



Karlsruhe Institute of Technology

# **Module Handbook Bachelor Course Mechanical Engineering (B.Sc.)**

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Long version

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Faculty of Mechanical Engineering



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# Studienplan der Fakultät Maschinenbau für den Bachelor of Science- und Master of Science- Studiengang Maschinenbau

Fassung vom 29. Juni 2011

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**Änderungshistorie (ab 29.10.2008)**

29.10.2008	<p>Änderungen im Abschnitt 1.2 Module des Bachelorstudiums „B.Sc.“:</p> <ul style="list-style-type: none"> <li>- Prüfungen im Modul 1 - Höhere Mathematik: Getrennte Prüfungen zu HM I und HM II</li> <li>- Prüfungen im Modul 3 - Technische Mechanik: Getrennte Prüfungen zu TM I und TM II</li> <li>- Modul "Schwerpunkt": Umfang des Kernbereichs: 8LP, Umfang des Ergänzungsbereichs: 4 LP</li> </ul>
10.12.2008	<p>Änderungen im Abschnitt 1.3 Studienplan des 1. Abschnitts des Bachelorstudiums „B.Sc.“</p> <ul style="list-style-type: none"> <li>- Informatik: V, Ü und P finden im ersten Semester statt</li> </ul> <p>Änderungen im Abschnitt 1.5 Masterstudium mit Vertiefungsrichtungen</p> <ul style="list-style-type: none"> <li>- „Es stehen folgende Vertiefungsrichtungen zur Auswahl“</li> </ul> <p>Änderungen im Abschnitt 2.1 Wahlpflichtfächer im Bachelor- und Masterstudiengang</p> <ul style="list-style-type: none"> <li>- Aufnahme von „Informationssysteme“ als Wahlpflichtfach für BSc, MSc, FzGT, M+M, PEK, PT</li> </ul> <p>Änderungen im Abschnitt 2.5</p> <ul style="list-style-type: none"> <li>- Umbenennung des „Allgemeinen Wahlfachs“ in „Wahlfach“</li> </ul> <p>Änderungen im Abschnitt 3.1 Fachpraktikum</p> <ul style="list-style-type: none"> <li>- Tabelle wurde durch Fließtext ersetzt</li> </ul> <p>Änderungen im Abschnitt 4 Berufspraktikum</p> <ul style="list-style-type: none"> <li>- Die Abschnitte der Fachpraktika sollen in einem geschlossenen Zeitraum durchgeführt werden</li> </ul> <p>Änderungen im Abschnitt 4.3 Sonderbestimmungen zur Anerkennung</p> <ul style="list-style-type: none"> <li>- Auf Erwerb gerichtete, berufspraktische Tätigkeiten werden nicht mehr erwähnt</li> </ul> <p>Änderungen im Abschnitt 6.1 Zuordnung der Schwerpunkte zum Bachelor- und den Vertiefungsrichtungen des Masterstudiengangs</p> <ul style="list-style-type: none"> <li>- „Informationsmanagement“ als Schwerpunkt für BSc und FzGT zugelassen</li> <li>- „Lifecycle Engineering“ als Schwerpunkt für BSc zugelassen</li> </ul> <p>Änderungen im Abschnitt 6.3 Wahlmöglichkeiten für den Schwerpunkt im „Bachelor of Science“</p> <ul style="list-style-type: none"> <li>- Aktualisierung des gesamten Schwerpunkt-Angebotes</li> </ul>
	<p>Umbenennung der „Wellenphänomene in der Physik“ in Wellenphänomene in der klassischen Physik</p> <p>Abschnitt 2.1: unter (18) : „Moderne Physik für Ingenieure“ anstelle der „Physik für Ingenieure“, in Abschnitt 2.1 keine Nennung der Dozenten</p> <p>Abschnitt 2.3: unter (11) : „Grundlagen der modernen Physik“ anstelle der „Höheren Physik für Maschinenbauer“</p> <p>Einfügung einer Zwischenüberschrift 6.4 mit entsprechender Änderung des Inhaltsverzeichnisses</p>
03.02.2010	<p>Änderungen von Veranstaltungen in den Abschnitten 2.1 bis 2.4</p> <p>Änderung im Punkt 6.1</p> <ul style="list-style-type: none"> <li>- Schwerpunkt 50 „Bahnsystemtechnik“ in Tabelle „Schwerpunkte“ eingefügt.</li> </ul> <p>Änderung im Punkt 6.2</p> <ul style="list-style-type: none"> <li>- 2. Absatz ergänzt um den Satz: „Stehen mehrere Wahlpflichtfächer (WP) als Auswahlmöglichkeit zur Verfügung, muss nur ein Wahlpflichtfach belegt werden.“</li> </ul> <p>Änderungen im Punkt 6.4</p> <ul style="list-style-type: none"> <li>- Schwerpunkttabellen ergänzt um die Spalten „Veranstaltungsnummer (VNr)“ und „Leistungspunkte (LP)“.</li> <li>- Aktuell vorhandene Daten wurden eingefügt.</li> <li>- Einfügungen und Streichungen von Veranstaltungen in den Schwerpunkten</li> <li>- Schwerpunkt 50 „Bahnsystemtechnik“ eingefügt</li> </ul>
07.07.2010	<p>Änderungen im Abschnitt 1.1:</p> <p>Ergänzung der Prüfungsmodalitäten</p> <p>Änderungen im Abschnitt 1.2:</p> <p>Umbenennung des „Workshops Teamkonstruktion“ in „Konstruieren im Team“;</p> <p>Bemerkung zu Erfolgskontrollen in Zusatzmodul im Bachelorstudium</p> <p>Änderungen im Abschnitt 1.4:</p> <p>Die Bachelorarbeit ist im Anschluss an den ersten Abschnitt zu absolvieren.</p> <p>Änderungen im Abschnitt 1.5:</p> <p>Bemerkung zu Erfolgskontrollen in Zusatzmodul im Masterstudiumj</p> <p>Änderungen im Abschnitt 2.1:</p> <p>Für manche Schwerpunkte kann die Wahl eines Wahlpflichtfachs empfohlen sein.</p> <p>Aktualisierung der wählbaren Wahlpflichtfächer</p> <p>Änderungen im Abschnitt 2.3 und 2.4:</p> <p>Aktualisierung der wählbaren Wahlfächer</p> <p>Änderungen im Abschnitt 4.1:</p> <p>Grundpraktikum auch an Universitäten und vergleichbaren Einrichtungen möglich</p> <p>Änderungen im Abschnitt 6.1 und 6.2:</p> <p>Zusätzliche Erläuterung zur vertiefungsrichtungsspezifischen Schwerpunktwahl;</p> <p>Maximaler Umfang des Schwerpunkts im Bachelorstudium: 16 statt 14 LP</p> <p>Änderungen im Abschnitt 6.3 und 6.4:</p> <p>Überarbeitung der Formulierungen und Anpassung von SWS an LP</p> <p>Aktualisierung der wählbaren Wahlpflichtfächer</p> <p>Änderungen im Abschnitt 6.4:</p> <p>Aktualisierung des Schwerpunktangebotes</p>
29.06.2011	<p>Änderungen im Abschnitt 1.4.: Ergänzung zu Durchführung</p> <p>Änderungen im Abschnitt 1.5.: Anpassung der Module</p> <p>Änderungen im Abschnitt 2.1.: Aktualisierung der Wahlpflichtfächer</p> <p>Änderungen im Abschnitt 2.3.: Aktualisierung der wählbaren Wahlpflichtfächer</p> <p>Änderungen im Abschnitt 4: Inhaltliche Anpassungen</p> <p>Änderungen im Abschnitt 4.1.: Inhaltliche Anpassung</p> <p>Änderungen im Abschnitt 4.2.: Inhaltliche Anpassung</p> <p>Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes</p>

## 0 Abkürzungsverzeichnis

Vertiefungsrichtungen:	MSc E+U FzgT M+M PEK PT ThM W+S	Master Maschinenbau (ohne Vertiefung) Energie- und Umwelttechnik Fahrzeugtechnik Mechatronik und Mikrosystemtechnik Produktentwicklung und Konstruktion Produktionstechnik Theoretischer Maschinenbau Werkstoffe und Strukturen für Hochleistungssysteme
Fakultäten:	mach inf etit ciw phys wiwi	Fakultät für Maschinenbau Fakultät für Informatik Fakultät für Elektrotechnik und Informationstechnik Fakultät für Chemieingenieurwesen und Verfahrenstechnik Fakultät für Physik Fakultät für Wirtschaftsingenieurwesen
Semester:	WS SS ww	Wintersemester Sommersemester wahlweise (Angebot im Sommer- und Wintersemester)
Schwerpunkte:	Kat K, KP E EM	Kategorie der Fächer im Schwerpunkt <b>K</b> ernmodulfach, ggf. <b>P</b> flicht im Schwerpunkt <b>E</b> rgänzungsfach im Schwerpunkt Ergänzungsfach ist nur im <b>M</b> asterstudiengang wählbar
Leistungen:	V Ü P LP mPr sPr Gew	Vorlesung Übung Praktikum Leistungspunkte mündliche Prüfung schriftliche Prüfung Gewichtung einer Prüfungsleistung im Modul bzw. in der Gesamtnote
Sonstiges:	B.Sc. M.Sc. SPO SWS WPF w p	Studiengang Bachelor of Science Studiengang Master of Science Studien- und Prüfungsordnung Semesterwochenstunden <b>W</b> ahlpflichtfach wählbar 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 unverhältnismäßig 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.

### 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) „Maschinenkonstruktion“ zugeordnete und mit insgesamt 4 Leistungspunkten bewertete Workshop „MKL – Konstruieren im Team“ wird wegen der hier integrativ in teamorientierter Projektarbeit vermittelten Lehrinhalten mit 2 Leistungspunkten dem Block (7) „Schlüsselqualifikationen“ zugerechnet.

Module	Veranstaltung	Koordinator	Studienleistung	LP	Erfolgskontrolle	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 Naturwissenschaftliche Grundlagen	Grundlagen der Chemie	Deutschmann		3	sPr	2	3
	Wellenphänomene in der klassischen Physik	Weiss		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			
4 Werkstoffkunde	Werkstoffkunde I	Wanner		7	mPr		15
	Werkstoffkunde II			5			
	Werkstoffkunde-Praktikum		PSchein	3			



Module	Veranstaltung	Koordinator	Studienleistung	LP	Erfolgskontrolle	Pr (h)	Gew
5 Technische Thermodynamik	Technische Thermodynamik und Wärmeübertragung I	Maas	ÜSchein	6,5	sPr	4	13
	Technische Thermodynamik und Wärmeübertragung II	Maas	ÜSchein	6,5			
6 Maschinenkonstruktionslehre	Maschinenkonstruktionslehre I mit CAD	Albers	ÜSchein	4	sPr	5	18
	Maschinenkonstruktionslehre II		ÜSchein	4			
	Maschinenkonstruktionslehre III		ÜSchein	4			
	MKL – Konstruieren im Team (mkl III)		ÜSchein	1			
	Maschinenkonstruktionslehre IV		ÜSchein	4			
	MKL –Konstruieren im Team (mkl IV)		ÜSchein	1			
7 Schlüsselqualifikationen	Arbeitstechniken im Maschinenbau	Wanner		4	Schein	-	6
	MKL III – Konstruieren im Team	Albers		1	Schein	-	
	MKL IV – Konstruieren im Team			1	Schein	-	
8 Betriebliche Produktionswirtschaft	Betriebliche Produktionswirtschaft	Furmans		5	sPr	3	5
9 Informatik	Informatik im Maschinenbau	Ovtcharova	PSchein	8	sPr	3	8
10 Elektrotechnik	Elektrotechnik und Elektronik			8	sPr	3	8
11 Mess- und Regelungstechnik	Grundlagen der Mess- und Regelungstechnik	Stiller		7	sPr	3	7
12 Strömungslehre	Strömungslehre	Oertel		7	sPr	3	7
13 Maschinen und Prozesse	Maschinen und Prozesse	Spicher	PSchein	7	sPr	3	7
14 Wahlpflichtfach	siehe Kapitel 2.1			5	sPr/ mPr	3	5
15 Schwerpunkt	Schwerpunkt-Kern siehe Kapitel 6	SP-Verantwortlicher		8	mPr		8
	Schwerpunkt-Ergänzung siehe Kapitel 6	SP-Verantwortlicher		4	mPr		4

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

Zusätzlich ist ein Berufs-Fachpraktikum 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 <sup>1</sup>						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	(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.

<sup>1</sup> 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
Unspezifischer Master 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	Wanner

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	Erfolgskontrolle	Pr. (h)	Gew
1.	Wahlpflichtfach 1	siehe Kapitel 2.1	5	sPr/mPr	3/	5
2.	Wahlpflichtfach 2	siehe Kapitel 2.1	5	sPr/mPr	3/	5
3.	Wahlpflichtfach 3	siehe Kapitel 2.1	5	sPr/mPr	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.

### 2.1 Wahlpflichtfächer im Bachelor- und Masterstudiengang

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

Im Bachelorstudiengang muss 1 WPF gewählt werden. Im Masterstudiengang werden 3 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).

Nr.	Wahlpflichtfächer (WPF)	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(1)	Arbeitswissenschaft		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)	Grundlagen der Statistik und Wahrscheinlichkeitstheorie				w	w			w	
(6)	Einführung in die Mehrkörperdynamik	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
(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 Mikrosystemtechnik I <u>oder</u> II		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	
(15)	Einführung in die moderne Physik <u>oder</u> Physik für Ingenieure	w	w	w	w	w			w	w
(16)	Product Lifecycle Management	w	w		w	w	w	w		
(17)	Simulation von Produktionssystemen und -prozessen	w	w					w		
(18)	Stochastik im Maschinenbau/ Mathematische Modelle von Produktionssystemen		w						w	

Nr.	Wahlpflichtfächer (WPF)	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(19)	Systematische Werkstoffauswahl	w	w	w	w	w	w		w	p
(20)	Wärme- und Stoffübertragung	w	w	p	w	w	w		w	
(21)	Technische Informationssysteme	w	w		w	w	w	w		
(22)	Modellierung und Simulation	w	w						w	w
(23)	Wissenschaftliches Programmieren für Ingenieure mit Übung	w	w						w	w
(24)	Mikrostruktursimulation	w	w						w	w
(25)	CAE-Workshop	w	w	w	w	w	p			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 Management	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

**2.2 Mathematische Methoden im Masterstudiengang**

Als Wahlmöglichkeiten für die Mathematischen Methoden im Masterstudiengang sind derzeit vom Fakultätsrat genehmigt:

Nr.	Vorlesung	Dozent	Institut/Fak.	Sem.
(1)	Grundlagen der Statistik und Wahrscheinlichkeitstheorie	Kadelka	math	WS
(2)	Mathematische Methoden der Dynamik	Proppe	itm	WS
(3)	Mathematische Methoden der Festigkeitslehre	Böhlke	itm	WS
(4)	Mathematische Methoden der Schwingungslehre	Seemann	itm	SS
(5)	Mathematische Methoden der Strömungslehre	N.N.	isl	SS
(6)	Mathematische Methoden der Strukturmechanik	Böhlke	itm	SS
(7)	Numerische Mathematik für Informatiker und Ingenieure	Neuß	math	SS
(8)	Mathematische Modelle von Produktionssystemen	Furmans/Proppe	ifl/itm	WS



**2.3 Wahlfach aus dem Bereich Naturwissenschaften/Informatik/Elektrotechnik im Masterstudiengang**

Für das Wahlfach aus dem Bereich der Naturwissenschaften, Informatik und Elektrotechnik sind vom Fakultätsrat derzeit folgende Wahlmöglichkeiten genehmigt:

Nr.	Vorlesung	Dozent	Institut/Fak.	Sem.
(1)	Aerothermodynamik	Seiler	isl	SS
(2)	Hardware/Software Codesign	Hübner	etit	WS
(3)	Kernspintomographie	Kasten	phys	ww
(4)	Methoden in der Signalverarbeitung	Puente	iiit	WS
(5)	Nanotechnologie mit Clustern	Gspann	imt	ww
(6)	Photovoltaik	Powalla	ikr	SS
(7)	Physikalische Grundlagen der Lasertechnik	Schneider	izbs	WS
(8)	Rheologie und Struktur	Hochsein	ciw	WS
(9)	Strömungen mit chemischen Reaktionen	Class	isl	WS
(10)	Technische Informatik	Bretthauer	aia	SS
(11)	Systems and Software Engineering	Müller-Glaser	itiv	WS
(12)	Magnetohydrodynamik	Bühler	isl	WS

## 2.4 Wahlfach aus dem Bereich Wirtschaft/Recht im Masterstudiengang

Für das Wahlfach aus dem Bereich Wirtschaft und Recht sind vom Fakultätsrat derzeit folgende Wahlmöglichkeiten genehmigt:

Nr.	Vorlesung	Dozent	Institut/Fak.	Sem.
(1)	Arbeitswissenschaft	Zülch	ifab	WS
(2)	F&E Projektmanagement mit Fallstudien	Schmied	wiwi	ww
(3)	Management- und Führungstechniken	Hatzl	ifab	SS
(4)	Öffentliches Recht I	Spieker (Döhmann)	inf	SS
(5)	Leadership and Management Development	Ploch	ipek	WS
(6)	Patentrecht	Geissler	inf	SS
(7)	Qualitätsmanagement	Lanza	wbk	WS
(8)	Unternehmensführung und strategisches Management	Lindstädt, Wolff, Bünn	wiwi	SS

## 2.5 Wahlfach im Masterstudiengang

Für das zu belegende Wahlfach sind vom Fakultätsrat derzeit alle Vorlesungen des Fächerkataloges der Fakultät für Maschinenbau genehmigt. Fächer anderer Fakultäten müssen von der Prüfungskommission genehmigt werden.

## 3 Fachpraktikum im Masterstudiengang

### 3.1 Fachpraktikum

Für das Fachpraktikum (3 LP) bestehen folgende Wahlmöglichkeiten:

Nr.	Praktikum	Dozent	Institut/Fak.	Sem.
(1)	Messtechnisches Praktikum	Stiller	MRT	SS
(2)	Dezentral gesteuerte Intralogistiksysteme	Furmans	IFL	WS
(3)	Schwingungstechnisches Praktikum	Fidlin	ITM	WS
(4)	Mechatronik-Praktikum	Albers <i>et al.</i>	IPEK <i>et al.</i>	WS

## 4 Berufspraktikum

Das Berufspraktikum (gemäß SPO § 13) 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 Praktikums erfolgt durch das Praktikantenamt der Fakultät für Maschinenbau. Zur Anerkennung ist die Vorlage des Ausbildungsvertrags und eines ordnungsgemäß abgefassten Praktikumsberichts für das Grundpraktikum (von der Firma bestätigt) und eines Original-Tätigkeitsnachweises 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 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 („Praktikantenzugnis“) benötigt, das Art und Dauer der Tätigkeiten während des Berufs-Fachpraktikums beschreibt. Eventuelle Fehltage sind zu vermerken.

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.

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	●	–	–	–	●	●	●	–

Institut für	Abk.	MSc	E+UT	FzgT	M+M	PEK	PT	ThM	W+S
Informationsmanagement im Ingenieurwesen	IMI	•	–	•	•	•	•	–	–
Keramik im Maschinenbau	IAM-KM	•	•	–	–	•	–	–	•
Kerntechnik und Reaktorsicherheit	IKR	•	•	–	–	–	–	–	–
Kolbenmaschinen	IFKM	•	•	•	–	•	–	–	–
Mess- und Regelungstechnik mit Maschinenlaboratorium	MRT	•	•	•	•	•	–	•	–
Mikrostrukturtechnik	IMT	•	•	•	•	•	•	–	–
Produktentwicklung	IPEK	•	•	•	•	•	•	–	•
Produktionstechnik	WBK	•	–	•	•	•	•	–	•
Strömungslehre	ISL	•	•	•	–	–	–	•	–
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 Bachelor- und 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 Master-Studium 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	



Nr.	Schwerpunkt	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(7)	Dimensionierung und Validierung mechanischer Konstruktionen	w	w	w	w	w	w		p	w
(8)	Dynamik und Schwingungslehre		w	w	w		w		p	
(9)	Dynamische Maschinenmodelle	w	w						w	
(10)	Entwicklung und Konstruktion	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		p	p
(14)	Fluid-Festkörper-Wechselwirkung		w	w	w		w		w	
(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	
(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
(26)	Materialwissenschaft und Werkstofftechnik	w	w	w	w	w	w		w	p
(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		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			
(35)	Modellbildung und Simulation		w		w	w	w		p	w
(36)	Polymerengineering		w	w	w		w			w
(37)	Produktionsmanagement		w					w		
(38)	Produktionssysteme	w								
(39)	Produktionstechnik		w		w		w	p		

Nr.	Schwerpunkt	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(40)	Robotik		w			p	w	w	w	
(41)	Strömungslehre		w	w	w		w		p	
(42)	Technische Akustik		w		w		w	w		
(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
(48)	Verbrennungsmotoren	w	w	w	p		w			
(49)	Zuverlässigkeit im Maschinenbau		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 Management	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 „Bachelor of Science“

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 „Master of Science Studiengang“

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 Veranstaltungen der Schwerpunkte zum Bachelor- und den Vertiefungsrichtungen des Masterstudiengangs

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

Schwerpunkte und Schwerpunkt-Verantwortliche:

- SP 1: Advanced Mechatronik (Bretthauer)
- SP 2: Antriebssysteme (Albers)
- SP 3: Arbeitswissenschaft (Zülch)
- 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 14: Fluid-Festkörper-Wechselwirkung (Gabi)
- SP 15: Grundlagen der Energietechnik (Bauer)
- SP 16: Industrial Engineering (engl.) (Zülch)
- 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 (Wanner)
- 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)
- SP 34: Mobile Arbeitsmaschinen (Geimer)
- SP 35: Modellbildung und Simulation (Proppe)
- SP 36: Polymerengineering (Elsner)
- SP 37: Produktionsmanagement (Zülch)
- SP 38: Produktionssysteme (Schulze)
- SP 39: Produktionstechnik (Schulze)
- SP 40: Robotik (Bretthauer)
- SP 41: Strömungslehre (Gabi)
- SP 42: Technische Akustik (Gabi)

- 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 (Spicher)
- SP 49: Zuverlässigkeit im Maschinenbau (Gumbsch)
- SP 50: Bahnsystemtechnik (Gratzfeld)
- SP 51: Entwicklung innovativer Geräte (Matthiesen)
- SP 52: Production Management (Zülch)
- SP 53: Fusionstechnologie (Stieglitz)

## 2 Actual Changes

Important changes are pointed out in this section in order to provide a better orientation. Although this process was done with great care, other/minor changes may exist.

## 3 Modules

### 3.1 All Modules

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

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

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 64)	4	W	7	F. Hettlich
0180800	Advanced Mathematics II (p. 65)	4	S	7	F. Hettlich
0131400	Advanced Mathematics III (p. 66)	4	W	7	A. Kirsch, T. Arens, F. Hettlich

#### Learning Control / Examinations

The module grade will be composed by the grades of the lectures of the module weighted by credit points

#### Conditions

None.

#### Learning Outcomes

The students should know the basic facts and tools of one dimensional analysis. The student should know the basics on vector spaces and multi-dimensional calculus and the basic techniques to solve differential equations. The student should know techniques and applications of the multi-dimensional calculus (vector calculus) and should 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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 60)	2	W	3	O. Deutschmann
2400411	(p. 120)	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****Content**



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

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

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 97)	3	W	4	T. Böhlke
2161246	Tutorial Engineering Mechanics I (p. 109)	2	W	1	T. Böhlke, Mitarbeiter
2161266	Lab course Engineering Mechanics I (p. 91)	2	W	1	T. Böhlke, T. Langhoff
2162250	Engineering Mechanics II (p. 98)	2	S	3	T. Böhlke
2162251	Tutorial Engineering Mechanics II (p. 110)	2	S	1	T. Böhlke, Mitarbeiter
2162252	Lab course Engineering Mechanics II (p. 92)	2	S	1	T. Böhlke, T. Langhoff
2161203	Engineering Mechanics III (p. 99)	2	W	3	W. Seemann
2161204	Engineering Mechanics III (Tutorial) (p. 111)	2	W	2	W. Seemann, Assistenten
2162231	Engineering Mechanics IV (p. 100)	2	S	3	W. Seemann
2162232	Engineering Mechanics IV (Tutorial) (p. 112)	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" and

"Engineering Mechanics IV" ,written, 180 Minutes;

**Conditions**

None.

**Learning Outcomes**

In EM III 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**

In EM III and EM IV first the kinematics and kinetics of a particle are presented and generalized for systems of particles and the plane motion of rigid bodies. This includes the momentum theorem, the principle of moment of momentum and the principle of work. Kinetic energy and potential energies are therefore presented. Impact problems are treated as applications. The second part of dynamics considers the kinematics and kinetics of an arbitrary three-dimensional motion of a rigid body. Especially the principle of moment of momentum leads to complicated relations and finally to Euler's equations. For systems of rigid bodies it is shown how the equations of motion can be derived in principle. Afterwards the analytical principles for the derivation of equations of motion are presented. This includes the principle of d'Alembert in Lagrange's form and Lagrange's equations of the second kind. At the end simple vibration system with one or two degrees of freedom are analysed.

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

**Coordination:** A. Wanner  
**Degree programme:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
15	Every term	2

**Courses in module**

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2173550	Material Science I for mach, mage, phys; Part 1 of class: Letters A-K (p. 122)	5	W	7	A. Wanner, H. Seifert, K. Weidenmann
2173551	Material Science I for mach, mage, phys; Part 2 of class: Letters L-Z (p. 121)	5	W	7	A. Wanner, H. Seifert, K. Weidenmann
2173552	Exercises in Material Science I for mach, mage, phys (p. 116)	1	W	0	K. Weidenmann, Gruber
2174560	Material Science II for mach, mage, phys; Part 1 of class: Letters A-K (p. 123)	4	S	5	A. Wanner, H. Seifert, K. Weidenmann
2174561	Material Science II for mach, mage, phys; Part 2 of class: Letters L-Z (p. 124)	4	S	5	A. Wanner, H. Seifert, K. Weidenmann
2174563	Exercises in Material Science II for mach, mage, phys (p. 117)	1	S	0	A. Wanner, Gruber
2174597	Experimental Lab Course in Material Science, mach, mage, part A of class, in groups (p. 55)	2	S	3	A. Wanner, H. Seifert, K. Weidenmann
2174587	Experimental Lab Course in Material Science, mach, mage, part B of class, in groups (p. 56)	2	S	3	A. Wanner, H. Seifert, K. Weidenmann

**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**

- Knowledge of basics about structural and functional materials
- Relationships between atomic structure, microstructure and properties
- assessment of material properties and corresponding applications

**Content**

The module "Materials Science and engineering" consists of the lectures "Materials Science and Engineering 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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
13	Every term	2

**Courses in module**

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2165526	Engineering Thermodynamics and Heat Transfer I (p. 102)	3	W	6,5	U. Maas
2166526	Technical Thermodynamics and Heat Transfer II (p. 103)	3	S	6,5	U. Maas
2165527	Tutorial: Engineering Thermodynamics I (p. 113)	2	W	0	U. Maas, Assisitenten
2166527	Excercises in Technical Thermodynamics and Heat Transfer II (p. 114)	2	S	0	U. Maas
2165501	Tutorial: Engineering Thermodynamics II - Repetition (p. 115)	2	W	0	UlrichMaas, Halmer

**Learning Control / Examinations**

prerequisite: attestation each semester by weekly homework assignments  
 written examn, graded

**Conditions**

None.

**Learning Outcomes**

Thermodynamics represent a crucial fundament in mechanical engineering, in particular in the field of power engineering. The knowledge of the basic principles of thermodynamics and heat transfer is a prerequisite to understand the complex energy conversion processes occurring in power plants and propulsion systems. Furthermore thermodynamics apply in a variety of different other disciplines e. g. refrigeration engineering, chemistry and material science. In the module "Engineering Thermodynamics" the fundamentals essential to this wide range of applications are taught.

