Karlsruhe Institute of Technology

Module Handbook
Master Course Mechanical Engineering (M.Sc.)

Winter Term 2012/2013
Long version
Date: 10/24/2012

Faculty of Mechanical Engineering

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

www.kit.edu

Publisher:

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

Frontpage Image: Rolls-Royce plc

Contact: rainer.schwarz@kit.edu

For informational use only. For legally binding information please refer to the german version of the handbook.

Table of Contents

Studienplan der Fakultät Maschinenbau für den Bachelor- und Masterstudiengang Maschinenbau

Fassung vom 24. Oktober 2012

Inhaltsverzeichnis

0 Abkürzungsverzeichnis

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

1 Studienpläne, Module und Prüfungen

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

1.1 Prüfungsmodalitäten

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

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

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

1.2 Module des Bachelorstudiums „B.Sc.“

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

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

Module	Veranstaltung	Koordinator	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	Frohnapfel		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[1]						2						
Technische Thermodynamik und Wärmeübertragung I, II							3	2		3	2	
Maschinenkonstruktionslehre I-IV	2	1		2	2		2	2		2	1	
MKL – Konstruieren im Team									1			1
Betriebliche Produktionswirtschaft										3	1	
Informatik im Maschinenbau	2	2	2									
Elektrotechnik und Elektronik							4	2				
Arbeitstechniken Maschinenbau				1		1						
Berufliches Grundpraktikum (6 Wochen vor Studienbeginn)												

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

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

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

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

1.5 Masterstudium mit Vertiefungsrichtungen

Es stehen folgende Vertiefungsrichtungen zur Auswahl:

Vertiefungsrichtung	**Abk.**	**Verantwortlicher**
Allgemeiner Maschinenbau	MSc	Furmans
Energie- und Umwelttechnik	E+U	Maas
Fahrzeugtechnik	FzgT	Gauterin
Mechatronik und Mikrosystemtechnik	M+M	Bretthauer
Produktentwicklung und Konstruktion	PEK	Albers
Produktionstechnik	PT	Lanza
Theoretischer Maschinenbau	ThM	Böhlke
Werkstoffe und Strukturen für Hochleistungssysteme	W+S	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	Erfolgs-kontrolle	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	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	w		
(13)	Physikalische Grundlagen der Lasertechnik	w	w	w	w	w	w	w		w
(14)	Numerische Mathematik für Informatiker und Ingenieure			w	w	w		w	w	
(15)	Einführung in die moderne Physik *<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	w	

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

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)	Wahrscheinlichkeitstheorie und Statistik	Winter	math	SS
(2)	Mathematische Methoden der Dynamik	Proppe	ITM	WS
(3)	Mathematische Methoden der Festigkeits-lehre	Böhlke	ITM	WS
(4)	Mathematische Methoden der Schwin-gungslehre	Seemann	ITM	SS
(5)	Mathematische Methoden der Strömungs-lehre	Class / Frohnapfel	IKET / ISL	SS
(6)	Mathematische Methoden der Strukturme-chanik	Böhlke	ITM	SS
(7)	Numerische Mathematik für Informatiker und Ingenieure	Neuß	math	SS
(8)	Mathematische Modelle von Produktions-systemen	Furmans/Proppe	IFL / ITM	WS

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

Wählbare Veranstaltungen siehe Modulhandbuch.

2.4 Wahlfach aus dem Bereich Wirtschaft/Recht im Masterstudiengang

Wählbare Veranstaltungen siehe Modulhandbuch.

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	SS
(4)	Mechatronik-Praktikum	Albers *et al.*	IPEK *et al.*	WS

4 Berufspraktikum

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

4.1 Inhalt und Durchführung des Berufspraktikums

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

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

Die Tätigkeiten im Grundpraktikum können aus folgenden Gebieten gewählt werden:

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

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

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

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

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

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

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

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

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

4.2 Anerkennung des Berufspraktikums

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

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

Zur Anerkennung des Berufs-Fachpraktikums wird ein Zertifikat des Ausbildungsbetriebes („Praktikantenzeugnis“) benötigt, das Art und Dauer der Tätigkeiten während des Berufs-Fachpraktikums beschreibt. Eventuelle Fehltage sind zu vermerken.

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

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

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

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

4.3 Sonderbestimmungen zur Anerkennung

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

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

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

5 Bachelor- und Masterarbeit

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

Institut für	**Abk.**	MSc	E+UT	FzgT	M+M	PEK	PT	ThM	W+S
Angewandte Informatik/ Automatisierungstechnik	AIA	●	●	●	●	●	●	●	●
Angewandte Werkstoffphysik	IAM-AWP	●	●	●	●	●	–	●	●
Arbeitswissenschaft u. Betriebsorganisation	ifab	●	●	–	–	●	●	–	–
Fahrzeugsystemtechnik	FAST	●	●	●	●	●	–	●	●
Fördertechnik u. Logistiksysteme	IFL	●	–	–	–	●	●	●	–
Informationsmanagement im Ingenieurwesen	IMI	●	–	●	●	●	●	–	–

Institut für	**Abk.**	MSc	E+UT	FzgT	M+M	PEK	PT	ThM	W+S
Keramik im Maschinenbau	IAM-KM	●	●	–	–	●	–	–	●
Kerntechnik u. Reaktorsicherheit	IKR	●	●	–	–	–	–	–	–
Kolbenmaschinen	IFKM	●	●	●	–	●	–	–	–
Mess- u. Regelungstechnik m. 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 u. 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	
(7)	Dimensionierung und Validierung mechanischer Konstruktionen	w								
(8)	Dynamik und Schwingungslehre		w	w	w		w		p	
(9)	Dynamische Maschinenmodelle	w	w					w	w	
(10)	Entwicklung und Konstruktion	w	w	w	w		w	w		
(11)	Fahrdynamik, Fahrzeugkomfort und –akustik		w		w	w	w		w	
(12)	Kraftfahrzeugtechnik	w	w		p		w			
(13)	Festigkeitslehre/ Kontinuumsmechanik	w	w	w	w	w	w	w	p	p
(14)	Gelöscht									
(15)	Grundlagen der Energietechnik	w	w	p	w	w	w			
(16)	Industrial Engineering (engl.)		w				w	w		
(17)	Informationsmanagement	w								
(18)	Informationstechnik	w	w	w	w	w	w	w	w	

Nr.	Schwerpunkt	B.Sc.	M.Sc.	E+U	FzgT	M+M	PEK	PT	ThM	W+S
(19)	Informationstechnik für Logistiksysteme		w				w	w		
(20)	Integrierte Produktentwicklung		w	w	w		p	w		
(21)	Kerntechnik		w	w					w	
(22)	Kognitive Technische Systeme		w		w	w	w	w	w	
(23)	Kraftwerkstechnik		w	w			w			
(24)	Kraft- und Arbeitsmaschinen	w	w	w	w		w			
(25)	Leichtbau		w	w	w		w	w		w
(26)	Materialwissenschaft und Werkstofftechnik	w	w	w	w	w	w	w	w	p
(27)	Modellierung und Simulation in der Energie- und Strömungstechnik		w	w	w	w	w			
(28)	Lifecycle Engineering		w		w	w	p	p		
(29)	Logistik und Materialflusslehre		w				w	p		
(30)	Mechanik und Angewandte Mathematik		w	w	w	w	w	w	p	w
(31)	Mechatronik	w	w	w	w	p	w	w	w	
(32)	Medizintechnik		w			w	w			
(33)	Mikrosystemtechnik		w	w	w	p	w	w		
(34)	Mobile Arbeitsmaschinen		w		p	w	w	w		
(35)	Modellbildung und Simulation		w		w	w	w	w	p	w
(36)	Polymerengineering		w	w	w		w	w		w
(37)	Produktionsmanagement		w					w		
(38)	Produktionssysteme	w								
(39)	Produktionstechnik		w		w		w	p		
(40)	Robotik		w			p	w	w	w	
(41)	Strömungslehre		w	w	w		w		p	
(42)	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	w
(48)	Verbrennungsmotoren	w	w	w	p		w			
(49)	Zuverlässigkeit im Maschinenbau		w	w	w	w	w	w	w	p
(50)	Bahnsystemtechnik	w	w		p	w	w			
(51)	Entwicklung innovativer Geräte		w	w	w		p	w		
(52)	Production 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.

SP 1: Advanced Mechatronics (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 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 (Frohnapfel)
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)

7 Änderungshistorie (ab 29.10.2008)

29.10.2008	Änderungen im Abschnitt 1.2 Module des Bachelorstudiums „B.Sc.“: - Prüfungen im Modul 1 - Höhere Mathematik: Getrennte Prüfungen zu HM I und HM II - Prüfungen im Modul 3 - Technische Mechanik: Getrennte Prüfungen zu TM I und TM II - Modul "Schwerpunkt": Umfang des Kernbereichs: 8LP, Umfang des Ergänzungsbereichs: 4 LP
10.12.2008	Änderungen im Abschnitt 1.3 Studienplan des 1. Abschnitts des Bachelorstudiums „B.Sc.“ - Informatik: V, Ü und P finden im ersten Semester statt Änderungen im Abschnitt 1.5 Masterstudium mit Vertiefungsrichtungen - „Es stehen folgende Vertiefungsrichtungen zur Auswahl“ Änderungen im Abschnitt 2.1 Wahlpflichtfächer im Bachelor- und Masterstudiengang - Aufnahme von „Informationssysteme“ als Wahlpflichtfach für BSc, MSc, FzgT, M+M, PEK, PT Änderungen im Abschnitt 2.5 - Umbenennung des „Allgemeinen Wahlfachs“ in „Wahlfach“ Änderungen im Abschnitt 3.1 Fachpraktikum - Tabelle wurde durch Fließtext ersetzt Änderungen im Abschnitt 4 Berufspraktikum - Die Abschnitte der Fachpraktika sollen in einem geschlossenen Zeitraum durchgeführt werden Änderungen im Abschnitt 4.3 Sonderbestimmungen zur Anerkennung - Auf Erwerb gerichtete, berufspraktische Tätigkeiten werden nicht mehr erwähnt Änderungen im Abschnitt 6.1 Zuordnung der Schwerpunkte zum Bachelor- und den Vertiefungsrichtungen des Masterstudiengangs - „Informationsmanagement“ als Schwerpunkt für BSc und FzgT zugelassen - „Lifecycle Engineering“ als Schwerpunkt für BSc zugelassen Änderungen im Abschnitt 6.3 Wahlmöglichkeiten für den Schwerpunkt im „Bachelor of Science“ - Aktualisierung des gesamten Schwerpunkt-Angebotes
	Umbenennung der „Wellenphänomene in der Physik“ in Wellenphänomene in der klassischen Physik Abschnitt 2.1: unter (18) : „Moderne Physik für Ingenieure“ anstelle der „Physik für Ingenieure“, in Abschnitt 2.1 keine Nennung der Dozenten Abschnitt 2.3: unter (11) : „Grundlagen der modernen Physik“ anstelle der „Höheren Physik für Maschinenbauer“ Einfügung einer Zwischenüberschrift 6.4 mit entsprechender Änderung des Inhaltsverzeichnisses
03.02.2010	Änderungen von Veranstaltungen in den Abschnitten 2.1 bis 2.4 Änderung im Punkt 6.1 - Schwerpunkt 50 „Bahnsystemtechnik“ in Tabelle „Schwerpunkte“ eingefügt. Änderung im Punkt 6.2 - 2. Absatz ergänzt um den Satz: „Stehen mehrere Wahlpflichtfächer (WP) als Auswahlmöglichkeit zur Verfügung, muss nur ein Wahlpflichtfach belegt werden.“ Änderungen im Punkt 6.4 - Schwerpunkttabellen ergänzt um die Spalten „Veranstaltungsnummer (VNr)“ und „Leistungspunkte (LP)“. Aktuell vorhandene Daten wurden eingefügt. - Einfügungen und Streichungen von Veranstaltungen in den Schwerpunkten - Schwerpunkt 50 „Bahnsystemtechnik“ eingefügt
07.07.2010	Änderungen im Abschnitt 1.1: Ergänzung der Prüfungsmodalitäten Änderungen im Abschnitt 1.2: Umbenennung des „Workshops Teamkonstruktion“ in „Konstruieren im Team“; Bemerkung zu Erfolgskontrollen in Zusatzmoduln im Bachelorstudium Änderungen im Abschnitt 1.4: Die Bachelorarbeit ist im Anschluss an den ersten Abschnitt zu absolvieren. Änderungen im Abschnitt 1.5: Bemerkung zu Erfolgskontrollen in Zusatzmoduln im Masterstudiumj Änderungen im Abschnitt 2.1: Für manche Schwerpunkte kann die Wahl eines Wahlpflichtfachs empfohlen sein. Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 2.3 und 2.4: Aktualisierung der wählbaren Wahlfächer Änderungen im Abschnitt 4.1: Grundpraktikum auch an Universitäten und vergleichbaren Einrichtungen möglich Änderungen im Abschnitt 6.1 und 6.2: Zusätzliche Erläuterung zur vertiefungsrichtungsspezifischen Schwerpunktwahl; Maximaler Umfang des Schwerpunkts im Bachelorstudium: 16 statt 14 LP Änderungen im Abschnitt 6.3 und 6.4: Überarbeitung der Formulierungen und Anpassung von SWS an LP Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes
29.06.2011	Änderungen im Abschnitt 1.4.: Ergänzung zu Durchführung Änderungen im Abschnitt 1.5.: Anpassung der Module Änderungen im Abschnitt 2.1.: Aktualisierung der Wahlpflichtfächer Änderungen im Abschnitt 2.3.: Aktualisierung der wählbaren Wahlpflichtfächer Änderungen im Abschnitt 4: Inhaltliche Anpassungen Änderungen im Abschnitt 4.1.: Inhaltliche Anpassung

	Änderungen im Abschnitt 4.2.: Inhaltliche Anpassung Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes
20.06.2012	Änderung im Abschnitt 2.4 (Wahlfach Wirtschaft /Recht): Die wählbare Fächer sind nun nicht mehr hier sondern im Modulhandbuch aufgeführt. Änderung in den Abschnitten 4. und 4.1 und 4.2 (Berufspraktikum): Inhaltliche Anpassung
24.10.2012	Änderung im Abschnitt 2.3 (Wahlfach Naturwissenschaften/Informatik/Elektrotechnik): Die wählbare Fächer sind nun nicht mehr hier, sondern im Modulhandbuch aufgeführt. Änderungen im Abschnitt 2.1: Aktualisierung der Wahlpflichtfächer Änderungen im Abschnitt 6.4: Aktualisierung des Schwerpunktangebotes (SP 14 gelöscht) Änderungen der Zuordnungen zur Vertiefungsrichtung Produktionstechnik Umbenennung der Vertiefungsrichtung "Unspezifischer Master Maschinenbau" in "Allgemeiner Maschinenbau"

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: Compulsory Elective Subject General Mechanical Engineering [MSc-Modul AM, WPF AM]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2109026	Work Science (p. 49)	W	B. Deml
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
2114093	Fluid Technology (p. 57)	W	M. Geimer
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 73)	S	A. Class, B. Frohnapfel
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2141861	Introduction to Microsystem Technology I (p. 58)	W	A. Last
2142874	Introduction to Microsystem Technology II (p. 59)	S	A. Last
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2121350	Product Lifecycle Management (p. 91)	W	J. Ovtcharova
2149605	Simulation of production systems and processes (p. 97)	W	K. Furmans, V. Schulze, P. Stock
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2121001	Integrated Information Systems for engineers (p. 103)	S	S. Rogalski, J. Ovtcharova
2183703	Modelling and Simulation (p. 82)	W/S	B. Nestler, P. Gumbsch
2181738	Scientific computing for Engineers (p. 109)	W	D. Weygand, P. Gumbsch
2183702	Modelling of Microstructures (p. 80)	W	B. Nestler, D. Weygand, A. August
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2165515	Fundmentals of Combustion I (p. 61)	W	U. Maas
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
2117054	Mathematical Models of Production Systems (p. 75)	W	K. Furmans, C. Proppe, Proppe
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject E+U [MSc-Modul E+U, WPF E+U]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
2114093	Fluid Technology (p. 57)	W	M. Geimer
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 73)	S	A. Class, B. Frohnapfel
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2165515	Fundmentals of Combustion I (p. 61)	W	U. Maas
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject FzgT [MSc-Modul FzgT, WPF FzgT]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
2114093	Fluid Technology (p. 57)	W	M. Geimer
0186000	Probability Theory and Statistics (p. 108)	W/S	D. Hug
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 73)	S	A. Class, B. Frohnapfel
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2121350	Product Lifecycle Management (p. 91)	W	J. Ovtcharova
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2121001	Integrated Information Systems for engineers (p. 103)	S	S. Rogalski, J. Ovtcharova
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2165515	Fundmentals of Combustion I (p. 61)	W	U. Maas
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder
23224	Electrical Engineering II (p. 55)	S	W. Menesklou

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject M+M [MSc-Modul M+M, WPF M+M]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
0186000	Probability Theory and Statistics (p. 108)	W/S	D. Hug
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2141861	Introduction to Microsystem Technology I (p. 58)	W	A. Last
2142874	Introduction to Microsystem Technology II (p. 59)	S	A. Last
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2121350	Product Lifecycle Management (p. 91)	W	J. Ovtcharova
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2121001	Integrated Information Systems for engineers (p. 103)	S	S. Rogalski, J. Ovtcharova
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2165515	Fundmentals of Combustion I (p. 61)	W	U. Maas
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject PEK [MSc-Modul PEK, WPF PEK]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2109026	Work Science (p. 49)	W	B. Deml
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
2114093	Fluid Technology (p. 57)	W	M. Geimer
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2141861	Introduction to Microsystem Technology I (p. 58)	W	A. Last
2142874	Introduction to Microsystem Technology II (p. 59)	S	A. Last
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2121350	Product Lifecycle Management (p. 91)	W	J. Ovtcharova
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2121001	Integrated Information Systems for engineers (p. 103)	S	S. Rogalski, J. Ovtcharova
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject PT [MSc-Modul PT, WPF PT]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2109026	Work Science (p. 49)	W	B. Deml
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2105011	Introduction into Mechatronics (p. 53)	W	G. Bretthauer, A. Albers
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2114093	Fluid Technology (p. 57)	W	M. Geimer
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
2141861	Introduction to Microsystem Technology I (p. 58)	W	A. Last
2142874	Introduction to Microsystem Technology II (p. 59)	S	A. Last
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2110031	Service Operations Management (p. 65)	S	B. Deml
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2117054	Mathematical Models of Production Systems (p. 75)	W	K. Furmans, C. Proppe, Proppe
2183703	Modelling and Simulation (p. 82)	W/S	B. Nestler, P. Gumbsch
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2121350	Product Lifecycle Management (p. 91)	W	J. Ovtcharova
2149605	Simulation of production systems and processes (p. 97)	W	K. Furmans, V. Schulze, P. Stock
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
2121001	Integrated Information Systems for engineers (p. 103)	S	S. Rogalski, J. Ovtcharova
2161212	Vibration Theory (p. 104)	W	W. Seemann
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject ThM [MSc-Modul ThM, WPF ThM]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2114093	Fluid Technology (p. 57)	W	M. Geimer
0186000	Probability Theory and Statistics (p. 108)	W/S	D. Hug
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161212	Vibration Theory (p. 104)	W	W. Seemann
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2154432	Mathematical Methods in Fluid Mechanics (p. 73)	S	A. Class, B. Frohnapfel
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
22512	Heat and mass transfer (p. 107)	W	H. Bockhorn
2183703	Modelling and Simulation (p. 82)	W/S	B. Nestler, P. Gumbsch
2181738	Scientific computing for Engineers (p. 109)	W	D. Weygand, P. Gumbsch
2183702	Modelling of Microstructures (p. 80)	W	B. Nestler, D. Weygand, A. August
2165515	Fundmentals of Combustion I (p. 61)	W	U. Maas
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov
2117054	Mathematical Models of Production Systems (p. 75)	W	K. Furmans, C. Proppe, Proppe
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Compulsory Elective Subject W+S [MSc-Modul W+S, WPF W+S]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
5		

ID	Course	Term	Lecturer
2162235	Introduction into the multi-body dynamics (p. 54)	S	W. Seemann
2161224	Machine Dynamics (p. 69)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider
2400311	Modern Physics for Engineers (p. 83)	S	B. Pilawa
2174576	Systematic Materials Selection (p. 99)	S	A. Wanner
2183703	Modelling and Simulation (p. 82)	W/S	B. Nestler, P. Gumbsch
2181738	Scientific computing for Engineers (p. 109)	W	D. Weygand, P. Gumbsch
2183702	Modelling of Microstructures (p. 80)	W	B. Nestler, D. Weygand, A. August
2147175	CAE-Workshop (p. 51)	W/S	A. Albers, Assistenten
2161212	Vibration Theory (p. 104)	W	W. Seemann
2142890	Physics for Engineers (p. 89)	S	P. Gumbsch, A. Nesterov-Müller, D. Weygand
2117095	Basics of Technical Logistics (p. 60)	W	M. Mittwollen, Madzharov

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 master´s program, a reduced catalogue exists for every specialization (see Studienplan).

