bachelorarbeit ist, dass die Studentin sich in der Regel im 3. Studienjahr befindet, höchstens eine der Modulteilprüfungen der ersten beiden Studienjahre laut § 17 Abs. 3 noch nicht bestanden hat und das Berufspraktikum gemäß § 12 anerkannt wurde. Auf Antrag der Studentin sorgt ausnahmsweise die Vorsitzende der jeweiligen Prüfungskommission dafür, dass die Studentin innerhalb von vier Wochen nach Antragstellung von einer Betreuerin ein Thema für die Bachelorarbeit erhält. Die Ausgabe des Themas erfolgt in diesem Fall über die Vorsitzende der jeweiligen Prüfungskommission.

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

(3) Der Bachelorarbeit werden 12 Leistungspunkte zugeordnet. Die empfohlene Bearbeitungsdauer beträgt drei Monate. Die maximale Bearbeitungsdauer beträgt einschließlich einer Verlängerung vier Monate. Im Anschluss an die Bachelorarbeit, spätestens vier Wochen nach Abgabe, findet am Institut der Prüferin ein Kolloquium von etwa 30 Minuten Dauer über das Thema der Bachelorarbeit und deren Ergebnisse statt. Die Bachelorarbeit kann im Einvernehmen mit der Prüferin auch auf Englisch oder Französisch geschrieben werden. Die Bachelorarbeit soll zeigen, dass die Studentin in der Lage ist, ein Problem aus dem Maschinenbau selbstständig und in begrenzter Zeit nach wissenschaftlichen Methoden zu bearbeiten.

(4) Die Bachelorarbeit kann von jeder Prüferin nach § 15 Abs. 2 vergeben und betreut werden. Soll die Bachelorarbeit außerhalb der Fakultät für Maschinenbau angefertigt werden, so bedarf dies der Genehmigung der jeweiligen Prüfungskommission. Der Studentin ist Gelegenheit zu geben, für das Thema Vorschläge zu machen. Die Bachelorarbeit kann auch in Form einer Gruppenarbeit zugelassen werden, wenn der als Prüfungsleistung zu bewertende Beitrag der einzelnen Studentin aufgrund objektiver Kriterien, die eine eindeutige Abgrenzung ermöglichen, deutlich unterscheidbar ist und die Anforderung nach Absatz 3 erfüllt.

(5) Bei der Abgabe der Bachelorarbeit hat die Studentin schriftlich zu versichern, dass sie die Arbeit selbstständig verfasst hat und keine anderen als die angegebenen Quellen und Hilfsmittel benutzt hat, die wörtlich oder inhaltlich übernommenen Stellen als solche kenntlich gemacht und die Satzung der Universität Karlsruhe (TH) zur Sicherung guter wissenschaftlicher Praxis in der jeweils gültigen Fassung beachtet hat. Wenn diese Erklärung nicht enthalten ist, wird die Arbeit nicht angenommen. Bei Abgabe einer unwahren Versicherung wird die Bachelorarbeit mit „nicht ausreichend“ (5.0) bewertet.

(6) Der Zeitpunkt der Ausgabe des Themas der Bachelorarbeit und der Zeitpunkt der Abgabe der Bachelorarbeit sind aktenkundig zu machen. Das Thema kann nur einmal und nur innerhalb des ersten Monats der Bearbeitungszeit zurückgegeben werden. Ein neues Thema ist binnen vier Wochen zu stellen und auszugeben. Auf begründeten Antrag der Studentin kann die jeweilige Prüfungskommission die in Absatz 3 festgelegte Bearbeitungszeit um höchstens einen Monat verlängern. Wird die Bachelorarbeit nicht fristgerecht abgeliefert, gilt sie als mit „nicht ausreichend“ bewertet, es sei denn, dass die Studentin dieses Versäumnis nicht zu vertreten hat. § 8 gilt entsprechend.

(7) Die Bachelorarbeit wird von einer Betreuerin sowie in der Regel von einer weiteren Prüferin bewertet. Eine der beiden muss Juniorprofessorin oder Professorin der Fakultät für Maschinenbau sein. Bei nicht übereinstimmender Beurteilung der beiden Prüferinnen setzt die jeweilige Prüfungskommission im Rahmen der Bewertung der beiden Prüferinnen die Note der Bachelorarbeit fest. Der Bewertungszeitraum soll sechs Wochen nicht überschreiten.