**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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 72)	2	W	2	A. Albers, Burkardt
2145185	Tutorials Mechanical Design I (p. 105)	1	W	2	A. Albers
2146178	Mechanical Design II (p. 74)	2	S	2	A. Albers, Burkardt
2146185	Tutorials Mechanical Design II (p. 106)	2	S	2	A. Albers, Divers tutors
2145151	Mechanical Design III (p. 75)	2	W	2	A. Albers, N. Burkardt
2145153	Tutorials Mechanical Design III (p. 107)	2	W	2	A. Albers, diverse
2146177	Mechanical Design IV (p. 77)	2	S	2	A. Albers, N. Burkardt
2146184	Tutorials Mechanical Design IV (p. 108)	1	S	2	A. Albers, diverse
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 84)	2	W/S	2	A. Albers, diverse

**Learning Control / Examinations**

written examination with theoretical and design part concerning the whole teaching program of Maschinenkonstruktionslehre 1 - 4 (mechanical design 1 - 4)

**Conditions**

Successful passing of the tutorials/workshops of MD 1 + 2

**Learning Outcomes**

Main teaching objective is the embodiment design of machine systems according to defined requirements what means the recognizing of functional interactions and their transfer into a cost efficient and function fulfilling design

**Content**

see detailed descriptions to the lectures Maschinenkonstruktionslehre 1-4

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

**Coordination:** A. Wanner  
**Degree programme:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b> 6	<b>Cycle</b> Every 2nd term, Summer Term	<b>Duration</b> 2
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**Courses in module**

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2174970	Working Methods in Mechanical Engineering (lecture) (p. 47)	1	S	2	A. Wanner
2145154	MD - Team Orientated Mechanical Design (3 + 4) (p. 84)	2	W/S	2	A. Albers, diverse
2110968	Workshop 'Working Methods in Mechanical Engineering' (IFAB) (p. 134)	1	S	2	G. Zülch, P. Stock
2118973	Workshop 'Working Methods in Mechanical Engineering' (IFL) (p. 137)	1	S	2	Baur
2142975	Workshop 'Working Methods in Mechanical Engineering' (IMT) (p. 141)	1	S	2	M. Worgull
2162983	Workshop I 'Working Methods in Mechanical Engineering' (ITM) (p. 149)	1	S	2	T. Böhlke, Mitarbeiter
2182981	Workshop II 'Working Methods in Mechanical Engineering' (IZBS) (p. 156)	1	S	2	O. Kraft, P. Gruber, Courty
2182974	Workshop I 'Working Methods in Mechanical Engineering' (IAM-ZBS, Gumbsch) (p. 146)	1	S	2	P. Gumbsch, M. Weber, K. Schulz
2106984	Workshop 'Working Methods in Mechanical Engineering' (AIA) (p. 126)	1	S	2	G. Bretthauer
2114450	Workshop 'Working Methods in Mechanical Engineering' (FAST-Leichtbautechnologie) (p. 129)	1	S	2	F. Henning
2114979	Workshop 'Working Methods in Mechanical Engineering' (FAST-MOBIMA) (p. 130)	1	S	2	M. Geimer
2114989	Workshop 'Working Methods in Mechanical Engineering' (FAST - Fahrzeugtechnik) (p. 128)	1	S	2	F. Gauterin, El-Haji, Unrau
2114990	Workshop 'Working Methods in Mechanical Engineering' (FAST - Bahnsystemtechnik) (p. 127)	1	S	2	P. Gratzfeld
2126980	Workshop 'Working Methods in Mechanical Engineering' (IKM) (p. 138)	1	S	2	M. Hoffmann
2128998	Workshop 'Working Methods in Mechanical Engineering' (IMI) (p. 140)	1	S	2	J. Ovtcharova, Mitarbeiter
2130985	Workshop 'Working Methods in Mechanical Engineering' (IKR) (p. 139)	1	S	2	D. Cacuci, Erkan Arslan
2134996	Workshop 'Working Methods in Mechanical Engineering' (IFKM) (p. 136)	1	S	2	U. Spicher

2138997	Workshop 'Working Methods in Mechanical Engineering' (MRT) (p. 145)	1	S	2	C. Stiller
2146971	Workshop I 'Working Methods in Mechanical Engineering' (IPEK) (p. 148)	1	S	2	A. Albers
2146972	Workshop II 'Working Methods in Mechanical Engineering' (IPEK) (p. 153)	1	S	2	S. Matthiesen, Wissenschaftlicher Mitarbeiter des IPEK
2150987	Workshop I 'Working Methods in Mechanical Engineering' (WBK) (p. 151)	1	S	2	V. Schulze
2150988	Workshop II 'Working Methods in Mechanical Engineering' (WBK) (p. 157)	1	S	2	G. Lanza
2150989	Workshop III 'Working Methods in Mechanical Engineering' (WBK) (p. 160)	1	S	2	J. Fleischer
2158978	Workshop 'Working Methods in Mechanical Engineering' (FSM) (p. 131)	1	S	2	M. Gabi
2162994	Workshop II 'Working Methods for Mechanical Engineering' (ITM) (p. 154)	1	S	2	C. Proppe
2162995	Workshop III 'Working Methods in Mechanical Engineering' (ITM) (p. 159)	1	S	2	W. Seemann
2166991	Workshop 'Working Methods in Mechanical Engineering' (ITT) (p. 144)	1	S	2	U. Maas
2170972	Workshop 'Working Methods in Mechanical Engineering' (ITS) (p. 143)	1	S	2	H. Bauer
2174976	Workshop I 'Working Methods in Mechanical Engineering' (IWK I) (p. 150)	1	S	2	K. Poser
2174986	Workshop II 'Working Methods in Mechanical Engineering' (IWK I) (p. 155)	1	S	2	A. Wanner
2174987	Workshop 'Working Methods in Mechanical Engineering' (IAM-AWP) (p. 132)	1	S	2	H. Seifert
2182982	Workshop 'Working Methods in Mechanical Engineering' (IAM-ZBS, Nestler) (p. 133)	1	S	2	B. Nestler, A. August
2190497	Workshop I 'Working Methods in Mechanical Engineering' (IFRT) (p. 147)	1	S	2	R. Stieglitz
2190498	Workshop II 'Working Methods in Mechanical Engineering' (IFRT) (p. 152)	1	S	2	K. Ivanov
2190975	Workshop III 'Working Methods in Mechanical Engineering' (IFRT) (p. 158)	1	S	2	X. Cheng
2110969	Working Methods in Mechanical Engineering (Lecture in English) (p. 48)	1	S	2	G. Zülch

**Learning Control / Examinations**

see submodule descriptions

**Conditions**

None.

**Learning Outcomes**

Key competences are trained in project and team work on mechanical engineering problems.

**Content**



## Module: Production Operations Management [BSc-Modul 09, BPW]

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

<b>ECTS Credits</b> 5	<b>Cycle</b> Every 2nd term, Summer Term	<b>Duration</b> 1
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### Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2110085	Production Operations Management (p. 49)	4	S	5	K. Furmans, G. Lanza, G. Zülch, F. Schultmann, Furmans, Lanza, Schultmann, Zülch

### Learning Control / Examinations

written examn, 90 min, graded

### Conditions

none

### Recommendations

none

### Learning Outcomes

The student

- knows about the connections between production science, work scheduling and -design, material flow and basics of economics,
- is able to differentiate between production systems and knows their characteristics,
- is able to design workplaces according to the requirements,
- is able to create a material flow system to ensure supply and
- has the knowledge to evaluate systems financially.

### 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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 67)	2	W	8	J. Ovtcharova, S. Rogalski
3121036	Computer Science for Engineers Lab Course (p. 51)	2	W	0	J. Ovtcharova
2121391	Exercises Computer Science for Engineers (p. 104)	2	W	0	J. Ovtcharova

**Learning Control / Examinations**

Science for Engineers", 100%, 180 minutes;  
 prerequisite: Computer Lab Certificate

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students have a basic understanding of the fundamental terms of information technology. The students master the essential methods of object-oriented programming (OOP) and OO-modeling with UML. They are acquainted with the most important dynamic data structures (graphs, trees, lists) that use the class concept.

After successfully completing this module, students should be able to develop simple object-oriented programs in 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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 54)	4+2	W	8	K. Becker

**Learning Control / Examinations**

graded, "Electrical Engineering for Mechanical Engineers", 100%, written exam, 180 minutes.

**Conditions**

None

**Learning Outcomes**

Gaining an overview of the physical basics of electrical engineering (electrical field, magnetic field, resistor, capacitor, inductor)

Learning methods for the calculation of electrical DC- and AC-circuits,

Understanding the construction and steady-state performance of the basic electrical machines (transformer, DC-, induction- and synchronous machine),

Getting an overview over the most important semiconductor devices and their functionality,

Understanding 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),

Learning 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:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 61)	3	W	7	C. Stiller

**Learning Control / Examinations**

written exam, 3 hours

**Conditions**

None.

**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 module 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**

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

**Coordination:** M. Gabi  
**Degree programme:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b>	<b>Cycle</b>	<b>Duration</b>
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. 94)	4	W	7	T. Schenkel

**Learning Control / Examinations**

written exam, 3 hours

**Conditions**

None.

**Learning Outcomes****Content**

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

**Coordination:** U. Spicher  
**Degree programme:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

<b>ECTS Credits</b> 7	<b>Cycle</b> Every 2nd term, Winter Term	<b>Duration</b> 1
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**Courses in module**

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2185000	Machinery and Processes (p. 70)	4	W	7	H. Kubach, M. Gabi, H. Bauer, U. Maas, Maas, Gabi, Bauer, Spicher, Kubach

**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**

None.

**Learning Outcomes**

The students get to know the basic energy conversion processes and their applications in different machines.

**Content**

basics of thermodynamics

thermal fluid machines

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

hydraulic fluid machines

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

internal combustion engines

- characteristic parameters
- engine parts
- kinematics
- engine processes

- fuels
- emissions
- alternative drive trains

**Remarks**

Lab course takes place in Summer Semester as well.  
English lecture will probably start in SS 2012.



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

**Coordination:** A. Wanner  
**Degree programme:** Bachelorstudiengang Maschinenbau (B.Sc.)  
**Subject:**

ECTS Credits	Cycle	Duration
5	Every term	1

ID	Course	Term	Lecturer
2105011	Introduction into Mechatronics (p. 52)	W	G. Bretthauer, A. Albers
2114093	Fluid Technology (p. 59)	W	M. Geimer
2162235	Introduction into the multi-body dynamics (p. 53)	S	W. Seemann
2161224	Machine Dynamics (p. 71)	W	C. Proppe
2161212	Vibration Theory (p. 101)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 79)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 80)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 81)	S	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 82)	S	A. Class
2400311	Modern Physics for Engineers (p. 86)	S	B. Pilawa
2121350	Product Lifecycle Management (p. 89)	W	J. Ovtcharova
2149605	Simulation of production systems and processes (p. 93)	W	K. Furmans, V. Schulze, G. Zülch
2174576	Systematic Materials Selection (p. 95)	S	A. Wanner
22512	Heat and mass transfer (p. 119)	W	H. Bockhorn
2121001	Integrated Information Systems for engineers (p. 96)	W	S. Rogalski, J. Ovtcharova
2183703	Modelling and Simulation (p. 85)	W/S	B. Nestler
2181738	Scientific computing for Engineers (p. 125)	W	D. Weygand, P. Gumbsch
2183702	Modelling of Microstructures (p. 83)	W	B. Nestler
2147175	CAE-Workshop (p. 50)	W/S	A. Albers, Assistenten
2165515	Fundamentals of Combustion I (p. 63)	W	U. Maas
2181612	Physical basics of laser technology (p. 88)	W	J. Schneider
3122031	Virtual Engineering (Specific Topics) (p. 118)	S	J. Ovtcharova
2142890	Physics for Engineers (p. 87)	S	P. Gumbsch, A. Nesterov-Müller, A. Nesterov-Müller
2117095	Basics of Technical Logistics (p. 62)	W	M. Mittwollen, Madzharov
2110031	Service Operations Management (p. 68)	S	G. Zülch
3109033	Industrial Management Case Study (p. 57)	W	G. Zülch

**Learning Control / Examinations**

graded oral or written exam, duration (depends on the lecture)

**Conditions**

See Studienplan

**Learning Outcomes**

In the compulsory elective subject the basics of different aspects of mechanical engineering are taught.

**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:** A. Wanner  
**Degree programme:** Bachelorstudiengang 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**

Within the major field special aspects of the mechanical engineering are taught.

**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).

## 4 Courses

### 4.1 All Courses

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

**Coordinators:** A. Wanner

**Part of the modules:** Key Competences (p. 35)[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

A lecture series deals with:

- scientific working and information skills
- time and project management, teamwork
- presentation skills

In addition to the lecture series workshops take place:

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 teaching staff and the students from the other teams.

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

**Coordinators:** G. Zülch

**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

For students of the Carl Benz School (International Department), study programme “Mechanical Engineering (B.Sc.)”.

Location: International Department.

Please refer to the information board of the International Department.

### Learning Outcomes

- Knowledge about prerequisites and ethics of scientific work
- Basic knowledge about techniques for time management and team work
- Basic knowledge about literature research
- Basic knowledge about presentation techniques (oral and written)

### 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

#### Learning material:

Handout online on: <https://ilias.rz.uni-karlsruhe.de>

#### Literature:

- MACKENZIE, Alec: The Time Trap. New York u.a.: Amacom, 3rd edition 1997.
- BARRASS, Robert: Study!: A Guide to Effective Learning, Revision and Examination Techniques. London, New York: Routledge Chapman & Hall, 2nd edition 2002.
- BARRASS, Robert: Scientists Must Write: A guide to better writing for scientists, engineers and students. London, New York: Routledge Chapman & Hall, 2nd edition 2003.
- WELLINGTON, Jerry; BATHMAKER, Ann-Marie; HUNT, Cheryl u.a.: Succeeding with your Doctorate. London u.a.: Sage Publications, 2005.
- MANDEL, Steve: Presentation Skills: A Practical Guide to Better Speaking. Boston, MA: Thomson NETg, 3rd edition 2000.

Please refer to the latest edition.

## Course: Production Operations Management [2110085]

**Coordinators:** K. Furmans, G. Lanza, G. Zülch, F. Schultmann, Furmans, Lanza, Schultmann, Zülch

**Part of the modules:** Production Operations Management (p. 38)[BSc-Modul 09, BPW]

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

### Learning Control / Examinations

written exam (duration: 1,5 hours)

### Conditions

none

### Recommendations

none

### Learning Outcomes

The student

- knows about the connections between production science, work scheduling and -design, material flow and basics of economics,
- is able to differentiate between production systems and knows their characteristics,
- is able to design workplaces according to the requirements,
- is able to create a material flow system to ensure supply and
- has the knowledge to evaluate systems financially.

### 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).

### Media

Presentation and black board

### Literature

Lecture notes

### Remarks

none

**Course: CAE-Workshop [2147175]****Coordinators:** A. Albers, Assistenten**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
3	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**

In the CAE - Workshops computer-aided tools used in the industrial product development process will be presented and trained. The complete process chain is shown using concrete examples of typical mechanical components. The possibilities and limits of virtual product development will be shown during this course. Here, the students get practical insight into the world of multi-body systems, the finite element method and optimization research questions.

The students receive the theoretical basics and are trained on modern hardware in the use of commercial software. In order to support the students to discuss the calculation and optimization results, the participants of the workshop must discuss their results in small groups and finally present it to all students.

**Content**

Content in the summer 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 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 hybrid multi-body simulation problems.

**Literature**

The workshop script will be allocated at Ilias.

## Course: Computer Science for Engineers Lab Course [3121036]

**Coordinators:** J. Ovtcharova

**Part of the modules:** Computer Science (p. 39)[BSc-Modul 09, Inf]

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

### 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, which have to be handed in and explained to the tutors regularly. The aim of the workshop is applying the skills taught in the tutorial. The students prove that they are able to independently implement what they have learned.

All assignments have to be handed in, before they can take part in the written exam at lecture 'Computer Science for Engineers'.

### 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: Introduction into Mechatronics [2105011]

**Coordinators:** G. Bretthauer, A. Albers

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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

Compulsory preconditions: none

### Learning Outcomes

Mechatronics is an interdisciplinary field, based on classical mechanical and electrical engineering as well as automation science and technology and computer science. The main activities focus on integral system development with technical components connected via an intelligent control system. In this regard simulation of mechanical and electrical systems becomes important for rapid and efficient development. First part of the lecture provides a survey of mechatronics. Subsequently the architecture of mechatronic systems is described. Furthermore fundamentals of modeling of mechanical, pneumatic, hydraulic, electrical and electronic components are discussed. Finally optimization methods, e. g. adaptive controllers, are presented. In the second part of the lecture basics of development methods as well as the characteristics of the development of mechatronic products are described. A further important item is the presentation of the system concept of mechatronics in comparison to conventional mechanical systems. The contents of the course are explained using examples for mechatronic products in the area of automotive engineering.

### 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. 45)[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**

Mechanisms, vehicles and industrial robots are examples of multibody systems. For dynamics simulations expressions for kinematical quantities and formulations of equations of motion are required which make it easy to switch from one system to another. Efficient methods are described.

The course is mainly divided in two parts: kinematics on the one hand and different possibilities to derive the equations of motion on the other hand.

**Content**

The role of multibody systems in engineering, kinematics of a single rigid body, Kinematics of multibody systems, rotation matrix, angular velocity, derivatives in different reference systems, holonomic and non-holonomic constraints, Newton-Euler's equations, principle of d'Alembert, principle of virtual power, Lagrange's equations, Kane's equations, structure of the equations of motion

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

**Coordinators:** K. Becker

**Part of the modules:** Electrical Engineering (p. 40)[BSc-Modul 10, ET]

ECTS Credits	Hours per week	Term	Instruction language
8	4+2	Winter term	de

### Learning Control / Examinations

written examination with duration of 3h

### Conditions

none

### Learning Outcomes

Gaining an overview of the physical basics of electrical engineering (electrical field, magnetic field, resistor, capacitor, inductor)

Learning methods for the calculation of electrical DC- and AC-circuits,

Understanding the construction and steady-state performance of the basic electrical machines (transformer, DC-, induction- and synchronous machine),

Getting an overview over the most important semiconductor devices and their functionality,

Understanding 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),

Learning 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, mage, part A of class, in groups [2174597]

**Coordinators:** A. Wanner, H. Seifert, K. Weidenmann

**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess materials on base of the data obtained by these methods.

#### 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, mage, part B of class, in groups [2174587]

**Coordinators:** A. Wanner, H. Seifert, K. Weidenmann

**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess materials on base of the data obtained by these methods.

### 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:** G. Zülch

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter 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 in the ifab-office 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

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.

### Content

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

#### Learning material:

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

#### Literature:

- ZÜLCH, Gert; CANO, Juan Luis; MULLER(-MALEK), Henri (Edts.): Production Management Simulation Games. Planning Games for Redesign of Production Systems and Logistic Structures. Supported by the European Leonardo da Vinci Programme. Aachen: Shaker Verlag, 2001. (esim – European Series in Industrial Management, Volume 4)
- ZÜLCH, Gert; RINN, Andreas (Edts.): Design and Application of Simulation Games in Industry and Services. Aachen: Shaker Verlag, 2000. (esim – European Series in Industrial Management, Volume 3)
- HORNGREN, Charles T.; FOSTER, George; DATAR, Srikant M.: Cost Accounting - A Managerial Emphasis. Englewood Cliffs, NJ: Prentice-Hall, 8th ed. 1994.
- KRAJEWSKI, Lee J.; RITZMAN, Larry P.: Operations Management. Upper Saddle River, NJ: Pearson Education, 7th ed. 2004.
- VOLLMANN, Thomas E.; BERRY, William L.; WHYBARK, D. Clay; JACOBS, F. Robert: Manufacturing Planning and Control Systems. New York, NY et al.: McGraw-Hill, 5th ed. 2005.

Please refer to the latest edition.

## Course: Fluid Technology [2114093]

**Coordinators:** M. Geimer

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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: Fundamentals of Chemistry [5408]****Coordinators:** O. Deutschmann**Part of the modules:** Principles of Natural Science (p. 30)[BSc-Modul 02, NG]

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

**Learning Control / Examinations**

Written examination

**Conditions**

None

**Learning Outcomes**

A basic understanding of chemical processes is to be acquired. Basic ideas concerning the structure of matter and of the proceeding of chemical reaction are to be understood. Important inorganic compounds and the metallurgy of important industrially used metals are to be known. The structure of organic compounds, the significance of important functional groups as well as the process of motoric combustion and the methods of exhaust after treatment are to be understood.

**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: Stoichiometric 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. 41)[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. 45)[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

The student:

- knows about processes and machines of technical logistics
- is able to handle fundamental structures and the impacts
- is able to refer to industrially used machines and
- practices the calculation on applying knowledge from lessons.

### 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: Fundamentals of Combustion I [2165515]****Coordinators:** U. Maas**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

**Learning Control / Examinations**

Oral

Duration: 30 min.

**Conditions**

None

**Recommendations**

None

**Learning Outcomes**

Based on the explanation of the fundamental concepts and observed phenomena in combustion, this lecture studies the experimental analysis and the mathematical description of laminar and turbulent flames. The lecture aims at giving insights in the fundamental physico-chemical processes during combustion, in particular with regard to technical combustion systems e.g. engines, gas turbines, furnaces.

**Content**

Fundamental concepts and 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

**Course: Advanced Mathematics I [0131000]****Coordinators:** F. Hettlich**Part of the modules:** Advanced Mathematics (p. 29)[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 should know the basic facts and tools of one dimensional analysis

**Content**

Basic concepts, sequences and convergence, functions and continuity, series, differential 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:** F. Hettlich**Part of the modules:** Advanced Mathematics (p. 29)[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 student should 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. 29)[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 student should know techniques and applications of the multi-dimensional calculus (vector calculus) and should 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. 39)[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 have a basic understanding of 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. The students master the essential methods of object-oriented programming (OOP) and OO-modeling with UML. They are acquainted with the most important dynamic data structures (graphs, trees, lists) that use the class concept. The students are capable of implementing effectively and efficiently both the theoretical and the practical concepts of information technology that are required for algorithmic thinking and the realization of algorithms as executable (JAVA) programs.

**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: Service Operations Management [2110031]

**Coordinators:** G. Zülch

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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

None.

### Recommendations

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

### Learning Outcomes

The lecture focuses on aspects on how to analyse, control and plan operations in service and administration. Operations Management is concerned with the design, planning control and improvement of an organisation's resources and processes to produce goods or services for customers. Service engineering is occupied with development and design of services using adequate process models methodologies and tools. Administration covers the necessary task of steering, maintaining and controlling in order to organize human life and society with respect to individual performance and all liabilities derived from them. It includes also the definition and realization of common goals and objectives.

Learning objectives:

- Insights into significance, objectives, and roles of service enterprises
- Knowledge about analysis, design control, and assessment of service operations
- Initial knowledge about approaches to perpetual improvement

### 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****Learning material:**

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

**Literature:**

- FITZSIMMONS, James A.; FITZSIMMONS, Mona J.: Service Management. New York NY: McGraw-Hill/Irwin, 5th ed. 2005.
- KRAJEWSKI, Lee J.; RITZMAN, Larry P.: Operations Management. Reading MA et al.: Addison-Wesley Publishing, 4th ed. 1996; 7th ed. 2004.
- SCHMENNER, Roger W.: Service Operations Management. Englewood Cliffs NJ: Prentice Hall, 1995.
- SLACK, Nigel; CHAMBERS, Stuart; HARLAND, Christine et al.: Operations Management. London et al.: Financial Times, Pitman Publishing, 2nd ed. 1998.
- SLACK, Nigel; CHAMBERS, Stuart; JOHNSTON, Robert et al.: Operations Management. London: Financial Times, Prentice Hall, 4th ed. 2003.

Please refer to the latest edition.

## Course: Machinery and Processes [2185000]

**Coordinators:** H. Kubach, M. Gabi, H. Bauer, U. Maas, Maas, Gabi, Bauer, Spicher, Kubach

**Part of the modules:** Machines and Processes (p. 43)[BSc-Modul 13, MuP]

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

### Learning Control / Examinations

successful lab course and written exam (2 h)

### Conditions

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

### Learning Outcomes

The students get to know the basic energy conversion processes and their applications in different machines.

### Content

basics of thermodynamics

thermal fluid machines

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

hydraulic fluid machines

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

internal combustion engines

- characteristic parameters
- engine parts
- kinematics
- engine processes
- fuels
- emissions
- alternative drive trains

### Media

slides and lecture notes to download

### Remarks

Every student attends one lab course. Passing the lab course is required to write the exam.

**Course: Machine Dynamics [2161224]****Coordinators:** C. Proppe**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

**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**

Application of engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery, e.g., 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. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

The exam in the discipline of mechanical engineering is composed of the topics from MD I to MD IV. The complete MD-exam consists of the theoretical and constructive part.

Exam duration:

- 2 h theoretical part
- 3 h constructive part

Both parts of the exam must be passed to pass the complete MD-exam.

### Conditions

Obligatory requirements: no

### Recommendations

Attendance at MKL I to MKL IV lectures.

### Learning Outcomes

Aims of the course

- Implementation of exemplary design process steps of product development with the help of **complex Systems**,
- Procurement of conforming to standards **interpretative rules and dimensioning rules** for part assemblies,
- Adduction to **complex** mechanical common used **machine parts** by fundamental considerations,
- Promotion of the **capacity for teamwork** as well as the **elaboration ability and assertiveness** during activity-related and supervised workshops

### 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

### 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. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

The knowledge will be proofed in a complete exam after MDII (CIW/VT/Dipl-Päd/Mech) or MD IV (MACH/ID).

### Conditions

Obligatory requirements: no

### Recommendations

Attendance Mechanical Design I

### Learning Outcomes

The lecture hat the goal

- to permute the complex steps of product engineering at the example of complex assemblies,
- to convey the normal application of depiction and drawing techniques, but also design and dimensioning instructions,
- to extend the view on machine elements, but also showing some parallels using the C&CM (Contact & Channel Model),

### Content

Following contents will be taught:Grundlagen Lagerung

- Bearings
- Selaings
- Design
- Tolerances and fittings
- Shaft-hub connections

### 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. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

The exam in the discipline of mechanical engineering is composed of the topics from MD I to MD IV.

The complete MD-exam consists of the theoretical and constructive part.

Exam duration:

- 2 h theoretical part
- 3 h constructive part

Both parts of the exam must be passed to pass the complete MD-exam.

### Conditions

Obligatory requirements: no

### Recommendations

Attendance at MKL I to MKL III lectures.

### Learning Outcomes

Aims of the course

- Implementation of exemplary design process steps of product development with the help of **complex Systems**,
- Procurement of conforming to standards **interpretative rules and dimensioning rules** for part assemblies,
- Adduction to **complex** mechanical common used **machine parts** by fundamental considerations,
- Promotion of the **capacity for teamwork** as well as the **elaboration ability and assertiveness** during activity-related and supervised workshops,
- introduction into engineering **software** tools.

In the MD III lectures machine parts will be holistically examined. Several part assemblies, integrated into complete systems, will be analyzed concerning requirements and functions.

During the work on the given comprehensive development and construction task, the motivation and the social skills of the students will be developed for team work. At the same time the students will be qualified to estimate the given task concerning time period and functional circumferences and they will be qualified to portion the task in the team on one's own responsibility.

### Content

These topics will be discussed:

**Tolerancing**

**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. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

The exam in the discipline of mechanical engineering is composed of the topics from MD I to MD IV.

The complete MD-exam consists of the theoretical and constructive part.

Exam duration:

- 2 h theoretical part
- 3 h constructive part

Both parts of the exam must be passed to pass the complete MD-exam.

### Conditions

Obligatory requirements: no

### Recommendations

Attendance at MD I to MD III lectures.

### Learning Outcomes

Aims of the course

- Implementation of exemplary design process steps of product development with the help of **complex systems**,
- Procurement of conforming to standards **interpretative and dimensioning rules** for part assemblies,
- Adduction to **complex**, common used **machine parts** by fundamental considerations,
- Promotion of the **capacity for teamwork** as well as the **elaboration ability and assertiveness** during activity-related and supervised workshops,
- introduction into engineering **software** tools.

In the MD IV lectures complex machine parts will be holistically examined. Several part assemblies, integrated into complete systems, will be analyzed concerning requirements and functions.

Due to the point of view on machine elements and machine systems with the help of the elementary model "working surface pairs & channel and support structure", students will be qualified to analyze and to pre-think unknown machine elements.

During the work on the given comprehensive development and construction task, the motivation and the social skills of the students will be developed for team work. At the same time the students will be qualified to estimate the given task concerning time period and functional circumferences and they will be qualified to portion the task in the team on one's own responsibility.

### 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  
Evolute 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  
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 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: Mathematical Methods in Dynamics [2161206]****Coordinators:** C. Proppe**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	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:

Principle of virtual work, variational calculations, Principle of Hamilton

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. 45)[BSc-Modul 14, WPF]

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

### Learning Control / Examinations

depending on choice according to actual version of study regulations  
Additives as announced

### Conditions

None.

### Recommendations

None.

### Learning Outcomes

The students can effectively and precisely apply the mathematical methods of strength of materials. They master the basic principles of tensor algebra and tensor analysis for a continuum mechanical modelling of materials. They know how to apply methods of continuum mechanics for dimensioning of work pieces.

### 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
- theory of plasticity

### 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. 45)[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 course presents several mathematical methods to analyze dynamical systems in the time and the frequency domain. In the first part, methods to solve ordinary single differential equations are discussed where attention is focused to non-periodic excitation. Systems of ordinary differential equations are considered next. Also partial differential equations (including the derivation of boundary value problems by Hamilton's principle) are treated. Analytical methods are emphasized but some selected approximate methods are dealt with as well. An introduction into the dynamic stability theory is also given.

**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**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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.

**Learning Outcomes**

The students can apply the mathematical methods of Dynamics effectively and precise.

They're able to use the basic mathematical methods for analytical and numerical modelling of the non linear behaviour moving fluids.

The students have a basic understanding of the procedures to describe, simplify and solve the Navier-Stokes equations by analytical integration, linearisation and important approximate solution methods (Finite Differences, Finite Volumes) for numerical calculations of the behaviour of flows.

In the accompanying tutorial 21433 the application of the methods can be trained.

**Content**

1.2 Regions of Flow

4.1.2 Linearisation

4.2.3 Finite Differences Method, Convergence, Stability

4.2.4 Finite Volume Method

5. Fluid Mechanical Applications

3.2.2 Reynolds Equations

3.2.3 Basic Turbulence Modelling

Numbering according to Lehrbuch Strömungsmechanik

**Literature**

Oertel, H., Böhle, M.: Strömungsmechanik, Vieweg-Verlag, 2006

Oertel, H., Dohrmann, U., Böhle, M.: Übungsbuch Strömungsmechanik, Vieweg-Verlag, 2006

Oertel, H., Laurien, E.: Numerische Strömungsmechanik, Vieweg Verlag 2003

## Course: Modelling of Microstructures [2183702]

**Coordinators:** B. Nestler

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2	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.