Module: Elective Subject [MSc-Modul 04, WF]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
4		

Learning Control / Examinations
graded oral exam

Conditions
None.

Learning Outcomes
In the elective subject the basics of a chosen aspect of mechanical engineering is taught.

Content
see chosen elective subject

Module: Modeling and Simulation [MSc-Modul 05, MS]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
7		

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2185227	Modelling and Simulation (p. 81)	4	W	7	C. Proppe, K. Furmans, C. Stiller, B. Pritz

Learning Control / Examinations
written, auxiliary means: own manuscripts

Conditions
none

Recommendations
none

Learning Outcomes
Models and simulations are components of almost any field of mechanical engineering. In this course, in which a multiplicity of institutes cooperate, an overview of modelling and simulation techniques typical in mechanical engineering is to be given. Thereby, students obtain the ability to carry out simulation studies starting from the formulation of problems by concepts, implementation, verification and validation. The mathematical-numerical bases are presented and illustrated by examples. In the exercises complex simulation studies are compiled and tested.

Content
Introduction: Overview, concept formation, simulation studies, time/event-discrete models, event-oriented/process orientated/transaction-oriented view, typical model classes (operation/maintenance, storekeeping, loss-susceptible systems)
Time-continuous models with concentrated parameters, model characteristics and model analysis, numerical treatment of ordinary differential equations and differential-algebraic sets of equations, coupled simulation of time-continuous models with concentrated parameters
Time-continuous models with distributed parameters, description of systems by means of partial differential equations, model reduction, numerical solution procedures for partial differential equations

Module: Product Development [MSc-Modul 06, PE]

Coordination: S. Matthiesen
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

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

Courses in module

ID	Course	Hours per week C/E/T	Term	CP	Responsible Lecturer(s)
2146176	Product Development - Methods of Product Development (p. 93)	3	S	6	A. Albers, N. Burkardt, Dipl.-Ing. N. Burkardt
2150510	Product Development - Manufacturing and Material Technology (p. 94)	6	S	9	V. Schulze

Learning Control / Examinations
Two exams, see according lectures

Conditions
Bachelor Mechanical Engineering

Learning Outcomes
Holistic view on the Life Cycle of Machine Systems with focus on product development, poduction technology and material selection

Content

- life cycle of technical systems
- integration of product development, production technology and material sciences
- teaching of corresponding activities and supporting methods

Module: Specialized Practical Training [MSc-Modul 07, FP]

Coordination: C. Stiller, K. Furmans
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
3		

ID	Course	Term	Lecturer
2138328	Measurement Instrumentation Lab (p. 78)	S	C. Stiller, P. Lenz
2117084	Dezentral gesteuerte Intralogistiksysteme (p. 52)	W	K. Furmans, T. Baur
2161241	Schwingungstechnisches Praktikum (p. 96)	S	H. Hetzler, A. Fidlin
2105014	Laboratory mechatronics (p. 77)	W	A. Albers, G. Bretthauer, C. Proppe, C. Stiller

Learning Control / Examinations

Conditions
none

Learning Outcomes

Content
see chosen practical training

Remarks
One of the training courses has to be chosen.

Module: Mathematic Methods [MSc-Modul 08, MM]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
6		

ID	Course	Term	Lecturer
0186000	Probability Theory and Statistics (p. 108)	W/S	D. Hug
2161206	Mathematical Methods in Dynamics (p. 70)	W	C. Proppe
2161254	Mathematical Methods in Strength of Materials (p. 71)	W	T. Böhlke
2162241	Mathematical methods of vibration theory (p. 72)	S	W. Seemann
2162280	Mathematical Methods in Structural Mechanics (p. 74)	S	T. Böhlke
2154432	Mathematical Methods in Fluid Mechanics (p. 73)	S	A. Class, B. Frohnapfel
2117054	Mathematical Models of Production Systems (p. 75)	W	K. Furmans, C. Proppe, Proppe
01874	Numerical Mathematics (p. 85)	S	C. Wieners, Neuß, Rieder

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

Conditions
None.

Learning Outcomes
In the chosen subject mathematical methods for solving problems of engineering mechanics are taught.

Content
see chosen elective subject

Module: Major Field 1 [MSc-Modul 09, SP 1]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
16		

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

Conditions
see Studienplan

Learning Outcomes
Within the major field a special aspect 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 (see Studienplan).

Module: Major Field 2 [MSc-Modul 10, SP 2]

Coordination: C. Proppe
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
16		

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

Conditions
see Studienplan

Learning Outcomes
Within the major field a special aspect 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 (see Studienplan).

Module: Elective Subject Natural Science/Computer Science/Electrical Engineering [MSc-Modul 11, WF NIE]

Coordination: U. Maas
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
6		

ID	Course	Term	Lecturer
2154436	Aerothermodynamics (p. 48)	S	F. Seiler
23620	Hardware/Software Codesign (p. 62)	W	M. Hübner
23113	Methoden der Signalverarbeitung (p. 79)	W	F. Puente
2143876	Nanotechnology with Clusterbeams (p. 84)	W/S	J. Gspann
23737	Photovoltaics (p. 88)	S	M. Powalla
2153406	Flows with chemical reactions (p. 98)	W	A. Class
2106002	Computer Engineering (p. 102)	S	G. Bretthauer
23605	Systems and Software Engineering (p. 100)	W	K. Müller-Glaser
2153429	Magnetohydrodynamics (p. 64)	W	L. Bühler
2181612	Physical basics of laser technology (p. 90)	W	J. Schneider

Learning Control / Examinations
Please refer to the description of the different courses.

Conditions
None.

Recommendations
None.

Learning Outcomes
After completing the elective course attendents can:

- explain the fundamentals in a specific subject of science, computer science or electrical engineering.

Content
Please refer to the description of the listet courses.

Module: Elective Subject Economics/Law [MSc-Modul 12, WF WR]

Coordination: K. Furmans
Degree programme: Masterstudiengang Maschinenbau (M.Sc.)
Subject:

ECTS Credits	Cycle	Duration
4		

ID	Course	Term	Lecturer
2109026	Work Science (p. 49)	W	B. Deml
2110017	Leadership and Conflict Management (in German) (p. 67)	S	H. Hatzl
2145184	Leadership and Product Development (p. 63)	W	A. Ploch
2149667	Quality Management (p. 95)	W	G. Lanza
2577900	Management and Strategy (p. 106)	S	H. Lindstädt
2581963	The Management of R&D Projects with Case Studies (p. 56)	W/S	H. Schmied
24016	Public Law I - Basic Principles (p. 86)	W	I. Spiecker genannt Döhmann
24656	Patent Law (p. 87)	S	P. Bittner

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

Conditions
None.

Learning Outcomes
In the elective subject econony/law the basics of one aspects of economy or law are taught.

Content
see chosen subject

4 Courses

4.1 All Courses

Course: Aerothermodynamics [2154436]

Coordinators: F. Seiler
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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
Students are familiar with the aerodynamic problems occurring during re-entry of space vehicles into the earth's atmosphere. During the flight the air flow is strongly heated by the bow wave formation in the high Mach number flow regime, wherefore the physics and chemistry, i.e. real gas effects and the behaviour of hot air at high temperatures need to be taken into account. The combination of the thermodynamics of hot air and the flow development at hypersonic flow conditions coupled with extreme heat flux phenomena is usually summarised in the term "Aerothermodynamics". The students can discuss the fundamental equations of fluid mechanics and aerothermodynamics for the case of a re-entry flight trajectory of a space vehicle.

Content
Nature of a hypersonic flow
Fundamentals of aerothermodynamics
Problems during re-entry
Flow regimes during re-entry
Applied hypersonic research

Literature
H. Oertel jun.: Aerothermodynamik, Springer-Verlag, Berlin Heidelberg New York, 1994
F. Seiler: Skript zur Vorlesung über Aerothermodynamik

Course: Work Science [2109026]

Coordinators: B. Deml

Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT]

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 usefull

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

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: CAE-Workshop [2147175]

Coordinators: A. Albers, Assistenten

Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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)
- stess and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to topology and shape optimization
- creation and calculation of various optimization models with the optimization package TOSCA and the Abaqus solver

Content in the winter semester:

- introduction to the finite element analysis (FEA)
- stress and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to multi-body simulation (MBS)
- preparation and running of multi-body simulation models. Coupling of the MBS and FEA to calculate hyprid multi-body simulation problems.

Literature
The workshop script will be allocated at Ilias.

Course: Dezentral gesteuerte Intralogistiksysteme [2117084]

Coordinators: K. Furmans, T. Baur
Part of the modules: Specialized Practical Training (p. 42)[MSc-Modul 07, FP]

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

Learning Control / Examinations
Certificate by colloquium with presentation

Conditions
None.

Learning Outcomes
The student is able to programm object-oriented. Decentralized logistic systems for material handling are known and the student is able to design models out of complex cinematic systems.

Content

- Introduction to material handling systems
- Construction of a model for decentralized logistic systems
- object-oriented programming with LabView
- Implementation of the model with Mindstorms

Presentation of the results

Course: Introduction into Mechatronics [2105011]

Coordinators: G. Bretthauer, A. Albers

Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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 PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

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

Course: Electrical Engineering II [23224]

Coordinators: W. Menesklou
Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT]

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

Learning Control / Examinations
The assessment consists of a written exam (120 min) taking place in the recess period (according to Section 4(2), 1 of the examination regulation). The examination takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
Successful completion of the module Electrical Engineering [WI1ING4].

Learning Outcomes
The student knows and understands basic components and techniques of electrical engineering.

Content
This course introduces undergraduate students of business engineering into topics of advanced electrical engineering like electrical instrumentation, semiconductors, and communication systems. Within the lecture, assignments to the curriculum are discussed and are used for preparation for written examination.

Media
Online material is available at http://www.iwe.kit.edu

Literature
Online material is available on http://www.iwe.kit.edu/
Elective literature:
Will be announced in the lecture.

Course: The Management of R&D Projects with Case Studies [2581963]

Coordinators: H. Schmied
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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

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

Conditions
None.

Learning Outcomes

- Students shall be able to discuss different tasks of R&D-management.
- Students shall be able to apply common approaches to solve these general problems.

Content

- The communication between R&D, production and marketing.
- Problems concerning measuring the productivity of the R&D system.
- Methods for improving the productivity of R&D systems.
- Planning of R&D projects with the help of the Communication-Matrix-Methods for controlling R&D projects' progress.
- The marketing of scientific skills.
- The communication matrix as a tool for the implementation of simultaneous engineering.
- Case studies.

Literature
will be announced in the course

Course: Fluid Technology [2114093]

Coordinators: M. Geimer
Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

ECTS Credits	Hours per week	Term	Instruction language
4	4	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: Introduction to Microsystem Technology I [2141861]

Coordinators: A. Last

Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In analogy to processes employed in fabrication of microelectronics circuits the core technologies as well as materials for producing microstructures and components are presented. Finally, various techniques for Silicon micromachining are explained and illustrated with examples for micro-components and micro-systems.

Content
- Introduction in Nano- and Microtechnologies
- Silicon and processes for fabricating microelectronics circuits
- Basic physics background and crystal structure
- Materials for micromachining
- Processing technologies for microfabrication
- Silicon micromachining
- Examples

Literature
Fundamentals of Microfabrication, M. Madou, CRC Press, Boca Raton 1997.

Course: Introduction to Microsystem Technology II [2142874]

Coordinators: A. Last
Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In the first part, methods for lithographic pattern transfer are summarized. Then specific techniques such as the LIGA process, micro-machining, and laser-patterning are explained and examples are given. Finally assembly and packaging methods are presented leading into a discussion of entire microsystems.

Content
- Introduction in Nano- and Microtechnologies
- Lithography
- LIGA-technique
- Mechanical microfabrication
- Patterning with lasers
- Assembly and packaging
- Microsystems

Literature
Fundamentals of Microfabrication, M. Madou, CRC Press, Boca Raton 1997.

Course: Basics of Technical Logistics [2117095]

Coordinators: M. Mittwollen, Madzharov

Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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: Fundmentals of Combustion I [2165515]

Coordinators: U. Maas

Part of the modules: Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M]

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

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

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students are able to:

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

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

Media
Blackboard and Powerpoint presentation

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

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

Course: Hardware/Software Codesign [23620]

Coordinators: M. Hübner
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Oral exam.

Conditions
None.

Recommendations
None.

Learning Outcomes
After completing the course, students can:

- understand the fundamentals of Hardware/Software Codedesign.
- comprehend and classify target architectures.
- apply methods for the estimation of design quality.
- describe partitioning strategies for HW/SW systems.

Content
Hardware/Software Co-design is the denomination of the concurrent and interlocked design of a system's hardware and software components. The most modern embedded systems (for example mobile phones, automotive and industrial controller devices, game consoles, home cinema systems, network routers) are composed of cooperating hardware and software components. Enabled by the rapid progress in microelectronics, embedded systems are becoming increasingly more complex with manifold application specific criteria. The deployment of computer aided design tools is not only necessary for handling the increasing complexity, but also for reducing the design costs and time-to-market. The lecture Hardware/Software Codesign discusses the needed criteria & methods and possible hardware/software target architectures on following topics:

- Target architectures of HW/SW-systems
- DSP, microcontrollers, ASIPs, FPGAs, ASIC, System-on-Chip
- Processor design: Pipelining, superscalar, cache, VLIW
- Estimation of design quality
- Hardware- and software-performance
- Methods for hardware/software partitioning
- Iterative and constructive heuristics

Interface and communications synthesis

Literature
Course material online: estudium.fsz.kit.edu
Literature: J. Teich, C. Haubelt: „Digitale Hardware/Software-Systeme-Synthese und Optimierung", Springer-Verlag, 2007 (2. Auflage)
D.D. Gajski, F. Vahid, S. Narayan, J. Gong: „Specification and Design of Embedded Systems", Prentice Hall, 1994

Course: Leadership and Product Development [2145184]

Coordinators: A. Ploch
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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: Magnetohydrodynamics [2153429]

Coordinators: L. Bühler
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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 gives an introduction to magnetohydrodynamics for students in mechanical engineering, physics or mathematics. Insight is provided into the interaction of electro- and fluid dynamics that is required for modeling of magnetohydrodynamic flows in engineering applications or for phenomena in geo and astrophysics.

Content

- Introduction
- Basics of electro and fluid dynamics
- Exact solutions, Hartmann flow, pump, generator, channel flows
- Inductionless approximation
- Developing flows, change of cross-section, variable magnetic fields
- Alfven waves
- Stability, transition to turbulence
- Liquid dynamos

Literature
U. Müller, L. Bühler,2001,Magnetofluiddynamics in Channels and Containers, ISBN 3-540-41253-0, Springer
R. Moreau, 1990, Magnetohydrodynamics, Kluwer Academic Publisher
P. A. Davidson, 2001, An Introduction to Magnetohydrodynamics, Cambridge University Press
J. A. Shercliff, 1965, A Textbook of Magnetohydrodynamics, Pergamon Press

Course: Service Operations Management [2110031]

Coordinators: B. Deml
Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT]

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

Learning Control / Examinations
Oral exam, length: 30 minutes
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

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: Leadership and Conflict Management (in German) [2110017]

Coordinators: H. Hatzl
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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

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: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

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

Conditions
none

Recommendations
none

Learning Outcomes
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: Mathematical Methods in Dynamics [2161206]

Coordinators: C. Proppe

Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Mathematic Methods (p. 43)[MSc-Modul 08, MM]

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

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

Conditions
none

Recommendations
none

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

Content
Dynamics of continua:
Concept of continuum, geometry of continua, kinematics and kinetics of continua

Dynamics of rigid bodies:
Kinematics and kinetics of rigid bodies

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

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

Applications

Literature
Lecture notes (available online)

J.E. Marsden, T.J.R. Hughes: Mathematical foundations of elasticity, New York, Dover, 1994

P. Haupt: Continuum mechanics and theory of materials, Berlin, Heidelberg, 2000

M. Riemer: Technische Kontinuumsmechanik, Mannheim, 1993

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

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

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

Course: Mathematical Methods in Strength of Materials [2161254]

Coordinators: T. Böhlke

Part of the modules: Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Mathematic Methods (p. 43)[MSc-Modul 08, MM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM]

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

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

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can effectively and precise 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.
During the associated tutorials the students apply the theoretical methods to solve concrete problems.

Content
Tensor algebra

- vectors; basis transformation; dyadic product; tensors of 2nd order
- properties of 2nd order tensors: symmetry, anti-symmetry, orthogonality etc.
- eigenvalue problem, theorem of Cayley-Hamilton, invariants; tensors of higher order
- tensor algebra in curvilinear coordinate systems
- tensor analysis in curvilinear coordinate systems
- Differentiation of tensor functions

Application of tensor calculus in strength of materials

- kinematics of infinitesimal and finite deformations
- transport theorem, balance equations, stress tensor
- theory of elasticity
- thermo-elasticity
- 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 PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Mathematic Methods (p. 43)[MSc-Modul 08, MM]

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, B. Frohnapfel
Part of the modules: Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Mathematic Methods (p. 43)[MSc-Modul 08, MM], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U]

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

Learning Control / Examinations
written

Duration: 3 hours

Aux. means: formules, pocket calculator

Conditions
None.

Recommendations
Basic Knowledge about Fluid Mechanics

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

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

Content
The lecture will cover a selection of the following topics

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

Media
Blackboard, Power Point

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

Course: Mathematical Methods in Structural Mechanics [2162280]

Coordinators: T. Böhlke
Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Mathematic Methods (p. 43)[MSc-Modul 08, MM]

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

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

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
Ther 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.
During the associated tutorial, the students apply the theoretical concepts to concrete problems.

Content
Basics of variational calculus

- functionals; Frechet-differential; Gateaux-differential; maximum or minimum problems
- lemma of variational calculus and Lagrange delta-process; Euler-Lagrange-equations

Applications: Principals of continuums mechanics

- variational principals in mechanics; variational formulierung of boundary value problem of elastostatic
- method of Ritz; finite element method

Applications: Homogenization methods for materials with microstructure

- mesoscopic and macroskopic stress and strain measures
- Mean values of ensembles, ergodicity
- effective elastic properties
- Homogenization of thermo-elastic properties
- Homogenization of plastic and visco-plastic properties
- Fe-based homogenization

Literature
Vorlesungsskript
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Gross, D., Seelig, T.: Bruchmechanik – Mit einer Einführung in die Mikromechanik.
Springer 2002.
Klingbeil, E.: Variationsrechnung, BI Wissenschaftsverlag, 1977
Torquato, S.: Random Heterogeneous Materials. Springer, 2002.

Course: Mathematical Models of Production Systems [2117054]

Coordinators: K. Furmans, C. Proppe, Proppe
Part of the modules: Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Mathematic Methods (p. 43)[MSc-Modul 08, MM], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

Learning Control / Examinations
oral

30min (electives), 60min (main subject)

examination aids: none

Conditions
none

Recommendations
Basic knowledge of statistic
recommended compusory optional subject:

- Stochastics in Mecanical Engineering

recommended lecture:

- Material flow in logistic systems (also parallel)

Learning Outcomes
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 exakt methods.
- knows basic methods for simulation of production systems

Content

- single server systems: M/M/1, M/G/1: priority rules, model of failures
- networks: open and closed approximations, exact solutions and approximations
- application to flexible manufacturing systems, AGV (automated guided vehicles) - systems
- modeling of control approaches like constant work in process (ConWIP) or kanban
- discrete-time modeling of queuing systems
- Modeling and simulation of production 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: Laboratory mechatronics [2105014]

Coordinators: A. Albers, G. Bretthauer, C. Proppe, C. Stiller
Part of the modules: Specialized Practical Training (p. 42)[MSc-Modul 07, FP]

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

Learning Control / Examinations
Certification of participation or oral examination depending on the “Studienplan” resp. “Prüfungs- und Studienordnung (SPO)” / IPEK: partial exmanination with grade

Conditions
Compulsory preconditions: none

Learning Outcomes
A manipulator as an examplary 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: Measurement Instrumentation Lab [2138328]

Coordinators: C. Stiller, P. Lenz
Part of the modules: Specialized Practical Training (p. 42)[MSc-Modul 07, FP]

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

Learning Control / Examinations
Colloquia

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
The laboratory complements the course "Introduction to Measurement and Control". While the course is organized into principles and subsystems, the laboratory presents complete measurement systems and methods for the most relevant industrial measurands.