§ 12 Berufspraktikum

(1) Während des Bachelorstudiums ist ein mindestens zwölfwöchiges Berufspraktikum abzuleisten. Davon entfallen sechs Wochen auf das Grundpraktikum und die restlichen sechs Wochen auf das Fachpraktikum, welches geeignet ist, der Studentin eine Anschauung von berufspraktischer Tätigkeit im Maschinenbau zu vermitteln. Dem Fachpraktikum sind 8 Leistungspunkte zugeordnet.

(2) Die Studentin setzt sich in eigener Verantwortung mit geeigneten privaten bzw. öffentlichen Einrichtungen in Verbindung, an denen das Praktikum abgeleistet werden kann. Die Studentin wird dabei von einer Prüferin nach § 15 Abs. 2 und einer Firmenbetreuerin betreut.

(3) Das sechswöchige Grundpraktikum soll vor Studienbeginn abgeleistet werden. Es ist möglich, auch Teile des Fachpraktikums schon vor Studienaufnahme abzuleisten.

(4) Bei der Anmeldung zum zweiten Abschnitt der Bachelorprüfung muss das komplette Berufspraktikum anerkannt sein.

(5) Weitere Regelungen zu Inhalt, Durchführung und Anerkennung des Berufspraktikums finden sich im Studienplan. Das Berufspraktikum geht nicht in die Gesamtnote ein.

§ 13 Zusatzmodule, Zusatzleistungen

(1) Die Studentin kann sich weiteren Prüfungen in Modulen im Umfang von höchstens 20 Leistungspunkten unterziehen. § 3 und § 4 der Studien- und Prüfungsordnung bleiben davon unberührt.

(2) Das Ergebnis maximal zweier Module, die jeweils mindestens 3 Leistungspunkte umfassen müssen, wird auf Antrag der Studentin in das Bachelorzeugnis als Zusatzmodul aufgenommen und als Zusatzmodul gekennzeichnet. Zusatzmodule werden bei der Festsetzung der Gesamtnote nicht mit einbezogen. Alle Zusatzleistungen werden im Transcript of Records automatisch aufgenommen und als Zusatzleistungen gekennzeichnet. Zusatzleistungen werden mit den gemäß

§ 7 vorgesehenen Noten gelistet. Diese Zusatzleistungen gehen nicht in die Festsetzung der Gesamt- und Modulnoten ein.

(3) Die Studentin hat bereits bei der Anmeldung zu einer Prüfung in einem Modul dieses als Zusatzleistung zu deklarieren.

§ 14 Prüfungskommission

(1) Für den Bachelorstudiengang Maschinenbau werden Prüfungskommissionen gebildet. Sie bestehen jeweils aus vier stimmberechtigten Mitgliedern: zwei Professorinnen, Juniorprofessorinnen, Hochschul- oder Privatdozentinnen, zwei Vertreterinnen der Gruppe der wissenschaftlichen Mitarbeiterinnen nach §11 Abs. 1, Satz 2, Nr. 2 LHG und einer Vertreterin der Studentinnen mit beratender Stimme. Die Amtszeit der nichtstudentischen Mitglieder beträgt zwei Jahre, die des studentischen Mitglieds ein Jahr.

(2) Die Vorsitzende, ihre Stellvertreterin, die weiteren Mitglieder der jeweiligen Prüfungskommission sowie deren Stellvertreterinnen werden vom Fakultätsrat bestellt, die Mitglieder der Gruppe der wissenschaftlichen Mitarbeiterinnen nach §11 Abs. 1, Satz 2, Nr. 2 LHG und die Vertreterin der Studentinnen auf Vorschlag der Mitglieder der jeweiligen Gruppe; Wiederbestellung ist möglich. Die Vorsitzende und deren Stellvertreterin müssen Professorin oder Juniorprofessorin sein. Die Vorsitzende der Prüfungskommission nimmt die laufenden Geschäfte wahr und wird durch die Prüfungssekretariate unterstützt.