### Learning Outcomes

The students are introduced into the fundamentals of liquid-solid and solid-solid phase transformations. We discuss microstructures such as dendrites, eutectics and peritectics and consider the specific physics of heat and mass transport combined with the particular phase transformation. We study polycrystalline grain structures and examine the motion of interfaces and the effect of various external fields. Next, we learn the method of phase-field modelling for simulation of microstructure formation processes. As an extension of the phase-field modelling for phase transitions, we get to know the coupling with other field variables. The course will be combined with practical exercises.

### Content

The course consists of a lecture and exercise classes. The aim is an introduction to the simulation of phase transformations and microstructure formation under the influence of different physical quantities. Contents are:

- fundamentals of phase transformation and microstructure evolution
- polycrystalline grain structures
- heat and mass diffusion
- phase-field modelling and simulation
- extension of phase-field modelling to include other physical fields

### Media

Black board and slides.

### Literature

Fundamentals of Solidification, Kurz and Fisher

Theory of Solidification, Davis.

The science of crystallization: microscopic interfacial phenomena, W. A. Tiller -> Only special reading

Transport phenomena in metallurgy, G.H. Geiger and D. R. Poirier

Transport Phenomena, R. Bird, W. Stewart, E. Lightfoot

Kinetics of Materials, W. Craig Carter

Physical Metallurgy, Porter and Easterling

Construction of binary phase diagrams, R. Haansen

Introduction to the thermodynamics of materials, David. R. Gaskell

Numerical recipes in C



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

**Coordinators:** A. Albers, diverse

**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL], Mechanical Design (p. 34)[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

A prosperous participation at the MD III and MD IV is compulsory to attend the exam.

### Recommendations

Attendance on MD I to MD IV lectures.

### Learning Outcomes

#### Workshop MD III and MD IV:

In MD III and MD IV the student will get a technical task, which is similar to a real development project and must be solved by teamwork. There are several sessions during the semester. In every session the student must solve a specific task. There are different boundary conditions and design clearances, which must be considered by the student. The tasks must be solved methodically, according to the lecture. Some parts must be solved in CAD software (Pro/Engineer).

### Content

Interrogation of the purchased knowledge in MD 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

In the case of an average number of three points (3,0) or above in MD II / III /IV workshop (weighting MD II : MD III : MD IV = 2 : 3 : 4) the student will achieve an extra bonus for the mechanical design exam. This bonus amounts to 0,3 exam points and it can only be achieved in case of passed MD-exam (lowest passing grade 4,0).

## Course: Modelling and Simulation [2183703]

**Coordinators:** B. Nestler

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

ECTS Credits	Hours per week	Term	Instruction language
4	2 + 1	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.

### Learning Outcomes

The students learn fundamental algorithms and numerical methods of particular importance for materials simulations. The course introduces solution techniques for dynamical systems and partial differential equations. The methods are applied to describe heat and mass diffusion processes and to model microstructure formation (e.g. phase-field method). The next aim is to learn adaptive and parallel algorithms. The students will get familiar with fundamental concepts of high performance computations. Practical experience is obtained by the integrated exercises.

### 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

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

**Course: Modern Physics for Engineers [2400311]****Coordinators:** B. Pilawa**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Physics for Engineers [2142890]****Coordinators:** P. Gumbsch, A. Nesterov-Müller, A. Nesterov-Müller**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

## Course: Physical basics of laser technology [2181612]

**Coordinators:** J. Schneider

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

None.

### Learning Outcomes

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 focus 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-AWP) at the KIT-campus north will be offered.

### Content

physical basics of laser technology

laser beam sources (solid state, diode, gas, liquid and other lasers)

beam properties, guiding and shaping

lasers in materials processing

lasers in measurement technology

lasers for medical applications

safety aspects

### Literature

F. K. Kneubühl, M. W. Sigrist: Laser, 2008, Vieweg+Teubner

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

H. Hügel, T. Graf: Laser in der Fertigung, 2009, Vieweg+Teubner

R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer

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

## Course: Product Lifecycle Management [2121350]

**Coordinators:** J. Ovtcharova

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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 goal of PLM lecture is to provide an overview of management and organizational approach to product lifecycle management. The students:

- know the management concept of PLM, its objectives and are able to highlight the economic benefits of the PLM concept
- know provider of PLM solutions and can represent the current market situation
- Understand 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
- know the processes and functions needed to support the entire product life cycle
- become aware of the main operating software systems (PDM, ERP, SCM, CRM) and the mainstreaming of these systems
- develop techniques to successfully introduce the concept of Management PLM.

### 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: Lab course Engineering Mechanics I [2161266]

**Coordinators:** T. Böhlke, T. Langhoff

**Part of the modules:** Engineering Mechanics (p. 31)[BSc-Modul 03, TM]

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

### Learning Control / Examinations

#### Conditions

None.

#### Recommendations

None.

### Learning Outcomes

application and practice of the contents of the lecture “Engineering Mechanics I”

#### Content

see lecture “Engineering Mechanics I”

#### Literature

see lecture “Engineering Mechanics I”



**Course: Lab course Engineering Mechanics II [2162252]****Coordinators:** T. Böhlke, T. Langhoff**Part of the modules:** Engineering Mechanics (p. 31)[BSc-Modul 03, TM]

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

**Learning Control / Examinations****Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

application and practice of the contents of the lecture “Engineering Mechanics II”

**Content**

see lecture “Engineering Mechanics II”

**Literature**

see lecture “Engineering Mechanics II”

## Course: Simulation of production systems and processes [2149605]

**Coordinators:** K. Furmans, V. Schulze, G. Zülch

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

### Learning Control / Examinations

oral examination

### Conditions

none

### Recommendations

none

### Learning Outcomes

The student knows different possibilities of simulation technology within the production technology and is able to use those methods. They range from the modeling of production and work systems down to simulation of single manufacturing processes.

### Content

The lecture is focused on the various aspects and possibilities of the usage of simulation technologies within the production technology. First the definition of the terminology and the basic knowledge is pointed out. In the chapter "Design of experiments and validation" the procedure of a simulation study with the preparation work, the selection of the simulation tools, the validation and the analysis of the simulation runs will be discussed. The chapter "Statistical basics" deals with probability distribution and random numbers as well as the use of Monte-Carlo-simulations in practical exercises. The chapter "Simulation of plant, machinery and processes" addresses the simulative analysis of single manufacturing processes via the examination of machine tools down to the modeling of a digital plant with the focus on the production facility. The chapter "Simulation of work systems" in addition considers the personnel integrated and orientated simulation. Here the assembly systems and the enterprise orientated simulation is considered. Finally the specifications of the material flow simulation for production systems are examined.

### Literature

none

### Remarks

The lecture starts in winter term 2011/12

**Course: Fluid Mechanics (german language) [2153412]****Coordinators:** T. Schenkel**Part of the modules:** Fluid mechanics (p. 42)[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 calculators

**Conditions**

None.

**Learning Outcomes**

Introduction to the fundamentals of fluid mechanics for students of mechanical engineering and related fields, physics and mathematics. The lecture is accompanied by a tutorial that is given in parallel.

**Content**

- Introduction
- Flows in Nature and Technologie
- Flow Regimes
- Fundamentals of Fluid Mechanics
- Properties of Fluids
- Hydro- und Aerostatics
- Hydro- und Aerodynamics
- Technical Flows
- Fundamental Equation
- Continuity equation
- Navier-Stokes equation
- Energy equation

## Course: Systematic Materials Selection [2174576]

**Coordinators:** A. Wanner

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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, bimaternal, 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 developed. 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;

### 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:** S. Rogalski, J. Ovtcharova

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

### Learning Control / Examinations

Oral examination, Duration: 25 min., Auxiliary Means: none

### Conditions

None

### Recommendations

None

### Learning Outcomes

Students should gain deeper knowledge about structures and functions of IT-systems applied in product development (engineering and manufacturing). They achieve general knowledge about the relevance of IT-support in engineering tasks.

Students know general approaches for introducing IT systems in existing Enterprise structures and have detail knowledge about “evolutionary process models of PLM” for a successful of IT-Systems installation.

### Content

- Information, information systems, information management
- CAP- and CAM-systems
- PPS- and ERP- systems
- PDM-Systems
- Virtual product configuration
- Installation of technical information systems in existing enterprise structures

### Literature

Lecture slides

## Course: Engineering Mechanics I [2161245]

**Coordinators:** T. Böhlke

**Part of the modules:** Engineering Mechanics (p. 31)[BSc-Modul 03, TM]

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

### Learning Control / Examinations

written, 90 min. Additives as announced

### Conditions

Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics I".

### Recommendations

None.

### Learning Outcomes

The Studenten know the basics for computing statical mechanical systems in engineering. Based on the notion of force, the students can analyse different equilibrium systems, e.g. plane and spatial force systems on rigid bodies. The students master the computation of internal forces and moments. In addition to the axion of equilibrium the students can effectively apply the principle of virtual displacements. In the framework of statics of straight bars the students can compute the internal forces and moments using elastic, thermo-elastic and elasto-plastic constitutive relations.

### 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

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. 31)[BSc-Modul 03, TM]

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

### Learning Control / Examinations

written, 90 min. Additives as announced

### Conditions

Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics 2".

### Recommendations

None.

### Learning Outcomes

The students master the elementary theories of bending, shear and torsion of straight beams. They know the principles of elasticity theory in 3D, especially multi-axial stress and strain states and Hookes law. The students can effectively apply energy methods and know approximation methods of elastostatics. They master the concept of stability and know basics of an elasto-plastic theory.

### Content

- bending
- shear
- torsion
- stress and strain state in 3D
- Hookes 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. 31)[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

Resources allowed during exam: onw lecture notes and notes from tutorial, books in 'Engineering Mechanics'

**Conditions**

Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics 3/4".

**Recommendations**

None.

**Learning Outcomes**

Engineering mechanics III deals with kinematics and kinetics of system of particles as well as plane motion of rigid bodies under the influence of forces and moments. Equations of motion are derived using Newton's axiom and the principle of moment of momentum. As applications the equations of motion are derived for systems of particles and simple systems of rigid bodies, including impact problems. Therefore, the course aims at applying Newton-Euler's equations, Principle of moment and principle of moment of momentum as well as principle of energy conservation for simple mechanical engineering problems.

**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. 31)[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 3/4".

### Learning Outcomes

The course is a continuation of Engineering Mechanics III. The goal is to understand the spatial motion of a rigid body. This includes both kinematics as well as dynamics. In a second part an introduction into analytic mechanics is given. The third part deals with vibration of simple one or two degrees of freedom systems.

### 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:** W. Seemann

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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 [2165526]****Coordinators:** U. Maas**Part of the modules:** Engineering Thermodynamics (p. 33)[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**

Thermodynamics is a theoretical discipline of mechanical engineering. One of the aims of the lecture is to introduce the correlations between the properties of pure substances and mixtures (temperature, pressure, volume, energy content etc.) and to develop the structure of these correlations. Furthermore, the lecture deals with the transformation of energy and the direction and the velocity of processes. The lecture is completed by exercises, where the subjects of the lecture are deepened by their application to selected examples.

**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. 33)[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**

Extended knowledge of thermodynamic processes and 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: Exercises Computer Science for Engineers [2121391]

**Coordinators:** J. Ovtcharova

**Part of the modules:** Computer Science (p. 39)[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: Tutorials Mechanical Design I [2145185]

**Coordinators:** A. Albers

**Part of the modules:** Mechanical Design (p. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

Workshop:

In every workshop session - integrated in the tutorials - the knowledge of the students will be reviewed. The knowledge and the handling of the workshop tasks are required to pass the MD I workshops.

The knowledge of the lecture will be proofed in a complete exam after MD IV.

### Conditions

A prosperous participation is compulsory to attend the exam.

### Learning Outcomes

#### Tutorial MD I:

In the exercises of MKL II the machine elements and their design guidelines, which were taught in the lecture, will be practiced with examples. The student will learn to calculate specific machine elements and to implement them into the construction.

#### Workshop MD I:

The students of the first semester have the chance to get in contact with real machine elements in three Workshops. That means, they can keep an eye on elements in interaction in a machine system.

The Workshop should convey additionally to the professional competence also those important Softskills. That is why the exercises are consequently made in one Group. So the students have to interchange their experience. For the appraisal is not only the personal achievement important, also the achievement of the whole group is important.

### Content

The tutorials in MD I are composed as follows:

Exercise:

The content of the tutorials is based on the content of the lectures. Additionally tutorials for technical drawing will be provided.

Workshop MD I in groups of 5 students

### Media

- Beamer
- Visualizer
- Gear box (Workshop)

### 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)

## Course: Tutorials Mechanical Design II [2146185]

**Coordinators:** A. Albers, Divers tutors

**Part of the modules:** Mechanical Design (p. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

The succes control will be done by test, which will take place during the lecture time.

### Conditions

Compulsory preconditions: none

### Recommendations

Attendance Tutorial Mechanical Design I

### Learning Outcomes

#### Tutorial MKL II

In the exercises of MKL II the machine elements and their design guidelines, which were taught in the lecture, will be practiced with examples. The student will learn to calculate specific machine elements and to implement them into the construction.

### Content

The tutorials are composed as follows:

Exercise:

The covered machine elements are bearings, design, tolerances and fittings. Additionally the student will be introduced into basic CAD techniques (Pro/Engineer).

### Media

- Beamer
- Visualizer
- model box (Workshop)

### 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)

## Course: Tutorials Mechanical Design III [2145153]

**Coordinators:** A. Albers, diverse

**Part of the modules:** Mechanical Design (p. 34)[BSc-Modul 06, MKL]

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

### Learning Control / Examinations

integrated in workshops (2145154):

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 MKL III workshops.

### Conditions

A prosperous participation is compulsory to attend the exam.

### Recommendations

Attendance on MD I to MD III lectures.

### Learning Outcomes

#### Tutorial MKL III:

In the exercises of MKL III the machine elements and their design guidelines, which were taught in the lecture, will be practiced with examples. The student will learn to calculate specific machine elements and to implement them into the construction.

#### Workshop MD III:

In the Workshop the student will get a technical task, which is similar to a real development project and must be solved by teamwork. There are several sessions during the semester. In every session the student must solve a specific task. There are different boundary conditions and design clearances, which must be considered by the student. The tasks must be solved methodically, according to the lecture. Some parts must be solved in CAD software (Pro/Engineer).

### Content

The tutorials are composed as follows:

Exercise:

The content of the tutorials is based on the content of the lectures. Additionally CAD tutorials will be provided in Pro/Engineer.

Workshop MD III:

An exam sheet will be solved in group work.

### Media

- Beamer
- Visualizer
- model box (Workshop)

### 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

In the case of an average number of three points (3,0) or above in MD II / III / IV workshop (weighting MD II : MD III : MD IV = 2 : 3 : 4) the student will achieve an extra bonus for the mechanical design exam. This bonus amounts to 0,3 exam points and it can only be achieved in case of passed MD-exam (lowest passing grade 4,0).



**Course: Tutorials Mechanical Design IV [2146184]****Coordinators:** A. Albers, diverse**Part of the modules:** Mechanical Design (p. 34)[BSc-Modul 06, MKL]

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

**Learning Control / Examinations**

Workshop:

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 MKL IV workshops.

**Conditions**

A prosperous participation is compulsory to attend the exam.

**Recommendations**

Attendance on MD I to MD IV lectures.

**Learning Outcomes****Tutorial MKL IV**

In the exercises of MKL IV the machine elements and their design guidelines which were taught in the lectures will be practiced with examples. The student will learn to calculate specific machine elements and to implement them into the construction.

**Workshop MD IV:**

In the Workshop the student will get a technical task which is similar to a real development project and must be solved by teamwork. There are several sessions during the semester. To every session the student must solve a specific task. There are different boundary conditions and design clearances which must be considered by the student. The tasks must be solved methodically, according to the lectures. Some parts must be solved in CAD software (Pro/Engineer).

**Content**

The tutorials are composed as follows:

Exercise:

The covered machine elements are basic connections, gear transmissions and tooth systems, couplings and hydraulic systems. Additionally CAD tutorials will be provided in Pro/Engineer.

Workshop MD IV:

Groups of up to 5 students

**Media**

- Beamer
- Visualizer
- Model box (Workshop)

**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**

In the case of an average number of three points (3,0) or above in MD II / III /IV workshop (weighting MD II : MD III : MD IV = 2 : 3 : 4) the student will achieve an extra bonus for the mechanical design exam. This bonus amounts to 0,3 exam points and it can only be achieved in case of an passed MD-exam (lowest passing grade 4,0).

**Course: Tutorial Engineering Mechanics I [2161246]****Coordinators:** T. Böhlke, Mitarbeiter**Part of the modules:** Engineering Mechanics (p. 31)[BSc-Modul 03, TM]

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

**Learning Control / Examinations**

Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics I".

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

Application and practice of the course "Engineering Mechanics I"

**Content**

see lecture Engineering Mechanics I

**Literature**

see lecture Engineering Mechanics I

## Course: Tutorial Engineering Mechanics II [2162251]

**Coordinators:** T. Böhlke, Mitarbeiter

**Part of the modules:** Engineering Mechanics (p. 31)[BSc-Modul 03, TM]

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

### Learning Control / Examinations

Homework is mandatory and a precondition to take part in the exam "Engineering Mechanics II"

### Conditions

None.

### Recommendations

None.

### Learning Outcomes

Application and practice of the course "Engineering Mechanics II"

### Content

see lecture Engineering Mechanics II

### Literature

see lecture Engineering Mechanics II

**Course: Engineering Mechanics III (Tutorial) [2161204]****Coordinators:** W. Seemann, Assistenten**Part of the modules:** Engineering Mechanics (p. 31)[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**

Application and practice of the course TM III

**Content**

In the Tutorial exercises for the corresponding subjects of the lecture are presented. During the tutorial part of the tutorial exercises are presented and instructions for those exercises 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. 31)[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

Application and practice of the course TM IV

### 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, Assisitenen**Part of the modules:** Engineering Thermodynamics (p. 33)[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**

Application and consolidating of the lecture matter

**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: Exercises in Technical Thermodynamics and Heat Transfer II [2166527]****Coordinators:** U. Maas**Part of the modules:** Engineering Thermodynamics (p. 33)[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**

Application and consolidating of the lecture matter

**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 [2165501]****Coordinators:** UlrichMaas, Halmer**Part of the modules:** Engineering Thermodynamics (p. 33)[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: Exercises in Material Science I for mach, mage, phys [2173552]****Coordinators:** K. Weidenmann, Gruber**Part of the modules:** Materials Science and Engineering (p. 32)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
0	1	Winter term	de

**Learning Control / Examinations**

none

**Conditions**

Lecture Materials Science and Engineering I

**Learning Outcomes**

Deepening of the lecture by exemplary calculations

**Content**

Exemplary calculations

**Literature**

Institute of Materials Science and Engineering I: Lecture Notes

**Course: Exercises in Material Science II for mach, mage, phys [2174563]****Coordinators:** A. Wanner, Gruber**Part of the modules:** Materials Science and Engineering (p. 32)[BSc-Modul 04, WK]

ECTS Credits	Hours per week	Term	Instruction language
0	1	Summer term	de

**Learning Control / Examinations**

none

**Conditions**

Lecture Materials Science and Engineering II

**Learning Outcomes**

Deepening of the lecture by exemplary calculations

**Content**

Exemplary calculations

**Literature**

Institute of Materials Science and Engineering I: Lecture Notes

**Course: Virtual Engineering (Specific Topics) [3122031]****Coordinators:** J. Ovtcharova**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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 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**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[BSc-Modul 14, WPF]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: [2400411]****Coordinators:** B. Pilawa**Part of the modules:** Principles of Natural Science (p. 30)[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****Content**

**Course: Material Sciencel for mach, mage, phys; Part 2 of class: Letters L-Z [2173551]****Coordinators:** A. Wanner, H. Seifert, K. Weidenmann**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess 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: Material Science I for mach, mage, phys; Part 1 of class: Letters A-K [2173550]****Coordinators:** A. Wanner, H. Seifert, K. Weidenmann**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess 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: Material Science II for mach, mage, phys; Part 1 of class: Letters A-K [2174560]****Coordinators:** A. Wanner, H. Seifert, K. Weidenmann**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess 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: Material Science II for mach, mage, phys; Part 2 of class: Letters L-Z [2174561]****Coordinators:** A. Wanner, H. Seifert, K. Weidenmann**Part of the modules:** Materials Science and Engineering (p. 32)[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 are familiar with the typical property profiles and applications of the most important engineering materials.

The students know about standard materials characterization methods and are able to assess 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: Scientific computing for Engineers [2181738]

**Coordinators:** D. Weygand, P. Gumbsch

**Part of the modules:** Compulsory Elective Subject (BSc) (p. 45)[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 learns the programming language C++ used for computational material science on parallel platforms. Numerical methods for the solution of differential equations are learned and used.

### Content

1. Introduction: why scientific computing
2. computer architectures
3. Introduction to Unix/Linux
4. Foundations of C++
  - \* programm 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. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (FAST - Bahnsystemtechnik) [2114990]****Coordinators:** P. Gratzfeld**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (FAST - Fahrzeugtechnik) [2114989]****Coordinators:** F. Gauterin, El-Haji, Unrau**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (FAST-Leichtbautechnologie) [2114450]****Coordinators:** F. Henning**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (FAST-MOBIMA) [2114979]****Coordinators:** M. Geimer**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (FSM) [2158978]****Coordinators:** M. Gabi**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**



**Course: Workshop 'Working Methods in Mechanical Engineering' (IAM-AWP) [2174987]****Coordinators:** H. Seifert**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (IAM-ZBS, Nestler) [2182982]**

**Coordinators:** B. Nestler, A. August

**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations**

depending on the topic either by presentation or documentation

**Conditions**

required: lecture 2174970

**Learning Outcomes**

Study of a given topic by literature search and by research articles, preparation of appropriate contents, selection of material for presentation and documentation

**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, books, articles

## Course: Workshop 'Working Methods in Mechanical Engineering' (IFAB) [2110968]

**Coordinators:** G. Zülch, P. Stock

**Part of the modules:** Key Competences (p. 35)[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 consideration 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](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' (IFKM) [2134996]****Coordinators:** U. Spicher**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (IFL) [2118973]****Coordinators:** Baur**Part of the modules:** Key Competences (p. 35)[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' (IKM) [2126980]****Coordinators:** M. Hoffmann**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (IKR) [2130985]****Coordinators:** D. Cacuci, Erkan Arslan**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**



**Course: Workshop 'Working Methods in Mechanical Engineering' (IMI) [2128998]****Coordinators:** J. Ovtcharova, Mitarbeiter**Part of the modules:** Key Competences (p. 35)[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. 35)[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 themselves. The contributions have to be 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
- Generation of technical program, budget, flyer etc. of the conference
- Definition of criteria for abstracts - communication of criteria

#### 2. part 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 scientific 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 conference

**Media**

Computer with internet access

**Literature**

Script for the Workshop - Fundamentals of scientific writing, poster design, moderation and presentation were summarized 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. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (ITT) [2166991]****Coordinators:** U. Maas**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop 'Working Methods in Mechanical Engineering' (MRT) [2138997]****Coordinators:** C. Stiller**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

### Course: Workshop I 'Working Methods in Mechanical Engineering' (IAM-ZBS, Gumb-sch) [2182974]

**Coordinators:** P. Gumbsch, M. Weber, K. Schulz

**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

#### Learning Control / Examinations

see lecture description

#### Conditions

required: lecture 2174970

#### Learning Outcomes

application of the lecture

#### Content

application of the lecture:

\* project work

\* presentations, poster

#### Literature

Lecture notes

**Course: Workshop I 'Working Methods in Mechanical Engineering' (IFRT) [2190497]****Coordinators:** R. Stieglitz**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**



**Course: Workshop I 'Working Methods in Mechanical Engineering' (IPEK) [2146971]****Coordinators:** A. Albers**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

Compulsory preconditions: none

**Learning Outcomes****Content**

**Course: Workshop I 'Working Methods in Mechanical Engineering' (ITM) [2162983]****Coordinators:** T. Böhlke, Mitarbeiter**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Recommendations**

None.

**Learning Outcomes****Content**

**Course: Workshop I 'Working Methods in Mechanical Engineering' (IWK I) [2174976]****Coordinators:** K. Poser**Part of the modules:** Key Competences (p. 35)[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 teaching staff and the students from the other teams.

**Course: Workshop I 'Working Methods in Mechanical Engineering' (WBK) [2150987]****Coordinators:** V. Schulze**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations**

see lecture description

**Conditions**

required: lecture 2174970

**Learning Outcomes**

application of the lecture.

**Content**

application of the lecture:

- \* project work
- \* presentations, poster

**Literature**

Lecture notes

**Course: Workshop II 'Working Methods in Mechanical Engineering' (IFRT) [2190498]****Coordinators:** K. Ivanov**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

## Course: Workshop II 'Working Methods in Mechanical Engineering' (IPEK) [2146972]

**Coordinators:** S. Matthiesen, Wissenschaftlicher Mitarbeiter des IPEK

**Part of the modules:** Key Competences (p. 35)[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)" is required
- Limited number of participants
- Registration via internet on <http://www.mach.kit.edu>
- Mandatory attendance in all workshops

### Learning Outcomes

Empowering students in the following areas:

- Find scientific sources and document the results with the program Zotero (Freeware)
- Quote to DIN 1505
- Scientific and technical writing, by submitting a summary of research results
- Teamwork, by working in a highly networked group, which has an team expert in it.
- Creativity techniques, by using the 635 method and the Gallery Method
- Decision-making in the team, by applying the weighted scoring method and the PMI (Plus / Minus / Interesting)
- presentation and communication techniques

### Content

Task:

Development of alternative concepts of separation processes in handheld devices. These concepts are elaborated in the following workshops.

1st Workshop:

Introduction to Zotero software, 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 of alternative separation method in a hand-held device.

### Media

Computer, Beamer, Flipchart

**Course: Workshop II 'Working Methods for Mechanical Engineering' (ITM) [2162994]****Coordinators:** C. Proppe**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop II 'Working Methods in Mechanical Engineering' (IWK I) [2174986]****Coordinators:** A. Wanner**Part of the modules:** Key Competences (p. 35)[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 teaching staff and the students from the other teams.



**Course: Workshop II 'Working Methods in Mechanical Engineering' (IZBS) [2182981]****Coordinators:** O. Kraft, P. Gruber, Courty**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations**

see lecture notes

**Conditions**

required: lecture 2174970

**Learning Outcomes**

application of the lecture.

**Content**

application of the lecture:

\* project work

\* presentations, poster

**Literature**

Lecture notes

**Course: Workshop II 'Working Methods in Mechanical Engineering' (WBK) [2150988]****Coordinators:** G. Lanza**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations**

see lecture description

**Conditions**

required: lecture 2174970

**Learning Outcomes**

application of the lecture.

**Content**

application of the lecture:

- \* project work
- \* presentations, poster

**Literature**

Lecture notes

**Course: Workshop III 'Working Methods in Mechanical Engineering' (IFRT) [2190975]****Coordinators:** X. Cheng**Part of the modules:** Key Competences (p. 35)[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****Content**

**Course: Workshop III 'Working Methods in Mechanical Engineering' (ITM) [2162995]****Coordinators:** W. Seemann**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Workshop III 'Working Methods in Mechanical Engineering' (WBK) [2150989]****Coordinators:** J. Fleischer**Part of the modules:** Key Competences (p. 35)[BSc-Modul 07, SQL]

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

**Learning Control / Examinations**

see lecture description

**Conditions**

required: lecture 2174970

**Learning Outcomes**

application of the lecture.