Content
A Signal recording:
- measurement of temperature
- measurement of lengths
B Signal pre-precessing:
- bridge circuits and principles of measurement
- analog/digital transducers
C Signal processing:
- measuring stochastic signals
D Complete systems:
- system identification
- inverse pendulum
- path control of a robot

Literature
Instructions to the experiments are available on the institute's website

Course: Methoden der Signalverarbeitung [23113]

Coordinators: F. Puente
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Written exam.

Conditions
None.

Recommendations
Knowledge of the fundamentals in signal processing and measurement engineering.

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

- understand the basics of signal processing theory and describe the properties and the representation of signals.
- understand the fundamentals of time frequency analysis.
- understand the theroetical background of estimation theory and apply as well as evaluate various estimation techniques.
- apply the theoretical knowledge to practical problems.

Content
This lecture is offered to master students in electrical engineering and information technology who focus deeper in the field of signal processing and estimation theory.
During the last years, time frequency analysis became an important part of signal processing theory. By means of time frequency analysis, signals with variable frequency content can be analyzed. Thus, time frequency analysis and synthesis are discussed in detail. The lecture also gives an extensive overview about parameter estimation and state estimation theory.
The lecture starts with fundamentals on signal processing. The main signal properties are discussed. Signal representation in the Hilbert space is explained and different possibilities for signal representation in basis and frame are presented.
Time frequency analysis is introduced by the short time Fourier transform (STFT). The wavelet transform, its application and realization as well as another time frequency distribution – the Wigner-Ville distribution – are discussed.
The second part of the lecture is concerned with estimation theory. After fundamental considerations on signal modeling, parameter estimation techniques are introduced. Different estimators, like least squares, Gauß-Markov and so on are derived and compared. Subsequently, model based estimation and Bayes estimation is presented. The Kalman filter is discussed for state estimation.
The lecture "Methods of Signal Processing" moderates advanced knowledge in signal processing and estimation theory. The theoretical considerations are exemplified by numerous examples of real applications.

Literature
Literature: Uwe Kiencke, Michael Schwarz, Thomas Weickert;Signalverarbeitung: Zeit-Frequenz-Analyse und Schätzverfahren; Oldenbourg Verlag; 1. Auflage 2008.
Exercises and additional materials under www.iiit.kit.edu.

Course: Modelling of Microstructures [2183702]

Coordinators: B. Nestler, D. Weygand, A. August
Part of the modules: Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM]

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

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

Conditions
None.

Recommendations
materials science
fundamental mathematics

Learning Outcomes
The students are introduced into the thermodynamic and statistic fundamentals of liquid-solid and solid-solid phase transformations. We present microstructures such as dendrites, eutectics and peritectics. The sense and the significance of equilibrium in alloys and the determination of phase diagrams is worked out. The motion of interface under a driving force is studied. Next, we learn the method of phase-field modeling for simulation of microstructure formation processes – by means both the classic ansatz and the models of the recent research in our group. The course will be combined with practical exercises.

Content
-Brief Introduction in thermodynamics
-Statistical interpretation of entropy
- Gibbs free energy and phase diagrams
- Free energy functional
- Phasefield equation
- Gibbs-Thomson-equation
- Driving forces
- Grand chemical potential functional and the evolution equations
- For compare: Free energy functional with driving forces

Media
Black board and slides.

Literature

- Gottstein, G. (2007) Physikalische Grundlagen der Materialkunde. Springer Verlag Berlin Heidelberg
- Kurz, W. and Fischer, D. (1998) Fundamentals of Solidification. Trans Tech Publications ltd, Switzerland Germany UK USA
- Porter, D.A. Eastering, K.E. and Sherif, M.Y. (2009) Phase transformation in metals and alloys (third edition). CRC Press, Taylor & Francis Group, Boca Raton, London, New York
- Gaskell, D.R., Introduction to the thermodynamics of materials
- Problem sheets

Course: Modelling and Simulation [2185227]

Coordinators: C. Proppe, K. Furmans, C. Stiller, B. Pritz
Part of the modules: Modeling and Simulation (p. 40)[MSc-Modul 05, MS]

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

Learning Control / Examinations
Master students: written exam
Seminar note by colloquium with presentation

Conditions
none

Recommendations
none

Learning Outcomes
The student:

- has an overview of modelling and simulation techniques typical in mechanical engineering ,
- obtains the ability to carry out simulation studies starting from the formulation of problems by concepts, implementation, verification and validation,
- exercises complex simulation studies.

Content
Introduction: Overview, concept formation, simulation studies, time/event-discrete models, event-oriented/process orientated/transaction-oriented view, typical model classes (operation/maintenance, storekeeping, loss-susceptible systems)
Time-continuous models with concentrated parameters, model characteristics and model analysis Numerical treatment of ordinary differential equations and differential-algebraic sets of equations coupled simulations with concentrated parameters
Time-continuous models with distributed parameters, description of systems by means of partial differential equations, model reduction, numerical solution procedures for partial differential equations

Media
presentations

Literature
None.

Remarks
none

Course: Modelling and Simulation [2183703]

Coordinators: B. Nestler, P. Gumbsch
Part of the modules: Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT]

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

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

Conditions
None.

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 E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

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

Conditions
Solid mathematical background, basic knowledge in physics.

Learning Outcomes
The students

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

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

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

Course: Nanotechnology with Clusterbeams [2143876]

Coordinators: J. Gspann
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
written examination
presence in more that 70% of the lectures
Duration: 1 h

aids: none

Conditions
None.

Learning Outcomes
Nanotechnology is presented on the basis of a technology for nano- and microstructuring by accelerated nanoparticles (clusters), mainly in view of nanomechanics.

Content
Nanotechnology in biology
Nanosystemstechnology
Cluster beam generation, ionisation and acceleration; cluster properties
Structure generation using accelerated metal clusters
Structuring via gas cluster impact; reactive accelerated cluster erosion (RACE)
Atomic force microscopy of impact structures; nanotribology
Comparison with femtosecond laser machining (Winter term only)
Simulations; Fullerene synthesis, impact structures, visionary nanomachinery

Literature
Foil copies with short commentaries are distributed during the lectures.

Course: Numerical Mathematics [01874]

Coordinators: C. Wieners, Neuß, Rieder

Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Mathematic Methods (p. 43)[MSc-Modul 08, MM], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM]

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

Learning Control / Examinations
Written examination, duration 3 hours

Conditions
None.

Learning Outcomes

Content

Literature
Elective literature:
- lecture notes (N. Neuß)
- W. Dahmen/A. Reusken: Numerik für Ingenieure und Naturwissenschaftler

Course: Public Law I - Basic Principles [24016]

Coordinators: I. Spiecker genannt Döhmann
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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

Learning Control / Examinations
The assessment consists of a written exam concerning the courses *Public Law I* [24016] and *Public Law II* [24520] (according to Section 4(2), 1 of the examination regulation).

Conditions
None.

Recommendations
Parallel to the lectures tutoria are offered in which legal thinking and argumentation is practised. Their attendance is strongly recommended.
During the semester, test exams to each lecture are offered with extensive coaching. During the lecture-free time, a Q-and-A-lecture is offered.Details on the homepage of the ZAR (www.kit.edu/zar).

Learning Outcomes
The students know the core principles of public law. They are acquainted with the basics of constitutional law, the fundamental rights which route governmental actions and the entire legal system, as well as possibilities of actions and instruments (especially law, administrative act, public-private contract) of the public authority. Furthermore the distinction between public and private law is clarified. Moreover, possibilities of legal protection regarding administrative behavior is addressed. Students know how to classify problems in public law and to solve (simple) administrative and constitutional cases.

Content
The course covers core material of constitutional and administrative law. It begins with the differentiation between public and private law. In the constitutional law part, the course will concentrate on the rule of law and individual rights, especially those protecting communication and entrepreneurship. The administrative law part will explain the different legal instruments of the administration how to act (rule, order, contract, etc.) and their propositions. Also, court proceedings to sue the administrative will be discussed. Students will learn the technique how to solve (simple) administrative and constitutional cases

Media
extensive script with cases; content structure, further information in the lectures

Literature
tba in srciptum
Elective literature:
tba in scriptum

Course: Patent Law [24656]

Coordinators: P. Bittner
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
It is the aim of this course to provide students with knowledge in the area of patent law and the business of technical intellectual property that builds upon, and goes beyond the knowledge the students have already acquired in the general lecture of *Industrial and intellectual property law*. Students shall understand how the legal rules depend upon, and interact with, the economic background and the legislative policy in the field of technical intellectual property, particularly in the field of information and communication technologies. Students shall learn about the rules of national, European and international patent law as well as know-how protection law and to apply these legal rules in practical cases, in particular in the area of utilizing technical intellectual property through agreements and lawsuits. The conflict between the monopoly of a patent and the antitrust law policies in Europe will be reviewed with the students.

Content
The course deals with the subject matter of the law of technical intellectual property, in particular inventions, patents, utility models, design patents, know-how, the rights and obligations of employees as creators of technical IP, licensing, limitations and exceptions to patenting, term of protection, enforcement of the rights and defence against these in invalidation and revocation actions. The course does not merely focus on German patent law, but likewise puts European, US and international patent law into perspective. Students shall understand how the legal rules depend upon, and interact with, the economic background and the legislative policy in the field of technical intellectual property, particularly in the field of information and communication technologies. Students shall learn about the rules of national, European and international patent law as well as know-how protection law and to apply these legal rules in practical cases, in particular in the area of utilizing technical intellectual property through agreements and lawsuits. The conflict between the monopolyöf a patent and the antitrust law policies in Europe will be reviewed with the students.

Media
transparancies

Literature

- Schulte, Rainer Patentgesetz Carl Heymanns Verlag, 7. Aufl. 2005 ISBN 3-452-25114-4
- Kraßer, Rudolf, Patentrecht Verlag C.H. Beck, 5. Aufl. 2004 ISBN 3-406-384552

Elective literature:
tba in the transparencies

Course: Photovoltaics [23737]

Coordinators: M. Powalla
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Turorials, written exams, alternatively oral exam.

Conditions
Basic knowledge of thermodynamics and solid state physics.

Recommendations
Complement to “Energy Systems” and “Fundamentals of Energy Technology”.

Learning Outcomes
After the course attendants can:

- understand energy conversion in semiconductors.
- discuss emerging technological and production relevant aspects.
- capture the interaction of photovoltaic energy sytems with different system components.
- quantify losses.

Content

- The significance of photovoltaics in national and global energy supply.
- Physical fundamentals of energy conversion.
- Photovoltaic cells (specific parameters, materials, loss assessment).
- Implementation concepts (Sillicon technology, thin layer cells, concentrator cells, dye cells and organic cells).
- Modular technique and production technology.
- Photovoltaic energy systems (Components, alternative current converter, solar tracking, system design).

Literature
P. Würfel, Physik der Solarzellen, 2. Auflage (Spektrum Akademischer Verlag, Heidelberg, 2000)
R. Sauer, Halbleiterphysik, (Oldenburg Wissenschaftsverlag, 2009)
H.J. Lewerenz, H. Jungblut, Photovoltaik (Springer, Berlin, 1995)
H.G. Wagemann, Photovotoltaik, (Vieweg, Wiebaden, 2010)
Tom Markvart, Luis Castaner, Photovoltaics Fundamentals and Applications, (Elsevier, Oxford, 2003)
Heinrich Häberlin, Photovoltaik, (AZ Verlag, Aarau, 2007)

Course: Physics for Engineers [2142890]

Coordinators: P. Gumbsch, A. Nesterov-Müller, D. Weygand

Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

Learning Control / Examinations
written exam, 90 min

Conditions
none

Learning Outcomes
The understanding of electrical and optical properties of materials requires the understanding of the physical foundations, the quantum mechanical principles. The students will know the fundamental experiments, which allowed formulating these principles, and their application to the explanation of materials properties and devices.

Content
1) Foundations of solid state physics

- Wave particle dualism
- Tunnelling
- Schrödinger equation
- H-atom

2) Electrical conductivity of solids

- solid state: periodic potentials
- Pauli Principle
- band structure
- metals, semiconductors and isolators
- p-n junction / diode

3) Optics

- quantum mechanical principles of the laser
- linear optics
- non-linear optics

Literature
Tipler und Mosca: Physik für Wissenschaftler und Ingenieure, Elsevier, 2004

Haken und Wolf: Atom- und Quantenphysik. Einführung in die experimentellen und theoretischen Grundlagen, 7. Aufl., Springer, 2000

Course: Physical basics of laser technology [2181612]

Coordinators: J. Schneider

Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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
Students know the basics of the emission of light, light amplification and the principle layout of laser sources.

Students know the most common types of laser-based materials processing and the essential influences of laser beam, materials and process parameters .

Students receive an impression of laser applications in metrology and medical technology.
Furthermore students know the essentials of laser safety.

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

savety aspects

Literature
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press
F. K. Kneubühl, M. W. Sigrist: Laser, 2008, Vieweg+Teubner
T. Graf: Laser - Grundlagen der Laserstrahlquellen, 2009, Vieweg-Teubner Verlag
R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer
H. Hügel, T. Graf: Laser in der Fertigung, 2009, Vieweg+Teubner
W. M. Steen: Laser Material Processing, 2010, Springer

Course: Product Lifecycle Management [2121350]

Coordinators: J. Ovtcharova
Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK]

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 Development - Methods of Product Development [2146176]

Coordinators: A. Albers, N. Burkardt, Dipl.-Ing. N. Burkardt
Part of the modules: Product Development (p. 41)[MSc-Modul 06, PE]

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

Learning Control / Examinations
Written exam, each semester.
Duration: 150 minutes.
Auiliary Means: German dictionary (books only), Calculator

Conditions
Authorisation by the Examination Office.

Recommendations
-

Learning Outcomes
The lecture mediates fundamental knowledge of systematic product development. It is the prime goal of the lecture to make all activities within the process chain transparent. This ranges from finding a concept all the way to the final product. Thus efficient applicable methods are discussed in the lecture for the support of solving these tasks. On the basis of practical examples creativity methods for finding a concept and a solution, concrete design guidelines for the draft and along with this applicable methods of quality assurance, are introduced. Questions of generation of costs and responsibility for costs are discussed within the design process.

Content
Basics of Product Development: Basic Terms, Classification of the Product Development into the industrial environment, generation of costs / responsibility for costs
Concept Development: List of demands / Abstraction of the Problem Definition / Creativity Techniques / Evaluation and selection of solutions
Drafting : Prevailing basic rules of Design / Design Principles as a problem oriented accessory
Rationalization within the Product Development: Basics of Development Management/
Simultaneous Engineering and Integrated Product Development/Development of Product Lines and Modular Construction Systems
Quality Assurance in early Development Phases : Methods of Quality Assurance in an overview/QFD/FMEA

Media
-

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

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

Course: Product Development - Manufacturing and Material Technology [2150510]

Coordinators: V. Schulze
Part of the modules: Product Development (p. 41)[MSc-Modul 06, PE]

ECTS Credits	Hours per week	Term	Instruction language
9	6	Summer term	de

Learning Control / Examinations
written exam

Conditions
None.

Learning Outcomes
The student is able to
• dimension the work pieces by means of their load
• 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
• select the materials by means of the application
• combine the material selection with the process selection

Content
Main goal of this lecture is merging the contents of teaching for the topics work piece design and dimensioning (IAM-WK) and manufacturing (WBK). A focus is set on the interfaces between the separate lecture topics and especially the interaction between them is highlighted.
The topics in detail are:
work piece dimensioning: basic load cases, combined load cases, notched impact, fatigue, notched fatigue, assessment of cracked components, endurance strength, residual stress, high temperature load cases, corrosion
manufacturing methods: primary shaping, forming, cutting, joining, coating, heat- and surface treatment
process selection: basics, procedure of Ashby, economics, consideration of other boundary conditions, Software CES-Edupack, sample applications
material selection: basics, material indices, material selection charts, procedure of Ashby, consideration of other boundary, trade-off, shape and efficiency, Software CES-Edupack

Media
commented lecture slides are provided on Ilias

Literature
Lecture notes

Course: Quality Management [2149667]

Coordinators: G. Lanza
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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: Schwingungstechnisches Praktikum [2161241]

Coordinators: H. Hetzler, A. Fidlin
Part of the modules: Specialized Practical Training (p. 42)[MSc-Modul 07, FP]

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: Simulation of production systems and processes [2149605]

Coordinators: K. Furmans, V. Schulze, P. Stock
Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

ECTS Credits	Hours per week	Term	Instruction language
5	4	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 consideres 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

Course: Flows with chemical reactions [2153406]

Coordinators: A. Class
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Oral examination

Duration: 30 min
as WF NIE
written homework

Lecture

Conditions
Mathematics

Learning Outcomes
Chemical reactions of liquid or gaseous media are tightly coupled to the underlying fluid flow. Often they even drive the flow.

Some typical examples are combustion (laminar and turbulent gas premixed or diffusion flames), the processes within the industrial reactors of chemical industry, the directional polymerization of plastics, the burning of a cigar, the high temperature synthesis of new materials, and also the explosion of a star as a supernova.

Content
In the lecture we mainly consider problems, where chemical reaktion is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficent numerical sollution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

Media
Black board

Literature
Lecture

Buckmaster, J.D.; Ludford, G.S.S.: Lectures on Mathematical Combustion, SIAM 1983

Course: Systematic Materials Selection [2174576]

Coordinators: A. Wanner

Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

Learning Control / Examinations
oral; 20 - 30 Minutes

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

Learning Outcomes
The students are able to select the best material for a given application. They are proficient in selecting materials on base of performance indices and materials selection charts. They can identify conflicting objectives and find sound compromises. They are aware of the potential and the limits of hybrid material concepts (composites, bimaterials, foams) and can determine whether following such a concept yields a useful benefit.

Content
Important aspects and criteria of materials selection are examined and guidelines for a systematic approach to materials selection are deeloped. The following topics are covered: the status of materials selection in mechanical design and product development; the most important classes of materials and their property profiles;

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: Systems and Software Engineering [23605]

Coordinators: K. Müller-Glaser
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Written exam.

Conditions
None.

Recommendations
Knowledge of the fundamentals of digital systems design and information technology.

Learning Outcomes
After attendacne of the course students are able to:

- solve complexe tasks in a structured and targeted way by applying methods, techniques and tools presented in the lecture.
- understand the concepts of System, systems engineering and software engineering.
- describe mathematical models of embedded systems and life cycle models.
- define specifications and develope project requirement documents and functional specifications applying description techniques and specification languages and formalisms.
- understand important topics of hardware design such as state charts, realization alternatives for electronic computation systems, aspects of concurrency and parallelization, pipelining, scheduling, real time systems and appropriate operating systems.
- describe mathematical models for reliability and operabality of complex electronic systems as well as risk assessment and simplified representations .
- describe the fundamentals of various languages and representations in software design.
- implement different testing and maintenance approaches.
- apply these fundamentals to specific and practical problems.

Content
The lecture Systems and Software Engineering is directed to all students, who themselves want to be challenged with the design of complex electronic systems with hardware and software components. It will introduce to students the tools, which allow for a structured solution to complex Problems. The lecture specially dwells on development processes, hardware design, software design, reliability as well as various aspects of modeling.
The lecture initially differentiates the terms system, systems engineering and software engineering. Life cycle models and methods for mathematical modeling of embedded electronic systems as well as lifecycle models (Waterfall model, V-Model and Hunger Model) are introduced. The focuses of the lecture are the early phases of system development, starting with definitions of requirements as well as the creation of project requirement documents and functional specifications. Aspects of requirements documentation methods and description techniques as well as specification languages and formalisms are brought near.
Concrete topics in the area of hardware design are state charts, realization alternatives for electronic computation systems, aspects of concurrency and parallelization, pipelining, scheduling, real time systems and the appropriate operating systems.
The domain reliability thematizes security and operability of complex electronical systems covering their complete lifetime. Mathematical modeling methods as well as risk analysis and simplified presentations like block diagrams are discussed.

Besides the various diagrams and modeling perspectives of UML (Use Case diagram, class diagram, object diagram, communication diagram, sequence diagram, package diagram, etc.) the area of software design covers dataflow diagram, Petri nets as well as various languages like the ENBF.
Testing and maintenance form another essential aspect of the system development. Approaches and procedures like black box testing and white box testing are presented and form a basic understanding for the importance of testing, verification and validation as well as quality assurance all over the development period.
Exercise
Exercises concerning the lecture as well as their appropriate solutions are handed out and discussed in the lecture hall exercise session. Transferring the lecture's theoretical content to examples with practical orientation clarify the usage and necessarity of techniques for modeling and representation techniques.

Literature
Course book online estudium.fsz.kit.edu.