(3) Die jeweilige Prüfungskommission ist zuständig für die Auslegung und Umsetzung der Prüfungsordnung sowie die Durchführung der ihr durch diese Studien- und Prüfungsordnung zugewiesenen Aufgaben. Sie achtet auf die Einhaltung der Bestimmungen dieser Studien- und Prüfungsordnung und fällt die Entscheidung in Prüfungsangelegenheiten. Sie entscheidet über die Anrechnung von Studienzeiten, Studienleistungen und Modulprüfungen und übernimmt die Gleichwertigkeitsfeststellung. Sie berichtet der jeweiligen Fakultät regelmäßig über die Entwicklung der Prüfungs- und Studienzeiten, einschließlich der Bearbeitungszeiten für die Bachelorarbeiten und die Verteilung der Modul- und Gesamtnoten. Sie ist zuständig für Anregungen zur Reform der Studien- und Prüfungsordnung und zu Modulbeschreibungen.

(4) Die Prüfungskommission kann die Erledigung ihrer Aufgaben für alle Regelfälle auf die Vorsitzende der Prüfungskommission übertragen.

(5) Die Mitglieder der Prüfungskommission haben das Recht, der Abnahme von Prüfungen beizuwohnen. Die Mitglieder der Prüfungskommission, die Prüferinnen und die Beisitzenden unterliegen der Amtsverschwiegenheit. Sofern sie nicht im öffentlichen Dienst stehen, sind sie durch die Vorsitzende zur Verschwiegenheit zu verpflichten.

(6) In Angelegenheiten der Prüfungskommission, die eine an einer anderen Fakultät zu absolvierende Prüfungsleistung betreffen, ist auf Antrag eines Mitgliedes der Prüfungskommission eine fachlich zuständige und von der betroffenen Fakultät zu nennende Professorin, Juniorprofessorin, Hochschul- oder Privatdozentin hinzuziehen. Sie hat in diesem Punkt Stimmrecht.

(7) Belastende Entscheidungen der Prüfungskommission sind schriftlich mitzuteilen. Sie sind zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen. Widersprüche gegen Entscheidungen der Prüfungskommission sind innerhalb eines Monats nach Zugang der Entscheidung schriftlich oder zur Niederschrift an die Prüfungskommission zu richten. Hilft die Prüfungskommission dem Widerspruch nicht ab, ist er zur Entscheidung dem für die Lehre zuständigen Mitglied des Rektorats vorzulegen.

§ 15 Prüferinnen und Beisitzende

(1) Die jeweils zuständige Prüfungskommission bestellt die Prüferinnen und die Beisitzenden. Sie kann die Bestellung der Vorsitzenden übertragen.

(2) Prüferinnen sind Hochschullehrerinnen und habilitierte Mitglieder sowie wissenschaftliche Mitarbeiterinnen der jeweiligen Fakultät, denen die Prüfungsbefugnis übertragen wurde. Bestellt werden darf nur, wer mindestens die dem jeweiligen Prüfungsgegenstand entsprechende fachwissenschaftliche Qualifikation erworben hat. Bei der Bewertung der Bachelorarbeit muss eine Prüferin Hochschullehrerin sein.

(3) Soweit Lehrveranstaltungen von anderen als den unter Absatz 2 genannten Personen durchgeführt werden, sollen diese zur Prüferin bestellt werden, wenn die Fakultät ihr eine diesbezügliche Prüfungsbefugnis erteilt hat.

(4) Zur Beisitzenden darf nur bestellt werden, wer einen Diplom- oder Masterabschluss in einem Studiengang der Fakultät für Maschinenbau oder einen gleichwertigen akademischen Abschluss erworben hat.

§ 16 Anrechnung von Studienzeiten, Anerkennung von Studienleistungen und Modulprüfungen

(1) Studienzeiten und gleichwertige Studienleistungen, Modulteilprüfungen und Modulprüfungen, die in gleichen oder anderen Studiengängen auch an anderen Hochschulen erbracht wurden, werden von Amts wegen angerechnet. Gleichwertigkeit ist festzustellen, wenn Leistungen in Inhalt, Umfang und in den Anforderungen denjenigen des Bachelorstudienganges der Universität Karlsruhe (TH) im Wesentlichen entsprechen. Dabei ist kein schematischer Vergleich, sondern eine Gesamtbetrachtung vorzunehmen. Bezüglich des Umfangs einer zur Anerkennung vorgelegten Studienleistung und Modulprüfung werden die Grundsätze des ECTS herangezogen; die inhaltliche Gleichwertigkeitsprüfung orientiert sich an den Qualifikationszielen des Moduls.