**Content**

application of the lecture:

- \* project work
- \* presentations, poster

**Literature**

Lecture notes

## 5 Major Fields

**SP 02: Powertrain Systems**

ID	Cat	Course	Lecturer	h	CP	Term
2113077	K	Drive Train of Mobile Machines (p. 191)	M. Geimer	2/1	4	W
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 192)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 193)	A. Albers, S. Ott	2	4	W
2163111	K	Dynamik vom Kfz-Antriebsstrang (p. 228)	A. Fidlin	4	8	W
2105012	E	Adaptive Control Systems (p. 186)	G. Bretthauer	2	4	W
2145181	E	Applied Tribology in Industrial Product Development (p. 190)	A. Albers, W. Burger	2	4	W
2162235	E	Introduction into the multi-body dynamics (p. 237)	W. Seemann	3	5	S
2117500	E	Energy efficient intralogistic systems (p. 245)	F. Schönung	2	4	W
2118083	E	IT for facility logistics (p. 301)	F. Thomas	4	6	S
2145184	E	Leadership and Product Development (p. 313)	A. Ploch	2	4	W
2161224	E	Machine Dynamics (p. 320)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 321)	C. Proppe	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 335)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 344)	M. Kohl, M. Sommer	2	4	W
2147160	E	Patents and Patent Strategies (p. 348)	F. Zacharias	2	4	W/S
2146194	E (P)	Mobile Robot Systems Lab (p. 357)	A. Albers, W. Burger	3	3	S
23311	E	Electrical Powertrains in Practice (p. 360)	M. Braun, Braun	2	3	S
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W
2173562	E	Failure Analysis (p. 385)	K. Poser	2	4	W
2150683	E	Control engineering (p. 401)	C. Gönnheimer	2	4	S
2146193	E	Strategic Product Planning (p. 402)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2181711	E	Failure of structural materials: deformation and fracture (p. 426)	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. 431)	J. Hoffmeister	2	4	W
23321	E	Hybrid Engines and Electrical Vehicals (p. 289)	M. Doppelbauer	2+1	4	W
2133101	E	Combustion Engines A with tutorial (p. 422)	U. Spicher	6	8	W
2134135	E	Combustion Engines B with Tutorial (p. 423)	U. Spicher	3	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2181113	E	Tribology A (p. 418)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 419)	M. Scherge, M. Dienwiebel	2	4	S

**Conditions:** Compulsory preconditions: none

**Recommendations:** Recommended Courses:

- 2147175 CAE-Workshop

**Remarks:**

**SP 05: Calculation Methods in Mechanical Engineering**

ID	Cat	Course	Lecturer	h	CP	Term
2154434	K	Applied Fluid Mechanics (p. 188)	T. Schenkel	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 237)	W. Seemann	3	5	S
2161252	K	Advanced Methods in Strength of Materials (p. 288)	T. Böhlke	2	4	W
2181740	E	Atomistic simulations and molecular dynamics (p. 198)	P. Gumbsch	2	4	S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2106004	E	Computational Intelligence I (p. 221)	G. Bretthauer, R. Mikut	2	4	S
2105015	E	Computational Intelligence II (p. 222)	G. Bretthauer, Mikut	2	4	W
2106020	E	Computational Intelligence III (p. 223)	R. Mikut	2	4	S
2162282	E	Introduction to the Finite Element Method (p. 232)	T. Böhlke	2	4	S
2154401	E	Fluid-Structure-Interaction (p. 262)	T. Schenkel	2	4	S
2146190	E	Lightweight Engineering Design (p. 305)	A. Albers, N. Burkardt	2	4	S
2161214	E	Vibration of continuous systems (p. 306)	H. Hetzler	2	4	W
2161224	E	Machine Dynamics (p. 320)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 321)	C. Proppe	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 324)	C. Proppe	2	4	W
2161254	E	Mathematical Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2162241	E	Mathematical methods of vibration theory (p. 326)	W. Seemann	3	5	S
2162280	E	Mathematical Methods in Structural Mechanics (p. 327)	T. Böhlke	2	4	S
2134134	E	Analysis tools for combustion diagnostics (p. 334)	U. Wagner	2	4	S
2183702	E	Modelling of Microstructures (p. 336)	B. Nestler	2	4	W
2183703	E	Modelling and Simulation (p. 340)	B. Nestler	2 + 1	4	W/S
2153408	E	Numerical Fluid Mechanics (p. 347)	T. Schenkel	2	4	W
2162244	E	Plasticity Theory (p. 350)	T. Böhlke	2	4	S
2161250	E	Computational Mechanics I (p. 382)	T. Böhlke, T. Langhoff	2	5	W
2162296	E	Computational Mechanics II (p. 383)	T. Böhlke, T. Langhoff	2	5	S
2114095	E	Simulation of Coupled Systems (p. 395)	M. Geimer	2/2	4	S
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 399)	C. Proppe	2	4	W
2117095	E	Basics of Technical Logistics (p. 277)	M. Mittwollen, Madzharov	4	6	W
2161212	E	Vibration Theory (p. 409)	W. Seemann	3	5	W
2117060	E/P	Analytical methods in material flow methodology (mach and wiwi) (p. 187)	K. Furmans	4	6	W
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 398)	C. Baumgarten	2	4	W
2163111	E	Dynamik vom Kfz-Antriebsstrang (p. 228)	A. Fidlin	4	8	W
2163113	E	Stabilitätstheorie (p. 400)	A. Fidlin	4	8	W
2162247	E	Nonlinear vibrations (p. 238)	A. Fidlin	4	8	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 390)	H. Hetzler, A. Fidlin	3	3	S
2117096	E	Elements of Technical Logistics (p. 244)	M. Mittwollen, Madzharov	4	6	W



## 5 MAJOR FIELDS

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ID	Cat	Course	Lecturer	h	CP	Term
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. <a href="#">227</a> )	H. Hetzler	2	4	S

**Conditions:**

**Recommendations:**

**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. 288)	T. Böhlke	2	4	W
2181745	K	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2162282	K	Introduction to the Finite Element Method (p. 232)	T. Böhlke	2	4	S
2173585	K	Fatigue of Metallic Materials (p. 389)	K. Lang	2	4	W
2174574	K	Materials for Lightweight Construction (p. 432)	K. Weidenmann	2	4	S
2123356	E (P)	CATIA V5 CAD training course (p. 216)	J. Ovtcharova, M. Hajdukovic	3	2	W/S
2123355	E (P)	CAD-NX5 training course (p. 217)	J. Ovtcharova, M. Hajdukovic	3	2	W/S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2161229	E	Designing with numerical methods in product development (p. 225)	E. Schnack	2	4	W
2125755	E	Introduction to Ceramics (p. 233)	M. Hoffmann	2	4	W
2175588	E (P)	Metallographic Lab Class, Metallographic Lab Class, Ferrous Materials (p. 249)	K. Poser, A. Wan-ner	3	4	W/S
2175589	E (P)	Metallographic Lab Class, Non-Ferrous Materials (p. 250)	K. Poser, A. Wan-ner	3	4	W/S
2173560	E (P)	Welding Lab Course, in groupes (p. 251)	V. Schulze	3	4	W
2146190	E	Lightweight Engineering Design (p. 305)	A. Albers, N. Burkardt	2	4	S
2161224	E	Machine Dynamics (p. 320)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 321)	C. Proppe	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 324)	C. Proppe	2	4	W
2161254	E	Mathematical Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2162280	E	Mathematical Methods in Structural Mechanics (p. 327)	T. Böhlke	2	4	S
2162244	E	Plasticity Theory (p. 350)	T. Böhlke	2	4	S
2173590	E	Polymer Engineering I (p. 354)	P. Elsner	2	4	W
2162275	E (P)	Lab course experimental solid mechanics (p. 358)	T. Böhlke, Mitarbeiter	2	2	S
2161250	E	Computational Mechanics I (p. 382)	T. Böhlke, T. Langhoff	2	5	W
2162296	E	Computational Mechanics II (p. 383)	T. Böhlke, T. Langhoff	2	5	S
2173562	E	Failure Analysis (p. 385)	K. Poser	2	4	W
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2174579	E	Technology of steel components (p. 411)	V. Schulze	2	4	S

**Conditions:****Recommendations:****Remarks:**

**SP 09: Dynamic Machine Models**

ID	Cat	Course	Lecturer	h	CP	Term
2162235	K	Introduction into the multi-body dynamics (p. 237)	W. Seemann	3	5	S
2118078	K	Logistics - organisation, design and control of logistic systems (p. 315)	K. Furmans	4	6	S
2105012	E	Adaptive Control Systems (p. 186)	G. Bretthauer	2	4	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 192)	A. Albers, S. Ott	2	4	S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2117500	E	Energy efficient intralogistic systems (p. 245)	F. Schönung	2	4	W
2113807	E	Handling Characteristics of Motor Vehicles I (p. 252)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 253)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 254)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 255)	F. Gauterin	2	4	S
2146190	E	Lightweight Engineering Design (p. 305)	A. Albers, N. Burkardt	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 324)	C. Proppe	2	4	W
2114095	E	Simulation of Coupled Systems (p. 395)	M. Geimer	2/2	4	S
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 424)	C. Stiller, T. Dang	2	4	S
2122378	E	Virtual Engineering II (p. 428)	J. Ovtcharova	3	4	S
2118087	E/P	Selected Applications of Technical Logistics (p. 202)	M. Mittwollen, Madzharov	3	4	S
2118088	E/P	Selected Applications of Technical Logistics and Project (p. 203)	M. Mittwollen, Madzharov	4	6	S
2163111	E	Dynamik vom Kfz-Antriebsstrang (p. 228)	A. Fidlin	4	8	W
2163113	E	Stabilitätstheorie (p. 400)	A. Fidlin	4	8	W
2162247	E	Nonlinear vibrations (p. 238)	A. Fidlin	4	8	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 390)	H. Hetzler, A. Fidlin	3	3	S
2161212	E	Vibration Theory (p. 409)	W. Seemann	3	5	W
2162241	E	Mathematical methods of vibration theory (p. 326)	W. Seemann	3	5	S
2161214	E	Vibration of continuous systems (p. 306)	H. Hetzler	2	4	W
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 227)	H. Hetzler	2	4	S
24152	E	Robotics I – Introduction to robotics (p. 384)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W

**Conditions:****Recommendations:****Remarks:**

## SP 10: Engineering Design

ID	Cat	Course	Lecturer	h	CP	Term
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 192)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 193)	A. Albers, S. Ott	2	4	W
2146190	K	Lightweight Engineering Design (p. 305)	A. Albers, N. Burkardt	2	4	S
2113073	K	Mobile Machines (p. 337)	M. Geimer	4	8	W
2145181	E	Applied Tribology in Industrial Product Development (p. 190)	A. Albers, W. Burger	2	4	W
2117064	E	Application of technical logistics in modern crane systems (p. 194)	M. Golder	2	4	W
2113079	E	Design and Development of Mobile Machines (p. 206)	M. Geimer	2	4	W
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2149657	E	Manufacturing Technology (p. 259)	V. Schulze	6	8	W
2113805	E	Automotive Engineering I (p. 272)	F. Gauterin, H. Unrau	4	8	W
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 282)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 283)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 284)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 285)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 286)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 287)	R. Frech	1	2	S
2174571	E	Design with Plastics (p. 304)	C. Bonten	2	4	S
2145184	E	Leadership and Product Development (p. 313)	A. Ploch	2	4	W
2110017	E	Leadership and Conflict Management (in German) (p. 318)	H. Hatzl	2	4	S
2105014	E (P)	Laboratory mechatronics (p. 331)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2145180	E	Methodic Development of Mechatronic systems (p. 335)	A. Albers, W. Burger	2	4	W
2146194	E (P)	Mobile Robot Systems Lab (p. 357)	A. Albers, W. Burger	3	3	S
2109025	E	Product Ergonomics (in German) (p. 365)	G. Zülch	2	4	W
2109028	E	Industrial Engineering I (in German) (p. 367)	G. Zülch	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W
2149667	E	Quality Management (p. 378)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 393)	H. Kany	2	4	W
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2146193	E	Strategic Product Planning (p. 402)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2158107	E	Technical Acoustics (p. 406)	M. Gabi	2	4	S
2146179	E	Technical Design in Product Development (p. 410)	M. Schmid, Dr.-Ing. Markus Schmid	2	4	S
2174574	E	Materials for Lightweight Construction (p. 432)	K. Weidenmann	2	4	S

## 5 MAJOR FIELDS

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ID	Cat	Course	Lecturer	h	CP	Term
2149902	E	Machine Tools and Industrial Handling (p. <a href="#">435</a> )	J. Fleischer	4	8	W
2161229	E	Designing with numerical methods in product development (p. <a href="#">225</a> )	E. Schnack	2	4	W

**Conditions:** SP 10 as bachelolor module selectable

SP10 as master module selection depends on individual specialisation of the master course

**Recommendations:** Recommended Courses:

- 2147175 CAE-Workshop
- 2105014 Mechatronik - Workshop

**Remarks:**

**SP 12: Automotive Technology**

ID	Cat	Course	Lecturer	h	CP	Term
2113805	KP	Automotive Engineering I (p. 272)	F. Gauterin, H. Unrau	4	8	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 192)	A. Albers, S. Ott	2	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2114850	E	Gesamtfahrzeugbewertung im virtueller Fahrversuch (p. 265)	B. Schick	2	4	S
2113807	E	Handling Characteristics of Motor Vehicles I (p. 252)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 253)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 254)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 255)	F. Gauterin	2	4	S
2113816	E	Vehicle Mechatronics I (p. 256)	D. Ammon	2	4	W
2138340	E	Automotive Vision (p. 257)	C. Stiller, M. Lauer	2	4	S
2114835	E	Automotive Engineering II (p. 273)	F. Gauterin, H. Unrau	2	4	S
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 275)	E. Lox	2	4	S
2114843	E	Basics and Methods for Integration of Tires and Vehicles (p. 281)	G. Leister	2	4	S
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 282)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 283)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 284)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 285)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 286)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 287)	R. Frech	1	2	S
2146190	E	Lightweight Engineering Design (p. 305)	A. Albers, N. Burkardt	2	4	S
2115808	E (P)	Motor Vehicle Laboratory (p. 308)	M. Frey, M. El-Haji	2	4	W/S
2182642	E	Laser in automotive engineering (p. 312)	J. Schneider	2	4	S
2149669	E	Materials and processes for the lightweight production of car bodies (p. 323)	H. Haepf	2	4	W
2147160	E	Patents and Patent Strategies (p. 348)	F. Zacharias	2	4	W/S
2123364	E	Product, Process and Resource Integration in the Automotive Industry (p. 364)	S. Mbang	3	4	S
2150690	E	Production Systems and Production Technology in Major Assembly Production (p. 368)	V. Stauch	2	4	W/S
2115817	E	Project Workshop: Automotive Engineering (p. 370)	F. Gauterin	3	6	W/S
2113071	E	Development of Mobile Hydraulic Systems (p. 371)	G. Geerling	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W

ID	Cat	Course	Lecturer	h	CP	Term
2162256	E	Computational Vehicle Dynamics (p. 380)	C. Proppe	2	4	S
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2146193	E	Strategic Product Planning (p. 402)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 424)	C. Stiller, T. Dang	2	4	S
2149655	E	Gear Cutting Technology (p. 427)	K. Felten	2	4	W
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 431)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 432)	K. Weidenmann	2	4	S
2153425	E	Industrial aerodynamics (p. 292)	T. Breitling	2	4	W
2133101	E	Combustion Engines A with tutorial (p. 422)	U. Spicher	6	8	W
2134135	E	Combustion Engines B with Tutorial (p. 423)	U. Spicher	3	4	S
2134112	E	Supercharging of Combustion Engines (p. 201)	R. Golloch	2	4	S
23321	E	Hybrid Engines and Electrical Vehicals (p. 289)	M. Doppelbauer	2+1	4	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 231)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 258)	F. Henning	2	4	S

**Conditions:**

**Recommendations:**

**Remarks:**

**SP 13: Strength of Materials/ Continuum Mechanics**

ID	Cat	Course	Lecturer	h	CP	Term
2161252	KP	Advanced Methods in Strength of Materials (p. 288)	T. Böhlke	2	4	W
2162282	K	Introduction to the Finite Element Method (p. 232)	T. Böhlke	2	4	S
2161254	K	Mathematical Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2162280	K	Mathematical Methods in Structural Mechanics (p. 327)	T. Böhlke	2	4	S
2181711	K	Failure of structural materials: deformation and fracture (p. 426)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
1606	E	Adaptive Finite Element Methods (p. 185)	Dörfler	2	3	S
2181740	E	Atomistic simulations and molecular dynamics (p. 198)	P. Gumbsch	2	4	S
1246	E	Boundary and Eigenvalue Problems (p. 214)	M. Plum, W. Reichel, Plum, Reichel	6	6	S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2162255	E	Designing with composites (p. 226)	E. Schnack	2	4	S
2182732	E	Introduction to Theory of Materials (p. 234)	M. Kamlah	2	4	S
19110	E	Finite Elements for Field- and Time Dependent Problems (p. 261)	K. Schweizerhof, Schweizerhof	2	3	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 276)	M. Kamlah	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 324)	C. Proppe	2	4	W
2183702	E	Modelling of Microstructures (p. 336)	B. Nestler	2	4	W
2183703	E	Modelling and Simulation (p. 340)	B. Nestler	2 + 1	4	W/S
2162244	E	Plasticity Theory (p. 350)	T. Böhlke	2	4	S
2162275	E (P)	Lab course experimental solid mechanics (p. 358)	T. Böhlke, Mitarbeiter	2	2	S
2161501	E	Process Simulation in Forming Operations (p. 376)	D. Helm	2	4	W
2162246	E	Computational Dynamics (p. 379)	C. Proppe	2	4	S
2161250	E	Computational Mechanics I (p. 382)	T. Böhlke, T. Langhoff	2	5	W
2162296	E	Computational Mechanics II (p. 383)	T. Böhlke, T. Langhoff	2	5	S
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2182740	E	Materials modelling: dislocation based plasticity (p. 434)	D. Weygand	2	4	S

**Conditions:****Recommendations:****Remarks:**



**SP 15: Fundamentals of Energy Technology**

ID	Cat	Course	Lecturer	h	CP	Term
2130927	KP	Fundamentals of Energy Technology (p. 271)	D. Cacuci, F. Badea	4	8	S
2166538	K	Fundamentals of combustion II (p. 279)	U. Maas	2	4	S
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 290)	M. Gabi	4	8	W
2130921	K	Energy Systems II: Nuclear Power Technology (p. 246)	D. Cacuci, F. Badea	2	4	S
2169453	K	Thermal Turbomachines I (p. 415)	H. Bauer	3	6	W
2117500	E	Energy efficient intralogistic systems (p. 245)	F. Schönung	2	4	W
2171486	E (P)	Integrated measurement systems for fluid mechanics applications (p. 298)	K. Dullenkopf, Mitarbeiter	5	4	W/S
2171487	E (P)	Laboratory Exercise in Energy Technology (p. 314)	H. Bauer, U. Maas, K. Dullenkopf, H. Wirbser	4	4	W/S
23737	E	Photovoltaics (p. 349)	M. Powalla	3	6	S
2169472	E	Thermal Solar Energy (p. 414)	R. Stieglitz	2	4	W
23381	E	Windkraft (p. 436)	N. Lewald, Lewald	2	4	W
2133109	E/P	Fuels and Lubricants for Combustion Engines and their Testing (p. 213)	J. Volz	2	4	W
2169459	E/P (P)	CFD-Lab using Open Foam (p. 220)	R. Koch	3	4	W
2158105	E/P	Hydraulic Fluid Machinery II (p. 291)	S. Caglar, M. Gabi	2	4	S
2134134	E/P	Analysis tools for combustion diagnostics (p. 334)	U. Wagner	2	4	S
2157441	E/P	Computational Methods in Fluid Mechanics (p. 345)	F. Magagnato	2	4	W
2169458	E/P	Numerical simulation of reacting two phase flows (p. 346)	R. Koch	2	4	W
2157442	E/P (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 359)	B. Pritz	2	4	W
2146192	E/P	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2158107	E/P	Technical Acoustics (p. 406)	M. Gabi	2	4	S
2158106	E/P	Technologies for energy efficient buildings (p. 412)	F. Schmidt	2	4	S
2133101	E/P	Combustion Engines A with tutorial (p. 422)	U. Spicher	6	8	W

**Conditions:****Recommendations:****Remarks:**

**SP 17: Information Management**

ID	Cat	Course	Lecturer	h	CP	Term
2121001	KP	Integrated Information Systems for engineers (p. 408)	S. Rogalski, J. Ovtcharova	3	5	W
2123356	E (P)	CATIA V5 CAD training course (p. 216)	J. Ovtcharova, M. Hajdukovic	3	2	W/S
2123355	E (P)	CAD-NX5 training course (p. 217)	J. Ovtcharova, M. Hajdukovic	3	2	W/S
2123380	E	CATIA advanced (p. 219)	J. Ovtcharova, M. Mrkonjic	2	2	S
2123357	E (P)	PLM-CAD workshop (p. 353)	J. Ovtcharova	4	4	W
2123370	E	Pro/ENGINEER advanced (p. 361)	J. Ovtcharova, M. Mrkonjic	2	2	W
2121350	K	Product Lifecycle Management (p. 362)	J. Ovtcharova	4	6	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 195)	J. Föllner	2	4	S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2149650	E	Electronic Business for industrial Companies (p. 242)	A. Weisbecker	2	4	W
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 294)	C. Kilger	2	4	S
2118083	E	IT for facility logistics (p. 301)	F. Thomas	4	6	S
2147160	E	Patents and Patent Strategies (p. 348)	F. Zacharias	2	4	W/S
2121366	K	PLM in the Manufacturing Industry (p. 352)	G. Meier	2	4	W
2122376	E	PLM for product development in mechatronics (p. 351)	M. Eigner			
2123364	E	Product, Process and Resource Integration in the Automotive Industry (p. 364)	S. Mbang	3	4	S
2110678	E (P)	Production Techniques Laboratory (p. 369)	K. Furmans, J. Ovtcharova, V. Schulze, G. Zülch, Research assistants of wbk, ifab und IFL	3	4	S
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W
2110036	E	Process Design and Industrial Engineering (p. 374)	S. Stowasser	2	4	S
2122387	K	Computer Integrated Planning of New Products (p. 381)	R. Kläger	2	4	S
2117062	E	Supply chain management (p. 404)	K. Aliche	4	6	W
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 429)	J. Ovtcharova, Jurica Katicic	3	4	W/S

**Conditions:** The course *Technische Informationssysteme* [2121001] is compulsory module and must be examined.

**Recommendations:** Attendance of the course Product Lifecycle Management [2121350] as elective module is recommended.

**Remarks:**

**SP 18: Information Technology**

ID	Cat	Course	Lecturer	h	CP	Term
2106004	K	Computational Intelligence I (p. 221)	G. Bretthauer, R. Mikut	2	4	S
2105015	K	Computational Intelligence II (p. 222)	G. Bretthauer, Mikut	2	4	W
2137309	K	Digital Control (p. 224)	M. Knoop	2	4	W
2137308	K	Machine Vision (p. 317)	C. Stiller, M. Lauer	4	8	W
2138326	K	Measurement II (p. 333)	C. Stiller	2	4	S
2106002	K	Computer Engineering (p. 407)	G. Bretthauer	3	4	S
2105012	E	Adaptive Control Systems (p. 186)	G. Bretthauer	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 195)	J. Föllner	2	4	S
2114092	E	BUS-Controls (p. 215)	M. Geimer	2	4	S
2106020	E	Computational Intelligence III (p. 223)	R. Mikut	2	4	S
2138340	E	Automotive Vision (p. 257)	C. Stiller, M. Lauer	2	4	S
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 294)	C. Kilger	2	4	S
2105022	E	Informationsverarbeitung in mechatronischen Systemen (p. 296)	M. Kaufmann	2	3	W
24102	E	Information Processing in Sensor Networks (p. 297)	U. Hanebeck, Hanebeck	3	4	W
2118083	E	IT for facility logistics (p. 301)	F. Thomas	4	6	S
2137304	E	Correlation Methods in Measurement and Control (p. 307)	F. Mesch	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 331)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2134137	E	Engine measurement techniques (p. 343)	S. Bernhardt	2	4	S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 356)	C. Stiller, P. Lenz	3	4	W
2150683	E	Control engineering (p. 401)	C. Gönnheimer	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 424)	C. Stiller, T. Dang	2	4	S

**Conditions:****Recommendations:****Remarks:**

**SP 24: Energy Converting Engines**

ID	Cat	Course	Lecturer	h	CP	Term
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 290)	M. Gabi	4	8	W
2169453	K	Thermal Turbomachines I (p. 415)	H. Bauer	3	6	W
2133101	K	Combustion Engines A with tutorial (p. 422)	U. Spicher	6	8	W
2158112	E	Low Temperature Technology (p. 189)	F. Haug	2	4	S
2134112	E	Supercharging of Combustion Engines (p. 201)	R. Golloch	2	4	S
22509	E	Design of combustion chamber in gas turbines (Project) (p. 204)	N. Zarzalis	2	4	S
2133109	E	Fuels and Lubricants for Combustion Engines and their Testing (p. 213)	J. Volz	2	4	W
2114093	E	Fluid Technology (p. 263)	M. Geimer	2/2	4	W
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 275)	E. Lox	2	4	S
2165515	E	Fundamentals of Combustion I (p. 278)	U. Maas	2	4	W
2166538	E	Fundamentals of combustion II (p. 279)	U. Maas	2	4	S
2158105	E	Hydraulic Fluid Machinery II (p. 291)	S. Caglar, M. Gabi	2	4	S
2157441	E	Computational Methods in Fluid Mechanics (p. 345)	F. Magagnato	2	4	W
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 359)	B. Pritz	2	4	W
2158107	E	Technical Acoustics (p. 406)	M. Gabi	2	4	S
2170476	E	Thermal Turbomachines II (p. 416)	H. Bauer	3	6	S
2169462	E	Turbine and compressor Design (p. 420)	H. Bauer, A. Schulz	2	4	W
2170478	E	Turbo Jet Engines (p. 421)	H. Bauer, A. Schulz	2	4	S
2134135	E	Combustion Engines B with Tutorial (p. 423)	U. Spicher	3	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S

**Conditions:****Recommendations:****Remarks:**

**SP 26: Materials Science and Engineering**

ID	Cat	Course	Lecturer	h	CP	Term
2173553	K	Material Science III (p. 433)	A. Wanner	5	8	W
2181740	E	Atomistic simulations and molecular dynamics (p. 198)	P. Gumbsch	2	4	S
2178643	E	Constitution and Properties of Wear resistant materials (p. 199)	S. Ulrich	2	4	S
2162255	E	Designing with composites (p. 226)	E. Schnack	2	4	S
2125755	E	Introduction to Ceramics (p. 233)	M. Hoffmann	2	4	W
2182734	E	Introduction to the Mechanics of Composite Materials (p. 235)	Y. Yang	2	4	S
2175588	E (P)	Metallographic Lab Class, Metallographic Lab Class, Ferrous Materials (p. 249)	K. Poser, A. Wanner	3	4	W/S
2175589	E (P)	Metallographic Lab Class, Non-Ferrous Materials (p. 250)	K. Poser, A. Wanner	3	4	W/S
2174575	E	Foundry Technology (p. 266)	C. Wilhelm	2	4	S
2193010	E	Grundlagen der Herstellungsverfahren der Keramik und Pulvermetallurgie (p. 274)	R. Oberacker	2	4	W
2174571	E	Design with Plastics (p. 304)	C. Bonten	2	4	S
2182642	E	Laser in automotive engineering (p. 312)	J. Schneider	2	4	S
2161983	E	Mechanics of laminated composites (p. 328)	E. Schnack	2	4	W
2173580	E	Mechanics and Strengths of Polymers (p. 329)	B. von Bernstorff (Graf), von Bernstorff	2	4	W
2183702	E	Modelling of Microstructures (p. 336)	B. Nestler	2	4	W
2183703	E	Modelling and Simulation (p. 340)	B. Nestler	2 + 1	4	W/S
2173590	E	Polymer Engineering I (p. 354)	P. Elsner	2	4	W
2183640	E (P)	Laboratory "Laser Materials Processing" (p. 355)	J. Schneider, W. Pflöging	3	4	W/S
2173562	E	Failure Analysis (p. 385)	K. Poser	2	4	W
2173565	E	Welding Technology I (p. 387)	B. Spies	1	2	W
2174570	E	Welding Technology II (p. 388)	B. Spies	1	2	S
2173585	E	Fatigue of Metallic Materials (p. 389)	K. Lang	2	4	W
2173577	E	Failure Analysis Seminar (p. 392)	K. Poser	2	2	W
2174579	E	Technology of steel components (p. 411)	V. Schulze	2	4	S
2181715	E	Failure of Structural Materials: Fatigue and Creep (p. 425)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 426)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2174586	E	Material Analysis (p. 430)	J. Gibmeier	2	4	S
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 431)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 432)	K. Weidenmann	2	4	S
2177601	E/P	Constitution and Properties of Protective Coatings (p. 200)	S. Ulrich	2	4	W
2181744	E/P	Size effects in micro and nanostructures materials (p. 270)	P. Gumbsch, D. Weygand, C. Eberl, P. Gruber, M. Dienwiebel	2	4	W
2162280	E/P	Mathematical Methods in Structural Mechanics (p. 327)	T. Böhlke	2	4	S
2162244	E/P	Plasticity Theory (p. 350)	T. Böhlke	2	4	S
2126749	E/P	Advanced powder metals (p. 377)	R. Oberacker	2	4	S
2126775	E/P	Structural and Functional Ceramics (p. 403)	M. Hoffmann	2	4	S

ID	Cat	Course	Lecturer	h	CP	Term
2182740	E/P	Materials modelling: dislocation based plasticity (p. 434)	D. Weygand	2	4	S
2193003	E	Festkörperreaktionen / Kinetik von Phasenumwandlungen, Korrosion mit Übungen (p. 260)	D. Cupid, P. Franke	3	4	W
2193002	E	Thermodynamische Grundlagen / Heterogene Gleichgewichte mit Übungen (p. 417)	H. Seifert	3	4	W

**Conditions:** Basic knowledge in materials science and engineering (Werkstoffkunde I/II)

**Recommendations:** suggested optional compulsory subject:

- 2174576 Systematic Materials Selection

**Remarks:**

**SP 31: Mechatronics**

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 186)	G. Bretthauer	2	4	W
2106004	K	Computational Intelligence I (p. 221)	G. Bretthauer, R. Mikut	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 237)	W. Seemann	3	5	S
2138340	K	Automotive Vision (p. 257)	C. Stiller, M. Lauer	2	4	S
2105024	K	Modern Concepts of Control (p. 341)	L. Gröll, Groell	2	4	W
2138336	K	Behaviour Generation for Vehicles (p. 424)	C. Stiller, T. Dang	2	4	S
2106005	E	Automation Systems (p. 208)	M. Kaufmann	2	4	S
2114092	E	BUS-Controls (p. 215)	M. Geimer	2	4	S
2147175	E (P)	CAE-Workshop (p. 218)	A. Albers, Assistenten	3	3	W/S
2105015	E	Computational Intelligence II (p. 222)	G. Bretthauer, Mikut	2	4	W
2106020	E	Computational Intelligence III (p. 223)	R. Mikut	2	4	S
2137309	E	Digital Control (p. 224)	M. Knoop	2	4	W
2106031	E	Experimental Modelling (p. 248)	L. Gröll	2	3	S
23144	E	Informationstechnik in der industriellen Automation (p. 295)	P. Bort, Bort	2	3	S
2118083	E	IT for facility logistics (p. 301)	F. Thomas	4	6	S
2149670	E (P)	Micro manufacturing laboratory (p. 309)	V. Schulze, C. Ruhs	5	4	W
2161224	E	Machine Dynamics (p. 320)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 321)	C. Proppe	2	4	S
2181710	E	Mechanics in Microtechnology (p. 330)	C. Eberl, P. Gruber	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 331)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
24659	E	Mensch-Maschine-Interaktion (p. 332)	Burghart	2	3	S
2138326	E	Measurement II (p. 333)	C. Stiller	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 335)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 344)	M. Kohl, M. Sommer	2	4	W
2147160	E	Patents and Patent Strategies (p. 348)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W
23109	E	Signals and Systems (p. 394)	F. Puente	2	3	W
2185264	E	Simulation in product development process (p. 396)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 399)	C. Proppe	2	4	W
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 429)	J. Ovtcharova, Jurica Katicic	3	4	W/S
23321	E	Hybrid Engines and Electrical Vehicals (p. 289)	M. Doppelbauer	2+1	4	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
24152	E	Robotics I – Introduction to robotics (p. 384)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W