Course: Computer Engineering [2106002]

Coordinators: G. Bretthauer
Part of the modules: Elective Subject Natural Science/Computer Science/Electrical Engineering (p. 46)[MSc-Modul 11, WF NIE]

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

Learning Control / Examinations
Written examination

Duration: 2 hours (compulsory subject)

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students possess essential knowledge about information processing in digital computers. Based on information representation and calculations of complexity, students are capable to design algorithms efficiently. The students are able to apply the knowledge about efficient algorithm design to important numerical computation methods in mechanical engineering. Students understand the importance of software quality in mechanical engineering and know basic concepts and important measures of quality assurance.

Content
Introduction: definitions, basic concepts, introductory examples

Information coding on finite automata: numbers, characters, commands, examples

Algorithm design: definitions, complexity of algorithms, complexity classes P and NP, examples

Sorting algorithms: relevance, algorithms, simplifications, examples

Software quality assurance: terms and measures, errors, phases of quality assurance, constructive measures, analytical measures, certification

Lectures are complemented by an exercice course.

Literature
Vorlesungsskript (Internet)

Becker, B., Molitor, P.: Technische Informatik : eine einführende Darstellung. München, Wien : Oldenbourg, 2008.

Hoffmann, D. W.: Grundlagen der Technischen Informatik. München: Hanser, 2007.

Balzert, H.: Lehrbuch Grundlagen der Informatik : Konzepte und Notationen in UML, Java und C++, Algorithmik und Software-Technik, Anwendungen. Heidelberg, Berlin : Spektrum, Akad. Verl., 1999.

Trauboth, H.: Software-Qualitätssicherung : konstruktive und analytische Maßnahmen. München, Wien : Oldenbourg, 1993.

Course: Integrated Information Systems for engineers [2121001]

Coordinators: S. Rogalski, J. Ovtcharova
Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK]

ECTS Credits	Hours per week	Term	Instruction language
5	3	Summer 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 systems, information management
- CAD systems and modelling methods
- CAP- and CAM-systems
- PPS- and ERP- systems
- PDM-Systems
- Installation of technical information systems in existing enterprise structures

Literature
Lecture slides

Course: Vibration Theory [2161212]

Coordinators: W. Seemann
Part of the modules: Compulsory Elective Subject PT (p. 36)[MSc-Modul PT, WPF PT], Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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: Management and Strategy [2577900]

Coordinators: H. Lindstädt
Part of the modules: Elective Subject Economics/Law (p. 47)[MSc-Modul 12, WF WR]

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

Learning Control / Examinations
The assessment consists of a written exam (60 min) taking place at the beginn of the recess period (according to §4 (2), 1 of the examination regulation). The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
The participants know about central concepts of strategic management along the ideal-typical strategy process: internal and external strategic analysis, concept and sources of competitive advantages, their importance when establishing competitive and corporate strategies as well as strategy assessment and implementation. They have a summary of the basic concepts and models of strategic management, i.e. they can provide in particular an action-oriented integration.

Content

- Corporate management principles
- Strategic management principles
- Strategic analysis
- Competitive strategy: modelling and selection on a divisional level
- Strategies for oligopolies and networks: anticipation of dependencies
- Corporate strategy: modelling and evaluation on a corporate level
- Strategy implementation

Media
Slides.

Literature

- Grant, R.M.: *Contemporary Strategy Analysis.* Blackwell, 5. Aufl. Massachusetts 2005.
- Lindstädt, H.; Hauser, R.: *Strategische Wirkungsbereiche von Unternehmen.* Gabler, Wiesbaden 2004.

The relevant excerpts and additional sources are made known during the course.

Course: Heat and mass transfer [22512]

Coordinators: H. Bockhorn

Part of the modules: Compulsory Elective Subject PEK (p. 35)[MSc-Modul PEK, WPF PEK], Compulsory Elective Subject E+U (p. 32)[MSc-Modul E+U, WPF E+U], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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

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

Conditions
None.

Recommendations

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

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

Content

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

Literature

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

Course: Probability Theory and Statistics [0186000]

Coordinators: D. Hug
Part of the modules: Compulsory Elective Subject FzgT (p. 33)[MSc-Modul FzgT, WPF FzgT], Compulsory Elective Subject M+M (p. 34)[MSc-Modul M+M, WPF M+M], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Mathematic Methods (p. 43)[MSc-Modul 08, MM]

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

Learning Control / Examinations
written exam (180 minutes)

Conditions
None.

Learning Outcomes
Students
- know the basic descriptive measures of distributions, and they are able to compute these in simple examples
- know the basic probabilistic models, concepts and methods, and they can apply these in simple examples
- know basic ideas of statistical inference, and they can set up estimators and confidence intervals in simple cases

Content
This course provides an introduction to basic concepts, methods and procedures in probability theory and statistics. It starts with descriptive statistics, explains the foundations of probability theory and treats statistical inference towards the end. Probability theory develops and applies mathematical models for phenomena of the real world that involve randomness, which are also of interest in their own right.
Probability theory constitutes the main part of the course. The task of descriptive statistics is to describe, order and collect data which arise from experiments. A presentation of these data can be given, for instance, by means of graphics or statistical characteristics (arithmetic mean, median, empirical variance etc.). Statistical inference is concerned with exploring in how far specific results of experiments are valid in greater generality, hence with inference from real data.

Content: Descriptive statistics
Events
Probability Spaces
Elements of Combinatorial Theory
Random Variables and their Distributions (discrete and continuous)
Conditional probability
Stochastic Independence
Descriptive Measures of Distributions
Generating Function and Laplace-Transform
Limit Theorems
Random Numbers and Simulation
Basic Problems of Statistics
Point Estimation
Confidence Regions
Statistical Tests

Course: Scientific computing for Engineers [2181738]

Coordinators: D. Weygand, P. Gumbsch
Part of the modules: Compulsory Elective Subject W+S (p. 38)[MSc-Modul W+S, WPF W+S], Compulsory Elective Subject ThM (p. 37)[MSc-Modul ThM, WPF ThM], Compulsory Elective Subject General Mechanical Engineering (p. 30)[MSc-Modul AM, WPF AM]

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++
* progamm organization
* data types, operator, control structures
* dynamic memory allocation
* functions
* class
* OpenMP parallelization
5. numeric /algorithms
* finite differences
* MD simulations: 2nd order differential equations
* algorithms for particle simulations
* solver for linear systems of eqns.

Literature
[1] C++: Einführung und professionelle Programmierung; U. Breymann, Hanser Verlag München
[2] C++ and object-oriented numeric computing for Scientists and Engineers, Daoqui Yang, Springer Verlag.
[3] The C++ Programming Language, Bjarne Stroustrup, Addison-Wesley
[4] Die C++ Standardbibliothek, S. Kuhlins und M. Schader, Springer Verlag

Numerik:

[1] Numerical recipes in C++ / C / Fortran (90), Cambridge University Press
[2] Numerische Mathematik, H.R. Schwarz, Teubner Stuttgart
[3] Numerische Simulation in der Moleküldynamik, Griebel, Knapek, Zumbusch, Caglar, Springer Verlag

5 Major Fields

SP 01: Advanced Mechatronics

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2106004	K	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2106020	K	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2138326	K	Measurement II (p. 389)	C. Stiller	2	4	S
2162216	K	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2161219	K	Wellenausbreitung (p. 543)	W. Seemann	2	4	W
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2137309	E	Digital Control (p. 235)	M. Knoop	2	4	W
2113816	E	Vehicle Mechatronics I (p. 278)	D. Ammon	2	4	W
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2161252	E	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2105022	E	Information Processing in Mechatronic Systems (p. 334)	M. Kaufmann	2	4	W
2118083	E	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2138341	E	Cogitive Automobiles - Laboratory (p. 345)	C. Stiller, M. Lauer, B. Kitt	2	4	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2137304	E	Correlation Methods in Measurement and Control (p. 351)	F. Mesch	2	4	W
2137308	E	Machine Vision (p. 364)	C. Stiller, M. Lauer	4	8	W
2161206	E	Mathematical Methods in Dynamics (p. 376)	C. Proppe	2	5	W
2161254	E	Mathematical Methods in Strength of Materials (p. 377)	T. Böhlke	2	5	W
2181710	E	Mechanics in Microtechnology (p. 384)	C. Eberl, P. Gruber	2	4	W
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2142881	E	Microactuators (p. 393)	M. Kohl	2	4	S
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 431)	C. Stiller, P. Lenz	3	4	W
2146194	E (P)	Mobile Robot Systems Lab (p. 432)	A. Albers, W. Burger	3	3	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2141864	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I (p. 219)	A. Guber	2	4	W
2142883	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II (p. 220)	A. Guber	2	4	S
2142879	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III (p. 221)	A. Guber	2	4	S
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S

ID	Cat	Course	Lecturer	h	CP	Term
24152	E	Robotics I – Introduction to robotics (p. 475)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W
24659	E	Human-Mashine-Interaction (p. 386)	M. Beigl, Takashi Miyaki	2	3	S
23109	E	(p. 489)	F. Puente, F. Puente León	2	3	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 02: Powertrain Systems

ID	Cat	Course	Lecturer	h	CP	Term
2113077	K	Drive Train of Mobile Machines (p. 179)	M. Geimer	3	4	W
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 181)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 182)	A. Albers, S. Ott	2	4	W
2163111	K	Dynamics of the Automotive Drive Train (p. 239)	A. Fidlin	4	5	W
2105012	E	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2145181	E	Applied Tribology in Industrial Product Development (p. 178)	A. Albers, W. Burger	2	4	W
2162235	E	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2118083	E	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2161224	E	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2146194	E (P)	Mobile Robot Systems Lab (p. 432)	A. Albers, W. Burger	3	3	S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2173562	E	Failure Analysis (p. 479)	K. Poser	2	4	W
2150683	E	Control engineering (p. 498)	C. Gönnheimer	2	4	S
2146193	E	Strategic Product Planing (p. 500)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2181711	E	Failure of structural materials: deformation and fracture (p. 535)	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. 545)	J. Hoffmeister	2	4	W
2133101	E	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2134135	E	Combustion Engines B with Tutorial (p. 532)	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. 525)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 526)	M. Scherge, M. Dienwiebel	2	4	S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W

Conditions:
Recommendations: Recommended Courses:

- 2147175 CAE-Workshop

Learning Outcomes: SP02 mediates technological and physical basics as well as the most important interactions inside powertrain systems. Powertrainsystems for passanger vehicles as well as powertrain systems for mobile and stationary

applications are discussed and analysed during this focus studies. The alumni of this focus can handle the complex calculation- and designmethods for powertrains considering the system interdependencies.
Remarks:

SP 03: Work Science

ID	Cat	Course	Lecturer	h	CP	Term
2109026	KP	Work Science (p. 192)	B. Deml	4	6	W
2109033	K (P)	Work Science Laboratory Course (in German) (p. 194)	P. Stock	2	4	W
2109025	K	Product Ergonomics (in German) (p. 441)	B. Deml	2	4	W
2110038	E	Computer-Supported Operations Planning (in German) (p. 186)	B. Deml	2	4	S
2109024	E	Occupational Safety and Labour Legislation (in German) (p. 188)	B. Deml	2	4	W
2109030	E	Occupational Health and Safety Management (in German) (p. 190)	B. Deml	1	2	W
2110037	E	Occupational Safety and Environmental Protection (in German) (p. 331)	R. von Kiparski	2	4	S
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2110017	E	Leadership and Conflict Management (in German) (p. 369)	H. Hatzl	2	4	S
2109034	E	Planning of Assembly Systems (in German) (p. 422)	E. Haller	2	4	W
2109028	E	Industrial Engineering I (in German) (p. 443)	B. Deml	2	4	W
2110036	E	Process Design and Industrial Engineering (p. 457)	S. Stowasser	2	4	S
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2146179	E	Technical Design in Product Development (p. 514)	M. Schmid, Dr. -Ing. Markus Schmid	2	4	S
2109042	E	Introduction to Industrial Production Economics (p. 330)	S. Dürrschnabel	2	4	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 04: Automation Technology

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2106005	K	Automation Systems (p. 208)	M. Kaufmann	2	4	S
2106004	K	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2137309	K	Digital Control (p. 235)	M. Knoop	2	4	W
2105024	K	Modern Concepts of Control (p. 401)	L. Gröll, Groell	2	4	W
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2113816	E	Vehicle Mechatronics I (p. 278)	D. Ammon	2	4	W
2137304	E	Correlation Methods in Measurement and Control (p. 351)	F. Mesch	2	4	W
2137308	E	Machine Vision (p. 364)	C. Stiller, M. Lauer	4	8	W
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2138326	E	Measurement II (p. 389)	C. Stiller	2	4	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 431)	C. Stiller, P. Lenz	3	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2150683	E	Control engineering (p. 498)	C. Gönnheimer	2	4	S
2161219	E	Wellenausbreitung (p. 543)	W. Seemann	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2123375	EM (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2149902	E	Machine Tools and Industrial Handling (p. 549)	J. Fleischer	4	8	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
24648	E	Man-Machine Systems in Automation Systems and Analysis of Scenes (p. 387)	E. Peinsipp-Byma, O. Sauer	2	3	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 05: Calculation Methods in Mechanical Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2154434	KP	Applied Fluid Mechanics (p. 176)	B. Frohnapfel	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2161252	K	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2157441	K	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2106004	E	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2162282	E	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2161214	E	Vibration of continuous systems (p. 350)	H. Hetzler	2	4	W
2161224	E	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 376)	C. Proppe	2	5	W
2161254	E	Mathematical Methods in Strength of Materials (p. 377)	T. Böhlke	2	5	W
2162241	E	Mathematical methods of vibration theory (p. 378)	W. Seemann	3	5	S
2162280	E	Mathematical Methods in Structural Mechanics (p. 380)	T. Böhlke	2	5	S
2134134	E	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2183702	E	Modelling of Microstructures (p. 395)	B. Nestler, D. Weygand, A. August	3	5	W
2183703	E	Modelling and Simulation (p. 400)	B. Nestler, P. Gumbsch	3	5	W/S
2162244	E	Plasticity Theory (p. 424)	T. Böhlke	2	5	S
2161250	E	Computational Mechanics I (p. 470)	T. Böhlke, T. Langhoff	2	6	W
2162296	E	Computational Mechanics II (p. 471)	T. Böhlke, T. Langhoff	2	6	S
2114095	E	Simulation of Coupled Systems (p. 490)	M. Geimer	4	4	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W
2117095	E	Basics of Technical Logistics (p. 312)	M. Mittwollen, Madzharov	4	6	W
2161212	E	Vibration Theory (p. 512)	W. Seemann	3	5	W
2117060	EM	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 493)	C. Baumgarten	2	4	W
2163111	E	Dynamics of the Automotive Drive Train (p. 239)	A. Fidlin	4	5	W
2163113	E	Theory of Stability (p. 497)	A. Fidlin	4	6	W
2162247	E	Introduction to Nonlinear Vibrations (p. 256)	A. Fidlin	4	7	S

ID	Cat	Course	Lecturer	h	CP	Term
2161241	E (P)	Schwingungstechnisches Praktikum (p. 486)	H. Hetzler, A. Fidlin	3	3	S
2117096	E	Elements of Technical Logistics (p. 262)	M. Mittwollen, Madzharov	3	4	W
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 238)	H. Hetzler	2	4	S
2154432	E	Mathematical Methods in Fluid Mechanics (p. 379)	A. Class, B. Frohnapfel	2	4	S
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2154430	E	Introduction to modeling of aerospace systems (p. 253)	G. Schlöffel	2	4	S
2117097	E	Elements of Technical Logistics and Project (p. 263)	M. Mittwollen, Madzharov	4	6	W

Conditions:
Recommendations:
Learning Outcomes: The students get familiar with simulation and calculation methods from several fields of mechanical engineering. These are the basis of several software packages used in industrial applications. These packages can be applied most efficiently and successful if the corresponding methods and the philosophy behind them are known.
Remarks:

SP 06: Computational Mechanics

ID	Cat	Course	Lecturer	h	CP	Term
2161226	K	Numerical Methods in Mechanics I (p. 254)	E. Schnack	3	5	W
2161250	K	Computational Mechanics I (p. 470)	T. Böhlke, T. Langhoff	2	6	W
2157441	K	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2162216	E	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2182735	E	Application of advanced programming languages in mechanical engineering (p. 185)	D. Weygand	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2153405	E	Finite Difference Methods for numerial solution of thermal and fluid dynamical problems (p. 234)	C. Günther	2	4	W
2162282	E	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2182732	E	Introduction to Theory of Materials (p. 249)	M. Kamlah	2	4	S
2183716	E (P)	FEM Workshop – constitutive laws (p. 283)	K. Schulz, D. Weygand, M. Weber	2	4	W/S
2154431	E	Finite Volume Methods for Fluid Flow (p. 288)	C. Günther	2	4	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 311)	M. Kamlah	2	4	W
2162240	E	Mathematical Foundation for Computational Mechanics (p. 375)	E. Schnack	2	4	S
2161983	E	Mechanics of laminated composites (p. 382)	E. Schnack	2	4	W
2167523	E	Modeling of Thermodynamical Processes (p. 399)	R. Schießl, U. Maas	3	6	W/S
2162298	E	Numerical Methods in Mechanics II (p. 413)	E. Schnack	3	5	S
2154449	E	Numerical Simulation of Turbulent Flows (p. 417)	G. Grötzbach	3	4	S
2162244	E	Plasticity Theory (p. 424)	T. Böhlke	2	5	S
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2162296	E	Computational Mechanics II (p. 471)	T. Böhlke, T. Langhoff	2	6	S
2161217	EM (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W
2169458	E	Numerical simulation of reacting two phase flows (p. 416)	R. Koch	2	4	W
2183721	E	High Performance Computing (p. 324)	B. Nestler, M. Selzer	3	5	W

Conditions: Either course no. 2161226 or course no. 2161250 can be chosen.
Recommendations:
Learning Outcomes: The module offers a wide interdisciplinary education of the students in the areas which are summarized internationally under the concept 'Computational Mechanics':

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

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

SP 08: Dynamics and Vibration Theory

ID	Cat	Course	Lecturer	h	CP	Term
2162235	K	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2161224	K	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2161212	K	Vibration Theory (p. 512)	W. Seemann	3	5	W
2163113	K	Theory of Stability (p. 497)	A. Fidlin	4	6	W
2162247	K	Introduction to Nonlinear Vibrations (p. 256)	A. Fidlin	4	7	S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2161216	E	Wave propagation (p. 255)	W. Seemann	2	4	W
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2162216	E	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 486)	H. Hetzler, A. Fidlin	3	3	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W
2161219	E	Wellenausbreitung (p. 543)	W. Seemann	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2161214	E	Vibration of continuous systems (p. 350)	H. Hetzler	2	4	W
2163111	E	Dynamics of the Automotive Drive Train (p. 239)	A. Fidlin	4	5	W
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 238)	H. Hetzler	2	4	S
2154430	E	Introduction to modeling of aerospace systems (p. 253)	G. Schlöffel	2	4	S
2154437	E	Hydrodynamic Stability: From Order to Chaos (p. 328)	A. Class	2	4	S

Conditions:
Recommendations:
Learning Outcomes: Vibration in mechanical or electromechanical systems are most important in systems of mechanical engineering. In most cases, these vibration have to be avoided, but there are also applications in which vibration are used to influence the process. Goal of this module is to get familiar with the theory of vibration and to learn the methods to analyse and simulate vibrating systems. This includes both theoretical aspects as well as experimental methods. Also industrial applications are examined in order to apply the corresponding methods.
Remarks:

SP 09: Dynamic Machine Models

ID	Cat	Course	Lecturer	h	CP	Term
2162235	K	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2118078	K	Logistics - organisation, design and control of logistic systems (p. 360)	K. Furmans	4	6	S
2105012	E	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 181)	A. Albers, S. Ott	2	4	S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2113807	E	Handling Characteristics of Motor Vehicles I (p. 274)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 275)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 276)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 277)	F. Gauterin	2	4	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2161206	E	Mathematical Methods in Dynamics (p. 376)	C. Proppe	2	5	W
2114095	E	Simulation of Coupled Systems (p. 490)	M. Geimer	4	4	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2122378	E	Virtual Engineering II (p. 539)	J. Ovtcharova	3	4	S
2118087	EM	Selected Applications of Technical Logistics (p. 198)	M. Mittwollen, Madzharov	3	4	S
2118088	EM	Selected Applications of Technical Logistics and Project (p. 199)	M. Mittwollen, Madzharov	4	6	S
2163111	E	Dynamics of the Automotive Drive Train (p. 239)	A. Fidlin	4	5	W
2163113	E	Theory of Stability (p. 497)	A. Fidlin	4	6	W
2162247	E	Introduction to Nonlinear Vibrations (p. 256)	A. Fidlin	4	7	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 486)	H. Hetzler, A. Fidlin	3	3	S
2161212	E	Vibration Theory (p. 512)	W. Seemann	3	5	W
2162241	E	Mathematical methods of vibration theory (p. 378)	W. Seemann	3	5	S
2161214	E	Vibration of continuous systems (p. 350)	H. Hetzler	2	4	W
2162207	E	Dynamics of mechanical Systems with tribological Contacts (p. 238)	H. Hetzler	2	4	S
24152	E	Robotics I – Introduction to robotics (p. 475)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W