(2) Werden Leistungen angerechnet, können die Noten – soweit die Notensysteme vergleichbar sind – übernommen werden und in die Berechnung der Modulnoten und der Gesamtnote einbezogen werden. Die Anerkennung wird im Zeugnis gekennzeichnet. Bei unvergleichbaren Notensystemen wird nur der Vermerk „anerkannt“ aufgenommen. Die Studentin hat die für die Anrechnung erforderlichen Unterlagen vorzulegen.

(3) Bei der Anrechnung von Studienzeiten und der Anerkennung von Studienleistungen, Modulteilprüfungen und Modulprüfungen, die außerhalb der Bundesrepublik erbracht wurden, sind die von der Kultusministerkonferenz und der Hochschulrektorenkonferenz gebilligten Äquivalenzvereinbarungen sowie Absprachen im Rahmen der Hochschulpartnerschaften zu beachten.

(4) Absatz 1 gilt auch für Studienzeiten, Studienleistungen, Modulteilprüfungen und Modulprüfungen, die in staatlich anerkannten Fernstudien- und an anderen Bildungseinrichtungen, insbesondere an staatlichen oder staatlich anerkannten Berufsakademien erworben wurden.

(5) Die Anerkennung von Teilen der Bachelorprüfung kann versagt werden, wenn in einem Studiengang mehr als die Hälfte aller Erfolgskontrollen und/oder in einem Studiengang mehr als die Hälfte der erforderlichen Leistungspunkte und/oder die Bachelorarbeit anerkannt werden soll/en. Dies gilt sowohl bei einem Studiengangwechsel als auch bei einem Studienortwechsel.

(6) Zuständig für die Anrechnungen ist die jeweilige Prüfungskommission. Vor Feststellungen über die Gleichwertigkeit können die zuständigen Fachvertreterinnen gehört werden. Die jeweilige Prüfungskommission entscheidet in Abhängigkeit von Art und Umfang der anzurechnenden Studien- und Prüfungsleistungen über die Einstufung in ein höheres Fachsemester.

II. Bachelorprüfung

§ 17 Umfang und Art der Bachelorprüfung

(1) Die Bachelorprüfung besteht aus den Modulprüfungen nach Absatz 2 und 3 sowie dem zweiten Abschnitt, der Bachelorarbeit (§ 11).

(2) In den ersten beiden Studienjahren sind Modulprüfungen oder Modulteilprüfungen durch den Nachweis von Leistungspunkten in folgenden Modulen abzulegen:

1. Höhere Mathematik: im Umfang von 21 Leistungspunkten,
2. Naturwissenschaftliche Grundlagen: im Umfang von 7 Leistungspunkten,
3. Technische Mechanik: im Umfang von 21 Leistungspunkten,
4. Werkstoffkunde: im Umfang von 15 Leistungspunkten,
5. Maschinenkonstruktionslehre: im Umfang von 18 Leistungspunkten,
6. Technische Thermodynamik: im Umfang von 13 Leistungspunkten,
7. Betriebliche Produktionswirtschaft: im Umfang von 5 Leistungspunkten,
8. Elektrotechnik: im Umfang von 8 Leistungspunkten,
9. Informatik: im Umfang von 8 Leistungspunkten.

Neben den Fachwissenschaftlichen Modulen ist ein Modul zu den Schlüsselqualifikationen im Umfang von 6 Leistungspunkten gemäß Studienplan zu belegen.

(3) Im dritten Studienjahr sind Modulteilprüfungen aus folgenden Modulen abzulegen:

1. Mess- und Regelungstechnik: im Umfang von 7 Leistungspunkten,
2. Strömungslehre: im Umfang von 7 Leistungspunkten,
3. Maschinen und Prozesse: im Umfang von 7 Leistungspunkten,
4. Wahlpflichtfach: im Umfang von 5 Leistungspunkten,
5. Schwerpunkt mit Kern- und Ergänzungsmodul: im Umfang von 12 Leistungspunkten.