**Conditions:****Recommendations:****Remarks:**

**SP 38: Production Systems**

ID	Cat	Course	Lecturer	h	CP	Term
2149657	K	Manufacturing Technology (p. 259)	V. Schulze	6	8	W
2149902	K	Machine Tools and Industrial Handling (p. 435)	J. Fleischer	4	8	W
2150660	K	Integrated production planning (p. 299)	G. Lanza	6	8	S
2109026	K	Work Science (p. 196)	G. Zülch	4	6	W
2149610	K	Global Production and Logistics - Part 1: Global Production (p. 267)	G. Lanza	2	4	W
2149600	K	Global Production and Logistics - Part 2: Global Logistics (p. 268)	K. Furmans	2	4	S
2117051	K	Material flow in logistic systems (p. 322)	K. Furmans	3	6	W
2149605	K	Simulation of production systems and processes (p. 397)	K. Furmans, V. Schulze, G. Zülch	3	5	W
2149650	E	Electronic Business for industrial Companies (p. 242)	A. Weisbecker	2	4	W
2118085	E	Automotive Logistics (p. 316)	K. Furmans	2	4	S
2121350	E	Product Lifecycle Management (p. 362)	J. Ovtcharova	4	6	W
2149667	E	Quality Management (p. 378)	G. Lanza	2	4	W
2150683	E	Control engineering (p. 401)	C. Gönnheimer	2	4	S
2121001	E	Integrated Information Systems for engineers (p. 408)	S. Rogalski, J. Ovtcharova	3	5	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2149903	E	Development Project for Machine Tools and Industrial Handling (p. 247)	J. Fleischer	2	4	W

**Conditions:****Recommendations:****Remarks:**



**SP 44: Technical Logistics**

ID	Cat	Course	Lecturer	h	CP	Term
2117095	KP	Basics of Technical Logistics (p. 277)	M. Mittwollen, Madzharov	4	6	W
2117096	K	Elements of Technical Logistics (p. 244)	M. Mittwollen, Madzharov	4	6	W
2118087	K	Selected Applications of Technical Logistics (p. 202)	M. Mittwollen, Madzharov	3	4	S
2118088	K	Selected Applications of Technical Logistics and Project (p. 203)	M. Mittwollen, Madzharov	4	6	S
2117064	E	Application of technical logistics in modern crane systems (p. 194)	M. Golder	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 195)	J. Föller	2	4	S
2117500	E	Energy efficient intralogistic systems (p. 245)	F. Schönung	2	4	W
2138341	E	Cognitive Automobiles - Laboratory (p. 303)	C. Stiller, M. Lauer, B. Kitt	2	3	S
2118097	E	Warehousing and distribution systems (p. 310)	K. Furmans, C. Huber	2	4	S
2117051	E	Material flow in logistic systems (p. 322)	K. Furmans	3	6	W
2149667	E	Quality Management (p. 378)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 393)	H. Kany	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 424)	C. Stiller, T. Dang	2	4	S
2118083	E/P	IT for facility logistics (p. 301)	F. Thomas	4	6	S
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S

**Conditions:** none**Recommendations:** Recommended compulsory optional subjects:

- Mathematical Methods in Dynamics
- Simulation of production systems and processes
- Stochastics in Mechanical Engineering
- Modelling and Simulation
- Technical Logistics I

**Remarks:**

**SP 48: Internal Combustion Engines**

ID	Cat	Course	Lecturer	h	CP	Term
2133101	KP	Combustion Engines A with tutorial (p. 422)	U. Spicher	6	8	W
2134135	K	Combustion Engines B with Tutorial (p. 423)	U. Spicher	3	4	S
2134138	K	Fundamentals of catalytic exhaust gas aftertreatment (p. 275)	E. Lox	2	4	S
2134134	K	Analysis tools for combustion diagnostics (p. 334)	U. Wagner	2	4	S
2134137	K	Engine measurement techniques (p. 343)	S. Bernhardt	2	4	S
2133109	E	Fuels and Lubricants for Combustion Engines and their Testing (p. 213)	J. Volz	2	4	W
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 398)	C. Baumgarten	2	4	W
2134141	E	Gas Engines (p. 264)	R. Golloch	2	4	S
2134150	E	Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines (p. 184)	M. Gohl			S
2134139	E	Model based Application Methods (p. 339)	F. Kirschbaum			S
2134001	E	Engine Laboratory (p. 342)	U. Spicher	2	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2166538	E	Fundamentals of combustion II (p. 279)	U. Maas	2	4	S
2113805	E	Automotive Engineering I (p. 272)	F. Gauterin, H. Unrau	4	8	W
2114835	E	Automotive Engineering II (p. 273)	F. Gauterin, H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 254)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 255)	F. Gauterin	2	4	S
2158107	E	Technical Acoustics (p. 406)	M. Gabi	2	4	S
2161224	E	Machine Dynamics (p. 320)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 321)	C. Proppe	2	4	S
2181113	E	Tribology A (p. 418)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 419)	M. Scherge, M. Dienwiebel	2	4	S
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2146192	E	Sustainable Product Engineering (p. 405)	K. Ziegahn	2	4	S
2147160	E	Patents and Patent Strategies (p. 348)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 373)	P. Gutzmer	2	4	W

**Conditions:****Recommendations:****Remarks:**

**SP 50: Rail System Technology**

ID	Cat	Course	Lecturer	h	CP	Term
2115919	KP	Rail System Technology (p. 210)	P. Gratzfeld	2	4	W/S
2115996	KP	Rail Vehicle Technology (p. 386)	P. Gratzfeld	2	4	W/S
2115995	E	Project Management in Rail Industry (p. 372)	P. Gratzfeld	2	4	W
2114916	E	Intermodalität und grenzüberschreitender Schienenverkehr (p. 300)	P. Gratzfeld, R. Grube	2	4	S
2115915	E	Mobility Concepts of Rail Transportation in 2030 (p. 338)	P. Gratzfeld	2	4	W/S
2114346	E	Electric Rail Vehicles (p. 243)	P. Gratzfeld	2	4	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 231)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 258)	F. Henning	2	4	S
2105011	E	Introduction into Mechatronics (p. 236)	G. Bretthauer, A. Albers	3	6	W
19306	E	Basics Operation Systems of Ground Born Guided Systems (p. 240)	E. Hohnecker, P. Gratzfeld, Hohnecker	2	4	W
19321	E	Operation Systems of Ground Born Guided Systems (p. 241)	E. Hohnecker, P. Gratzfeld, Hohnecker	2	4	S
19066	E	Basics of Ground Born Guided Systems (p. 280)	E. Hohnecker, P. Gratzfeld, Hohnecker	3	4	S
2138340	E	Automotive Vision (p. 257)	C. Stiller, M. Lauer	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 380)	C. Proppe	2	4	S
2161217	E (P)	Mechatronic Softwaretools (p. 399)	C. Proppe	2	4	W

**Conditions:** The lectures “Rail System Technology” and “Rail Vehicle Technology” are mandatory. They can be attended in the same term.

**Recommendations:** none

**Remarks:**

**SP 52: Production Management**

ID	Cat	Course	Lecturer	h	CP	Term
2109041	KP	Introduction to Industrial Engineering (p. 229)	G. Zülch	2	4	S
2118092	KP	Selected Topics in Manufacturing Technologies (p. 391)	V. Schulze	2	4	S
2150653	E	Basics in Material Handling and Logistics Systems (p. 211)	K. Furmans	2	4	S

**Conditions:****Recommendations:****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. 181)[SP\_48\_mach]

ECTS Credits	Hours per week	Term	Instruction language
		Summer term	de

#### Learning Control / Examinations

##### Conditions

None.

#### Learning Outcomes

##### Content

**Course: Adaptive Finite Element Methods [1606]****Coordinators:** Dörfler**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. [171](#))[SP\_13\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Adaptive Control Systems [2105012]****Coordinators:** G. Bretthauer**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 31: Mechatronics (p. 178)[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

Auxiliary 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, identification 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:** K. Furmans**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. 163)[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 compulsory optional subject:

- Stochastics in Mechanical Engineering

recommended lecture:

- Material flow in logistic systems (also parallel)

**Learning Outcomes**

The student:

- has basis knowledge necessary to understand analytical solvable stochastic models of material flow systems,
- Based on easy models of queueing theory the student is able to model material flow networks and knows how control methods like Kanban can be implemented,
- executes practical computer experiments and
- uses simulation and exact 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 queueing 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: Applied Fluid Mechanics [2154434]****Coordinators:** T. Schenkel**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. 163)[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.

**Learning Outcomes**

The lecture supplements the fundamentals of fluid mechanics as taught in the fundamental lecture 'Fluid Mechanics'. The student enhances his understanding of fluid mechanical phenomena. The lecture is therefore the basis for a focus on fluid mechanics.

**Content**

- Introduction
- Aerodynamics
- Fundamentals of Aerodynamics
- Prandtl's Theory of Airfoils
- Boundary Layers
- Transsonic Airfoils
- Flows with Heat Transfer
- Fundamentals of Heat Transfer
- Konvection on a heated plate
- Rayleigh Benard Konvection
- Pipe Flow

Content will vary.

Not all content will be taught in every semester!

**Literature**

Oertel, H., Böhle, M.: Strömungsmechanik, Vieweg-Verlag, 2006

Schlichting, H., Gersten, K.: Grenzschichttheorie, Springer-Verlag, 2006

Oertel, H. (Hrsg.): Prandtl-Führer durch die Strömungslehre, Vieweg-Verlag 2002

Oertel, H. (Hrsg.): Prandtl's Essentials for Fluid Mechanics, Springer-Verlag 2004

**Course: Low Temperature Technology [2158112]****Coordinators:** F. Haug**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[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 indispensable 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. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

### Learning Control / Examinations

#### Conditions

compulsory preconditions: none

### Learning Outcomes

#### Content

**Course: Drive Train of Mobile Machines [2113077]****Coordinators:** M. Geimer**Part of the modules:** SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2/1	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.

**Content**

In this course will be discussed the different drive train of mobile machinery. The focus of this course is:

- improve the fundamentals
- mechanical gears
- torque converter
- hydrostatic drives
- continuous variable transmission
- electrical drives
- axial
- terra mechanic

**Media**

presentation

**Literature**

scriptum for the lecture downloadable

**Course: Powertrain Systems Technology A: Automotive Systems [2146180]****Coordinators:** A. Albers, S. Ott**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

compulsory preconditions: none

**Recommendations**

Power Train Systems Technology B: Stationary Machinery

**Learning Outcomes**

The student should know 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**

1. Kirchner, E.; "Leistungsübertragung in Fahrzeuggetrieben: Grundlagen der Auslegung, Entwicklung und Validierung von Fahrzeuggetrieben und deren Komponenten", Springer Verlag Berlin Heidelberg 2007
2. 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. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

Compulsory preconditions: none

**Recommendations**

Powertrain Systems Technology A: Automotive Systems

**Learning Outcomes**

The student should know 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**

1. VDI-2241: "Schaltare fremdbetätigte Reibkupplungen und -bremsen", VDI Verlag GmbH, Düsseldorf
2. 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. 167)[SP\_10\_mach], SP 44: Technical Logistics (p. 180)[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**

The student:

- knows the proceeding during the dimensioning of a modern crane installation,
- is able to transfer the approche for the dimensioning of other material handling systems.

**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. Föllner

**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 17: Information Management (p. 173)[SP\_17\_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

The course provides basics of sorting techniques.

### 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: Work Science [2109026]****Coordinators:** G. Zülch**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations****Specialisation “Produktionstechnik”:**

Written exam, length: 90 minutes

(only in German)

Allowed resource materials: non-programmable calculator

**Other specialisations:**

Oral exam, length: 30 minutes

(only in German)

Allowed resource materials: none

**Conditions**

- The exams “Arbeitswissenschaft (2109026)” and “Ergonomie und Arbeitswirtschaft (2109029)” are mutually exclusive.
- The exams “Arbeitswissenschaft (2109026)” and “Arbeitsschutz und Arbeitsrecht (2109024)” are mutually exclusive.

**Recommendations**

- Willingness to learn interdisciplinarily (Product design, Legal regulations Work physiology, Work psychology ...)
- Basic knowledge of Production Management is useful

**Learning Outcomes**

- Become proficient within the general terms of ergonomics, methods study and personnel planning
- Know elementary methods and procedures of applied work science
- Know relevant labour law and regulations
- Become proficient in applying ergonomic evaluation and judgement

**Content**

1. Introduction
2. Basics of human performance
3. Design of workplaces
4. Time study
5. Evaluation of workplaces and determination of wages
6. Work structuring
7. Personnel planning
8. Leadership

9. Labour legislation

10. Representation of interest groups

### Literature

#### Learning material:

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

#### Literature:

- BULLINGER, Hans-Jörg: Ergonomie. Stuttgart: B. G. Teubner 1994.
- REFA - Verband für Arbeitsstudien, Betriebsorganisation und Unternehmensentwicklung (Hrsg.): Datenermittlung. München: Carl Hanser Verlag, 1997. (Methodenlehre der Betriebsorganisation)
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Anforderungsermittlung (Arbeitsbewertung). München: Carl Hanser Verlag, 2. Auflage 1991. (Methodenlehre der Betriebsorganisation)
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Grundlagen der Arbeitsgestaltung. München: Carl Hanser Verlag, 1991. (Methodenlehre der Betriebsorganisation)
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Entgeltdifferenzierung. München: Carl Hanser Verlag, 1991. (Methodenlehre der Betriebsorganisation)
- SCHLICK, Christopher; BRUDER, Ralph; LUCZAK, Holger: Arbeitswissenschaft. Heidelberg u.a.: Springer, 3rd edition 2010.
- SCHMIDTKE, Heinz (Hrsg.): Ergonomie. München, Wien: Carl Hanser Verlag, 3. Auflage 1998.

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. 176)[SP\_26\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_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

**Learning Outcomes**

The student learns the physical foundation of particle base simulation methods (e.g. molecular dynamics) and its application to problems in material 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) wie alle guten MD Bücher stark aus dem Bereich der physikalischen Chemie motiviert und auch aus diesem Bereich mit Anwendungsbeispielen gefüllt, trotzdem für mich das beste Buch zum Thema!

[2] Computer simulation of liquids, M. P. Allen and Dominic J. Tildesley (Clarendon Press, Oxford, 1996) Immer noch der Klassiker zu klassischen MD Anwendungen. Weniger stark im Bereich der Nichtgleichgewichts-MD.

**Course: Constitution and Properties of Wear resistant materials [2178643]****Coordinators:** S. Ulrich**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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. 176)[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: Supercharging of Combustion Engines [2134112]****Coordinators:** R. Golloch**Part of the modules:** SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach]

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

**Learning Control / Examinations**

1. part: written, ca. 45 min.

2. part: oral group examination, ca. 45 min.

**Conditions**

none

**Recommendations**

Combustion Engines A helpful

**Learning Outcomes**

The students get to know the increasing field of supercharging fourstroke gasoline, Diesel and gas engines as a measure to increase power and decrease emissions and fuel consumption. After describing the fundamentals of supercharging including intercooling the most common superchargers and their field of application is shown. Another focus are different supercharging methods whereas new and complex methods such as controlled two-stage supercharging are covered. Furthermore the difference in the combustion process of naturally aspirated and supercharged engines is described.

**Content**

Fundamentals of supercharging

Supercharger

Combination of engine and supercharger

Mechanical supercharging

Turbocharger

Complex supercharging methods

Special fields of supercharged engines

**Literature**

Lecture notes available in the lectures

**Course: Selected Applications of Technical Logistics [2118087]****Coordinators:** M. Mittwollen, Madzharov**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_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) =&gt; (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**

Based on the knowledge from GTL/ESTL to be able to work on specific tasks of conveyor machines (e.g. crane, s/r machines, fork lifts, elevators).

practice calculation on applying knowledge from lessons

Guest lectures give an idea of industrial solutions.

**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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_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) =&gt; (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**

The student

- is able to work on specific tasks of conveyor machines, based on the knowledge from GTL/ESTL (e.g. crane, s/r machines, fork lifts, elevators),
- practices calculation on applying knowledge from lessons
- reports on a project topic

**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: Design of combustion chamber in gas turbines (Project) [22509]****Coordinators:** N. Zarzalis**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[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 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_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 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 know 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 know 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. 167)[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 being thought. This includes among others:

- Defining the size and dimensions,
- the dimensioning of the drive train,
- Determining the kinematics of the equipment,
- the dimension of the working hydraulics and
- Calculations of strength

The entire design process of these machines is strongly influenced by the use of standards and guidelines (ISO/DIN-EN). Even this aspect is dealt with.

The lecture is based on the knowledge from the fields of mechanics, strength of materials, machine elements, propulsion and fluid technique. The lecture requires active participation and continued collaboration.

**Literature**

None.

**Course: Automated Production Line [2150904]****Coordinators:** J. Fleischer**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Automation Systems [2106005]****Coordinators:** M. Kaufmann**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Automobile and Environment [2186126]****Coordinators:** H. Kubach, U. Spicher, U. Maas, H. Wirbser**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach]

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

**Learning Control / Examinations**

Presentation with written documentation

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

Thermodynamics:

The student shall understand the fundamental principles of combustion processes in engines including pollutant formation

Combustion Engines:

The student shall understand the fundamental principle modes of operation of combustion engines. Especially emission formation, fuel consumption and impact on the environment are discussed.

**Content**

Principles of combustion processes, chemical reaction, reaction mechanisms, NO-formation, NO-reduction, soot formation, unburnt hydrocarbons, flame extinction, combustion in Otto-engines (ignition, flame propagation, engine knock), combustion in Diesel engines (spray formation, spray combustion)

**Literature**

J. Warnatz, U. Maas, R. W. Dibble: Combustion, Springer

**Course: Rail System Technology [2115919]****Coordinators:** P. Gratzfeld**Part of the modules:** SP 50: Rail System Technology (p. 182)[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**

- Overview about fundamental components of a modern rail system (vehicles, infrastructure, operation)
- History and economic impact of rail systems
- Vehicle dynamics
- Wheel-rail-contact
- Train protection
- Traction power supply
- Vehicles

**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:** K. Furmans**Part of the modules:** SP 52: Production Management (p. 183)[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**

The student:

- understands basic material flow processes,
- is able to model material flow systems in simple models,
- knows how to determine essential performance indicators like throughput, utilization, etc.
- has the basis knowledge necessary to understand logistic systems,
- knows algorithms and is able to apply them to basic logistic problems.

**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: Fuels and Lubricants for Combustion Engines and their Testing [2133109]****Coordinators:** J. Volz**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 24: Energy Converting Engines (p. 175)[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 get basic knowledge about composition and meaning of fuels, lubricants and coolants as important components in the system of today's Otto and Diesel engines. Content of this lecture are definition and chemical composition of fuels and lubricants, the meaning of crude oil as basic primary product, production processes, major properties, standards and specifications, testing methods. Furthermore future worldwide trends in the field of conventional and alternative fuels are discussed 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: Boundary and Eigenvalue Problems [1246]****Coordinators:** M. Plum, W. Reichel, Plum, Reichel**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. [171](#))[SP\_13\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: BUS-Controls [2114092]****Coordinators:** M. Geimer**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[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 V5 CAD training course [2123356]****Coordinators:** J. Ovtcharova, M. Hajdukovic**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 17: Information Management (p. 173)[SP\_17\_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	3	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, to generate drawings due to the created geometry and then carry out FE-studies and kinematic simulations using the integrated CAE tools. With advanced, knowledge-based functionalities of CATIA the participants will learn 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 V5 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-NX5 training course [2123355]****Coordinators:** J. Ovtcharova, M. Hajdukovic**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 17: Information Management (p. 173)[SP\_17\_mach]

ECTS Credits	Hours per week	Term	Instruction language
2	3	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, to generate drawings due to the created geometry and then carry out FE-studies and kinematic simulations using the integrated CAE tools. With advanced, knowledge-based functionalities of NX5 the participants will learn 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 UG NX5
- 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 UG NX5

**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 17: Information Management (p. 173)[SP\_17\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	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**

In the CAE - Workshops computer-aided tools used in the industrial product development process will be presented and trained. The complete process chain is shown using concrete examples of typical mechanical components. The possibilities and limits of virtual product development will be shown during this course. Here, the students get practical insight into the world of multi-body systems, the finite element method and optimization research questions.

The students receive the theoretical basics and are trained on modern hardware in the use of commercial software. In order to support the students to discuss the calculation and optimization results, the participants of the workshop must discuss their results in small groups and finally present it to all students.

**Content**

Content in the summer 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 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 hybrid multi-body simulation problems.

**Literature**

The workshop script will be allocated at Ilias.

**Course: CATIA advanced [2123380]****Coordinators:** J. Ovtcharova, M. Mrkonjic**Part of the modules:** SP 17: Information Management (p. 173)[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 V5 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. 172)[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

- Application of Open Foam modules
- Grid generation
- Proper definition of boundary conditions
- Numerical errors

### Content

- Introduction to using Open Foam
- Grid generation
- 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.openfoam.com/docs](http://www.openfoam.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 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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

Auxiliary 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**

Kienzl, 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 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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

Auxiliary 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 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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

Auxiliary 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. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[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 introduces key methods for the analysis and design of digital feedback control systems. Starting point is the discretisation of linear, continuous-time models. State space based and z-transform based controller design techniques are presented for discrete-time, single-input single-output systems. Furthermore, plants with dead-time and deadbeat design are covered.

**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. 165)[SP\_07\_mach],  
SP 10: Engineering Design (p. 167)[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. Non-linear 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. 171)[SP\_13\_mach], SP 26: Materials Science and Engineering (p. 176)[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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Summer 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 physical-mathematical description and addresses common solution strategies. By several example problems typical 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: Dynamik vom Kfz-Antriebsstrang [2163111]****Coordinators:** A. Fidlin**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	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 [2109041]****Coordinators:** G. Zülch**Part of the modules:** SP 52: Production Management (p. 183)[SP\_52\_mach]

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**

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**

- Knowledge about organisational structures of production enterprises
- Insights into order processing
- Initial knowledge about planning processes

**Content**

1. Introduction to the course
2. Objectives and process models
3. Market analysis, product design, and production programme
4. Analysis of processes
5. Production planning and control
6. Planning of resources
7. Quality management
8. Product utilisation and recycling
9. Principles of project management
10. Management systems

**Literature****Learning material:**

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

**Literature:**

- KRAJEWSKI, Lee J.; RITZMAN, Larry P.: Operations Management: Strategy and Analysis. London: Prentice Hall, 4th ed. 2003.
- VOLLMANN, Thomas E.; BERRY, William L.; WHYBARK, D. Clay; JACOBS, F. Robert: Manufacturing Planning and Control Systems. New York NY: et al. McGraw-Hill, 5th ed. 2005.
- NAHMIAS, Steven: Production and Operations Analysis. New York NY: McGraw-Hill/Irwin, 4th ed. 2001.
- HOPP, Wallace J.; SPEARMAN, Mark L.: Factory Physics. New York NY: McGraw-Hill, 2nd ed. 2000.

Please refer to the latest edition.

**Course: Introduction to Automotive Lightweight Technology [2113101]****Coordinators:** F. Henning**Part of the modules:** SP 50: Rail System Technology (p. 182)[SP\_50\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

verbally

duration: 30 - 60 min

auxiliary means: none

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

Introduction to automotive lightweight design. Becoming acquainted with established strategies and construction methods as well as materials for automotive lightweight design.

**Content**

Strategies for lightweight design, construction methods, metallic materials for lightweight design, introduction to polymers

**Course: Introduction to the Finite Element Method [2162282]****Coordinators:** T. Böhlke**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach]

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

**Learning Control / Examinations**

depending on choice according to actual version of study regulations  
 Additives as announced

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students can effectively apply the finite element method (FEM) for structural and temperature analysis. They know the mathematical and mechanical foundations of FEM. The students can set up the weak formulation of boundary value problems and the linear system of the FEM as well. They know different numerical solution methods for linear systems. The students are thus well prepared for a job in construction or computing divisions.

**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 (\*enthält eine Einführung in ABAQUS\*)

**Course: Introduction to Ceramics [2125755]****Coordinators:** M. Hoffmann**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach]

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

**Learning Control / Examinations**

oral

20 min

Auxiliary means:none

**Conditions**

None.

**Learning Outcomes**

The lecture gives an overview of the relationship among processing, microstructure and properties of ceramics. Important processing routes and characterization methods will be discussed on various examples.

**Content**

Atomic bonding in solids

Crystal structures and structural imperfections

Surfaces, interfaces and grain boundaries

Binary and ternary phase diagrams

Structure of glass

Characterization and processing of ceramic powders

Shaping methods (pressing, slip casting, injection molding)

Densification and grain growth (sintering)

Introduction to fracture mechanics, strength and failure probability of brittle materials

Materials behavior at high temperatures

Toughening mechanisms

Methods for microstructural characterization

**Literature**

H. Salmang, H. Scholze, Keramik, Teil I: Allgemeine Grundlagen und wichtige Eigenschaften, Teil II: Keramische Werkstoffe, Springer Verlag, Berlin, (1982).

W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, John Wiley & Sons, New York, (1976).

D. Munz, T. Fett, Mechanisches Verhalten keramischer Werkstoffe, Springer Verlag, (1989).

**Course: Introduction to Theory of Materials [2182732]****Coordinators:** M. Kamlah**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[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**

Classes of constitutive material behaviour and its mathematical representation

**Content**

Following a brief introduction into continuum mechanics at small deformations, the classification into elastic, viscoelastic, plastic and viscoplastic material behaviour is discussed. Then, the corresponding constitutive models are motivated and mathematically formulated. As far as possible, their properties are demonstrated by means of elementary analytical solutions.

In the lab, the behavior of the discussed constitutive material laws are investigated for simple geometries and loading situations with the finite element program ABAQUS.

**Literature**

[1] Peter Haupt: Continuum Mechanics and Theory of Materials, Springer

[2] ABAQUS Manual

## Course: Introduction to the Mechanics of Composite Materials [2182734]

**Coordinators:** Y. Yang

**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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 could analyze the stresses und strength of a structure with composite materials. Using the advantages of composite materials, the students could make optimization and design in a light structure.

### 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. 182)[SP\_50\_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**

Compulsory preconditions: none

**Learning Outcomes**

Mechatronics is an interdisciplinary field, based on classical mechanical and electrical engineering as well as automation science and technology and computer science. The main activities focus on integral system development with technical components connected via an intelligent control system. In this regard simulation of mechanical and electrical systems becomes important for rapid and efficient development. First part of the lecture provides a survey of mechatronics. Subsequently the architecture of mechatronic systems is described. Furthermore fundamentals of modeling of mechanical, pneumatic, hydraulic, electrical and electronic components are discussed. Finally optimization methods, e. g. adaptive controllers, are presented. In the second part of the lecture basics of development methods as well as the characteristics of the development of mechatronic products are described. A further important item is the presentation of the system concept of mechatronics in comparison to conventional mechanical systems. The contents of the course are explained using examples for mechatronic products in the area of automotive engineering.

**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. 163)[SP\_05\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 02: Powertrain Systems (p. 162)[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**

Mechanisms, vehicles and industrial robots are examples of multibody systems. For dynamics simulations expressions for kinematical quantities and formulations of equations of motion are required which make it easy to switch from one system to another. Efficient methods are described.

The course is mainly divided in two parts: kinematics on the one hand and different possibilities to derive the equations of motion on the other hand.

**Content**

The role of multibody systems in engineering, kinematics of a single rigid body, Kinematics of multibody systems, rotation matrix, angular velocity, derivatives in different reference systems, holonomic and non-holonomic constraints, Newton-Euler's equations, principle of d'Alembert, principle of virtual power, Lagrange's equations, Kane's equations, structure of the equations of motion

**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: Nonlinear vibrations [2162247]****Coordinators:** A. Fidlin**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	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 Engineering. 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: Basics Operation Systems of Ground Born Guided Systems [19306]

**Coordinators:** E. Hohnecker, P. Gratzfeld, Hohnecker

**Part of the modules:** SP 50: Rail System Technology (p. 182)[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 have a fundamental knowledge about logistics and operation in railway systems.

### Content

- Operating basics
- Train control
- Capacity and operation quality of lines and stations

### Media

All slides can be bought.

### Literature

1. Fiedler: Grundlagen der Bahntechnik, Werner Verlag Düsseldorf
2. Pacht: Systemtechnik des Schienenverkehrs; Teubner-Verlag Stuttgart

## Course: Operation Systems of Ground Born Guided Systems [19321]

**Coordinators:** E. Hohnecker, P. Gratzfeld, Hohnecker

**Part of the modules:** SP 50: Rail System Technology (p. 182)[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 have a deepened knowledge about national and international operating and signalling systems.