Conditions:
Recommendations:
Learning Outcomes: Many systems of mechanical engineering are dynamical systems for which the temporal behavior is most important. Goal of this module is to be able to analyse, simulate and examine such systems of different areas of mechanical engineering by using adequate methods and tools.
Remarks:

SP 10: Engineering Design

ID	Cat	Course	Lecturer	h	CP	Term
2146180	K	Powertrain Systems Technology A: Automotive Systems (p. 181)	A. Albers, S. Ott	2	4	S
2145150	K	Powertrain Systems Technology B: Stationary Machinery (p. 182)	A. Albers, S. Ott	2	4	W
2146190	K	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2114073	K	Mobile Machines (p. 396)	M. Geimer	4	8	S
2145181	E	Applied Tribology in Industrial Product Development (p. 178)	A. Albers, W. Burger	2	4	W
2117064	E	Application of technical logistics in modern crane systems (p. 183)	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. 225)	A. Albers, Assistenten	3	3	W/S
2149657	E	Manufacturing Technology (p. 285)	V. Schulze	6	8	W
2113805	E	Automotive Engineering I (p. 304)	F. Gauterin, H. Unrau	4	8	W
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 318)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 319)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 320)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 321)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 322)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 323)	R. Frech	1	2	S
2174571	E	Design with Plastics (p. 348)	M. Liedel	2	4	S
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2110017	E	Leadership and Conflict Management (in German) (p. 369)	H. Hatzl	2	4	S
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2146194	E (P)	Mobile Robot Systems Lab (p. 432)	A. Albers, W. Burger	3	3	S
2109025	E	Product Ergonomics (in German) (p. 441)	B. Deml	2	4	W
2109028	E	Industrial Engineering I (in German) (p. 443)	B. Deml	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2146193	E	Strategic Product Planing (p. 500)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2158107	E	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2146179	E	Technical Design in Product Development (p. 514)	M. Schmid, Dr.-Ing. Markus Schmid	2	4	S
2174574	E	Materials for Lightweight Construction (p. 546)	K. Weidenmann	2	4	S

ID	Cat	Course	Lecturer	h	CP	Term
2149902	E	Machine Tools and Industrial Handling (p. 549)	J. Fleischer	4	8	W
2161229	E	Designing with numerical methods in product development (p. 236)	E. Schnack	2	4	W
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W

Conditions:
Recommendations: Recommended Courses:

- 2147175 CAE-Workshop
- 2105014 Mechatronik - Workshop

Learning Outcomes: Superior learning objective is the achievement of abilities, worked out knowledge and proficiency in engineering design trained in special courses to be implemented on systems in research and industrial practice in general
Remarks:

SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics

ID	Cat	Course	Lecturer	h	CP	Term
2113806	K	Vehicle Comfort and Acoustics I (p. 276)	F. Gauterin	2	4	W
2114825	K	Vehicle Comfort and Acoustics II (p. 277)	F. Gauterin	2	4	S
2158107	K	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2105012	E	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 181)	A. Albers, S. Ott	2	4	S
2161216	E	Wave propagation (p. 255)	W. Seemann	2	4	W
2114850	E	Global vehicle evaluation within virtual road test (p. 297)	B. Schick	2	4	S
2113807	E	Handling Characteristics of Motor Vehicles I (p. 274)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 275)	H. Unrau	2	4	S
2113816	E	Vehicle Mechatronics I (p. 278)	D. Ammon	2	4	W
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2114835	E	Automotive Engineering II (p. 305)	F. Gauterin, H. Unrau	2	4	S
2153425	E	Industrial aerodynamics (p. 329)	T. Breitling	2	4	W
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2105024	E	Modern Concepts of Control (p. 401)	L. Gröll, Groell	2	4	W
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2162216	E	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S

Conditions:
Recommendations: Recommended courses:

- 2162235 Introduction into the multi-body dynamics
- 2161212 Vibration Theory

Learning Outcomes: The student
• knows and understands the dynamic characteristics of vehicles, owing to the construction and design tokens,
• knows and understands especially the factors being relevant for comfort and acoustics
• is capable of fundamentally evaluating and rating handling characteristics.
Remarks:

SP 12: Automotive Technology

ID	Cat	Course	Lecturer	h	CP	Term
2113805	KP	Automotive Engineering I (p. 304)	F. Gauterin, H. Unrau	4	8	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 181)	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	Global vehicle evaluation within virtual road test (p. 297)	B. Schick	2	4	S
2113807	E	Handling Characteristics of Motor Vehicles I (p. 274)	H. Unrau	2	4	W
2114838	E	Handling Characteristics of Motor Vehicles II (p. 275)	H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 276)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 277)	F. Gauterin	2	4	S
2113816	E	Vehicle Mechatronics I (p. 278)	D. Ammon	2	4	W
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2114835	E	Automotive Engineering II (p. 305)	F. Gauterin, H. Unrau	2	4	S
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 307)	E. Lox	2	4	S
2114843	E	Basics and Methods for Integration of Tires and Vehicles (p. 317)	G. Leister	2	4	S
2113814	E	Fundamentals for Design of Motor-Vehicles Bodies I (p. 318)	H. Bardehle	1	2	W
2114840	E	Fundamentals for Design of Motor-Vehicles Bodies II (p. 319)	H. Bardehle	1	2	S
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 320)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 321)	J. Zürn	1	2	S
2113810	E	Fundamentals of Automobile Development I (p. 322)	R. Frech	1	2	W
2114842	E	Fundamentals of Automobile Development II (p. 323)	R. Frech	1	2	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2115808	E (P)	Motor Vehicle Laboratory (p. 353)	M. Frey, M. El-Haji	2	4	W/S
2182642	E	Laser in automotive engineering (p. 357)	J. Schneider	2	4	S
2149669	E	Materials and processes for the lightweight production of car bodies (p. 374)	D. Steegmüller, S. Kienzle	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2123364	E	Product, Process and Resource Integration in the Automotive Industry (p. 439)	S. Mbang	3	4	S
2150690	E	Production Systems and Production Technology in Major Assembly Production (p. 447)	V. Stauch	2	4	W/S
2115817	E	Project Workshop: Automotive Engineering (p. 451)	F. Gauterin	3	6	W/S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W

ID	Cat	Course	Lecturer	h	CP	Term
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2146193	E	Strategic Product Planing (p. 500)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2149655	E	Gear Cutting Technology (p. 536)	M. Klaiber	2	4	W
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 545)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 546)	K. Weidenmann	2	4	S
2153425	E	Industrial aerodynamics (p. 329)	T. Breitling	2	4	W
2133101	E	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2134135	E	Combustion Engines B with Tutorial (p. 532)	U. Spicher	3	4	S
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 243)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 282)	F. Henning	2	4	S
2157443	E	Computational methods for the heat protection of a full vehicle (p. 211)	H. Reister	2	4	W

Conditions:
Recommendations:
Learning Outcomes: The student
• knows the most important components of a vehicle,
• knows and understands the functioning and the interaction of the individual components,
• knows the basics of dimensioning the components,
• knows and understands the procedures in automobile development,
• knows and understands the technical specifications at the development procedures,
• is aware of notable boundaries like legislation.
Remarks:

SP 13: Strength of Materials/ Continuum Mechanics

ID	Cat	Course	Lecturer	h	CP	Term
2161252	KP	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2162282	K	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2161254	K	Mathematical Methods in Strength of Materials (p. 377)	T. Böhlke	2	5	W
2162280	K	Mathematical Methods in Structural Mechanics (p. 380)	T. Böhlke	2	5	S
2181711	K	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2162255	E	Designing with composites (p. 237)	E. Schnack	2	4	S
2182732	E	Introduction to Theory of Materials (p. 249)	M. Kamlah	2	4	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 311)	M. Kamlah	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 376)	C. Proppe	2	5	W
2183702	E	Modelling of Microstructures (p. 395)	B. Nestler, D. Weygand, A. August	3	5	W
2183703	E	Modelling and Simulation (p. 400)	B. Nestler, P. Gumbsch	3	5	W/S
2162244	E	Plasticity Theory (p. 424)	T. Böhlke	2	5	S
2162275	E (P)	Lab course experimental solid mechanics (p. 434)	T. Böhlke, Mitarbeiter	2	2	S
2161501	E	Process Simulation in Forming Operations (p. 459)	D. Helm	2	4	W
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S
2161250	E	Computational Mechanics I (p. 470)	T. Böhlke, T. Langhoff	2	6	W
2162296	E	Computational Mechanics II (p. 471)	T. Böhlke, T. Langhoff	2	6	S
2182740	E	Materials modelling: dislocation based plasticy (p. 548)	D. Weygand	2	4	S
2161251	E	Microstructure characterization and modelling (p. 394)	T. Böhlke, F. Fritzen	2	5	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 15: Fundamentals of Energy Technology

ID	Cat	Course	Lecturer	h	CP	Term
2130927	KP	Fundamentals of Energy Technology (p. 303)	F. Badea, D. Cacuci	4	8	S
2130921	K	Energy Systems II: Nuclear Power Technology (p. 267)	F. Badea	2	4	S
2166538	K	Fundamentals of combustion II (p. 314)	U. Maas	2	4	S
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 326)	M. Gabi	4	8	W
2169453	K	Thermal Turbomachines I (p. 521)	H. Bauer	3	6	W
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2171486	E (P)	Integrated measurement systems for fluid mechanics applications (p. 337)	H. Bauer, Mitarbeiter	5	4	W/S
2171487	E (P)	Laboratory Exercise in Energy Technology (p. 359)	H. Bauer, U. Maas, H. Wirbser	4	4	W/S
23737	E	Photovoltaics (p. 421)	M. Powalla	3	6	S
2189910	E	(p. 503)	X. Cheng	2	4	W
2169472	E	Thermal Solar Energy (p. 520)	R. Stieglitz	2	4	W
2133109	EM	Fuels and Lubricants for Combustion Engines and their Testing (p. 212)	J. Volz	2	4	W
2169459	EM (P)	CFD-Lab using Open Foam (p. 227)	R. Koch	3	4	W
2158105	EM	Hydraulic Fluid Machinery II (p. 327)	S. Caglar, M. Gabi, Martin Gabi	2	4	S
2134134	EM	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2157441	EM	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2169458	EM	Numerical simulation of reacting two phase flows (p. 416)	R. Koch	2	4	W
2157442	EM (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2146192	EM	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2158107	EM	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2158106	EM	Technologies for energy efficient buildings (p. 516)	F. Schmidt	2	4	S
2133101	EM	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
23381	E	Windpower (p. 551)	Lewald	2/0	3	W
2129901	E	Energy Systems I: Renewable Energy (p. 265)	R. Dagan	3	6	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 16: Industrial Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2109041	KP	Introduction to Industrial Engineering (p. 241)	B. Deml	2	4	S
2110033	KP	Introduction to Ergonomics (p. 245)	B. Deml	2	4	S
2109040	E	Controlling and Simulation of Production Systems (p. 232)	B. Deml	2	4	W
3109033	E	Industrial Management Case Study (p. 280)	P. Stock	2	4	W
2110031	E	Service Operations Management (p. 367)	B. Deml	2	4	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 18: Information Technology

ID	Cat	Course	Lecturer	h	CP	Term
2106004	K	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2105015	K	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2137309	K	Digital Control (p. 235)	M. Knoop	2	4	W
2137308	K	Machine Vision (p. 364)	C. Stiller, M. Lauer	4	8	W
2138326	K	Measurement II (p. 389)	C. Stiller	2	4	S
2106002	K	Computer Engineering (p. 511)	G. Bretthauer	3	4	S
2105012	E	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 184)	J. Föller	2	4	S
2114092	E	BUS-Controls (p. 222)	M. Geimer	2	4	S
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 333)	C. Kilger	2	4	S
2105022	E	Information Processing in Mechatronic Systems (p. 334)	M. Kaufmann	2	4	W
2118083	E	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2137304	E	Correlation Methods in Measurement and Control (p. 351)	F. Mesch	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2134137	E	Engine measurement techniques (p. 403)	S. Bernhardt	2	4	S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 431)	C. Stiller, P. Lenz	3	4	W
2150683	E	Control engineering (p. 498)	C. Gönnheimer	2	4	S
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
24102	E	Information Processing in Sensor Networks (p. 335)	U. Hanebeck, F. Beutler	3	4	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 19: Information Technology of Logistic Systems

ID	Cat	Course	Lecturer	h	CP	Term
2118094	K	Information Systems in Logistics and Supply Chain Management (p. 333)	C. Kilger	2	4	S
2118083	K	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2118078	K	Logistics - organisation, design and control of logistic systems (p. 360)	K. Furmans	4	6	S
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 184)	J. Föller	2	4	S
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2118097	E	Warehousing and distribution systems (p. 355)	K. Furmans, C. Huber	2	4	S
2117056	E	Airport logistics (p. 362)	A. Richter	2	4	W
2118090	E	Quantitative Methods for Supply Chain Risk Management (p. 463)	A. Cardeneo	4	6	S
2117062	E	Supply chain management (p. 508)	K. Alicke	4	6	W

Conditions: none
Recommendations: Recommended compulsory optional subjects:

- Basics of statistic and probability theory
- Simulation of production systems and processes
- Stochastics in Mecanical Engineering
- Integrated Information Systems for engineers
- Modelling and Simulation

Learning Outcomes: The student:

- knows basic conveying technology and the connected information technology like sensors,
- is able to choose control and communication systems and knows basic functions,
- knows information systems for logistic processes,
- is able to answer basic questions concerning logistics.

Remarks: none

SP 20: Integrated Product Development

ID	Cat	Course	Lecturer	h	CP	Term
2145156	KP	Integrated Product Development (p. 338)	A. Albers	4	8	W
2145300	KP	Project Work in Product Development (p. 440)	A. Albers	2	4	W
2145157	KP	Workshop Product Development (p. 554)	A. Albers	2	4	W
2145150	E	Powertrain Systems Technology B: Stationary Machinery (p. 182)	A. Albers, S. Ott	2	4	W
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2146193	E	Strategic Product Planing (p. 500)	A. Siebe	2	4	S
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S

Conditions: The participation in “Integrated Product Development” requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).
Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from april to july. The selection itself is made by Prof. Albers in personal interviews.
Recommendations: Recommended Courses:

- 2147175 CAE-Workshop

Learning Outcomes: The lecture mediates on the basis of practical experiences and by means of examples from the Industry, the theory of systematic planning, verification and controlling of development and innovation processes as well as the team oriented employment of effective methods for their efficient support. Strategies of development- and innovation management of the technical system analysis and team leadership will be discussed and trained.
Remarks:

SP 21: Nuclear Energy

ID	Cat	Course	Lecturer	h	CP	Term
2130929	K	Energy systems II: Nuclear Energy Fundamentals (p. 266)	F. Badea, D. Cacuci	3	6	S
2170460	K	Nucleaer Power Plant Technology (p. 344)	T. Schulenberg	2	4	S
2189910	K	(p. 503)	X. Cheng	2	4	W
2189473	K	Neutron physics of fusion reactors (p. 409)	U. Fischer	2	4	W
23271	K	(p. 499)	M. Urban	2	4	W
2130973	E	Innovative Nuclear Systems (p. 336)	X. Cheng	2	4	S
2189465	EM	Reactor Safety I: Fundamentals (p. 464)	V. Sánchez-Espinoza	2	4	W
2169470	E	Two-Phase Flow and Heat Transfer (p. 555)	T. Schulenberg, M. Wörner	2	4	W
2130910	E	CFD for Power Engineering (p. 226)	I. Otic	2	4	S
2129901	E	Energy Systems I: Renewable Energy (p. 265)	R. Dagan	3	6	W
2194650	E	Materials under high thermal or neutron loads (p. 519)	A. Möslang, Dr. Michael Rieth	2	4	S
19435	E	Decommissioning of Nuclear Facilities I (p. 478)	S. Gentes	2	4	W
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2190464	E	Nuclear Safety II: Safety Assessment of Nuclear Power Plants (p. 465)	V. Sánchez-Espinoza	2	4	S
2189908	E	Nuclear Thermal-Hydraulics (p. 410)	X. Cheng	2	4	W
2130974	E	Introduction to Nuclear Engineering (p. 248)	X. Cheng	2	4	S
2189904	E	Ten lectures on turbulence (p. 518)	I. Otic	2	4	W

Conditions: "Fundamentals of Energy Technology" (Nr. 2130927) is mandatory (KP) for students in the Specialization "Energy- and Environment Engineering".
Recommendations:
Learning Outcomes:
Remarks:

SP 22: Cognitive Technical Systems

ID	Cat	Course	Lecturer	h	CP	Term
2106004	K	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2138340	K	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2138336	K	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2137309	E	Digital Control (p. 235)	M. Knoop	2	4	W
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 333)	C. Kilger	2	4	S
2138341	E	Cogitive Automobiles - Laboratory (p. 345)	C. Stiller, M. Lauer, B. Kitt	2	4	S
2137304	E	Correlation Methods in Measurement and Control (p. 351)	F. Mesch	2	4	W
2137308	E	Machine Vision (p. 364)	C. Stiller, M. Lauer	4	8	W
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2138326	E	Measurement II (p. 389)	C. Stiller	2	4	S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 431)	C. Stiller, P. Lenz	3	4	W
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
24152	E	Robotics I – Introduction to robotics (p. 475)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W
24102	E	Information Processing in Sensor Networks (p. 335)	U. Hanebeck, F. Beutler	3	4	W
24572	E	Cognitive Systems (p. 346)	R. Dillmann, A. Waibel, Christian Mohr, Markus Przybylski, Kai Welke	4	6	S
24613	E	Localization of Mobile Agents (p. 363)	U. Hanebeck, M. Baum	3	4	S
24635	E	Robotik III - Sensors in Robotics (p. 477)	R. Dillmann, Meißner, Gonzalez, Aguirre	2	3	S
23064	E	(p. 173)	G. Trommer	2	3	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 23: Power Plant Technology

ID	Cat	Course	Lecturer	h	CP	Term
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 326)	M. Gabi	4	8	W
2170460	K	Nucleaer Power Plant Technology (p. 344)	T. Schulenberg	2	4	S
2169461	K	Coal fired power plants (p. 347)	P. Fritz, T. Schulenberg	2	4	W
2169453	K	Thermal Turbomachines I (p. 521)	H. Bauer	3	6	W
2170476	K	Thermal Turbomachines II (p. 522)	H. Bauer	3	6	S
2170490	K	Combined Cycle Power Plants (p. 293)	T. Schulenberg	2	4	S
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2169483	E	Fusion Technology A (p. 291)	R. Stieglitz	2	4	W
2165515	E	Fundmentals of Combustion I (p. 313)	U. Maas	2	4	W
2158105	E	Hydraulic Fluid Machinery II (p. 327)	S. Caglar, M. Gabi, Martin Gabi	2	4	S
2110037	E	Occupational Safety and Environmental Protection (in German) (p. 331)	R. von Kiparski	2	4	S
2171486	E (P)	Integrated measurement systems for fluid mechanics applications (p. 337)	H. Bauer, Mitarbeiter	5	4	W/S
2169452	E	Power and Heat economics (p. 352)	H. Bauer	2	4	W
2170463	E	Cooling of thermally high loaded gas turbine components (p. 354)	H. Bauer, A. Schulz	2	4	S
2171487	E (P)	Laboratory Exercise in Energy Technology (p. 359)	H. Bauer, U. Maas, H. Wirbser	4	4	W/S
2157441	E	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2173562	E	Failure Analysis (p. 479)	K. Poser	2	4	W
2173585	E	Fatigue of Metallic Materials (p. 485)	K. Lang	2	4	W
2158107	E	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2169472	E	Thermal Solar Energy (p. 520)	R. Stieglitz	2	4	W
2169462	E	Turbine and compressor Design (p. 527)	H. Bauer, A. Schulz	2	4	W
2170495	E	Hydrogen Technologies (p. 542)	T. Jordan	2	4	S
2169470	E	Two-Phase Flow and Heat Transfer (p. 555)	T. Schulenberg, M. Wörner	2	4	W
2170491	E (P)	Simulator Exercises Combined Cycle Power Plants (p. 494)	T. Schulenberg	2	2	S
2130974	E	Introduction to Nuclear Engineering (p. 248)	X. Cheng	2	4	S
2130973	E	Innovative Nuclear Systems (p. 336)	X. Cheng	2	4	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 24: Energy Converting Engines