(4) Die den Modulen zugeordneten, zum Teil wählbaren Lehrveranstaltungen und Leistungspunkte, die Erfolgskontrollen und Studienleistungen sowie die für den Schwerpunkt zur Auswahl stehenden Module sind im Studienplan festgelegt. Zu den entsprechenden Modulteilprüfungen kann nur zugelassen werden, wer die Anforderungen nach § 5 erfüllt.

(5) Im dritten Studienjahr ist als eine weitere Prüfungsleistung eine Bachelorarbeit gemäß § 11 anzufertigen.

§ 18 Leistungsnachweise für die Bachelorprüfung

Voraussetzung für die Anmeldung zur letzten Modulprüfung der Bachelorprüfung ist die Bescheinigung über das erfolgreich abgeleistete Berufspraktikum nach § 12. In Ausnahmefällen, die die Studentin nicht zu vertreten hat, kann die jeweilige Prüfungskommission die nachträgliche Vorlage dieses Leistungsnachweises genehmigen.

§ 19 Bestehen der Bachelorprüfung, Bildung der Gesamtnote

(1) Die Bachelorprüfung ist bestanden, wenn alle in § 17 genannten Prüfungsleistungen mindestens mit „ausreichend“ bewertet und das Berufspraktikum nach § 12 anerkannt wurde.

(2) Die Gesamtnote der Bachelorprüfung errechnet sich aus den Modulnoten als ein mit Leistungspunkten gewichteter Notendurchschnitt.

(3) Hat die Studentin die Bachelorarbeit mit der Note 1.0 und die Bachelorprüfung mit einem Durchschnitt von 1.2 oder besser abgeschlossen, so wird das Prädikat „mit Auszeichnung“ (with distinction) verliehen.

§ 20 Bachelorzeugnis, Bachelorurkunde, Transcript of Records und Diploma Supplement

(1) Über die Bachelorprüfung wird nach Bewertung der letzten Prüfungsleistung eine Bachelorurkunde und ein Zeugnis erstellt. Die Ausfertigung von Bachelorurkunde und Zeugnis soll nicht später als sechs Wochen nach der Bewertung der letzten Prüfungsleistung erfolgen. Bachelorurkunde und Bachelorzeugnis werden in deutscher und englischer Sprache ausgestellt. Bachelorurkunde und Zeugnis tragen das Datum der erfolgreichen Erbringung der letzten Prüfungsleistung. Sie werden der Studentin gleichzeitig ausgehändigt. In der Bachelorurkunde wird die Verleihung des akademischen Bachelorgrades beurkundet. Die Bachelorurkunde wird von der Rektorin und der Dekanin unterzeichnet und mit dem Siegel der Universität versehen.

(2) Das Zeugnis enthält die in den zugeordneten Modulprüfungen erzielten Noten (bei Wahlpflichtfach und Schwerpunkt mit Bezeichnung der gewählten Fächer), Note und Thema der Bachelorarbeit, die jeweils zugeordneten Leistungspunkte und ECTS-Noten und die Gesamtnote und die ihr entsprechende ECTS-Note. Das Zeugnis ist von den Dekaninnen der beteiligten Fakultäten und von der Vorsitzenden der jeweiligen Prüfungskommission zu unterzeichnen.

(3) Weiterhin erhält die Studentin als Anhang ein Diploma Supplement in deutscher und englischer Sprache, das den Vorgaben des jeweils gültigen ECTS User’s Guide entspricht. Das Diploma Supplement enthält eine Abschrift der Studiendaten der Studentin (Transcript of Records).

(4) Die Abschrift der Studiendaten (Transcript of Records) enthält in strukturierter Form alle erbrachten Prüfungsleistungen. Dies beinhaltet alle Module mit den Modulnoten und ihre entsprechende ECTS-Note samt den zugeordneten Leistungspunkten sowie die den Modulen zugeordneten Lehrveranstaltungen samt Noten und zugeordneten Leistungspunkten. Aus der Abschrift der Studiendaten soll die Zugehörigkeit von Lehrveranstaltungen zu den einzelnen Modulen deutlich erkennbar sein. Angerechnete Studienleistungen sind im Transcript of Records aufzunehmen.