### Content

- National and international operating systems
- National and international signalling systems
- Driverless operation
- Safety case of new operating systems

### Media

All slides can be bought.

### Literature

Pachl: Systemtechnik des Schienenverkehrs; Teubner-Verlag Stuttgart

**Course: Electronic Business for industrial Companies [2149650]****Coordinators:** A. Weisbecker**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

oral exam, 30 min

**Conditions**

None.

**Learning Outcomes****Content**

This lecture leads to the technical bases and a general survey for applications of electronic business in industrial enterprises.

Students get acquainted with the technical bases of electronic business and will be able to develop new applications in practice. Furthermore they will learn the ability to evaluate the benefit of new applications of information technologies referring electronic business in industrial enterprises.

1. Electronic Business
2. Product Information Management (PIM)
3. Portals for Business Clients and Employees
4. Supply Chain Management (SCM)
5. Customer Relationship Management (CRM)
6. Mobile Computing
7. Production Networks
8. E-Collaboration / E-Engineering
9. Service Engineering
10. Teleservice

**Course: Electric Rail Vehicles [2114346]****Coordinators:** P. Gratzfeld**Part of the modules:** SP 50: Rail System Technology (p. 182)[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 the modern locomotives with three-phase induction motors.
- They know the basics of railway transportation and vehicle dynamics
- They understand 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 new developments in the field of electric railway vehicles.

**Content**

- History of electric traction with railway vehicles
- Basics of railway transportation
- Transmission of tractive effort to the rails
- Electric traction drives and line interferences
- Traction power supply
- Modern developments of electric traction

**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 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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) =&gt; (look at "Studienplan Maschinenbau", latest version)

**Conditions**

None.

**Learning Outcomes**

The student:

- knows about elements and systems of technical logistics
- knows about structures and function of special conveying machines
- knows about material flow systems
- and is able to equip material flow systems with applicable 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: Energy efficient intralogistic systems [2117500]****Coordinators:** F. Schönung**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_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**

The student has basics for the analysis and the design of energy and resource efficient intralogistic systems for production and distribution.

**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 II: Nuclear Power Technology [2130921]****Coordinators:** D. Cacuci, F. Badea**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. [172](#))[SP\_15\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Development Project for Machine Tools and Industrial Handling [2149903]****Coordinators:** J. Fleischer**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

Performance is assessed in the form of one oral examination (30 min) during the lecture-free period. The examination will take place once every semester and can be retaken at every official examination date.

**Conditions**

Can only be taken with the lecture machine tools and industrial handling.  
Only five students are able to take part.

**Learning Outcomes**

The student

- has knowledge about the application of machine tools.
- comprehends the assembly and the operation purpose of the major components of a machine tool.
- is able to apply methods of selection and assessment of production machines to new tasks.
- is able to assess the dimensioning of a machine tool.

**Content**

As part of this lecture, a development project in the field of machine tools and handling equipment is carried out by students under supervision. It covers current problems of an involved industrial partner..

**Course: Experimental Modelling [2106031]****Coordinators:** L. Gröll**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Metallographic Lab Class, Metallographic Lab Class, Ferrous Materials [2175588]****Coordinators:** K. Poser, A. Wanner**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[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 access to metallography and its working methods as well as insights into the possibilities, correlations and results of light-microscopic testing of metallic materials at an elementary basis. They learn in several experiments about the correlations between structure and mechanical properties by using light-microscopic evaluation, the preparation of samples and microstructural development.

**Content**

Light microscope in metallography

metallographic sections of metallic materials

Investigation of the microstructure of unalloyed steels and cast iron

Structure development of steels with accelerated cooling from the austenite area

Investigation of structures of alloyed steels

Investigation of failures Qualitative structural analysis

Structural testing of copper-based alloys

Structural testing of technically relevant non-ferrous metals  
(aluminium-based, nickel-based, titanium-based 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: Metallographic Lab Class, Non-Ferrous Materials [2175589]****Coordinators:** K. Poser, A. Wanner**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[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 access to metallography and its working methods as well as insights into the possibilities, correlations and results of light-microscopic testing of metallic materials at an elementary basis. They learn in several experiments about the correlations between structure and mechanical properties by using light-microscopic evaluation, the preparation of samples and microstructural development.

**Content**

Light microscope in metallography

metallographic sections of metallic materials

Investigation of the microstructure of unalloyed steels and cast iron

Structure development of steels with accelerated cooling from the austenite area

Investigation of structures of alloyed steels

Investigation of failures Qualitative structural analysis

Structural testing of copper-based alloys

Structural testing of technically relevant non-ferrous metals  
(aluminium-based, nickel-based, titanium-based 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:** V. Schulze**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[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**

certificate of attendance for Welding technique I

**Learning Outcomes**

During the lab class a survey of current welding processes and their suitability for joining different materials is given. An important goal of the lab class is to understand and to evaluate the advantages and disadvantages of the individual procedures.

**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



**Course: Handling Characteristics of Motor Vehicles I [2113807]****Coordinators:** H. Unrau**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_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.

**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. Heiing, B.; Ersoy, M.: Fahrwerkhandbuch, Vieweg Verlag 2007
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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 12: Automotive Technology (p. 169)[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: 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.

**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. Heiing, B.; Ersoy, M.: Fahrwerkhandbuch, Vieweg Verlag 2007

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. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 09: Dynamic Machine Models (p. 166)[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 are noise and vibration, 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.

**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 chassis 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. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 09: Dynamic Machine Models (p. 166)[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.

**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. 169)[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 systematic analysis, conception, and design of mechatronic systems, focussing on mechatronically extended suspension 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 stabilizer bars
  - Vehicle dynamics controls, driver assistance 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. 182)[SP\_50\_mach], SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 31: Mechatronics (p. 178)[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**

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 'Being 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. 182)[SP\_50\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

verbally

duration: 30 - 60 min

auxiliary means: none

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

Becoming acquainted with composite materials and their application in automotive lightweight design.

**Content**

Textile reinforcements; processing, finishing and joining of composites; design guidelines; test methods and repair; recycling

**Course: Manufacturing Technology [2149657]****Coordinators:** V. Schulze**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

Performance is assessed in the form of one written examination (180 min) during the lecture-free period. The examination will take place once every semester and can be retaken at every official examination date.

**Conditions**

None.

**Learning Outcomes**

The student

- is able to name the different manufacturing methods and to explain their functions
- is able to classify the manufacturing methods by their general structure and functionality according to specific main groups
- is able to perform a process selection based on the methods he/she has learned about and their characteristics
- is able to identify the correlation between different methods
- is able to evaluate the different methods against specific applications on the basis of technical and economical aspects

**Content**

The objective of the lecture is to look at manufacturing engineering within the wider context of production engineering, to provide an overview over the different manufacturing methods and to impart detailed process knowledge of the common methods. The lecture covers the basic principles of manufacturing engineering and deals with the manufacturing methods according to their classification into main groups on the basis of technical and economical aspects. The lecture is completed with topics such as process chains in manufacturing.

The following topics will be covered:

- Introduction
- Quality control
- Primary processing (casting, plastics engineering, sintering, generative 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
- Work preparation

**Media**

Slides and lecture notes for the manufacturing technology lecture will be made available through ilias.

**Literature**

lecture notes



**Course: Festkörperreaktionen / Kinetik von Phasenumwandlungen, Korrosion mit Übungen [2193003]****Coordinators:** D. Cupid, P. Franke**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Finite Elements for Field- and Time Dependent Problems [19110]****Coordinators:** K. Schweizerhof, Schweizerhof**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Fluid-Structure-Interaction [2154401]****Coordinators:** T. Schenkel**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. [163](#))[SP\_05\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content****Remarks**

Lecture will be given starting summer semester 2012

**Course: Fluid Technology [2114093]****Coordinators:** M. Geimer**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[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. 181)[SP\_48\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Gesamtfahrzeugbewertung im virtueller Fahrversuch [2114850]****Coordinators:** B. Schick**Part of the modules:** SP 12: Automotive Technology (p. 169)[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 design 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.: Skriptum zur Vorlesung "Fahreigenschaften I"
3. Unrau, H.-J.: Skriptum 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. 176)[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**

Basic knowledge from the field of casting technology for mechanical engineers; the focus is placed on moulding materials, moulding processes, casting materials and metallurgy. Special notes of virtual casting development.

**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: Global Production and Logistics - Part 1: Global Production [2149610]****Coordinators:** G. Lanza**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

oral exam

**Conditions**

None.

**Recommendations**

Basic knowledge of production planning

**Learning Outcomes**

The student

- understands the challenges and fields of action of companies operating at the global level
- is able to apply the methods for the structuring and design of global networks he/she has learned about to new problems
- is able to analyse opportunities and risks and give a thorough evaluation.

**Content**

The lecture explains the challenges and the fields of action companies operating at the global level are faced with as well as the most important aspects of global production networks. Firstly, the economic and legal background is discussed along with opportunities and risks. The focus of the lecture is on a methodical approach to the structuring and design of global networks and also includes a strategy for the selection of production sites. Site-specific adjustments to product design and to production technology are also covered. The special characteristics and requirements of global procurement, research & development and sales and marketing are dealt with in detail.

Main topics of the lecture:

1. Introduction: history, motivation and goals, risks
2. General conditions
3. Global distribution
4. Site selection
5. Site-specific production adjustments
6. Development of a new production site
7. Global procurement
8. Structuring global production networks
9. Managing global production networks
10. Global research and development
11. Outlook

**Literature**

Abele, E. et al: Global Production – A Handbook for Strategy and Implementation, Springer 2008



**Course: Global Production and Logistics - Part 2: Global Logistics [2149600]****Coordinators:** K. Furmans**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

**Conditions**

Prerequisites: "Logistics – Organisation, Design and Control of Logistics Systems".

**Recommendations**

none

**Learning Outcomes**

The student

- will have sound knowledge about planning and operations of global supply chains and will be able to use simple models for planning,
- will be familiar with the requirements and characteristics of global trade and transport.

**Content**

Characteristics of global trade

- Incoterms
- Customs clearance, documents and export control

Global transport and shipping

- Maritime transport, esp. container handling
- Air transport

Modeling of supply chains

- SCOR model
- Value stream analysis

Location planning in cross-border-networks

- Application of the Warehouse Location Problem
- Transport Planning

Inventory Management in global supply chains

- Stock keeping policies

Inventory management considering lead time and shipping costs

**Media**

presentations, black board

**Literature****Elective literature:**

- Arnold/Isermann/Kuhn/Tempelmeier. HandbuchLogistik, Springer Verlag, 2002 (Neuaufgabe in Arbeit)
- Domschke. Logistik, Rundreisen und Touren, Oldenbourg Verlag, 1982

- Domschke/Drexl. Logistik, Standorte, OldenbourgVerlag, 1996
- Gudehus. Logistik, Springer Verlag, 2007
- Neumann-Morlock. Operations-Research, Hanser-Verlag, 1993
- Tempelmeier. Bestandsmanagement in SupplyChains, Books on Demand 2006
- Schönsleben. IntegralesLogistikmanagement, Springer, 1998

**Remarks**

none

**Course: Size effects in micro and nanostructures materials [2181744]****Coordinators:** P. Gumbsch, D. Weygand, C. Eberl, P. Gruber, M. Dienwiebel**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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

**Learning Outcomes**

The student will be confronted to the limits of classical material behaviour, observed in nano and micrometer sized structured materials. New processing routes, experimental testing methods and modelling tools will be presented.

**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**

Folien

**Course: Fundamentals of Energy Technology [2130927]****Coordinators:** D. Cacuci, F. Badea**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. [172](#))[SP\_15\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Summer term	

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Automotive Engineering I [2113805]****Coordinators:** F. Gauterin, H. Unrau**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 48: Internal Combustion Engines (p. 181)[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 the calculation methods for sizing. They are able to lay out the appropriate modules of a vehicle.

**Content**

1. Driving mechanics: Driving resistances and driving performances, mechanics of the longitudinal and transverse forces, collision mechanics
2. Engine: Classification, comparison processes, real processes, waste gas emission, alternative drives
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. Reimpell, J.: Fahrwerktechnik: Fahrzeugmechanik, Vogel Verlag, 1992
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. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[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: 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 construct the appropriate components correctly.

**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. Reimpell, J.: Fahrwerktechnik: Grundlagen, Vogel Verlag, 1995
2. Burckhardt, M.: Bremsdynamik und Pkw-Bremsanlagen, Vogel Verlag, 1991
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. 176)[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: Ceramic 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. Thümmeler, 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. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 24: Energy Converting Engines (p. 175)[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 helpful

**Learning Outcomes**

The student get an overview over 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.

At first the students find out which emissions are formed in combustion engines, why these emissions are health-related critical and which measures the legislator has established to reduce the emissions.

In the following the assembly of an exhaust gas aftertreatment system is explained.

The economic conditions of this technology are discussed regarding prices and treatment of noble metals.

**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. Schaefer, R. van Basshuysen, Springer Verlag Wien New York, 1995 ISBN 3-211-82718-8
6. "Autoabgaskatalysatoren : Grundlagen - 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. 171)[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**

General kinematics of large deformations, general structure of continuum theories

**Content**

- \* Mathematical foundations: tensor algebra, tensor analysis
- \* Kinematics: motion, deformation and strains at large deformations, geometrical linearization
- \* Balance laws: general structure of balance laws, balance laws of continuum mechanics
- \* Special theories of continuum mechanics

**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. 163)[SP\_05\_mach], SP 44: Technical Logistics (p. 180)[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) =&gt; (look at "Studienplan Maschinenbau", latest version)

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The student:

- knows about processes and machines of technical logistics
- is able to handle fundamental structures and the impacts
- is able to refer to industrially used machines and
- practices the calculation on applying knowledge from lessons.

**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: Fundamentals of Combustion I [2165515]****Coordinators:** U. Maas**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach]

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

**Learning Control / Examinations**

Oral

Duration: 30 min.

**Conditions**

None

**Recommendations**

None

**Learning Outcomes**

Based on the explanation of the fundamental concepts and observed phenomena in combustion, this lecture studies the experimental analysis and the mathematical description of laminar and turbulent flames. The lecture aims at giving insights in the fundamental physico-chemical processes during combustion, in particular with regard to technical combustion systems e.g. engines, gas turbines, furnaces.

**Content**

Fundamental concepts and 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

**Course: Fundamentals of combustion II [2166538]****Coordinators:** U. Maas**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 24: Energy Converting Engines (p. 175)[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**

Based on the contents of the lecture "Fundamentals of Combustion I", this lecture studies particular issues such as ignition processes, engine knock and pollutant formation.

**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: Basics of Ground Born Guided Systems [19066]

**Coordinators:** E. Hohnacker, P. Gratzfeld, Hohnacker

**Part of the modules:** SP 50: Rail System Technology (p. 182)[SP\_50\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	3	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 complexity of “Ground Borne Guided Systems”.

### Content

- Definitions
- Track guidance and vehicle dynamics
- Vehicles
- Alignment and layout of lines
- Track construction

### Media

All slides can be bought.

### Literature

Zilch, Diederichs, Katzenbach (Hrsg.): Handbuch für Bauingenieure, Springer-Verlage 2001

**Course: Basics and Methods for Integration of Tires and Vehicles [2114843]****Coordinators:** G. Leister**Part of the modules:** SP 12: Automotive Technology (p. 169)[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.

**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 pressure: 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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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, so that the design of relevant assemblies can be performed to the required demands.

**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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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. They have 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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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 cap concepts, the interior and the interior design process.

**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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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 are able to create general vehicle concepts tailored for different areas of application. They 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.

**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., Striffler, 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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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.

**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. 167)[SP\_10\_mach], SP 12: Automotive Technology (p. 169)[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.

**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
7. Excursion

**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 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations**

depending on choice according to actual version of study regulations  
 Additives as announced

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students can effectively apply the methods of advanced strength of materials. The students especially master the description of the strength characteristics of materials, the elastic, plastic and the hardening behaviour of metallic materials. The students can apply the failure description by deformation localization, damage or fracture. The students know the basics of bearing structures.

**Content**

- basics of tensor calculus
- elasticity theory
- application of elasticity: linear elastic fracture mechanics
- application of elasticity: bearing structures
- plasticity theory
- application of plasticity: stability of materials

**Literature**

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. Parkus, H.: Mechanik der festen Körper. Springer 1988.

**Course: Hybrid Engines and Electrical Vehicals [23321]****Coordinators:** M. Doppelbauer**Part of the modules:** SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2+1	Winter term	de

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Hydraulic Fluid Machinery I (Basics) [2157432]****Coordinators:** M. Gabi**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter 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**

The lecture introduces the basics of Hydraulic Fluid Machinery (pumps, fans, water- and wind-turbines, hydrodynamic transmissions). 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.

**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. Pfeleiderer, 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**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_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**

Hydraulic Fluid Machinery I (Basics)

**Recommendations**

none

**Learning Outcomes**

Based on the lecture Fluid Machinery I (Basics, Prof. Gabi) aspects of operation characteristics and design of pumps, fans and turbines are discussed.

**Content**

Rotodynamic pumps and fans of different types of construction

Water turbines

Wind turbines

Hydrodynamic drives

**Literature**

1. Fister, W.: Fluidenergiemaschinen I & II, Springer-Verlag
2. Siegloch, H.: Strömungsmaschinen, Hanser-Verlag
3. Pfeleiderer, 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. 169)[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**

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 exemplarily.

An excursion to the DaimlerChrysler wind tunnel and the research and development centers is planned.

**Content**

Einführung

Industriell eingesetzte Strömungsmeßtechnik

Strömungssimulation in der Industrie, Kontrolle des numerischen Fehlers und verwendete Turbulenzmodelle

Kühlströmungen

Strömung, Gemischbildung und Verbrennung bei direkteinspritzenden Dieselmotoren

Strömung, Gemischbildung und Verbrennung bei Ottomotoren

Fahrzeugumströmung

Klimatisierung/Thermischer Komfort

Aeroakustik

Aerodynamik und Höchstleistungsrechnen

**Literature**

keine Angabe

**Course: Information Systems in Logistics and Supply Chain Management [2118094]****Coordinators:** C. Kilger**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

examination aids: none

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

The student:

- knows information systems for logistics processes
- is able to identify the requirements of a supply chain and choose an appropriate information system.

**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: Informationstechnik in der industriellen Automation [23144]****Coordinators:** P. Bort, Bort**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Informationsverarbeitung in mechatronischen Systemen [2105022]****Coordinators:** M. Kaufmann**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Information Processing in Sensor Networks [24102]****Coordinators:** U. Hanebeck, Hanebeck**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Integrated measurement systems for fluid mechanics applications [2171486]****Coordinators:** K. Dullenkopf, Mitarbeiter**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[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**

This course provides the opportunity to gain both a theoretical and practical understanding of the fundamentals of computer aided measurements. Each section includes a PC exercise.

**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. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

Performance is assessed in the form of one written examination during the lecture-free period. The examination will take place once every semester and can be retaken at every official examination date.

**Conditions**

None.

**Learning Outcomes**

The student

- has knowledge of the content covered by this lecture and understands the challenges and the fields of action of integrated production planning,
- is able to apply the methods of integrated production planning he/she has learned about to new problems,
- is able to analyse and evaluate the suitability of the methods, procedures and techniques he/she has learned about for a specific problem.

**Content**

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:

1. The basic principles of production planning
2. Links between product planning and production planning
3. Integrating a production site into a production network
4. Steps and methods of factory planning
5. Approach to the integrated planning of manufacturing and assembly plants
6. Layout of production sites
7. Maintenance
8. Material flow
9. Digital factory
10. Process simulation for material flow optimisation
11. Start-up



**Course: Intermodalität und grenzüberschreitender Schienenverkehr [2114916]****Coordinators:** P. Gratzfeld, R. Grube**Part of the modules:** SP 50: Rail System Technology (p. 182)[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****Content**

**Course: IT for facility logistics [2118083]****Coordinators:** F. Thomas**Part of the modules:** SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

examination aids: none

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The student:

- knows automation technologie for material flow and the information technology necessary,
- knows how to handle risks of failure,
- knows practical implementations and is able to use his knowledfe for exercises.

**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: Cognitive Automobiles - Laboratory [2138341]****Coordinators:** C. Stiller, M. Lauer, B. Kitt**Part of the modules:** SP 44: Technical Logistics (p. 180)[SP\_44\_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	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:** C. Bonten**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 26: Materials Science and Engineering (p. 176)[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**

In a first step, the students will be enabled to distinguish plastics from other 'classic' materials, like metal, wood and ceramics. They will understand the chemical differences, differences in melt behaviour as well as in solid condition. The students will understand the main plastics processes (injection moulding, extrusion, blow moulding, compression moulding), the main joining techniques (welding, glueing, screws, snapfits) as well as the main rapid prototyping techniques. In the main part of the lecture, the students will get the chance to apply this theoretic background on real plastics parts. The students will be able to discuss plastics parts' economical production with the variety of plastics processing technologies. Also technological risks and counter measures will be discussed. Additionally, the students will be able to decide the right plastics material, the right manufacturing process as well as the right joining technology. Finally, the students will be able to distinguish between good and bad design of plastics parts.

**Content**

Structure and properties of polymeric materials, Properties of the solid body and influences on these, Processing of plastics, Design under consideration of load, manufacturing process, material, Calculation of plastic parts, Integration of function and process steps

**Literature**

Scriptum will be handed out during the lecture. Additional recommendations Bonten: „Kunststofftechnik für Designer“, Bonten: „Produktentwicklung“, Michaeli: 'Introduction into plastics processing', Gebhardt: „Rapid Prototyping“ (all published at Carl Hanser Publishers)

**Course: Lightweight Engineering Design [2146190]****Coordinators:** A. Albers, N. Burkardt**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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**

Compulsory preconditions: none

**Recommendations**

None.

**Learning Outcomes**

Lightweight design is one of the key technologies in material and energy efficiency as well as environmental and climate protection. The lecture covers diversified fundamentals of lightweight design and their context to the product development process and the associated complex interrelations.

Moreover, this lecture is intended to give students a profound understanding in classical and modern lightweight design. Additionally, guest speakers from industry will present lightweight design from an practical point of view.

**Content**

General aspects of lightweight design, lightweight strategies, construction methods, design principles, lightweight construction, stiffening techniques, lightweight materials, virtual product engineering, bionics, joining techniques, validation, recycling

**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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	Winter 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. 174)[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. 169)[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.

**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: Micro manufacturing laboratory [2149670]****Coordinators:** V. Schulze, C. Ruhs**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations**

Participate the practice tests and complete the colloquia successfully.

**Conditions**

None.

**Recommendations**

Knowledge in CAD and machining technologies are usefule.

**Learning Outcomes**

The microproduction technique laboratory teaches basic knowledge in the subject of micro production and of the whole process chain for the manufacturing of smallest parts using molding processes

**Content**

Following manufacturing technologies will be taught:

Micromilling

Micro-EDM

Microlaserablation

LIGA

Micromolding

Micrometrology

As an example for the process chain, a demonstrator will be designed, developed and produced.

**Literature**

None.

**Course: Warehousing and distribution systems [2118097]****Coordinators:** K. Furmans, C. Huber**Part of the modules:** SP 44: Technical Logistics (p. 180)[SP\_44\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

**Conditions**

none

**Recommendations**

logistics lecture

**Learning Outcomes**

The student:

- understands material and information processes in warehouse and distribution systems
- he is able to evaluate them quantitatively.

**Content**

- Control and organisation of distribution centers
- Analytical models for analysing and dimensioning of warehouse systems
- Distribution Center Reference Model (DCRM)
- Lean Distribution
- The processes from receiving to shipping
- Planning and controlling
- Distribution networks

**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. 176)[SP\_26\_mach], SP 12: Automotive Technology (p. 169)[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**

None.

**Recommendations**

None.

**Learning Outcomes**

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.

**Content**

physical basics of laser technology

laser beam sources (Nd:YAG-, CO<sub>2</sub>-, diode-laser)

beam properties, guiding and shaping

basics of materials processing with lasers

laser applications in automotive engineering

economical aspects

safety aspects

**Literature**

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

F. K. Kneubühl, M. W. Sigrist: Laser, 2008, Vieweg+Teubner

H. Hügel, T. Graf: Laser in der Fertigung, 2009, Vieweg+Teubner

R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer

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

J. Schneider: Skript zur Vorlesung „Physikalische Grundlagen der Lasertechnik“

**Course: Leadership and Product Development [2145184]****Coordinators:** A. Ploch**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral exam

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

The target of the lecture is to convey 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, K. Dullenkopf, H. Wirbser**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach]

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

**Learning Control / Examinations**

Discussion of the documented results with the assistants

Duration: 30 minutes

no tools or reference materials may be used

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

This lab class on energy technology provides all interested students the opportunity to learn about scientific research. Students participate in selected current projects. Experimental, design and theoretical tasks are offered. The lab class is concluded with an evaluation and written documentation of the results.

**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 diffusors
- Investigation of pollutant and noise emission as well as reliability and material deterioration
- Exhaust gas treatment
- Exhaust gas turbocharger

**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. 166)[SP\_09\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

examination aids: none

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The student:

- has the basis knowledge necessary to understand logistic systems,
- he knows algorithms and is able to apply them to logistic problems.

**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. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The student:

- knows about essential logistic questions, in a complex production network. As an example the automobile industry is used.
- is able to apply practical solutions 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. 174)[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. 167)[SP\_10\_mach]

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

**Learning Control / Examinations**

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

Allowed resource materials: none

**Conditions**

- Compact course
- Limited number of participants
- Students of the International Department will be preferred
- Registration in the ifab-office 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.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_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. 163)[SP\_05\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**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**

Application of engineering-oriented calculation methods in order to model and to understand dynamic effects in rotating machinery, e.g., 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 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral exam, no auxiliary means allowed

**Conditions**

none

**Recommendations**

Machine Dynamics

**Learning Outcomes**

Ability to build detailed models in the machine dynamics: Continuum models, fluid structure interaction, stability analyses

**Content**

- hydrodynamic bearings
- rotating shafts in hydrodynamic bearings
- belt drives
- vibration 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. 179)[SP\_38\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

**Conditions**

none

**Recommendations**Recommended compulsory optional subject:  
Stochastics in mechanical engineering**Learning Outcomes**

The student:

- understands material flow processes and knows how to plan material flow systems,
- is able to model material flow systems in simple models,
- he knows how to determine essential performance indicators like throughput, utilization, etc.

**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

**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 the lightweight production of car bodies [2149669]****Coordinators:** H. Haepf**Part of the modules:** SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

oral Examination

**Conditions**

None.

**Learning Outcomes**

Teaching of practical experience in the manufacture for automotive lightweight construction, with special consideration of metallic lightweight materials and innovative manufacturing processes.

**Content**

## 1. Introduction

- Motivation / Goals for the weight reduction of car body constructions

## 2. options to reduce vehicle weight

- lightweight with materials, lightweight production, lightweight construction, concept lightweight and form lightweight

## 3. Lightweight Materials

- Requirements for lightweight construction materials from the perspective of vehicle development
- Requirements for lightweight construction materials from the viewpoint of production
- Development of materials for steel, aluminum and magnesium
- Plastics for the vehicle structure and the outer body

## 4. Production Lightweight

- Joining in the body with special reference to composite construction
- Quality assurance of joining

## 5. Corrosion protection components for body weight reduction

- Corrosion protection on the substrate production
- Corrosion protection materials / procedures in vehicle painting

## 6. Summary / Outlook

**Literature**

lecture notes (download)



**Course: Mathematical Methods in Dynamics [2161206]****Coordinators:** C. Proppe**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	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:

Principle of virtual work, variational calculations, Principle of Hamilton

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 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations**

depending on choice according to actual version of study regulations  
 Additives as announced

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students can effectively and precisely apply the mathematical methods of strength of materials. They master the basic principles of tensor algebra and tensor analysis for a continuum mechanical modelling of materials. They know how to apply methods of continuum mechanics for dimensioning of work pieces.

**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
- theory of plasticity

**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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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 course presents several mathematical methods to analyze dynamical systems in the time and the frequency domain. In the first part, methods to solve ordinary single differential equations are discussed where attention is focused to non-periodic excitation. Systems of ordinary differential equations are considered next. Also partial differential equations (including the derivation of boundary value problems by Hamilton's principle) are treated. Analytical methods are emphasized but some selected approximate methods are dealt with as well. An introduction into the dynamic stability theory is also given.

**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 Structural Mechanics [2162280]****Coordinators:** T. Böhlke**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations**

depending on choice according to actual version of study regulations  
 Additives as announced

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

Their students can effectively and precisely apply the mathematical methods of structural mechanics. They master the basic principles of variational calculus and the variational principles of mechanics. They know different homogenization methods in order to describe materials with microstructure.

**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 formulation of boundary value problem of elastostatic
- method of Ritz; finite element method

Applications: Homogenization methods for materials with microstructure

- mesoscopic and macroscopic stress and strain measures
- Homogenization of elastic properties I: elementary Voigt and Reuss bounds; Hashin-Shtrikman bounds
- Homogenization of elastic properties II: estimation of effective elastic properties

**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. 176)[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 'laminated' 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. 176)[SP\_26\_mach]

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

**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**

Introduction to molecular structure, morphology and process parameters and their influence on the mechanics, strength and failure mechanisms of polymeric materials and composites. The strength and design of engineering parts exposed to complex loadings and loading histories will be derived.