ID	Cat	Course	Lecturer	h	CP	Term
2157432	K	Hydraulic Fluid Machinery I (Basics) (p. 326)	M. Gabi	4	8	W
2169453	K	Thermal Turbomachines I (p. 521)	H. Bauer	3	6	W
2133101	K	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2158112	E	Low Temperature Technology (p. 177)	F. Haug	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. 212)	J. Volz	2	4	W
2114093	E	Fluid Technology (p. 289)	M. Geimer	4	4	W
2134138	E	Fundamentals of catalytic exhaust gas aftertreatment (p. 307)	E. Lox	2	4	S
2165515	E	Fundmentals of Combustion I (p. 313)	U. Maas	2	4	W
2166538	E	Fundamentals of combustion II (p. 314)	U. Maas	2	4	S
2158105	E	Hydraulic Fluid Machinery II (p. 327)	S. Caglar, M. Gabi, Martin Gabi	2	4	S
2157441	E	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2158107	E	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2170476	E	Thermal Turbomachines II (p. 522)	H. Bauer	3	6	S
2169462	E	Turbine and compressor Design (p. 527)	H. Bauer, A. Schulz	2	4	W
2170478	E	Turbo Jet Engines (p. 528)	H. Bauer, A. Schulz	2	4	S
2134135	E	Combustion Engines B with Tutorial (p. 532)	U. Spicher	3	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W
2157443	E	Computational methods for the heat protection of a full vehicle (p. 211)	H. Reister	2	4	W
2157450	E	Wind- and Waterpower (p. 550)	M. Gabi, N. Lewald	2	4	W
23381	E	Windpower (p. 551)	Lewald	2/0	3	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 25: Lightweight Construction

ID	Cat	Course	Lecturer	h	CP	Term
2113101	KP	Introduction to Automotive Lightweight Technology (p. 243)	F. Henning	2	4	W
2114052	KP	Composites for Lightweight Design (p. 282)	F. Henning	2	4	S
2146190	K	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2174574	K	Materials for Lightweight Construction (p. 546)	K. Weidenmann	2	4	S
2181708	E (P)	Biomechanics: design in nature and inspired by nature (p. 216)	C. Mattheck	2	4	W
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2161229	E	Designing with numerical methods in product development (p. 236)	E. Schnack	2	4	W
2162255	E	Designing with composites (p. 237)	E. Schnack	2	4	S
2162282	E	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2182734	E	Introduction to the Mechanics of Composite Materials (p. 250)	Y. Yang	2	4	S
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2182731	E (P)	Finite Element Workshop (p. 287)	C. Mattheck, D. Weygand	2	4	S
2174575	E	Foundry Technology (p. 298)	C. Wilhelm	2	4	S
2161252	E	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2174571	E	Design with Plastics (p. 348)	M. Liedel	2	4	S
2182642	E	Laser in automotive engineering (p. 357)	J. Schneider	2	4	S
2149669	E	Materials and processes for the lightweight production of car bodies (p. 374)	D. Steegmüller, S. Kienzle	2	4	W
2173590	E	Polymer Engineering I (p. 428)	P. Elsner	2	4	W
2173565	E	Welding Technology I (p. 481)	B. Spies	1	2	W
2174570	E	Welding Technology II (p. 483)	B. Spies	1	2	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2181715	E	Failure of Structural Materials: Fatigue and Creep (p. 534)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 26: Materials Science and Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2173553	K	Material Science III (p. 547)	A. Wanner	5	8	W
2193002	K	Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria (with exercises) (p. 523)	H. Seifert	2	4	W
2193003	K	Solid State Reactions and Kinetics of Phase Transformations (with exercises) (p. 286)	D. Cupid, P. Franke	2	4	W
2174579	E	Technology of steel components (p. 515)	V. Schulze	2	4	S
2125768	E	Introduction to Ceramics (p. 343)	M. Hoffmann	4	6	W
2193010	E	Grundlagen der Herstellungsverfahren der Keramik und Pulvermetallurgie (p. 306)	R. Oberacker	2	4	W
2178643	E	Constitution and Properties of Wear resistant materials (p. 196)	S. Ulrich	2	4	S
2174586	E	Material Analysis (p. 544)	J. Gibmeier	2	4	S
2175590	E (P)	Metallographic Lab Class (p. 272)	A. Wanner	3	4	W/S
2174575	E	Foundry Technology (p. 298)	C. Wilhelm	2	4	S
2173565	E	Welding Technology I (p. 481)	B. Spies	1	2	W
2174570	E	Welding Technology II (p. 483)	B. Spies	1	2	S
2173570	E	Materials and mechanical loads in the power train: engines, gearboxes and drive sections (p. 545)	J. Hoffmeister	2	4	W
2174574	E	Materials for Lightweight Construction (p. 546)	K. Weidenmann	2	4	S
2182642	E	Laser in automotive engineering (p. 357)	J. Schneider	2	4	S
2174571	E	Design with Plastics (p. 348)	M. Liedel	2	4	S
2182734	E	Introduction to the Mechanics of Composite Materials (p. 250)	Y. Yang	2	4	S
2161983	E	Mechanics of laminated composites (p. 382)	E. Schnack	2	4	W
2162255	E	Designing with composites (p. 237)	E. Schnack	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2173580	E	Mechanics and Strengths of Polymers (p. 383)	B. von Bernstorff (Graf), von Bernstorff	2	4	W
2183702	E	Modelling of Microstructures (p. 395)	B. Nestler, D. Weygand, A. August	3	5	W
2183703	E	Modelling and Simulation (p. 400)	B. Nestler, P. Gumbsch	3	5	W/S
2173590	E	Polymer Engineering I (p. 428)	P. Elsner	2	4	W
2183640	E (P)	Laboratory "Laser Materials Processing" (p. 430)	J. Schneider, W. Pfleging	3	4	W/S
2173562	E	Failure Analysis (p. 479)	K. Poser	2	4	W
2173577	E	Failure Analysis Seminar (p. 487)	K. Poser	2	2	W
2181715	E	Failure of Structural Materials: Fatigue and Creep (p. 534)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2173585	E	Fatigue of Metallic Materials (p. 485)	K. Lang	2	4	W
2177601	EM	Constitution and Properties of Protective Coatings (p. 197)	S. Ulrich	2	4	W
2181744	EM	Size effects in micro and nanostructures materials (p. 302)	P. Gumbsch, D. Weygand, C. Eberl, P. Gruber, M. Dienwiebel	2	4	W
2126749	EM	Advanced powder metals (p. 461)	R. Oberacker	2	4	S

ID	Cat	Course	Lecturer	h	CP	Term
2162280	EM	Mathematical Methods in Structural Mechanics (p. 380)	T. Böhlke	2	5	S
2162244	EM	Plasticity Theory (p. 424)	T. Böhlke	2	5	S
2126775	EM	Structural Ceramics (p. 506)	M. Hoffmann	2	4	S
2182740	EM	Materials modelling: dislocation based plasticy (p. 548)	D. Weygand	2	4	S

Conditions: Basic knowledge in materials science and engineering (Werkstoffkunde I/II)
Recommendations: suggested optional compulsory subject:

- 2174576 Systematic Materials Selection

Learning Outcomes: The students are familiar with the contents of materials science and engineering III. Furthermore they learn about at least one chosen topic of materials science and engineering.
Remarks:

SP 27: Modeling and Simulation in Energy- and Fluid Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2167523	K	Modeling of Thermodynamical Processes (p. 399)	R. Schießl, U. Maas	3	6	W/S
2157441	K	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2169458	K	Numerical simulation of reacting two phase flows (p. 416)	R. Koch	2	4	W
2165525	E	Mathematical models and methods in combustion theory (p. 381)	V. Bykov, U. Maas	2	4	W
2134134	E	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2130934	E	Numerical Modeling of Multiphase Flowsf Multi-phase Flows (p. 415)	M. Wörner	2	4	S
2154449	E	Numerical Simulation of Turbulent Flows (p. 417)	G. Grötzbach	3	4	S
2166543	E	Reduction methods for the modeling and the simulation of combustion processes (p. 472)	V. Bykov, U. Maas	2	4	S
2153406	E	Flows with chemical reactions (p. 502)	A. Class	2	4	W
2123375	E (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 493)	C. Baumgarten	2	4	W
2189904	E	Ten lectures on turbulence (p. 518)	I. Otic	2	4	W
2130910	E	CFD for Power Engineering (p. 226)	I. Otic	2	4	S

Conditions: None.
Recommendations: Recommended Lecture:

- 2154432 Mathematische Methoden der Strömungslehre

Learning Outcomes: After completing SP 27 students can:

- formulate the governing equations for specific systems in energy and fluid engineering.
- explain the different numerical schemes applied to solve the system of equations.
- use frequently applied simulation tools in a more efficient and successful way.

Remarks:

SP 28: Lifecycle Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2121352	KP	Virtual Engineering I (p. 538)	J. Ovtcharova	5	6	W
2122378	KP	Virtual Engineering II (p. 539)	J. Ovtcharova	3	4	S
2123355	EM (P)	CAD-NX5 training course (p. 224)	J. Ovtcharova	3	2	W/S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2122371	E	Efficient creativity - Processes and Methods within the automotive industrie (p. 240)	R. Lamberti	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2122376	E	PLM for Product Development in Mechatronics (p. 425)	M. Eigner	2	4	S
2121350	E	Product Lifecycle Management (p. 437)	J. Ovtcharova	4	6	W
2118090	E	Quantitative Methods for Supply Chain Risk Management (p. 463)	A. Cardeneo	4	6	S
2122387	E	Computer Integrated Planning of New Products (p. 469)	R. Kläger	2	4	S
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2117062	E	Supply chain management (p. 508)	K. Alicke	4	6	W
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2123357	E (P)	PLM-CAD workshop (p. 427)	J. Ovtcharova	4	4	W
2121370	E	Virtual Engineering for Mechatronic Products (p. 537)	S. Rude	2	4	W
2123375	EM (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2117060	E	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W
2110036	E	Process Design and Industrial Engineering (p. 457)	S. Stowasser	2	4	S
2109042	E	Introduction to Industrial Production Economics (p. 330)	S. Dürrschnabel	2	4	W
2149680	E	Project Mikromanufacturing: Development and Manufacturing of Microsystems (p. 452)	V. Schulze, P. Hoppen	3	6	W

Conditions: The courses “Virtual Engineering I” and “Virtual Engineering II” are compulsory and must be examined.
Recommendations:
Learning Outcomes: Student gain a basic understanding of holistic development, validation and production of products, components and systems.
Students are able to appreciate the product and process complexity of today’s products and manufacturing facilities. They know exemplary IT-Systems to support the complexity.
Students can describe the necessary information management for the product emergence process.
Students know the fundamental terms or virtual reality and are able to use a CAVE as tool to promote technical or management decisions.
Remarks:

SP 29: Logistics and Material Flow Theory

ID	Cat	Course	Lecturer	h	CP	Term
2117051	KP	Material flow in logistic systems (p. 373)	K. Furmans	4	6	W
2117060	K	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W
2118078	K	Logistics - organisation, design and control of logistic systems (p. 360)	K. Furmans	4	6	S
2118090	K	Quantitative Methods for Supply Chain Risk Management (p. 463)	A. Cardeneo	4	6	S
2137309	E	Digital Control (p. 235)	M. Knoop	2	4	W
2149610	E	Global Production and Logistics - Part 1: Global Production (p. 299)	G. Lanza	2	4	W
2149600	E	Global Production and Logistics - Part 2: Global Logistics (p. 300)	K. Furmans	2	4	S
2118094	E	Information Systems in Logistics and Supply Chain Management (p. 333)	C. Kilger	2	4	S
2118097	E	Warehousing and distribution systems (p. 355)	K. Furmans, C. Huber	2	4	S
2118085	E	Automotive Logistics (p. 361)	K. Furmans	2	4	S
2117056	E	Airport logistics (p. 362)	A. Richter	2	4	W
2110678	E (P)	Production Techniques Laboratory (p. 448)	K. Furmans, J. Ovtcharova, V. Schulze, B. Deml, Research assi-tants of wbk, ifab und IFL	3	4	S
2149605	E	Simulation of production systems and processes (p. 492)	K. Furmans, V. Schulze, P. Stock	4	5	W
2117062	E	Supply chain management (p. 508)	K. Alicke	4	6	W
2117095	E	Basics of Technical Logistics (p. 312)	M. Mittwollen, Madzharov	4	6	W
2117096	E	Elements of Technical Logistics (p. 262)	M. Mittwollen, Madzharov	3	4	W
2110036	E	Process Design and Industrial Engineering (p. 457)	S. Stowasser	2	4	S
2117097	E	Elements of Technical Logistics and Project (p. 263)	M. Mittwollen, Madzharov	4	6	W

Conditions: none
Recommendations: Recommended compulsory optional subjects:

- Basics of statistic and probability theory
- Simulation of production systems and processes
- Stochastics in Mecanical Engineering
- Modelling and Simulation
- Technical Logistics I

Learning Outcomes: The student

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

Remarks: none

SP 30: Engineering Mechanics and Applied Mathematics

ID	Cat	Course	Lecturer	h	CP	Term
2161254	K	Mathematical Methods in Strength of Materials (p. 377)	T. Böhlke	2	5	W
2161250	K	Computational Mechanics I (p. 470)	T. Böhlke, T. Langhoff	2	6	W
2161212	K	Vibration Theory (p. 512)	W. Seemann	3	5	W
2162282	E	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2182732	E	Introduction to Theory of Materials (p. 249)	M. Kamlah	2	4	S
2182734	E	Introduction to the Mechanics of Composite Materials (p. 250)	Y. Yang	2	4	S
2161216	E	Wave propagation (p. 255)	W. Seemann	2	4	W
2162247	E	Introduction to Nonlinear Vibrations (p. 256)	A. Fidlin	4	7	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 311)	M. Kamlah	2	4	W
2161252	E	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2161206	E	Mathematical Methods in Dynamics (p. 376)	C. Proppe	2	5	W
2162280	E	Mathematical Methods in Structural Mechanics (p. 380)	T. Böhlke	2	5	S
2154432	E	Mathematical Methods in Fluid Mechanics (p. 379)	A. Class, B. Frohnapfel	2	4	S
2173580	E	Mechanics and Strengths of Polymers (p. 383)	B. von Bernstorff (Graf), von Bernstorff	2	4	W
2161501	E	Process Simulation in Forming Operations (p. 459)	D. Helm	2	4	W
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2162216	E	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2162296	E	Computational Mechanics II (p. 471)	T. Böhlke, T. Langhoff	2	6	S
2161219	E	Wellenausbreitung (p. 543)	W. Seemann	2	4	W
2181738	E	Scientific computing for Engineers (p. 553)	D. Weygand, P. Gumbsch	2	4	W
2161214	E	Vibration of continuous systems (p. 350)	H. Hetzler	2	4	W
2163113	E	Theory of Stability (p. 497)	A. Fidlin	4	6	W
2153406	E	Flows with chemical reactions (p. 502)	A. Class	2	4	W
2154437	E	Hydrodynamic Stability: From Order to Chaos (p. 328)	A. Class	2	4	S
2154430	E	Introduction to modeling of aerospace systems (p. 253)	G. Schlöffel	2	4	S
2161251	E	Microstructure characterization and modelling (p. 394)	T. Böhlke, F. Fritzen	2	5	W
01874	E	(p. 412)	C. Wieners, Neuß, Rieder	2/1	4,5	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 31: Mechatronics

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2106004	K	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2162235	K	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2138340	K	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2105024	K	Modern Concepts of Control (p. 401)	L. Gröll, Groell	2	4	W
2138336	K	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2106005	E	Automation Systems (p. 208)	M. Kaufmann	2	4	S
2114092	E	BUS-Controls (p. 222)	M. Geimer	2	4	S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2137309	E	Digital Control (p. 235)	M. Knoop	2	4	W
2118083	E	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2161224	E	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2181710	E	Mechanics in Microtechnology (p. 384)	C. Eberl, P. Gruber	2	4	W
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2138326	E	Measurement II (p. 389)	C. Stiller	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2161217	E (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
24152	E	Robotics I – Introduction to robotics (p. 475)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W
24659	E	Human-Mashine-Interaction (p. 386)	M. Beigl, Takashi Miyaki	2	3	S
23109	E	(p. 489)	F. Puente, F. Puente León	2	3	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 32: Medical Technology

ID	Cat	Course	Lecturer	h	CP	Term
2106006	K	Biomedical Instrument Engineering (p. 244)	H. Malberg	2	4	S
23261	K	(p. 213)	O. Dössel	2	3	W
23269	K	(p. 217)	A. Bolz	3	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2106008	E	Ersatz menschlicher Organe durch technische Systeme (p. 271)	C. Pylatiuk	2	4	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2181710	E	Mechanics in Microtechnology (p. 384)	C. Eberl, P. Gruber	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2141864	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I (p. 219)	A. Guber	2	4	W
2142883	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II (p. 220)	A. Guber	2	4	S
2142879	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III (p. 221)	A. Guber	2	4	S
2149680	E	Project Mikromanufacturing: Development and Manufacturing of Microsystems (p. 452)	V. Schulze, P. Hoppen	3	6	W
2105992	E	(p. 308)	C. Pylatiuk	2	4	W
23262	E	(p. 214)	O. Dössel	2	3	S
23264	E	Bioelectric Signals and Fields (p. 215)	G. Seemann	2	3	S
23270	E	(p. 218)	A. Bolz	3	4	S
23289	E	(p. 411)	F. Maul, H. Doerfel	1	2	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 33: Microsystem Technology

ID	Cat	Course	Lecturer	h	CP	Term
2141861	K	Introduction to Microsystem Technology I (p. 309)	A. Last	2	4	W
2142874	K	Introduction to Microsystem Technology II (p. 310)	A. Last	2	4	S
2143875	K (P)	Introduction to Microsystem Technology - Practical Course (p. 435)	A. Last	2	4	W/S
2143892	E	Selected Topics on Optics and Microoptics for Mechanical Engineers (p. 202)	T. Mappes	2	4	W/S
2143882	E	Fabrication Processes in Microsystem Technology (p. 284)	K. Bade	2	4	W/S
2181710	E	Mechanics in Microtechnology (p. 384)	C. Eberl, P. Gruber	2	4	W
2142881	E	Microactuators (p. 393)	M. Kohl	2	4	S
2143876	E	Nanotechnology with Clusterbeams (p. 405)	J. Gspann	2	4	W/S
2181712	E	Nanotribology and -Mechanics (p. 407)	M. Dienwiebel, H. Hölscher	2	4	W
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2142885	E	Optofluidics (p. 419)	D. Rabus	2	4	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2142860	E	Scanning probe microscopy (p. 406)	H. Hölscher, M. Dienwiebel, Stefan Walheim	2	4	S
2143893	E	Replication Technologies in Microsystem Technology (p. 473)	M. Worgull	2	4	W/S
2149605	E	Simulation of production systems and processes (p. 492)	K. Furmans, V. Schulze, P. Stock	4	5	W
2142884	EM	Microoptics and Lithography (p. 392)	T. Mappes	2	4	S
2141864	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I (p. 219)	A. Guber	2	4	W
2142883	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II (p. 220)	A. Guber	2	4	S
2142879	E	BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III (p. 221)	A. Guber	2	4	S
2143500	E	Chemical, physical and material scientific aspects of polymers in microsystem technologies (p. 228)	H. Moritz, M. Worgull, D. Häringer	2	4	W/S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 34: Mobile Machines

ID	Cat	Course	Lecturer	h	CP	Term
2114073	KP	Mobile Machines (p. 396)	M. Geimer	4	8	S
2113077	K	Drive Train of Mobile Machines (p. 179)	M. Geimer	3	4	W
2113079	K	Design and Development of Mobile Machines (p. 206)	M. Geimer	2	4	W
2114092	K	BUS-Controls (p. 222)	M. Geimer	2	4	S
2117064	E	Application of technical logistics in modern crane systems (p. 183)	M. Golder	2	4	W
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2114093	E	Fluid Technology (p. 289)	M. Geimer	4	4	W
2113812	E	Fundamentals in the Development of Commercial Vehicles I (p. 320)	J. Zürn	1	2	W
2114844	E	Fundamentals in the Development of Commercial Vehicles II (p. 321)	J. Zürn	1	2	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2114095	E	Simulation of Coupled Systems (p. 490)	M. Geimer	4	4	S
2113080	E	Tractors (p. 524)	M. Kremmer	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2121370	E	Virtual Engineering for Mechatronic Products (p. 537)	S. Rude	2	4	W
2134135	E	Combustion Engines B with Tutorial (p. 532)	U. Spicher	3	4	S
2133101	E	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2157443	EM	Computational methods for the heat protection of a full vehicle (p. 211)	H. Reister	2	4	W