(5) Die Bachelorurkunde, das Bachelorzeugnis und das Diploma Supplement einschließlich des Transcript of Records werden vom Studienbüro der Universität ausgestellt.

III. Schlussbestimmungen

§ 21 Bescheid über Nicht-Bestehen, Bescheinigung von Prüfungsleistungen

(1) Der Bescheid über die endgültig nicht bestandene Bachelorprüfung wird der Studentin in schriftlicher Form erteilt. Der Bescheid ist mit einer Rechtsbehelfsbelehrung zu versehen.

(2) Hat die Studentin die Bachelorprüfung endgültig nicht bestanden, wird ihr auf Antrag und gegen Vorlage der Exmatrikulationsbescheinigung eine schriftliche Bescheinigung ausgestellt, welche die erbrachten Prüfungsleistungen und deren Noten sowie die zur Prüfung noch fehlenden Prüfungsleistungen enthält und erkennen lässt, dass die Prüfung insgesamt nicht bestanden ist. Dasselbe gilt, wenn der Prüfungsanspruch erloschen ist.

§ 22 Aberkennung des Bachelorgrades

(1) Hat die Studentin 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 Bachelorprüfung für „nicht bestanden“ erklärt werden.

(2) Waren die Voraussetzungen für die Zulassung zu einer Prüfung nicht erfüllt, ohne dass die Studentin darüber täuschen wollte, und wird diese Tatsache erst nach Aushändigung des Zeugnisses bekannt, wird dieser Mangel durch das Bestehen der Prüfung geheilt. Hat die Studentin die Zulassung vorsätzlich zu Unrecht erwirkt, so kann die Modulprüfung für „nicht ausreichend“ (5.0) und die Bachelorprüfung für „nicht bestanden“ erklärt werden.

(3) Vor einer Entscheidung der jeweiligen Prüfungskommission 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 Bachelorurkunde einzuziehen, wenn die Bachelorprüfung aufgrund einer Täuschung für „nicht bestanden“ erklärt wurde.

(5) Eine Entscheidung nach Absatz 1 und Absatz 2, Satz 2 ist nach einer Frist von fünf Jahren ab dem Datum des Zeugnisses ausgeschlossen.

(6) Die Aberkennung des akademischen Grades richtet sich nach den gesetzlichen Vorschriften.

§ 23 Einsicht in die Prüfungsakten

(1) Nach Abschluss der Bachelorprüfung wird der Studentin auf Antrag innerhalb eines Jahres Einsicht in ihre Bachelorarbeit, die darauf bezogenen Gutachten und in die Prüfungsprotokolle gewährt.

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

(3) Die Prüferin bestimmt Ort und Zeit der Einsichtnahme.

(4) Prüfungsunterlagen sind mindestens fünf Jahre aufzubewahren.

§ 24 In-Kraft-Treten

(1) Diese Studien- und Prüfungsordnung tritt am 1. Oktober 2008 in Kraft.

(2) Gleichzeitig tritt die Prüfungsordnung der Universität Karlsruhe (TH) für den Diplomstudiengang Maschinenbau vom 27. Juli 2000 und die Prüfungsordnung der Universität Karlsruhe (TH) für den Bachelorstudiengang Maschinenbau vom 08. Februar 2000 außer Kraft.

(3) Auf Antrag können Studentinnen, die auf Grundlage der Prüfungsordnung der Universität Karlsruhe (TH) für den Diplomstudiengang Maschinenbau vom 27. Juli 2000 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr.18 vom 15. August 2000, S. 107 ff.) ihr Studium an der Universität Karlsruhe (TH) aufgenommen haben, ihr Studium auf Grundlage der vorliegenden Prüfungsordnung fortsetzen.

(4) Auf Antrag können Studentinnen, die auf Grundlage der Prüfungsordnung der Universität Karlsruhe (TH) für den Bachelorstudiengang Maschinenbau vom 08. Februar 2000 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr.18 vom 15. August 2000, S. 94 ff.) ihr Studium an der Universität Karlsruhe (TH) aufgenommen haben, ihr Studium auf Grundlage der vorliegenden Prüfungsordnung fortsetzen.