**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:** C. Eberl, P. Gruber**Part of the modules:** SP 31: Mechatronics (p. 178)[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**

Understanding of:

- Mechanical phenomena in Small dimensions
- Material science and engineering for microsystems
- Mechanical micro-sensors
- Micro-actuators

**Content**

1. Introduction: Application and Processing of Microsystems
2. Scaling Effects
3. Fundamentals: Stress and Strain, (anisotropic) Hooke's Law
4. Fundamentals: Mechanics of Beams and Membranes
5. Thin Film Mechanics: Origin and Role of Mechanical Stresses
6. Characterization of Mechanical Properties of Thin Films and Small Structures: Measurement of Stresses and Mechanical Parameters such as Young's Modulus and Yield Strength; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Electrostatics,...
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 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_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 examination with grade

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

A manipulator as an exemplary mechatronic system is used to practise the contents of the stage II - lectures on mechatronics. The laboratory course comprises simulation, bus communication, measurement instrumentation, control engineering and programming. Instead of separate experiments the laboratory course continuously handles with the several aspects of the manipulator system. The final aim is to integrate the different subsystems to a working compound system.

**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: Mensch-Maschine-Interaktion [24659]****Coordinators:** Burghart**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Measurement II [2138326]****Coordinators:** C. Stiller**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 31: Mechatronics (p. 178)[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 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 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_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 helpful

**Learning Outcomes**

The students get to know state-of-the-art methods to analyse the process in combustion engines. Both, special measuring techniques such as optical and laser analysis and thermodynamical modelling of the engine process is covered.

**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. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations**

Oral examination

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

The development of mechatronic systems implies interdisciplinary work in teams. Often there are typical problems and misunderstandings due to different ways of working and thinking of mechanical engineers, electronics engineers and computer scientists. In order to avoid these problems and to cross the borders between different disciplines, one has to build up an at least basic understanding of the methods and problems of other co-workers. Especially the team leader has to be able to understand the problems of his team members and to moderate in case of misunderstandings. This lecture aims at students with their concentration on mechatronics. It provides insights into the mindsets and problem solving strategies of electronics engineers and computer scientists and explains the basic terms and tools of future colleagues. Also typical problems arising from diverse interdependencies of social and technical systems are discussed. Additionally issues like quality assurance in mechatronics products, safety and reliability and team-management are covered.

**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: Modelling of Microstructures [2183702]****Coordinators:** B. Nestler**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2	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.

**Learning Outcomes**

The students are introduced into the fundamentals of liquid-solid and solid-solid phase transformations. We discuss microstructures such as dendrites, eutectics and peritectics and consider the specific physics of heat and mass transport combined with the particular phase transformation. We study polycrystalline grain structures and examine the motion of interfaces and the effect of various external fields. Next, we learn the method of phase-field modelling for simulation of microstructure formation processes. As an extension of the phase-field modelling for phase transitions, we get to know the coupling with other field variables. The course will be combined with practical exercises.

**Content**

The course consists of a lecture and exercise classes. The aim is an introduction to the simulation of phase transformations and microstructure formation under the influence of different physical quantities. Contents are:

- fundamentals of phase transformation and microstructure evolution
- polycrystalline grain structures
- heat and mass diffusion
- phase-field modelling and simulation
- extension of phase-field modelling to include other physical fields

**Media**

Black board and slides.

**Literature**

Fundamentals of Solidification, Kurz and Fisher

Theory of Solidification, Davis.

The science of crystallization: microscopic interfacial phenomena, W. A. Tiller -> Only special reading

Transport phenomena in metallurgy, G.H. Geiger and D. R. Poirier

Transport Phenomena, R. Bird, W. Stewart, E. Lightfoot

Kinetics of Materials, W. Craig Carter

Physical Metallurgy, Porter and Easterling

Construction of binary phase diagrams, R. Haansen

Introduction to the thermodynamics of materials, David. R. Gaskell

Numerical recipes in C

**Course: Mobile Machines [2113073]****Coordinators:** M. Geimer**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter 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**

The students will learn the basic structure and construction of mobile machines. The basis will be practically introduced by consultants from industry area. Thereby, the typical working process will be described.

**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. 182)[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 innovation process 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.

**Course: Model based Application Methods [2134139]****Coordinators:** F. Kirschbaum**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach]

ECTS Credits	Hours per week	Term	Instruction language
		Summer term	

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**



**Course: Modelling and Simulation [2183703]****Coordinators:** B. Nestler**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2 + 1	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.

**Learning Outcomes**

The students learn fundamental algorithms and numerical methods of particular importance for materials simulations. The course introduces solution techniques for dynamical systems and partial differential equations. The methods are applied to describe heat and mass diffusion processes and to model microstructure formation (e.g. phase-field method). The next aim is to learn adaptive and parallel algorithms. The students will get familiar with fundamental concepts of high performance computations. Practical experience is obtained by the integrated exercises.

**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**

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. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Engine Laboratory [2134001]****Coordinators:** U. Spicher**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[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

**Learning Outcomes**

The students learn to apply their theoretically acquired knowledge of the lectures by means of 5 practical engine experiments on modern 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 18: Information Technology (p. 174)[SP\_18\_mach], SP 48: Internal Combustion Engines (p. 181)[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 helpful

**Learning Outcomes**

Students get to know state-of-the-art measurement techniques for combustion engines. In particular basic techniques for measuring engine operating parameters such as torque, speed, power and temperature.

Possible measurement errors and aberrations are discussed.

Furthermore techniques for measuring exhaust emissions, air/fuel ratio, fuel consumption as well as pressure indication for thermodynamic analysis are covered.

**Content**

Energy balance and conversion in combustion engines

test bench assembly

Measurement of basic engine parameters

Measurement of special engine parameters

Exhaust gas analysis

**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. 162)[SP\_02\_mach], SP 31: Mechatronics (p. 178)[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 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_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 lecture deals with up-to-date computational methods for the simulation of fluid flows for industrial applications. The selection of appropriate boundary and initial condition as well as the turbulence models will be discussed. With the help of test cases the mesh generation process will be explained. We discuss the convergence acceleration techniques like multigrid, implicit methods etc. as well as the applicability of these methods to parallel and vector processors. Problems of the mesh generation process occurring during the application of these methods will be shown. The lecture introduces some commercial codes like Fluent, Star-CD etc. as well as the research code SPARC. New aspects of the numerical simulations of fluid flows in the future like Large Eddy Simulation and Direct Numerical Simulation will be discussed.

### 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 can be downloaded from [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_crs\\_84185.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_crs_84185.html)

### 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. 172)[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 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.

**Content**

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 predicting 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: Numerical Fluid Mechanics [2153408]****Coordinators:** T. Schenkel**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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**

The lecture is a guide to the fundamentals of numerical solution methods for the basic equations of fluid dynamics with the help of selected applications. Following the industrial technology programs, the numerical solution methods are presented in the fields of airfoil flows, aerodynamics of motor vehicles, fluid flow machinery and heat transfer problems. In detail the lecture deals with algorithms for geometry definition and grid generation as well as different numerical solution methods on various computer architectures.

The student knows the fundamental approaches to plan and perform a numerical simulation of fluid mechanical problems. He can analyse a simple fluid mechanical problem and transform it into a well posed mathematical-numerical model. Although the lecture can only cover the most important models and methods, the student is enabled to understand advanced texts and use them purposefully.

**Content**

Fluid flow problems: Aeronautics, automotive industry, fluid flow machinery, heat transfer.

Basic equations of fluid mechanics: Navier-Stokes equations, Reynolds equations, perturbation-differential equation.

Discretisation: Geometry definition, grid generation, discretisation in space and time, behavior of errors, convergence, consistency and stability.

Numerical solution methods: Finite-difference, finite-volume, finite-element and spectral methods.

Computer architectures and techniques: Computers and data network, programming of vector and parallel computers.

Examples of numerical solutions: Flow around an airfoil, convective flow.

**Literature**

Oertel, H.: Strömungsmechanik, Vieweg-Verlag, 1999

Oertel, H., Laurien, E.: Numerische Strömungsmechanik, Springer-Verlag 1995



**Course: Patents and Patent Strategies [2147160]****Coordinators:** F. Zacharias**Part of the modules:** SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations**

Oral Examen

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

The goal of the lecture is to convey the basics of intellectual property rights and the industrial property right strategie at the Porsche AG .

**Content**

After basic explanation of the different types of intellectual property rights and the conditions and procedure for the granting of an intellectual property right, the importance of intellectual property is identified. Using examples and influence of Porsche AG project integrated strategies concerning intellectual property are deduced that meet the importance of these expectations.

**Course: Photovoltaics [23737]****Coordinators:** M. Powalla**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. [172](#))[SP\_15\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Plasticity Theory [2162244]****Coordinators:** T. Böhlke**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students know the basics of elasticity and plasticity of large deformations. They master tensoralgebra and tensoranalysis as well as the kinematics of large deformations. The students can set up the balance equations in regular and irregular points. They can apply the principles of material theory. They know the fundamental equations of finite elasticity and finite plasticity. In the framework of plasticity the students know the theory of crystal plasticity.

**Content**

- tensor calculus, kinematics, balance equations
- principles of material theory
- finite elasticity
- infinitesimal elasto(visco)plasticity
- exact solutions of infinitesimal plasticity
- finite elasto(visco)plasticity
- infinitesimal and finite crystal(visco)plasticity
- hardening and failure

**Literature**

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. 173)[SP\_17\_mach]

ECTS Credits	Hours per week	Term	Instruction language
			de

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: PLM in the Manufacturing Industry [2121366]****Coordinators:** G. Meier**Part of the modules:** SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

Oral group examination, Duration 1 hour, Auxiliary Means: none

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

Students know essential aspects of PLM Processes which are exemplarily introduced with examples from Heidelberger Druckmaschinen.

Students know objects of the PLM Process and know the interconnection between CAD and PLM.

Students understand the procedure of PLM-installation in an industrial enterprise and occurring challenges concerning strategy, vendor selection and psychology.

They are able to create installation concepts for PLM systems in the scope of team exercises and explain the approaches in presentations.

**Content**

A description of systematic requirement engineering is given, based on the introduction of PLM-Processes and (Multi-) Project management in the product development process. By the introduction of a PLM-Project, Objects of the PLM Process like material master, bill of material, documents and classifications are explained. Furthermore a 3D-Process chain is introduced to show the implementation of technical modifications. Finally, specific aspects of the mechatronic development are introduced.

**Literature**

Lecture slides

**Course: PLM-CAD workshop [2123357]****Coordinators:** J. Ovtcharova**Part of the modules:** SP 17: Information Management (p. 173)[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 holistically 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. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[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.

**Content**

1. Economical aspects of polymers
2. Introduction of mechanical, chemical and electrical properties
3. Processing of polymers (introduction)
4. Material science of polymers
5. Synthesis

**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. 176)[SP\_26\_mach]

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

**Learning Control / Examinations**

presentation (15 min) and oral examination

no tools or reference materials

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The laboratory covers 8 half-day experiments on various aspects of laser materials processing.

**Content**

safty aspects in laser processing

laser systems, beam shaping, beam characterization

hardening and remelting of cast iron, steel, aluminium

cutting of steel

surface refinement of ceramics by alloying and dispersing

welding of steel and aluminium

transmission welding of polymers

surface modification of polymers with respect to their wetting behaviour

surface texturing of steel and ceramics

drilling of steel, ceramic and polymers

**Literature**

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

F. K. Kneubühl, M. W. Sigrist: Laser, 2008, Vieweg+Teubner

H. Hügel, T. Graf: Laser in der Fertigung, 2009, Vieweg+Teubner

R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer

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

J. Schneider: Skript zur Vorlesung „Physikalische Grundlagen der Lasertechnik“



**Course: Lab Computer-aided methods for measurement and control [2137306]****Coordinators:** C. Stiller, P. Lenz**Part of the modules:** SP 18: Information Technology (p. 174)[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 lab comprises 9 experiments.

**Literature**

Instructions to the experiments are available on the institute's website

**Course: Mobile Robot Systems Lab [2146194]****Coordinators:** A. Albers, W. Burger**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

Certification of participation / No optional subject!

**Conditions**

Compulsory preconditions: none

**Recommendations**

Basic knowledge of electrical engineering, control engineering and computer science (programming)

**Learning Outcomes**

The theoretical contents of different lectures will be practiced based on the development of an exemplary mechatronic system, an omniwheel powered robot platform. The bandwidth involves simulation and measurement technology, open and closed-loop control and programming. The students will not deal with separated tasks, but work on the development of one platform during the whole semester. The objective of the lab is to successfully integrate and test all necessary components into one working system. At this not only professional skill but also soft skills like teamwork or communication abilities are practiced. Especially in mechatronics these capabilities are mandatory.

**Content**

Development of a mobile robot system:

- Sensors
- Modelling
- Programming (Matlab/Simulink, C, ...)
- Development of electronic components
- Manufacturing
- System integration

**Literature**

Manuals for the laboratory available

**Course: Lab course experimental solid mechanics [2162275]****Coordinators:** T. Böhlke, Mitarbeiter**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach]

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

**Learning Control / Examinations**

attestation without grade

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students know the basic measurement techniques for determination of all material parameters necessary in linear thermoelasticity. They master the identification of important parameters of stress-strain-curves based on measurements under appropriate stress states. The students can define simply nonlinear material laws.

**Content**

- 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: Computational Methods in Fluid Mechanics (Exercise) [2157442]****Coordinators:** B. Pritz**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach]

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

**Learning Control / Examinations**Certificate of participation;  
oral examination on request**Conditions**

none

**Learning Outcomes**

This practical course serves as supplement of the lecture "Computational Methods for Fluid Dynamics". The methods as taught within the lecture, required for performing fluid dynamics calculations will be practised on PC. Fluid dynamics calculations include the geometry and mesh generation, the definition of boundary conditions, the calculation and the visualisation and interpretation of data. First, the single steps at the PC will be developed by using appropriate examples and software. Later on, full calculation cycles (starting with mesh generation through to data interpretation) will be performed within small groups, solving typical fluid flow problems.

**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 I: Flat plate
6. Further calculation cycles

**Literature**

1. Lecture notes/handout
2. See literature list of lecture „Numerische Methoden der Strömungstechnik“

**Course: Electrical Powertrains in Practice [23311]****Coordinators:** M. Braun, Braun**Part of the modules:** SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Pro/ENGINEER advanced [2123370]****Coordinators:** J. Ovtcharova, M. Mrkonjic**Part of the modules:** SP 17: Information Management (p. 173)[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 38: Production Systems (p. 179)[SP\_38\_mach], SP 17: Information Management (p. 173)[SP\_17\_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 goal of PLM lecture is to provide an overview of management and organizational approach to product lifecycle management. The students:

- know the management concept of PLM, its objectives and are able to highlight the economic benefits of the PLM concept
- know provider of PLM solutions and can represent the current market situation
- Understand 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
- know the processes and functions needed to support the entire product life cycle
- become aware of the main operating software systems (PDM, ERP, SCM, CRM) and the mainstreaming of these systems
- develop techniques to successfully introduce the concept of Management PLM.

**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 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 17: Information Management (p. 173)[SP\_17\_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

The industrial focus of the lecture gives the students an insight into specific industrial implementation as well as the possibility to become acquainted with the industrial IT-applications, IT- and work processes in the automotive industry.

**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 work and distributed development.

**Literature**

Lecture slides

**Remarks**

Max. 20 students, registration necessary (ILIAS)

**Course: Product Ergonomics (in German) [2109025]****Coordinators:** G. Zülch**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach]

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

**Learning Control / Examinations**

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

Allowed resource materials: none

**Conditions**

None.

**Recommendations**

- Willingness to learn interdisciplinarily (Product design, Legal regulations Work physiology, Work psychology ...)
- Knowledge of Technical design is usefull

**Learning Outcomes**

- Become proficient within the general terms of ergonomics
- Know legal regulations
- Know elementary methods and procedures
- Become proficient in applying ergonomic evaluation and judgement

**Content**

1. Introduction and case study
2. Terminology of ergonomics
3. Course of action of construction and legal regulations
4. Anthropometrical design (Body measures, functional dimensions, kinematics, statics, kinetics)
5. Design of Human-machine-interfaces (Functional design, readouts, adjustment mechanisms)
6. Evaluation of design solutions

**Literature****Learning material:**

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

**Literature:**

- BRUDER, Ralph (Hrsg.): Ergonomie und Design. Stuttgart: ergonomia Verlag, 2004.
- KIRCHNER, Johannes-Henrich; BAUM, Eckart: Ergonomie für Konstrukteure und Arbeitsgestalter. Hrsg.: REFA Verband für Arbeitsstudien und Betriebsorganisation. München: Carl Hanser Verlag, 1990.
- LANDAU, Kurt (Hrsg.): Good Practice. Stuttgart: ergonomia Verlag, 2003.
- LANDAU, Kurt (Hrsg.): Ergonomie Software Tools in Product and Workplace Design. Stuttgart Verlag ERGON, 2000.

- LAURIG, Wolfgang: Grundzüge der Ergonomie. Berlin, Köln: Beuth Verlag, 4. Auflage 1992.
- LUCZAK, Holger: Arbeitswissenschaft. Berlin u.a.: Springer-Verlag, 2. Auflage 1998.
- MERKEL, Torsten u.a.: Ergonomie-Lehrmodule für die Ausbildung von Konstrukteuren. Sankt Augustin: Verein zur Förderung der Arbeitssicherheit in Europa, 2008. (Kommission Arbeitsschutz und Normung, KAN-Bericht 42) <http://www.kan.de/de/publikationen/kan-berichte/kan-berichte-anzeige/kandocs/9b6c0a0258/kanbericht/2695.html>, Stand: 18.01.2011.
- SCHMIDTKE, Heinz (Hrsg.): Ergonomie. München, Wien: Carl Hanser Verlag, 3. Auflage 1998.
- SCHMIDT, Ludger; SCHLICK, Christopher M.; GROSCHE, Jürgen (Hrsg.): Ergonomie und Mensch-Maschine-Systeme. Berlin, Heidelberg: Springer-Verlag, 2008.

Please refer to the latest edition.

**Course: Industrial Engineering I (in German) [2109028]****Coordinators:** G. Zülch**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach]

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

**Learning Control / Examinations**

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

Allowed resource materials: none

**Conditions**

None.

**Recommendations**

- Willingness to learn interdisciplinarily (Technique, Economy, Legal regulations, Informatics ...)

**Learning Outcomes**

- Become proficient within the general terms of Production Management
- Know the basics of production planning and control

**Content**

1. Terminology
2. Departmental organisation
3. Process organisation
4. Product development and programme planning
5. Work preparation (Operations planning, Production planning and control)
6. Materials management

**Literature****Learning material:**

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

**Literature:**

- HACKSTEIN, Rolf: Produktionsplanung und -steuerung (PPS). Düsseldorf: VDI-Verlag, 1984.
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Planung und Steuerung.
  - Teil 1: Grundbegriffe...
  - Teil 2: Programm und Auftrag...
  - Teil 3: Durchlaufzeit- und Terminermittlung...
 München: Carl Hanser Verlag, 1991. (Methodenlehre der Betriebsorganisation)
- WIENDAHL, Hans-Peter: Betriebsorganisation für Ingenieure. München, Wien: Carl Hanser Verlag, 7. Auflage 2010.

Please refer to the latest edition.

## Course: Production Systems and Production Technology in Major Assembly Production [2150690]

**Coordinators:** V. Stauch

**Part of the modules:** SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

### Learning Control / Examinations

oral exam

### Conditions

None.

### Recommendations

Attendance of the lecture 'Manufacturing Engineering' [2149657] is recommended prior to attending this lecture.

### Learning Outcomes

The student

- understands the challenges a global automotive company is facing in current times
- knows the possibilities of modern manufacturing engineering and is aware of specific application examples from major assembly production
- is able to apply the methods and approaches covered by the lecture to problems from the context of the lecture.

### Content

This lecture has a clear focus on real-life situations and conditions, provides many recent examples from industry and illustrates these examples by means of a study trip to Daimler's Untertürkheim plant. In addition to the technological aspects of major assembly production (engines, axles, transmissions), management-related aspects (HR management of approximately 20,000 employees), logistics-related aspects and other important general conditions (e.g. environmental requirements) will be addressed.

Main topics of the lecture:

- Facts and figures of the Daimler group and of the Untertürkheim plant
- Overview over the MDS and the major assembly process
- Powertrain systems
- Factory planning, start-up and total cost of ownership
- MPS - Mercedes Benz Production System
- Logistics
- Occupational health and safety and environmental protection
- Management and HR
- Quality management
- Study trip to the Untertürkheim plant

### Literature

lecture notes

**Course: Production Techniques Laboratory [2110678]**

**Coordinators:** K. Furmans, J. Ovtcharova, V. Schulze, G. Zülch, Research assistants of wbk, ifab und IFL  
**Part of the modules:** SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

Participate in practice exercise courses and complete the colloquia successfully.

**Conditions**

Participation in the following lectures:  
 Informationssysteme in logistics and supply chain management,  
 Material flow in logistic systems,  
 manufacturing technology,  
 Work Science

**Recommendations**

none

**Learning Outcomes**

The student:

- knows the components of a modern factory are presented,
- is able to gain a deeper understanding of these components by exercises.

**Content**

The production technique laboratory (PTL) is a collaboration of the institutes wbk, IFL, IMI and ifab.

1. Computer Aided Product Development
2. Production of parts with CNC turning machines
3. Controlling of production systems using PLCs
4. Workplace configuration
5. NN
6. Configuration of Display Work Stations
7. Time study
8. Optical identification in production and logistics
9. NN
10. Storage and order-picking systems
11. Computer communication in factory

**Media**

several

**Literature**

lecture notes

**Remarks**

none

**Course: Project Workshop: Automotive Engineering [2115817]****Coordinators:** F. Gauterin**Part of the modules:** SP 12: Automotive Technology (p. 169)[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.

**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 Mobile Hydraulic Systems [2113071]

**Coordinators:** G. Geerling

**Part of the modules:** SP 12: Automotive Technology (p. 169)[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

During the lecture the design and development of fluidic systems with special respect to the mobile hydraulics are to be mediated:

- marketing und development
- temperature regulation
- hydro-storage
- filtration

### Content

Introduction to the application-oriented development of mobile hydraulic systems with practice-oriented applications.



**Course: Project Management in Rail Industry [2115995]****Coordinators:** P. Gratzfeld**Part of the modules:** SP 50: Rail System Technology (p. 182)[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**

- Project management system (project, project management, 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, DPS, WBS, risk and opportunity management, change management, project closure)

**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 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

Oral examination

Duration: 20 minutes

Auxiliary means: none

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

The management of projects is an factor of high significance for successfull companies. The course introduces the methods of the project management with the help of practical examples. Product development processes and the required organizational structures are also discussed. Participants learn to handle project management situations in global 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 Design and Industrial Engineering [2110036]****Coordinators:** S. Stowasser**Part of the modules:** SP 17: Information Management (p. 173)[SP\_17\_mach]

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

**Learning Control / Examinations**

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

Allowed resource materials: none

There is the possibility to acquire the so-called "MTM-Grundschein" (non-academic certificat).

**Conditions**

- Compact course (one week full-time)
- Limited Number of Participants
- Registration in the ifab-office necessary
- Compulsory attendance during the whole lecture

**Recommendations**

- Knowledge of work science is usefull

**Learning Outcomes**

- Ability to design work operations and processes effectivly and efficiently
- Instruction in methods of time study (MTM, Data acquisition etc.)
- Instruction in methods and principles of process design
- The Students are able to apply methods for the design of workplaces, work operations and processes.
- The Students are able to apply actual approaches of process and production organisation.

**Content**

1. Definition and terminology of process design and industrial engineering
2. Tasks of industrial engineering
3. Actual approaches of organisation of production (Holistic production systems, Guided group work et al.)
4. Methods and principles of industrial engineering and production systems
5. Case studies and exercises for process design

**Media**

Powerpoint, movies, exercises

**Literature****Learning material:**

Handout online on: [https://ilias.rz.uni-karlsruhe.de/goto\\_rz-uka\\_cat\\_29099.html](https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html)

**Literature:**

- BASZENSKI, Norbert: Methodensammlung zur Unternehmensprozessoptimierung. Köln: Wirtschaftsverlag Bachem, 3. Auflage 2008.
- BOKRANZ, Rainer; LANDAU, Kurt: Produktivitätsmanagement von Arbeitssystemen. Stuttgart: Schäffer Poeschel, 2006.
- Themenheft: Methodisches Produktivitätsmanagement: Umsetzung und Perspektiven. In: Zeitschrift angewandte Arbeitswissenschaft, Köln, 204(2010).
- NEUHAUS, Ralf: Produktionssysteme: Aufbau - Umsetzung - betriebliche Lösungen. Köln: Wirtschaftsverlag Bachem, 2008.
- ROTHER, Mike; SHOOK, John: Sehen lernen - mit Wertstromdesign die Wertschöpfung erhöhen und Verschwendung beseitigen. Aachen: Lean Management Institut, 2004.

Please refer to the latest edition.

**Course: Process Simulation in Forming Operations [2161501]****Coordinators:** D. Helm**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[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 student knows the most important forming operations and technological aspects of them. He learns the elementary basis of modelling and simulating as well as of continuum mechanics and material theory. The student knows how to numerically solve initial-boundary-value problems using the finite element method.

**Content**

The lecture gives an introduction to simulation of forming processes of metallic materials and contains the basics of continuum mechanics, material theory and numerics.

**Course: Advanced powder metals [2126749]****Coordinators:** R. Oberacker**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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 assess 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 Specialties, 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. Thümmel, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

**Course: Quality Management [2149667]****Coordinators:** G. Lanza**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_mach]

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

**Learning Control / Examinations**

Oral exams: Mechanical Engineering (Maschinenbaudiplom); Erasmus and Industrial Engineering (Wi.-Ing.): written examination

**Conditions**

None.

**Learning Outcomes**

The student

- has knowledge of the content covered by the lecture,
- understands the quality philosophies covered by the lecture,
- is able to apply the QM tools and methods he/she has learned about in the lecture to new problems from the context of the lecture,
- is able to analyse and evaluate the suitability of the methods, procedures and techniques he/she has learned about in the lecture for a specific 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-specific fields of application of quality assurance methods are presented. The lecture covers the current state of the art in preventive and non-preventive quality management methods in addition to manufacturing metrology, statistical methods and service-related quality management. The content is completed with the presentation of certification possibilities and legal quality aspects.

Main topics of the lecture:

1. The term "quality"
2. Total Quality Management (TQM) and Six Sigma
3. Universal methods and tools
4. QM during early product stages – product definition
5. QM during product development and in procurement
6. QM in production – manufacturing metrology
7. QM in production – statistical methods
8. QM in service
9. Quality management systems
10. Legal aspects of QM

**Literature**

Lecture notes

**Course: Computational Dynamics [2162246]****Coordinators:** C. Proppe**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[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. G eradin, 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 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 50: Rail System Technology (p. 182)[SP\_50\_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. 173)[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. 171)[SP\_13\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

None.

**Recommendations**

"Mathematical Methods in Strength of Materials" and "Introduction to the Finite Element Method"

**Learning Outcomes**

The students know the principles and the theory of the linear finite element method. They master the basic applications of the finite element method in solid mechanics and know the formulation as well as the numerical solution of linear two-dimensional problems.

**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. 171)[SP\_13\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

Successful participation in lecture Computational Mechanics I

**Learning Outcomes**

The students can effectively use the theoretical basics of inelastic mechanical material behaviour and master the numerical implementation. They know the weak formulation of two-dimensional non-linear problems of solid mechanics and obtain a numerical solution of the discretized equations using the Finite-Element-Method. They know the basics of numerics of nonlinear systems, kinematics and balance equations of non-linear solid mechanics, of finite elasticity and infinitesimal plasticity, of linear and non-linear thermoelasticity.

**Content**

- overview quasistatic nonlinear phenomena
- numerics of nonlinear systems
- foundations of nonlinear continuum mechanics
- balance equations of geometrically nonlinear solid mechanics
- finite elasticity
- infinitesimal plasticity
- linear and geometrically nonlinear thermoelasticity

**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, Welke, Do, Vahrenkamp**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 31: Mechatronics (p. 178)[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: Failure Analysis [2173562]****Coordinators:** K. Poser**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach]

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

**Learning Control / Examinations**

oral

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 able to discuss damage evaluation and to perform damage investigations. They know the common necessary investigation methods and can regard failures considering load and material resistance. Furthermore they can describe and discuss the most important types of failure and damage appearance.

**Content**

Aim, procedure and content of examining failure

Examination methods

Types of failure:

Failure due to mechanical loads

Failure due to corrosion in electrolytes

Failure due to thermal loads

Failure due to tribological loads

Damage systematics

**Literature**

A literature list, specific documents and partial lecture notes shall be handed out during the lecture.

**Course: Rail Vehicle Technology [2115996]****Coordinators:** P. Gratzfeld**Part of the modules:** SP 50: Rail System Technology (p. 182)[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**

- Main systems of rail vehicles
- Electric and non-electric traction drives
- Brakes
- Bogies
- 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).

**Remarks**

None.

**Course: Welding Technology I [2173565]****Coordinators:** B. Spies**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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 occurring during the application of different welding processes relating to design, material and production.

classification and importance of welding technology 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 processesSurvey: fusion welding,  
pressure welding.  
seam preparation/design  
welding positions  
weldability  
gas welding, thermal cuttingmanual metal-arc welding  
submerged arc welding  
IV characteristics: arc/sources of energy  
gas-shielded metal-arc welding**Literature**

Ruge: Handbuch der Schweißtechnik, Springer-Verlag, 1985

Dilthey: Schweißtechnische Fertigungsverfahren I, Augustinus, Aachen, 1991

Fachbände des Deutschen Verlags für Schweißtechnik



**Course: Welding Technology II [2174570]****Coordinators:** B. Spies**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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 occurring 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 weldingspot welding / projection welding  
heat flow at weldingwelding of low-alloy steel / time-temperature-transformation curve.  
welding of high-alloy steel / austenite / Schaefflerdiagramm  
low temperature steels  
welding of cast ironheat treatment for welding  
welding of aluminium alloys  
residual welding stress  
methods of testing  
design of welded constructions**Literature**

Ruge: Handbuch der Schweißtechnik, Springer-Verlag, 1985

Dilthey: Schweißtechnische Fertigungsverfahren II, Augustinus, Aachen, 1991

**Course: Fatigue of Metallic Materials [2173585]****Coordinators:** K. Lang**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[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 lecture gives an overview of the deformation and damage behaviour of metallic materials under cyclic loading. Both the fundamental microstructural processes as well as the development of macroscopic damages are mentioned. The fundamental procedures for the evaluation of uniform and stochastic cyclical loadings are also explained. The students will be able to recognize possible damage due to cyclical loadings and evaluate the fatigue behaviour of components both qualitatively as well as quantitatively.