Conditions:
Recommendations: Knowledge of Fluid Power Systems is helpful, otherwise it is recommended to take the course *Fluid Power Systems* [2114093].
Learning Outcomes: The student

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

Remarks:

SP 35: Modeling and Simulation

ID	Cat	Course	Lecturer	h	CP	Term
2162282	K	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2162235	K	Introduction into the multi-body dynamics (p. 252)	W. Seemann	3	5	S
2161252	K	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2161224	K	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2161212	K	Vibration Theory (p. 512)	W. Seemann	3	5	W
2110038	E	Computer-Supported Operations Planning (in German) (p. 186)	B. Deml	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2123356	E (P)	CATIA V5 CAD training course (p. 223)	J. Ovtcharova	3	2	W/S
2123355	E (P)	CAD-NX5 training course (p. 224)	J. Ovtcharova	3	2	W/S
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2169459	E (P)	CFD-Lab using Open Foam (p. 227)	R. Koch	3	4	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2165525	E	Mathematical models and methods in combustion theory (p. 381)	V. Bykov, U. Maas	2	4	W
2134134	E	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2161250	E	Computational Mechanics I (p. 470)	T. Böhlke, T. Langhoff	2	6	W
2162296	E	Computational Mechanics II (p. 471)	T. Böhlke, T. Langhoff	2	6	S
2114095	E	Simulation of Coupled Systems (p. 490)	M. Geimer	4	4	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2122378	E	Virtual Engineering II (p. 539)	J. Ovtcharova	3	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2182740	E	Materials modelling: dislocation based plasticy (p. 548)	D. Weygand	2	4	S
2181738	E	Scientific computing for Engineers (p. 553)	D. Weygand, P. Gumbsch	2	4	W
2117060	EM	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 493)	C. Baumgarten	2	4	W
2163111	E	Dynamics of the Automotive Drive Train (p. 239)	A. Fidlin	4	5	W
2163113	E	Theory of Stability (p. 497)	A. Fidlin	4	6	W
2162247	E	Introduction to Nonlinear Vibrations (p. 256)	A. Fidlin	4	7	S
2161241	E (P)	Schwingungstechnisches Praktikum (p. 486)	H. Hetzler, A. Fidlin	3	3	S
2134139	E	Model based Application Methods (p. 398)	F. Kirschbaum	2	4	S
2161217	EM (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W
2183721	E	High Performance Computing (p. 324)	B. Nestler, M. Selzer	3	5	W
2154430	E	Introduction to modeling of aerospace systems (p. 253)	G. Schlöffel	2	4	S
2154437	E	Hydrodynamic Stability: From Order to Chaos (p. 328)	A. Class	2	4	S

ID	Cat	Course	Lecturer	h	CP	Term
2153406	E	Flows with chemical reactions (p. 502)	A. Class	2	4	W

Conditions:
Recommendations:
Learning Outcomes: The module provides modelling competence and continues thus the compulsory subject modelling and simulation of the master studies. To this end, courses, case studies and training periods with relation to simulation were combined. Students of this module will be able to carry out simulation studies in typical application fields of mechanical engineering, to judge critically the models and to interpret the obtained results.
Remarks:

SP 36: Polymer Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2173590	K	Polymer Engineering I (p. 428)	P. Elsner	2	4	W
2174596	K	Polymer Engineering II (p. 429)	P. Elsner	2	4	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 243)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 282)	F. Henning	2	4	S
2174571	E	Design with Plastics (p. 348)	M. Liedel	2	4	S
2173580	E	Mechanics and Strengths of Polymers (p. 383)	B. von Bernstorff (Graf), von Bernstorff	2	4	W

Conditions: Basic knowledge in materials science and engineering (Werkstoffkunde I/II)
Recommendations: suggested optional compulsory subject:

- 2174576 Systematic Materials Selection

Learning Outcomes: The students are familiar with the contents of polymer engineering I and II. Furthermore they learn about at least one chosen topic of materials science and engineering.
Remarks: Emphasis module in the master´s program only.

SP 37: Production Management

ID	Cat	Course	Lecturer	h	CP	Term
2109028	KP	Industrial Engineering I (in German) (p. 443)	B. Deml	2	4	W
2110028	KP	Industrial Engineering II (p. 444)	B. Deml	2	4	S
2109029	K	Ergonomics and Work Economics (in German) (p. 269)	B. Deml	2	4	W
2110038	E	Computer-Supported Operations Planning (in German) (p. 186)	B. Deml	2	4	S
2109030	E	Occupational Health and Safety Management (in German) (p. 190)	B. Deml	1	2	W
2150660	E	Integrated production planning (p. 339)	G. Lanza	6	8	S
2110017	E	Leadership and Conflict Management (in German) (p. 369)	H. Hatzl	2	4	S
2109034	E	Planning of Assembly Systems (in German) (p. 422)	E. Haller	2	4	W
2110032	E	Production Planning and Control (Planning Game of a Bicycle Factory; in German) (p. 445)	A. Rinn	2	4	S
2110678	E (P)	Production Techniques Laboratory (p. 448)	K. Furmans, J. Ovtcharova, V. Schulze, B. Deml, Research assistants of wbk, ifab und IFL	3	4	S
2110029	E	Controlling of Production Economics (in German) (p. 449)	B. Deml	2	4	S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2149605	E	Simulation of production systems and processes (p. 492)	K. Furmans, V. Schulze, P. Stock	4	5	W
2110036	E	Process Design and Industrial Engineering (p. 457)	S. Stowasser	2	4	S
2109042	E	Introduction to Industrial Production Economics (p. 330)	S. Dürrschnabel	2	4	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 39: Production Technology

ID	Cat	Course	Lecturer	h	CP	Term
2149657	K	Manufacturing Technology (p. 285)	V. Schulze	6	8	W
2149902	K	Machine Tools and Industrial Handling (p. 549)	J. Fleischer	4	8	W
2150660	K	Integrated production planning (p. 339)	G. Lanza	6	8	S
2150904	K	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2149610	K	Global Production and Logistics - Part 1: Global Production (p. 299)	G. Lanza	2	4	W
2149600	K	Global Production and Logistics - Part 2: Global Logistics (p. 300)	K. Furmans	2	4	S
2149669	E	Materials and processes for the lightweight production of car bodies (p. 374)	D. Steegmüller, S. Kienzle	2	4	W
2150690	E	Production Systems and Production Technology in Major Assembly Production (p. 447)	V. Stauch	2	4	W/S
2149668	E	Process Simulation in Cutting (p. 460)	A. Zabel	2	4	W
2150681	E	metal forming (p. 529)	T. Herlan, Dr. Herlan	2	4	S
2149655	E	Gear Cutting Technology (p. 536)	M. Klaiber	2	4	W
2150683	E	Control engineering (p. 498)	C. Gönnheimer	2	4	S
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2173560	E (P)	Welding Lab Course, in groupes (p. 273)	V. Schulze	3	4	W
2173565	E	Welding Technology I (p. 481)	B. Spies	1	2	W
2174570	E	Welding Technology II (p. 483)	B. Spies	1	2	S
2174575	E	Foundry Technology (p. 298)	C. Wilhelm	2	4	S
2174579	E	Technology of steel components (p. 515)	V. Schulze	2	4	S
2110678	E (P)	Production Techniques Laboratory (p. 448)	K. Furmans, J. Ovtcharova, V. Schulze, B. Deml, Research assitants of wbk, ifab und IFL	3	4	S
2110038	E	Computer-Supported Operations Planning (in German) (p. 186)	B. Deml	2	4	S
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2118097	E	Warehousing and distribution systems (p. 355)	K. Furmans, C. Huber	2	4	S
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2118085	E	Automotive Logistics (p. 361)	K. Furmans	2	4	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2109034	E	Planning of Assembly Systems (in German) (p. 422)	E. Haller	2	4	W
2121366	E	PLM in the Manufacturing Industry (p. 426)	G. Meier	2	4	W
2110032	E	Production Planning and Control (Planning Game of a Bicycle Factory; in German) (p. 445)	A. Rinn	2	4	S
2110029	E	Controlling of Production Economics (in German) (p. 449)	B. Deml	2	4	S
2149605	E	Simulation of production systems and processes (p. 492)	K. Furmans, V. Schulze, P. Stock	4	5	W
2117095	E	Basics of Technical Logistics (p. 312)	M. Mittwollen, Madzharov	4	6	W
2117060	EM	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W

ID	Cat	Course	Lecturer	h	CP	Term
2110036	E	Process Design and Industrial Engineering (p. 457)	S. Stowasser	2	4	S
2109042	E	Introduction to Industrial Production Economics (p. 330)	S. Dürrschnabel	2	4	W
2117096	E	Elements of Technical Logistics (p. 262)	M. Mittwollen, Madzharov	3	4	W
2183640	E (P)	Laboratory “Laser Materials Processing” (p. 430)	J. Schneider, W. Pfleging	3	4	W/S
2149903	E	Development Project for Machine Tools and Industrial Handling (p. 268)	J. Fleischer	2	4	W
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W
2149680	E	Project Mikromanufacturing: Development and Manufacturing of Microsystems (p. 452)	V. Schulze, P. Hoppen	3	6	W
2117097	E	Elements of Technical Logistics and Project (p. 263)	M. Mittwollen, Madzharov	4	6	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 40: Robotics

ID	Cat	Course	Lecturer	h	CP	Term
2105012	K	Adaptive Control Systems (p. 171)	G. Bretthauer	2	4	W
2138340	K	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
24152	K	Robotics I – Introduction to robotics (p. 475)	R. Dillmann, Welke, Do, Vahrenkamp	2	3	W
24712	K	Robotics II - Programming of industrial and autonomous service robots (p. 476)	R. Dillmann, Schmidt-Rohr, Jäkel	2	3	S
2138336	K	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2145150	E	Powertrain Systems Technology B: Stationary Machinery (p. 182)	A. Albers, S. Ott	2	4	W
2106004	E	Computational Intelligence I (p. 229)	G. Bretthauer, R. Mikut	2	4	S
2105015	E	Computational Intelligence II (p. 230)	G. Bretthauer, MIkut	2	4	W
2106020	E	Computational Intelligence III (p. 231)	R. Mikut	2	4	S
2137309	E	Digital Control (p. 235)	M. Knoop	2	4	W
2138341	E	Cogitive Automobiles - Laboratory (p. 345)	C. Stiller, M. Lauer, B. Kitt	2	4	S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2137308	E	Machine Vision (p. 364)	C. Stiller, M. Lauer	4	8	W
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2138326	E	Measurement II (p. 389)	C. Stiller	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2105024	E	Modern Concepts of Control (p. 401)	L. Gröll, Groell	2	4	W
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2137306	E (P)	Lab Computer-aided methods for measurement and control (p. 431)	C. Stiller, P. Lenz	3	4	W
2146194	E (P)	Mobile Robot Systems Lab (p. 432)	A. Albers, W. Burger	3	3	S
2162216	E	Computerized Multibody Dynamics (p. 468)	W. Seemann	2	4	S
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2150683	E	Control engineering (p. 498)	C. Gönnheimer	2	4	S
2146192	E	Sustainable Product Engineering (p. 509)	K. Ziegahn	2	4	S
2106002	E	Computer Engineering (p. 511)	G. Bretthauer	3	4	S
2123375	E (P)	Virtual Reality Laboratory (p. 540)	J. Ovtcharova	3	4	W/S
2117060	EM	Analytical methods in material flow methodology (mach and wiwi) (p. 174)	K. Furmans, J. Stoll, E. Özden	4	6	W
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
24613	E	Localization of Mobile Agents (p. 363)	U. Hanebeck, M. Baum	3	4	S
24635	E	Robotik III - Sensors in Robotics (p. 477)	R. Dillmann, Meißner, Gonzalez, Aguirre	2	3	S

Conditions:
Recommendations:
Learning Outcomes:

Remarks:

SP 41: Fluid Mechanics

ID	Cat	Course	Lecturer	h	CP	Term
2154434	K	Applied Fluid Mechanics (p. 176)	B. Frohnapfel	2	4	S
2153405	K	Finite Difference Methods for numerial solution of thermal and fluid dynamical problems (p. 234)	C. Günther	2	4	W
2154431	K	Finite Volume Methods for Fluid Flow (p. 288)	C. Günther	2	4	S
2154437	K	Hydrodynamic Stability: From Order to Chaos (p. 328)	A. Class	2	4	S
2157441	K	Computational Methods in Fluid Mechanics (p. 414)	F. Magagnato	2	4	W
2154449	K	Numerical Simulation of Turbulent Flows (p. 417)	G. Grötzbach	3	4	S
2154044	K	Scaling in fluid dynamics (p. 495)	L. Bühler	2	4	S
2169459	E (P)	CFD-Lab using Open Foam (p. 227)	R. Koch	3	4	W
2154432	E	Mathematical Methods in Fluid Mechanics (p. 379)	A. Class, B. Frohnapfel	2	4	S
19228	E	Building- and Environmental Aerodynamics (p. 295)	B. Ruck, Ruck	2	4	S
2153425	E	Industrial aerodynamics (p. 329)	T. Breitling	2	4	W
2153429	E	Magnetohydrodynamics (p. 366)	L. Bühler	2	4	W
2169458	E	Numerical simulation of reacting two phase flows (p. 416)	R. Koch	2	4	W
2157442	E (P)	Computational Methods in Fluid Mechanics (Exercise) (p. 436)	B. Pritz	2	4	W
2154407	E	Flows in rotating systems (p. 501)	R. Bohning	2	4	S
2153406	E	Flows with chemical reactions (p. 502)	A. Class	2	4	W
2154409	E (P)	(p. 418)	B. Frohnapfel, T. Baumann	2	4	S
2130934	E	Numerical Modeling of Multiphase Flowsf Multi-phase Flows (p. 415)	M. Wörner	2	4	S
2169470	E	Two-Phase Flow and Heat Transfer (p. 555)	T. Schulenberg, M. Wörner	2	4	W
2154436	E	Aerothermodynamics (p. 172)	F. Seiler	2	4	S
2153410	E	Optical Flow Measurement: Fundamentals and Applications (p. 316)	F. Seiler	2	4	W
2157443	E	Computational methods for the heat protection of a full vehicle (p. 211)	H. Reister	2	4	W
2154430	E	Introduction to modeling of aerospace systems (p. 253)	G. Schlöffel	2	4	S
2153428	E	Vortex Flows (p. 552)	K. Bühler	2	4	W
2154445	E (P)	(p. 504)	B. Frohnapfel, T. Baumann	2	4	W
2154448	E	Processes and Methods for efficient product development (p. 258)	F. Ohle	2	4	S

Conditions:
Recommendations: recommended course: “Mathematical Methods in Fluid Mechanics”
Core subjects are to be selected in such a way that numerical, experimental and theoretical methods are covered.
Learning Outcomes: Students enhancen their understanding in fluid mechanics. They are capable of adressing fluid mechanical problems independently by applying theoretical, numerical and experimental methods.
Remarks: Within SP41 it is generally possible to also attend lectures of the Institute of Hydromechanics (www.ifh.kit.edu). These include

- fluid mechanics of turbulent flows
- turbulence model in fluid mechanics - RANS and LES
- numerical flow simulations I
- numerical flow simulations II
- experimental techniques I

Please contact Prof. Frohnapfel (bettina.frohnapfel@kit.edu) for further information if you are interested in this option.

SP 42: Technical Acoustics

ID	Cat	Course	Lecturer	h	CP	Term
2158107	KP	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2161224	K	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2161212	K	Vibration Theory (p. 512)	W. Seemann	3	5	W
2161216	E	Wave propagation (p. 255)	W. Seemann	2	4	W
2113806	E	Vehicle Comfort and Acoustics I (p. 276)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 277)	F. Gauterin	2	4	S
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2162246	E	Computational Dynamics (p. 466)	C. Proppe	2	4	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 43: Technical Ceramics and Powder Materials

ID	Cat	Course	Lecturer	h	CP	Term
2126775	K	Structural Ceramics (p. 506)	M. Hoffmann	2	4	S
2193010	K	Grundlagen der Herstellungsverfahren der Keramik und Pulvermetallurgie (p. 306)	R. Oberacker	2	4	W
2125768	K	Introduction to Ceramics (p. 343)	M. Hoffmann	4	6	W
2125762	E	Nanoanalytics (p. 404)	M. Bäurer	2	4	W
2125751	E (P)	Practical Course Technical Ceramics (p. 433)	F. Porz	2	4	W
2126749	E	Advanced powder metals (p. 461)	R. Oberacker	2	4	S
2125763	E	Structural and phase analysis (p. 505)	S. Wagner	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2126784	E	Functional Ceramics (p. 290)	M. Hoffmann, M. Bäurer	2	4	S

Conditions: none
Recommendations: Recommended compulsory elective subjects:

- Systematic Materials Selection
- Modern Physics for Engineers
- Physics for Engineers
- Physical basics of laser technology

Learning Outcomes: The students acquires comprehensive and fundamental knowledge of

- preparation, processing and characterization of technical powders
- consolidation of powders by various shaping techiques
- densification of powdermetallurgical products by sintering
- the manifold possibilities of microstructural design of powdermetallurgical materials
- the microstructure property relationships

Remarks:

SP 44: Technical Logistics

ID	Cat	Course	Lecturer	h	CP	Term
2117095	KP	Basics of Technical Logistics (p. 312)	M. Mittwollen, Madzharov	4	6	W
2117096	K	Elements of Technical Logistics (p. 262)	M. Mittwollen, Madzharov	3	4	W
2118087	K	Selected Applications of Technical Logistics (p. 198)	M. Mittwollen, Madzharov	3	4	S
2118088	K	Selected Applications of Technical Logistics and Project (p. 199)	M. Mittwollen, Madzharov	4	6	S
2117064	E	Application of technical logistics in modern crane systems (p. 183)	M. Golder	2	4	W
2118089	E	Application of technical logistics in sorting- and distribution technology (p. 184)	J. Föller	2	4	S
2117500	E	Energy efficient intralogistic systems (p. 264)	F. Schönung	2	4	W
2138341	E	Cogitive Automobiles - Laboratory (p. 345)	C. Stiller, M. Lauer, B. Kitt	2	4	S
2118097	E	Warehousing and distribution systems (p. 355)	K. Furmans, C. Huber	2	4	S
2117051	E	Material flow in logistic systems (p. 373)	K. Furmans	4	6	W
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2138336	E	Behaviour Generation for Vehicles (p. 533)	C. Stiller, T. Dang	2	4	S
2118083	EM	IT for facility logistics (p. 341)	F. Thomas	4	6	S
2150904	E	Automated Production Line (p. 207)	J. Fleischer	6	8	S
2117097	E	Elements of Technical Logistics and Project (p. 263)	M. Mittwollen, Madzharov	4	6	W

Conditions: none
Recommendations: Recommended compulsory optional subjects:

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

Learning Outcomes: The student

- acquires well-founded knowledge on the main topics of technical logistics
- gets an overview of different applications of technical logistics in practice,
- acquires expertise and understanding about functionality of material handling systems.