(5) Studentinnen die auf Grundlage der Prüfungsordnung für den Diplomstudiengang Maschinenbau vom 27. Juli 2000 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr. 18 vom 15. August 2000, S. 107 ff.) ihr Studium an der Universität Karlsruhe (TH) aufgenommen haben, können einen Antrag auf Zulassung zur Prüfung letztmalig am 30. September 2015 stellen.

(6) Studentinnen, die auf Grundlage der Prüfungsordnung für den Bachelorstudiengang Maschinenbau vom 08. Februar 2000 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr. 18 vom 15. August 2000, S. 94 ff.) ihr Studium an der Universität Karlsruhe (TH) aufgenommen haben, können einen Antrag auf Zulassung zur Prüfung letztmalig am 30. September 2015 stellen.

Karlsruhe, den 28. Februar 2008

Professor Dr. sc. tech. Horst Hippler
(Rektor)

Universität des Landes Baden-Württemberg und
nationales Forschungszentrum in der Helmholtz-Gemeinschaft

Amtliche Bekanntmachung

2011 **Ausgegeben Karlsruhe, den 1. August 2011** **Nr. 42**

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Satzung zur Änderung der Studien- und Prüfungsordnung des Karlsruher Instituts für Technologie (KIT) für den Bachelorstudiengang Maschinenbau

vom 1. August 2011

Aufgrund von § 10 Abs. 2 Ziff. 6 und § 20 des Gesetzes über das Karlsruher Institut für Technologie (KIT-Gesetz - KITG) in der Fassung vom 14. Juli 2009 (GBl. S. 317 f) sowie § 8 Abs. 5 und § 34 Abs. 1 des Gesetzes über die Hochschulen in Baden-Württemberg (Landeshochschulgesetz - LHG) in der Fassung vom 1. Januar 2005 (GBl. S. 1 f), zuletzt geändert durch Artikel 12 des Gesetzes zur Reform des Notariats- und Grundbuchwesens in Baden-Württemberg vom 29. Juli 2010 (GBl. S. 555, 562), hat der Senat des Karlsruher Instituts für Technologie (KIT) am 18. Juli 2011 die folgende Satzung zur Änderung der Studien- und Prüfungsordnung für den Bachelorstudiengang Maschinenbau vom 09. September 2008 (Amtliche Bekanntmachung der Universität Karlsruhe (TH) Nr. 78 vom 09. September 2008) beschlossen.

Die Präsidenten haben ihre Zustimmung am 1. August 2011 erklärt.

Artikel 1

1. § 7 Abs. 14 wird ersatzlos gestrichen.

2. § 11 Abs. 1 Satz 1 wird wie folgt gefasst:

   „**(1)** Voraussetzung für die Zulassung zur Bachelorarbeit ist, dass die Studentin sich in der Regel im 3. Studienjahr befindet, höchstens eine der Modulteilprüfungen der ersten beiden Studienjahre laut § 17 Abs. 2 noch nicht bestanden hat und das Berufspraktikum gemäß § 12 anerkannt wurde."

3. § 13 Abs. 1 Satz 1 wird wie folgt gefasst:

   „**(1)** Die Studentin kann sich weiteren Prüfungen in Modulen im Umfang von höchstens 40 Leistungspunkten unterziehen. Über Ausnahmen entscheidet die Prüfungskommission."

4. § 13 Abs. 2 Satz 1 wird wie folgt gefasst:

   „**(2)** Maximal drei Module, die jeweils mindestens 3 Leistungspunkte umfassen müssen, werden mit dem jeweiligen Ergebnis auf Antrag der Studentin in das Bachelorzeugnis als Zusatzmodule aufgenommen und als Zusatzmodule gekennzeichnet."

Artikel 2

Diese Satzung tritt am Tage nach ihrer Veröffentlichung in den Amtlichen Bekanntmachungen des Karlsruher Instituts für Technologie (KIT) in Kraft.

Karlsruhe, den 1. August 2011

Professor Dr. sc. tech. Horst Hippler	*Professor Dr. Eberhard Umbach*
(Präsident)	*(Präsident)*

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