**Content**

Introduction: some interesting cases of damage

Testing Facilities

Cyclic Stress Strain Behaviour

Crack Initiation

Crack Propagation

Lifetime Behaviour under Cyclic Loading

Fatigue of Notched Components

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 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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
- \* Determination of Lehr's damping measure from resonance
- \* 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
- \* resonance of clamped beams with variable cross section
- \* experimental modal analysis

**Literature**

comprehensive instructions will be handed out

**Course: Selected Topics in Manufacturing Technologies [2118092]****Coordinators:** V. Schulze**Part of the modules:** SP 52: Production Management (p. [183](#))[SP\_52\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Failure Analysis Seminar [2173577]****Coordinators:** K. Poser**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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. appropriate reporting. It starts with the basic failure mechanisms of mechanically, chemically, and thermally induced failures and its 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. 167)[SP\_10\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach]

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

**Learning Control / Examinations**

oral / written (if necessary) =&gt; (see "Studienplan Maschinenbau", version of 7.7.2010)

examination aids: none

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

The student:

- has basic knowledge of safety engineering,
- knows the basics of industrial health and labour protection in Germany,
- is familiar with the national and european safety regulations and the basics for the safe methods of design of machinery.
- is able to realize these objectives by using examples in the field of storage- and conveyor-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**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

## Course: Simulation of Coupled Systems [2114095]

**Coordinators:** M. Geimer

**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2/2	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

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

The limitation of the simulation programs and the related problems will be introduced by using the example of the working movement of a wheel loader. As a solution the coupled simulation of multiple programs by using the mentioned example will be shown.

### 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 in product development process [2185264]****Coordinators:** A. Albers, T. Böhlke, J. Ovtcharova**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

Not graded:

term paper in group work

- written part: 10 pages per person
- presentation: 15 minutes per group

**Conditions**

Compulsory preconditions: none

**Recommendations**

None.

**Learning Outcomes**

The students learn the connections between simulation methods, the necessary IT technique and the integration of such methods within the product development process. They know the basic approximation methods in mechanics and methods of modelling material behaviour using the finite-element-method. The students learn the integration within the product development process as well as the necessity of coupling different methods and systems. They master the modelling of heterogeneous technical systems and know the foundations of virtual reality.

**Content**

- approximation methods of mechanics: FDM, BEM, FEM, MBS
- material modelling using the finite-element-methode
- product life cycle
- coupling of methods and system integration
- modelling heterogeneous technical systems
- functional Digital Mock-Up (DMU), virtual prototypes

**Literature**

sildes of lectures will be available

**Course: Simulation of production systems and processes [2149605]****Coordinators:** K. Furmans, V. Schulze, G. Zülch**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

The student knows different possibilities of simulation technology within the production technology and is able to use those methods. They range from the modeling of production and work systems down to simulation of single manufacturing processes.

**Content**

The lecture is focused on the various aspects and possibilities of the usage of simulation technologies within the production technology. First the definition of the terminology and the basic knowledge is pointed out. In the chapter "Design of experiments and validation" the procedure of a simulation study with the preparation work, the selection of the simulation tools, the validation and the analysis of the simulation runs will be discussed. The chapter "Statistical basics" deals with probability distribution and random numbers as well as the use of Monte-Carlo-simulations in practical exercises. The chapter "Simulation of plant, machinery and processes" addresses the simulative analysis of single manufacturing processes via the examination of machine tools down to the modeling of a digital plant with the focus on the production facility. The chapter "Simulation of work systems" in addition considers the personnel integrated and orientated simulation. Here the assembly systems and the enterprise orientated simulation is considered. Finally the specifications of the material flow simulation for production systems are examined.

**Literature**

none

**Remarks**

The lecture starts in winter term 2011/12

## Course: Simulation of spray and mixture formation processes in combustion engines [2133114]

**Coordinators:** C. Baumgarten

**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

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

### Learning Control / Examinations

oral examination, Duration: ca. 45 min., no auxiliary means

### Conditions

None.

### Recommendations

basic knowledge in combustion engines and fluid dynamics helpful

### Learning Outcomes

Students get to know the more and more important field of mathematical modelling and simulation of three dimensional spray and mixture formation processes. After describing the fundamental mechanisms and categories of the in-cylinder spray and mixture formation the basic equations needed for sub-processes such as spray breakup, droplet deceleration, droplet collision, ignition etc. are discussed. Last but not least trend-setting mixture formation strategies and their potential for engines with direct injection are discussed.

### Content

Fundamentals of mixture formation in combustion engines

Injection systems and nozzle types

basic equations of fluid dynamics

modelling of spray and mixture formation

DI Diesel engines

DI Gasoline engines

HCCI combustion process

### Literature

Slides available in the lectures

**Course: Mechatronic Softwaretools [2161217]****Coordinators:** C. Proppe**Part of the modules:** SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 50: Rail System Technology (p. 182)[SP\_50\_mach]

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

**Learning Control / Examinations**

written exam, duration: 1 h

**Conditions**

none

**Recommendations**

none

**Learning Outcomes**

Mechatronic Softwaretools is a practical training course on using the software packages Maple, Matlab, Simulink and Adams. Mechatronic problems are solved using these packages on PCs.

**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: Stabilitätstheorie [2163113]****Coordinators:** A. Fidlin**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	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 stability analysis for equilibria
- to apply the stability analysis for periodic solution
- to apply the stability 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., Gubanov 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 engineering [2150683]****Coordinators:** C. Gönheimer**Part of the modules:** SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 38: Production Systems (p. 179)[SP\_38\_mach]

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

**Learning Control / Examinations**

oral examination

**Conditions**

None.

**Learning Outcomes**

The lecture deals with technical bases of process-oriented information- and control technologies, signal theory and electrical drive technology, programmable logic control, numerical control and robot control technologies as long as computer communication and process control. Furthermore modern field bus technologies are illustrated and current trends in automation technologies are presented. Demonstration of the production science laboratory and an excursion to an industry partner shows the implementation in real applications of the lecture themes.

**Content**

1. Basics of control engineering
2. Control periphery
3. Programmable logic control (PLC)
4. Numerical control (NC)
5. Robot Control
6. Communication technology
7. Trends in automation technology

**Course: Strategic Product Planing [2146193]****Coordinators:** A. Siebe**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

oral exam

**Conditions**

Compulsory preconditions: none

**Learning Outcomes**

Successful enterprises at an early stage know how their offers do look like on the markets of tomorrow. Thus, beneath the market potentials, also the possible market ratings i.e. the products as well as the underlying technologies must be thought ahead. The lecture introduces systematically into future management. Different approaches are explained and evaluated. Based on this foundation, the scenariobased strategic productplanning is explained theoretically and exemplified through concretely.

**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: Structural and Functional Ceramics [2126775]****Coordinators:** M. Hoffmann**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach]

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

**Learning Control / Examinations**

oral

20 min

Auxiliary means:none

**Conditions**

None.

**Learning Outcomes**

Based on concrete examples the importance of microstructural constitution on mechanical, thermal, chemical and electrical properties is shown.

**Content**

The lecture gives an overview on structure and properties of technical relevant structural and functional ceramic materials and parts. The following groups of materials are presented:

Silicon Nitride, Silicon Carbide, Alumina, Zirconia, Ferroelectric ceramics.

**Literature**

W.D. Kingery, H.K. Bowen, D.R. Uhlmann, Introduction to Ceramics, John Wiley & Sons, New York, (1976)

E. Dörre, H. Hübner, Alumina, Springer Verlag Berlin, (1984)

J. Kriegesmann, Technische Keramische Werkstoffe, Deutscher Wirtschaftsdienst Köln, (1989)

A. J. Moulson, J. M. Herbert, Electroceramics, Materials, Properties, Applications, Chapman and Hall, London, (1990)



**Course: Supply chain management [2117062]****Coordinators:** K. Alicke**Part of the modules:** SP 17: Information Management (p. 173)[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

**Learning Outcomes**

The student knows theoretical and practical basics to use approaches of Supply Chain Management within the operational practice.

**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 17: Information Management (p. 173)[SP\_17\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach]

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

### Learning Control / Examinations

oral exam

### Conditions

Compulsory preconditions: none

### Learning Outcomes

The goal of the lecture is to convey the main elements of sustainable product development in the economic, social and ökologischen context.

### Content

- understanding of sustainability objectives and their role in product development, the interaction between technical products and their environment, the holistic approach and the equality of economic, social and environmental aspects and environmental aspects
- skills for life-cycle product design using the example of complex automotive components such as airbag systems and other current products
- understanding of product environmental stresses with relevancy to praxis at the example of technology-intensive components, robustness and durability of products as the basis for a sustainable product development, development of skills for the application of environmental simulation during the process of development of technical products
- delivery of key skills such as team skills / project / self / presentation based on realistic projects

**Course: Technical Acoustics [2158107]****Coordinators:** M. Gabi**Part of the modules:** SP 10: Engineering Design (p. 167)[SP\_10\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 24: Energy Converting Engines (p. 175)[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**

none

**Learning Outcomes**

First, the students get to know the fundamental physical-mathematical laws of acoustics in general and the human hearing characteristics. Second, the difference of sound and noise will be outlined. Physical-empirical laws for determination of sound and noise levels of various emission and immission situations will be worked out or derived. Further on general sound measurement methods of machinery will be taught. A special focus here are fluid machinery.

**Content**

Human ear, wave propagation, wave equation, concept of acoustic poles, acoustic level notation, levels of various physical magnitudes, and levels which are corrected by means of hearing sensation, physical-empirical laws of wave propagation in various media, measurement techniques for machinery, fluid driven noise

**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. 174)[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 exercise 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++, Algorithmen 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:** S. Rogalski, J. Ovtcharova

**Part of the modules:** SP 38: Production Systems (p. 179)[SP\_38\_mach], SP 17: Information Management (p. 173)[SP\_17\_mach]

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

### Learning Control / Examinations

Oral examination, Duration: 25 min., Auxiliary Means: none

### Conditions

None

### Recommendations

None

### Learning Outcomes

Students should gain deeper knowledge about structures and functions of IT-systems applied in product development (engineering and manufacturing). They achieve general knowledge about the relevance of IT-support in engineering tasks.

Students know general approaches for introducing IT systems in existing Enterprise structures and have detail knowledge about “evolutionary process models of PLM” for a successful of IT-Systems installation.

### Content

- Information, information systems, information management
- CAP- and CAM-systems
- PPS- and ERP- systems
- PDM-Systems
- Virtual product configuration
- Installation of technical information systems in existing enterprise structures

### Literature

Lecture slides

**Course: Vibration Theory [2161212]****Coordinators:** W. Seemann**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 163)[SP\_05\_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. 167)[SP\_10\_mach]

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

**Learning Control / Examinations**

For the reason of high student number the exam is a written exam.  
Only dictionary is allowed.

**Conditions**

Authorisation by the Examination Office.

**Recommendations**

None

**Learning Outcomes**

Status of Technical Design in current Product Development; the lecture supports current examples of the fields of Precision Mechanics, Mechanical and Automotive Engineering

**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

**Media**

-

**Literature**

Hexact (R) Lehr- und Lernportal

**Remarks**

-

**Course: Technology of steel components [2174579]****Coordinators:** V. Schulze**Part of the modules:** SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach],  
SP 26: Materials Science and Engineering (p. 176)[SP\_26\_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 &amp; II

**Learning Outcomes**

At the begin of this lecture the basics for the evaluation of the influence of manufacturing processes on the behaviour of metallic components are imparted. After this, the different aspects of changing the behaviour of steel components by forming, heat treating, mechanical surface treatments and joining are discussed.

**Content**

Meaning, development and characterization of component states

Description of the influence of component states on

mechanical properties at quasistatic loading

mechanical properties at cyclic loading

tribological properties

Stability of component states

Component states due to forming

Component states due to quenching and tempering

Component states due to case hardening

Component states due to surface hardening

Component states due to nitriding

Component states due to machining

Component states due to mechanical surface treatments

Component states due to joining

**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**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_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**

Basic knowledge of thermodynamics and heat transfer

**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.

1. Terms and definitions: energy economics, climate change mitigation, energy use in buildings
2. Factors influencing energy consumption in buildings and occupants' comfort
3. Heat transfer through the building envelope, insulation technologies
4. Windows and glazings
5. Daylight use, glare protection, shadings
6. Ventilation and air-conditioning, „passive house“ concept
7. Heating and cooling with low-exergy systems (LowEx); ground heat sources and sinks
8. Solar thermal energy use in buildings
9. Heat and cold storage
10. Heat pumps (mechanically / thermally driven)
11. Solar Cooling
12. Cogeneration and Trigeneration
13. Examples of realised system concepts
14. Buildings within supply infrastructures; district heating
15. Excursion

**Media**

Powerpoint, blackboard, clicker (audience response system)

**Literature**

1. Voss, K.; Löhnert, G.; Herkel, S.; Wagner, A.; Wambganß, M.: Bürogebäude mit Zukunft - Konzepte, Analysen, Erfahrungen. Solarpraxis Verlag, 2. Aufl. 2007.
2. Wagner, A.: Energieeffiziente Fenster und Verglasungen. Solarpraxis Verlag, 3. Aufl. 2007.
3. Henning, H.-M. (ed.): Solar Assisted Air-Conditioning in Buildings. Springer, 2nd ed. 2007.
4. Marko, A.; Braun, P.: Thermische Solarenergienutzung an Gebäuden. Springer 1997.

**Remarks**

Participation in the computer lab exercise (2158108) is a prerequisite for the exam.

**Course: Thermal Solar Energy [2169472]****Coordinators:** R. Stieglitz**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. [172](#))[SP\_15\_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**

Basics in heat and mass transfer

**Learning Outcomes**

The lecture elaborates the basics of the solar technology and the definition of the major wordings and its physical content such as radiation, thermal use, insulation etc.. Further the design of solar collectors for different purposes is discussed and analyzed. The functional principle of solar plants is elaborated before at the end the ways for solar climatization is dis-cussed.

**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.

**Literature**

At the end of the lecture the content will be distributed by a CD containing all relevant information of the given lectures.

**Course: Thermal Turbomachines I [2169453]****Coordinators:** H. Bauer**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach]

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

**Learning Control / Examinations**

oral

Duration: approximately 1 hour

no tools or reference materials may be used during the exam

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The main topics of the course are the design principles, construction and applications of modern turbo-machinery. These issues are not only addressed on the level of individual components and assemblies, but are also considered by viewing the role of the complete turbine in the power generation process. In this manner the role of physical, economic and ecological factors in the design of the machines becomes evident. It is a recommended lecture combination with 'Thermal Turbomachines II'.

**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. 175)[SP\_24\_mach]

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

**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.

**Learning Outcomes**

This lecture builds on the fundamentals learned in Thermal Turbo Machines I and focusses on the design aspects and operations of the machines. It is a recommended lecture combination with 'Thermal Turbomachines I'.

**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: Thermodynamische Grundlagen / Heterogene Gleichgewichte mit Übungen [2193002]****Coordinators:** H. Seifert**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**

**Course: Tribology A [2181113]****Coordinators:** M. Scherge, M. Dienwiebel**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral exam 30 minutes

**Conditions**

None.

**Recommendations**

preliminary knowlegde in mathematics, mechanics and materials

**Learning Outcomes**

The lecture Tribology A introduces fundamental mechanisms present in tribological systems. In the course of the lecture the principal aspects of Tribology at the interface of Mechanical Engineering, Physics, Chemistry and Materials Science are treated. At the end of the lecture participants are able to evaluate Friction and Wear in tribological Systems and can name possible solutions for tribological optimization.

**Content**

\* Chapter 1: Friction Adhesion, geometrical and real area of contact, Friction experiments, friction powder, tribological stressing, environmental influences, tribological age, contact models, Simulation of contacts, roughness.

\* Chapter 2: Wear, plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-in, running- in dynamics, shear stress.

\* Chapter 3: Lubrication, base oils, Stribeck plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid lubrication.

**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. 181)[SP\_48\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral examination in combination with tribology A, Duration: 0,5 hours, also possible as a part of a major subject, no auxiliary means

**Conditions**

None.

**Recommendations**

helpful: basic knowledge about engines and materials science

**Learning Outcomes**

The students get to know the analysis of mechanical interaction, its consequences as well as the prevention of defects and breakdown

On the basis of a wide physical introduction the problems of dissipation as well as the reaction of solid bodies are discussed with the help of practical examples of engine components.

Additionally state-of-the-art measuring methods are introduced, which characterize the mechanical processes on the length scale from millimeters to the atomic range.

**Content**

Friction

Wear

Lubrication, additives

**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. 175)[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 lecture is intended to expand the knowledge from Thermal Turbomachines I+II. Special types of components such as radial turbines and transonic compressors are discussed with emphasis on the proper design of each individual component.

**Content**

Thermal Turbomaschinen, 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 Verlag, 1977, 1982

**Course: Turbo Jet Engines [2170478]****Coordinators:** H. Bauer, A. Schulz**Part of the modules:** SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach]

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

**Learning Control / Examinations**

oral

Duration: approximately 30 minutes

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

**Conditions**

None.

**Learning Outcomes**

The lecture concentrates on design concepts and operation of modern jet engines. Based on thermodynamics and fluid mechanics the main components of a jet engine are introduced such as intake, compressor, combustor, turbine and thrust nozzle. Various methods for reducing emissions, noise and fuel consumption are also discussed.

**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: Combustion Engines A with tutorial [2133101]****Coordinators:** U. Spicher**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. 172)[SP\_15\_mach], SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach]

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

**Learning Control / Examinations**

oral examination, Duration: 45 min., no auxiliary means

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

The students get basic knowledge in construction, thermodynamic process, main concepts of gasoline and Diesel engines, driving gear dynamics and design of combustion engines. In particular the thermodynamical processes and the problems of exhaust gas emissions are discussed.

Also, this lecture provides fundamentals for continuative lectures in the field of combustion engines.

**Content**

Introduction

Engine and operating parameters

Thermodynamics of combustion engines

Gas exchange

Otto-process

Diesel-process

**Literature**

Lecturer notes available in the 'Studentenhaus'

**Remarks**

weekly exercises to consolidate the lecture material

**Course: Combustion Engines B with Tutorial [2134135]****Coordinators:** U. Spicher**Part of the modules:** SP 48: Internal Combustion Engines (p. 181)[SP\_48\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 24: Energy Converting Engines (p. 175)[SP\_24\_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 knowledge from the lecture combustion engines A. They get to know construction elements, development tools and latest development trends. They will be able to understand and judge a wide variety of powertrain concepts.

**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**

exercises every two weeks to consolidate the lecture material

**Course: Behaviour Generation for Vehicles [2138336]****Coordinators:** C. Stiller, T. Dang**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach], SP 44: Technical Logistics (p. 180)[SP\_44\_mach], SP 18: Information Technology (p. 174)[SP\_18\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 31: Mechatronics (p. 178)[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. 176)[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

**Learning Outcomes**

- Mechanical Understanding of Load vs Material Strength
- Empirical Material Behavior
- Physical Understanding of Failure Phenomena
- Statistical Description of Failure
- Material Selection and Understanding Alloying Effects

**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 Description of Creep

## 2.4 Creep Mechanisms

## 2.5 Alloying Effects

**Literature**

1. Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); sehr lesenswert, relativ einfach aber dennoch umfassend, verständlich
2. Mechanical Behavior of Materials, Thomas H. Courtney (2nd Edition, McGraw Hill, Singapur); Klassiker zu den mechanischen Eigenschaften der Werkstoffe, umfangreich, gut
3. Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relativ einfach aber dennoch umfassender Überblick für metallische Werkstoffe
4. Fatigue of Materials, Subra Suresh (2nd Edition, Cambridge University Press); Standardwerk über Ermüdung, alle Materialklassen, umfangreich, für Einsteiger und Fortgeschrittene

**Course: Failure of structural materials: deformation and fracture [2181711]****Coordinators:** P. Gumbsch, O. Kraft, D. Weygand**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_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**

- Mechanical Understanding of Load vs Material Strength
- Empirical Material Behavior
- Physical Understanding of Failure Phenomena

**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
  - 6.1 hypotheses for failure
  - 6.2 linear elastic fracture mechanics
  - 6.3 crack resistance
  - 6.4 experimental measurement of fracture toughness
  - 6.5 defect measurement
  - 6.6 crack propagation
  - 6.7 application of fracture mechanics
  - 6.8 atomistics of fracture

**Literature**

1. Engineering Materials, M. Ashby and D.R. Jones (2nd Edition, Butterworth-Heinemann, Oxford, 1998); sehr lesenswert, relativ einfach aber dennoch umfassend, verständlich
2. Mechanical Behavior of Materials, Thomas H. Courtney (2nd Edition, McGraw Hill, Singapur); Klassiker zu den mechanischen Eigenschaften der Werkstoffe, umfangreich, gut
3. Bruchvorgänge in metallischen Werkstoffen, D. Aurich (Werkstofftechnische Verlagsgesellschaft Karlsruhe), relativ einfach aber dennoch umfassender Überblick für metallische Werkstoffe

**Course: Gear Cutting Technology [2149655]****Coordinators:** K. Felten**Part of the modules:** SP 12: Automotive Technology (p. 169)[SP\_12\_mach]

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

**Learning Control / Examinations**

oral, duration 30 min., no resources

**Conditions**

None.

**Learning Outcomes**

The student

- has the knowledge about the presented content,
- understands the within the lecture taught theory of gears and gear cutting as well as the taught basics and characteristics of the covered gear cutting processes,
- is able to transfer the within the lecture learned knowledge about the basics of the gearing geometry and the manufacturing of gears on new problematic issues and
- is able to analyze and to evaluate the applicability of the taught processes and techniques for various problems.

**Content**

This lecture is focused on the demands of the modern manufacturing process of gears on the basis of the gearing geometry and the theory of gears and transmission types. For this purpose the processes for manufacturing various gearing types are covered, which are state of the technology in current operational practice. The subdivision of the processes is made in soft and hard machining, in each case in cutting and non-cutting methods. For the comprehensive understanding of the taught processes initially the description of the kinematics, the machine technology, the tools, the fields of application and the speciality as well as the current trends are made. Subsequent for the evaluation and classification in the fields of application and the capability of the processes finally the sequence of manufacturing of gears in mass production and the manufacturing errors are covered in the lecture. The content of the lecture will be rounded off by demonstrative example parts and the possibility of the visit of real manufacturing environments within two short excursions to gear manufacturing companies.

1. History of gears
2. Basic factors of gear geometry
3. Types of toothed wheels
4. Types of gearings
5. Overview of methods for soft machining of gears (subdivided in metal-cutting and non-cutting, representation of the different processes regarding kinematics, machine-tool, tool and trend of development)
6. Overview over methods for hard machining of gears (subdivided in geometrical defined and undefined cutting edge, representation of the different processes regarding kinematics, machine-tool, tool and trend of development)
7. Sequence of manufacturing in mass production
8. Manufacturing errors of gears
9. Special applications of gearings

**Literature**

Lecture notes



**Course: Virtual Engineering II [2122378]****Coordinators:** J. Ovtcharova**Part of the modules:** SP 09: Dynamic Machine Models (p. 166)[SP\_09\_mach]

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

**Learning Control / Examinations**

Oral examination

Duration: 20 min

Auxiliary Means: none

**Conditions**

None.

**Recommendations**

None.

**Learning Outcomes**

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.

They will be able to model a scene in VR and store the VR graph on a computer. They will understand the inner workings of the VR pipeline for visualizing the scene works. They will be familiar with various systems of interacting with the VR scene and will be able to assess the advantages and disadvantages of various manipulation and tracking devices.

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).

They will get to know the vision of an integrated virtual product development and understand 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, Jurica Katicic**Part of the modules:** SP 31: Mechatronics (p. 178)[SP\_31\_mach], SP 17: Information Management (p. 173)[SP\_17\_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:

- draft 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 parts:

- Basics: Introduction in Virtual Reality (hardware, software, applications)
- Tool Kit: 3DVIA Virtools as application development environment
- Application: autonomous further development of an existing driving simulator in Virtual Reality in small groups

**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. 176)[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 auxillary 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 basic 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 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. 176)[SP\_26\_mach], SP 02: Powertrain Systems (p. 162)[SP\_02\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_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

Deep understanding of materials and mechanical loads in engines, gearboxes and drive sections, especially cast materials (cast aluminium alloys, cast magnesium alloys, cast iron), case-hardened steel, and other structural materials used in the power train.

### 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 for Lightweight Construction [2174574]****Coordinators:** K. Weidenmann**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[SP\_26\_mach], SP 12: Automotive Technology (p. 169)[SP\_12\_mach], SP 07: Dimensioning and Validation of Mechanical Constructions (p. 165)[SP\_07\_mach], SP 10: Engineering Design (p. 167)[SP\_10\_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 know different lightweight materials, their composition, properties and fields of application and can apply this knowledge effectively and precisely.

They master the hardening mechanisms of lightweight materials and can transfer this knowledge to applied problems.

The students have a basic understanding of basic mechanical models of composites - mainly polymer matrix composites - and can depict differences in the mechanical properties depending on composition and structure.

**Content**

Introduction

Constructive, production-oriented 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: Material Science III [2173553]****Coordinators:** A. Wanner**Part of the modules:** SP 26: Materials Science and Engineering (p. 176)[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. They can assess the effects of heat treatments and of alloying on the microstructure and the properties of iron-based materials (steels in particular). They can select steels for structural applications in mechanical engineering and subject them to appropriate heat treatments.

**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-Fe<sub>3</sub>C; 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. &amp; Honeycombe, R.W.K.

Steels – Microstructure and Properties

CIMA Publishing, 3. Auflage, 2006

**Course: Materials modelling: dislocation based plasticity [2182740]****Coordinators:** D. Weygand**Part of the modules:** SP 13: Strength of Materials/ Continuum Mechanics (p. 171)[SP\_13\_mach], SP 26: Materials Science and Engineering (p. 176)[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.

**Learning Outcomes**

Understanding of the physical basics of dislocations and their interaction with other point, line and area defects. Knowledge of modelling approaches for dislocation based plasticity. Modelling of microstructure evolution with discrete methods.

**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**

- D. Hull and D.J. Bacon, Introduction to Dislocations, Oxford Pergamon 1994
- J.P. Hirth and J. Lothe: Theory of dislocations, New York Wiley 1982. (oder 1968)
- J. Friedel, Dislocations, Pergamon Oxford 1964.
- V. Bulatov, W. Cai, Computer Simulations of Dislocations, Oxford University Press 2006
- 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 10: Engineering Design (p. 167)[SP\_10\_mach], SP 38: Production Systems (p. 179)[SP\_38\_mach]

ECTS Credits	Hours per week	Term	Instruction language
8	4	Winter term	de

**Learning Control / Examinations**

Performance is assessed in the form of one oral examination (45 min) during the lecture-free period. The examination will take place once every semester and can be retaken at every official examination date.

**Conditions**

None.

**Learning Outcomes**

The student

- has knowledge about the application of machine tools.
- comprehends the assembly and the operation purpose of the major components of a machine tool.
- is able to apply methods of selection and assessment of production machines to new tasks.
- is able to assess the dimensioning of a machine tool.

**Content**

The lecture overviews the assembly, dimensioning and application of machine tools and industrial handling. A consolidated and practice oriented knowledge is imparted about the choice, dimensioning and assessment of production machines. At first, the major components of machine tools are explained systematically. At this, the characteristics of dimensioning of machine tools are described in detail. Finally, the application of machine tools is demonstrated by means of example machines of the manufacturing processes turning, milling, grinding, massive forming, sheet metal forming and toothing.

**Media**

Lecture notes for the lecture "Machine Tools and Industrial Handling" will be made available through ilias.

**Literature**

lecture notes



**Course: Windkraft [23381]****Coordinators:** N. Lewald, Lewald**Part of the modules:** SP 15: Fundamentals of Energy Technology (p. [172](#))[SP\_15\_mach]

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

**Learning Control / Examinations****Conditions**

None.

**Learning Outcomes****Content**



Universität Karlsruhe (TH) | Der Rektor  
Forschungsuniversität · gegründet 1825

# Amtliche Bekanntmachung

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2008

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Nr. 78

## Inhalt

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Studien- und Prüfungsordnung der Universität Karlsruhe (TH) 360  
für den Bachelorstudiengang Maschinenbau

## **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.

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#### **II. Bachelorprüfung**

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- § 18 Leistungsnachweise für die Bachelorprüfung
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- § 21 Bescheid über Nicht-Bestehen, Bescheinigung von Prüfungsleistungen
- § 22 Aberkennung des Bachelorgrades
- § 23 Einsicht in die Prüfungsakten
- § 24 In-Kraft-Treten

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 berufs-feldbezogen 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 Leistungspunkten 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	<i>nicht bestanden</i> (failed) - es sind Verbesserungen erforderlich, bevor die Leistungen anerkannt werden,
F	<i>nicht bestanden</i> (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)



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