Remarks:

SP 45: Engineering Thermodynamics

ID	Cat	Course	Lecturer	h	CP	Term
2165515	K	Fundmentals of Combustion I (p. 313)	U. Maas	2	4	W
2166538	K	Fundamentals of combustion II (p. 314)	U. Maas	2	4	S
2167523	K	Modeling of Thermodynamical Processes (p. 399)	R. Schießl, U. Maas	3	6	W/S
2167541	E	Selected chapters of the combustion fundamentals (p. 203)	U. Maas	2	4	W/S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2165525	E	Mathematical models and methods in combustion theory (p. 381)	V. Bykov, U. Maas	2	4	W
2134134	E	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2166543	E	Reduction methods for the modeling and the simulation of combustion processes (p. 472)	V. Bykov, U. Maas	2	4	S
2153406	E	Flows with chemical reactions (p. 502)	A. Class	2	4	W
2169453	E	Thermal Turbomachines I (p. 521)	H. Bauer	3	6	W
2170476	E	Thermal Turbomachines II (p. 522)	H. Bauer	3	6	S
2167048	E	Combustion diagnositics (p. 530)	R. Schießl, U. Maas	2	4	W/S
2133101	E	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2166534	E	Heatpumps (p. 541)	H. Wirbser, U. Maas	2	4	S
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 493)	C. Baumgarten	2	4	W
2157443	E	Computational methods for the heat protection of a full vehicle (p. 211)	H. Reister	2	4	W

Conditions: None.
Recommendations: Recommended Course:

- 22512 Heat- and Mass transfer

Learning Outcomes: After completion of SP 45 students are able to:

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

Remarks:

SP 46: Thermal Turbomachines

ID	Cat	Course	Lecturer	h	CP	Term
2169453	KP	Thermal Turbomachines I (p. 521)	H. Bauer	3	6	W
2170476	K	Thermal Turbomachines II (p. 522)	H. Bauer	3	6	S
2170454	E	Selected Topics in Aeronautics and Astronautics I (p. 200)	S. Wittig	2	4	S
2169486	E	Selected Topics in Aeronautics and Astronautics II (p. 201)	S. Wittig	2	4	W
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2161252	E	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2171486	E (P)	Integrated measurement systems for fluid mechanics applications (p. 337)	H. Bauer, Mitarbeiter	5	4	W/S
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2170463	E	Cooling of thermally high loaded gas turbine components (p. 354)	H. Bauer, A. Schulz	2	4	S
2161224	E	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2169458	E	Numerical simulation of reacting two phase flows (p. 416)	R. Koch	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2173562	E	Failure Analysis (p. 479)	K. Poser	2	4	W
2173585	E	Fatigue of Metallic Materials (p. 485)	K. Lang	2	4	W
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2154407	E	Flows in rotating systems (p. 501)	R. Bohning	2	4	S
2161212	E	Vibration Theory (p. 512)	W. Seemann	3	5	W
2169462	E	Turbine and compressor Design (p. 527)	H. Bauer, A. Schulz	2	4	W
2170478	E	Turbo Jet Engines (p. 528)	H. Bauer, A. Schulz	2	4	S
2181715	E	Failure of Structural Materials: Fatigue and Creep (p. 534)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	E	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2174574	E	Materials for Lightweight Construction (p. 546)	K. Weidenmann	2	4	S
2170490	E	Combined Cycle Power Plants (p. 293)	T. Schulenberg	2	4	S
2170491	E (P)	Simulator Exercises Combined Cycle Power Plants (p. 494)	T. Schulenberg	2	2	S

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 47: Tribology

ID	Cat	Course	Lecturer	h	CP	Term
2181113	K	Tribology A (p. 525)	M. Scherge, M. Dienwiebel	2	4	W
2182139	K	Tribology B (p. 526)	M. Scherge, M. Dienwiebel	2	4	S
2145181	E	Applied Tribology in Industrial Product Development (p. 178)	A. Albers, W. Burger	2	4	W
2146180	E	Powertrain Systems Technology A: Automotive Systems (p. 181)	A. Albers, S. Ott	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2178643	E	Constitution and Properties of Wear resistant materials (p. 196)	S. Ulrich	2	4	S
2181712	E	Nanotribology and -Mechanics (p. 407)	M. Dienwiebel, H. Hölscher	2	4	W
2173590	E	Polymer Engineering I (p. 428)	P. Elsner	2	4	W
2142860	E	Scanning probe microscopy (p. 406)	H. Hölscher, M. Dienwiebel, Stefan Walheim	2	4	S
2177618	E	Superhard Thin Film Materials (p. 507)	S. Ulrich	2	4	W

Conditions: none
Recommendations: preliminary knowlegde in mathematics, mechanics and materials science
Learning Outcomes: The students are familiar with the contents of the lectures “tribology A” (2181113) and “tribology B” (2182139). Furthermore they learn more about at least two other chosen topics.
Remarks:

SP 48: Internal Combustion Engines

ID	Cat	Course	Lecturer	h	CP	Term
2133101	KP	Combustion Engines A with tutorial (p. 531)	U. Spicher	6	8	W
2134135	K	Combustion Engines B with Tutorial (p. 532)	U. Spicher	3	4	S
2134138	K	Fundamentals of catalytic exhaust gas aftertreatment (p. 307)	E. Lox	2	4	S
2134134	K	Analysis tools for combustion diagnostics (p. 390)	U. Wagner	2	4	S
2134137	K	Engine measurement techniques (p. 403)	S. Bernhardt	2	4	S
2133109	E	Fuels and Lubricants for Combustion Engines and their Testing (p. 212)	J. Volz	2	4	W
2133114	E	Simulation of spray and mixture formation processes in combustion engines (p. 493)	C. Baumgarten	2	4	W
2134141	E	Gas Engines (p. 294)	R. Golloch	2	4	S
2134150	E	Analysis of Exhaust Gas und Lubricating Oil in Combustion Engines (p. 170)	M. Gohl	2	4	S
2134139	E	Model based Application Methods (p. 398)	F. Kirschbaum	2	4	S
2134001	E	Engine Laboratory (p. 402)	U. Spicher	2	4	S
2186126	E	Automobile and Environment (p. 209)	H. Kubach, U. Spicher, U. Maas, H. Wirbser	2	4	S
2133112	E	Drive Systems and Possibilities to Increase Efficiency (p. 180)	H. Kollmeier	1	2	W
2166538	E	Fundamentals of combustion II (p. 314)	U. Maas	2	4	S
2113805	E	Automotive Engineering I (p. 304)	F. Gauterin, H. Unrau	4	8	W
2114835	E	Automotive Engineering II (p. 305)	F. Gauterin, H. Unrau	2	4	S
2113806	E	Vehicle Comfort and Acoustics I (p. 276)	F. Gauterin	2	4	W
2114825	E	Vehicle Comfort and Acoustics II (p. 277)	F. Gauterin	2	4	S
2158107	E	Technical Acoustics (p. 510)	M. Gabi	2	4	S
2161224	E	Machine Dynamics (p. 371)	C. Proppe	3	5	W
2162220	E	Machine Dynamics II (p. 372)	C. Proppe	2	4	S
2181113	E	Tribology A (p. 525)	M. Scherge, M. Dienwiebel	2	4	W
2182139	E	Tribology B (p. 526)	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. 509)	K. Ziegahn	2	4	S
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W

Conditions:
Recommendations:
Learning Outcomes:
Remarks:

SP 49: Reliability in Mechanical Engineering

ID	Cat	Course	Lecturer	h	CP	Term
2181715	K	Failure of Structural Materials: Fatigue and Creep (p. 534)	O. Kraft, P. Gumbsch, P. Gruber	2	4	W
2181711	K	Failure of structural materials: deformation and fracture (p. 535)	P. Gumbsch, O. Kraft, D. Weygand	2	4	W
2182735	E	Application of advanced programming languages in mechanical engineering (p. 185)	D. Weygand	2	4	S
2181740	E	Atomistic simulations and molecular dynamics (p. 195)	P. Gumbsch	2	4	S
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2181708	E (P)	Biomechanics: design in nature and inspired by nature (p. 216)	C. Mattheck	2	4	W
2162282	E	Introduction to the Finite Element Method (p. 247)	T. Böhlke	2	5	S
2182732	E	Introduction to Theory of Materials (p. 249)	M. Kamlah	2	4	S
2182734	E	Introduction to the Mechanics of Composite Materials (p. 250)	Y. Yang	2	4	S
2183716	E (P)	FEM Workshop – constitutive laws (p. 283)	K. Schulz, D. Weygand, M. Weber	2	4	W/S
2182731	E (P)	Finite Element Workshop (p. 287)	C. Mattheck, D. Weygand	2	4	S
2181720	E	Foundations of nonlinear continuum mechanics (p. 311)	M. Kamlah	2	4	W
2181744	E	Size effects in micro and nanostructures materials (p. 302)	P. Gumbsch, D. Weygand, C. Eberl, P. Gruber, M. Dienwiebel	2	4	W
2161252	E	Advanced Methods in Strength of Materials (p. 325)	T. Böhlke	2	4	W
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2161254	E	Mathematical Methods in Strength of Materials (p. 377)	T. Böhlke	2	5	W
2162280	E	Mathematical Methods in Structural Mechanics (p. 380)	T. Böhlke	2	5	S
2181710	E	Mechanics in Microtechnology (p. 384)	C. Eberl, P. Gruber	2	4	W
2183702	E	Modelling of Microstructures (p. 395)	B. Nestler, D. Weygand, A. August	3	5	W
2183703	E	Modelling and Simulation (p. 400)	B. Nestler, P. Gumbsch	3	5	W/S
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2173562	E	Failure Analysis (p. 479)	K. Poser	2	4	W
2173585	E	Fatigue of Metallic Materials (p. 485)	K. Lang	2	4	W
2173577	E	Failure Analysis Seminar (p. 487)	K. Poser	2	2	W
2117061	E	Safety engineering (p. 488)	H. Kany	2	4	W
2185264	E	Simulation in product development process (p. 491)	A. Albers, T. Böhlke, J. Ovtcharova	2	4	W
2182740	E	Materials modelling: dislocation based plasticy (p. 548)	D. Weygand	2	4	S
2181738	E	Scientific computing for Engineers (p. 553)	D. Weygand, P. Gumbsch	2	4	W

Conditions: none
Recommendations:

Learning Outcomes: The students are familiar with the contents of the lectures “failure of structural materials: fatigue and creep” (2181715) and “failure of structural materials: deformation and fracture”(2181711) . Furthermore they learn more about at least two other chosen topics.
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. 480)	P. Gratzfeld	2	4	W/S
2115995	E	Project Management in Rail Industry (p. 455)	P. Gratzfeld	2	4	W
2114916	E	Intermodal Transport and Cross-Border Rail Traffic (p. 340)	P. Gratzfeld, R. Grube	2	4	S
2115915	E	Mobility Concepts of Rail Transportation in 2030 (p. 397)	P. Gratzfeld	2	4	W/S
2114346	E	Electric Rail Vehicles (p. 261)	P. Gratzfeld	2	4	S
2113101	E	Introduction to Automotive Lightweight Technology (p. 243)	F. Henning	2	4	W
2114052	E	Composites for Lightweight Design (p. 282)	F. Henning	2	4	S
2105011	E	Introduction into Mechatronics (p. 251)	G. Bretthauer, A. Albers	3	6	W
19306	E	Basics Operation Systems of Ground Born Guided Systems (p. 259)	E. Hohnecker, P. Gratzfeld, Hohnecker	2	4	W
19321	E	Operation Systems of Ground Born Guided Systems (p. 260)	E. Hohnecker, P. Gratzfeld, Hohnecker	2	4	S
19066	E	Basics of Ground Born Guided Systems (p. 315)	E. Hohnecker, P. Gratzfeld, Hohnecker	3	4	S
2138340	E	Automotive Vision (p. 279)	C. Stiller, M. Lauer	2	4	S
2162256	E	Computational Vehicle Dynamics (p. 467)	C. Proppe	2	4	S
2161217	E (P)	Mechatronic Softwaretools (p. 496)	C. Proppe	2	4	W

Conditions:
Recommendations: none
Learning Outcomes:

- The students understand relations and interdependencies between rail vehicles, infrastructure and operation in a rail system.
- They deduct the fundamental requirements for rail vehicles out of it and assess concepts of rail vehicles.
- They know about major systems in a rail vehicle and evaluate their fitness in specific fields of application.
- Supplementary lectures present further major aspects of a rail system.

Remarks:

SP 51: Development of innovative appliances and power tools

ID	Cat	Course	Lecturer	h	CP	Term
2145164	KP	Appliance and Power Tool Design (p. 296)	S. Matthiesen	3	6	W
2145165	KP (P)	Appliance and Power Tool Design Project Work (p. 453)	S. Matthiesen	4	2	W
2146190	E	Lightweight Engineering Design (p. 349)	A. Albers, N. Burkardt	2	4	S
2145180	E	Methodic Development of Mechatronic systems (p. 391)	A. Albers, W. Burger	2	4	W
2147161	E	Intellectual Property Rights and Strategies in Industrial Companies (p. 420)	F. Zacharias	2	4	W/S
2141865	E	Novel actuators and sensors (p. 408)	M. Kohl, M. Sommer	2	4	W
2109025	E	Product Ergonomics (in German) (p. 441)	B. Deml	2	4	W
2145182	E	Project management in Global Product Engineering Structures (p. 456)	P. Gutzmer	2	4	W
2145184	E	Leadership and Product Development (p. 358)	A. Ploch	2	4	W
2146193	E	Strategic Product Planing (p. 500)	A. Siebe	2	4	S
2174571	E	Design with Plastics (p. 348)	M. Liedel	2	4	S
2149667	E	Quality Management (p. 462)	G. Lanza	2	4	W
2147175	E (P)	CAE-Workshop (p. 225)	A. Albers, Assistenten	3	3	W/S
2105014	E (P)	Laboratory mechatronics (p. 385)	A. Albers, G. Bretthauer, C. Proppe, C. Stiller	3	4	W
2113072	E	Development of Oil-Hydraulic Powertrain Systems (p. 454)	G. Geerling	2	4	W

Conditions: SP 51 is not selectable in bachelor degree course.
It is selectable in masters course, depending on specialization.
Due to organizational reasons, the number of participants is limited. At the beginning of august, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous.
Recommendations: CAE Workshop is recommended as elective course or complementary subject.
Learning Outcomes: SP 51 considers important courses, which are relevant for the development of innovative mechatronical technical appliances and power tools. The superior learning objective is to understand the development of technical appliances and power tools, which connects different specialist disciplines, theoretically and practically.
Remarks:

SP 53: Fusion Technology

ID	Cat	Course	Lecturer	h	CP	Term
2169483	K	Fusion Technology A (p. 291)	R. Stieglitz	2	4	W
2190492	K	Fusion Technology B (p. 292)	R. Stieglitz	2	4	S
23271	K	(p. 499)	M. Urban	2	4	W
2189473	E	Neutron physics of fusion reactors (p. 409)	U. Fischer	2	4	W
2153429	E	Magnetohydrodynamics (p. 366)	L. Bühler	2	4	W
2190496	E	Magnet Technology of Fusion Reactors (p. 365)	W. Fietz, K. Weiss	2	4	
2169470	E	Two-Phase Flow and Heat Transfer (p. 555)	T. Schulenberg, M. Wörner	2	4	W
2181745	E	Design of highly stresses components (p. 205)	J. Aktaa	2	4	W
2194650	E	Materials under high thermal or neutron loads (p. 519)	A. Möslang, Dr. Michael Rieth	2	4	S
2130910	E	CFD for Power Engineering (p. 226)	I. Otic	2	4	S
2129901	E	Energy Systems I: Renewable Energy (p. 265)	R. Dagan	3	6	W
2189904	E	Ten lectures on turbulence (p. 518)	I. Otic	2	4	W

Conditions:
Recommendations:
Learning Outcomes:
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. 164)[SP_48_mach]

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

Learning Control / Examinations
Letter of attendance or oral exam (30 minutes, no testing aids)

Conditions
none

Recommendations
Knowledge in the field of engine technology and measurement techniques is advantageous

Learning Outcomes
The Students know the challenges concerning the current emission standards in engine development. They know the basic principles of measurement techniques and methods to analyse exhaust gas components and components of engine oil. Hence, the students have the ability to choose the right methods and to interpret the results.

Content
The students get involved in the application of different measurement techniques in the field of exhaust gas and lubricating oil analysis. The functional principles of the systems as well as the application areas of the latter are discussed. In addition to a general overview of standard applications, current specific development and research activities are introduced.

Media
Lecture with Powerpoint slides

Literature
The lecture documents are distributed during the courses.

Course: Adaptive Control Systems [2105012]

Coordinators: G. Bretthauer
Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
Measuring and Automatic Control

Learning Outcomes
The students know different types, structures and operation of adaptive control systems. They are capable of setting up system equations theoretically and experimentally. By experimenting with examples students are prepared to apply adaptive control systems in practice.

Content
Introduction: definitions, classification of adaptive control systems, objectives

Structures of adaptive control systems: overview, parameter-, structure- and signal-adaptive control systems, open-loop and closed loop ARS, ARS with reference/identification model, application

Modeling: methods, experimental conditions, experimental modeling, identifcation methods for single input single output systems and multi input multi output systems

Parameter adaptive control systems: definitions, design methods

Literature
W. Weber. Adaptive Regelungssysteme, volume I, II. R. Oldenbourg, München, 1971.

Course: Aerothermodynamics [2154436]

Coordinators: F. Seiler
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_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
Students are familiar with the aerodynamic problems occurring during re-entry of space vehicles into the earth's atmosphere. During the flight the air flow is strongly heated by the bow wave formation in the high Mach number flow regime, wherefore the physics and chemistry, i.e. real gas effects and the behaviour of hot air at high temperatures need to be taken into account. The combination of the thermodynamics of hot air and the flow development at hypersonic flow conditions coupled with extreme heat flux phenomena is usually summarised in the term "Aerothermodynamics". The students can discuss the fundamental equations of fluid mechanics and aerothermodynamics for the case of a re-entry flight trajectory of a space vehicle.

Content
Nature of a hypersonic flow
Fundamentals of aerothermodynamics
Problems during re-entry
Flow regimes during re-entry
Applied hypersonic research

Literature
H. Oertel jun.: Aerothermodynamik, Springer-Verlag, Berlin Heidelberg New York, 1994
F. Seiler: Skript zur Vorlesung über Aerothermodynamik

Course: [23064]

Coordinators: G. Trommer
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Elective literature:

- Jan Wendel: Integrierte Navigationssysteme : Sensordatenfusion, GPS und Inertiale Navigation, München 2007.
- D. H. Titterton, J. L. Weston: Strapdown Inertial Navigation Technology.
- R. Brown, P. Hwang: Introduction to Random Signals and Applied Kalman Filtering, John Wiley & Sons.
- Farrell, J.; Barth, M.: The Global Positioning System & Inertial Navigation, McGraw-Hill, 1999, New York.
- Grewal, M.S. u.a.: Global Positioning Systems, Inertial Navigation and Integration, John Wiley & Sons, 2001, New York.

Course: Analytical methods in material flow methodology (mach and wiwi) [2117060]

Coordinators: K. Furmans, J. Stoll, E. Özden

Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
oral

30min (electives), 60min (main subject)

examination aids: none

Conditions
none

Recommendations
Basic knowledge of statistic
recommended compusory optional subject:

- Stochastics in Mecanical Engineering

recommended lecture:

- Material flow in logistic systems (also parallel)

Learning Outcomes
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 exakt methods.

Content

- single server systems: M/M/1, M/G/1: priority rules, model of failures
- networks: open and closed approximations, exact solutions and approximations
- application to flexible manufacturing systems, AGV (automated guided vehicles) - systems
- modeling of control approaches like constant work in process (ConWIP) or kanban
- discrete-time modeling of queuing systems

Media
black board, lecture notes, presentations

Literature
Wolff: Stochastic Modeling and the Theory of Queues, Prentice Hall, 1989

Shanthikumar, Buzacott: Stochastic Models of Manufacturing Systems

Remarks
none

Course: Applied Fluid Mechanics [2154434]

Coordinators: B. Frohnapfel
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach]

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

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
Fundamental Knowledge about Fluid Mechanics

Learning Outcomes
The students are familiar with different aspects of fluid mechanics beyond a basic level. They know how to apply theoretical, experimental and numerical tools in order to adress fluid mechanical problems of practical relevance. After having completed this course students are in particular familiar with experimental tools, while having obtained an overview about numerical and advanced theoretical approaches.

Content
This lecture focuses on experimental methods of fluid mechanics and their application to solve flow problems of practical relevance. In addition an overview of numerical and advanced theoretical methods of fluid mechanics will be given.
The lecture covers a selection of the following topics:

- measuring techniques and measureable quantities
- pressure measurements
- hot wire measurements
- optical measuring techniques
- error analysis
- scaling laws
- turbulent flows
- aerodynamics
- airfoil theory
- potential flows
- boundary layers
- pipe flow
- data evalatuation

Literature
Kundu, P.K., Cohen, K.M.: Fluid Mechanics, Elsevier, 4th Edition, 2008
Schlichting, H., Gersten, K.: Boundary Layer Theory, Springer 2000

Tropea, Yarin, Foss: Springer Handbook of Experimental Fluid Mechanics, Springer 2007

Course: Low Temperature Technology [2158112]

Coordinators: F. Haug
Part of the modules: SP 24: Energy Converting Engines (p. 137)[SP_24_mach]

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

Learning Control / Examinations
oral examination
duration: 30 minutes
no tools or reference materials may be used during the exam

Conditions
none

Recommendations
Knowledge in Thermodynamics I is of advantage (however, no prerequisite)

Learning Outcomes
The lecture gives an introduction to the interdisciplinary field of low temperature technology (cryogenics) with emphasis on thermodynamics and process engineering. Fundamentals are explained followed by exercises and practical examples comprising industrial cryoplants. Where useful reference is made to cryogenic systems at CERN, the European Organization for high energy physics. Low temperature technology is a comparatively young engineering branch with future potential and is indispensible for basic research, space technology, some medical technologies, industry, superconductivity, research centres.

Content

1. Introduction to low temperature technology
2. The research centre CERN
3. Fundamentals (thermo-physical)
4. Low temperature properties of materials
5. Cryogens
6. Thermal insulation, storage, transfer of cryogenic fluids
7. Fundamentals (laws of thermodynamics)
8. Cycles and processes
9. Refrigerators and components
10. Instrumentation, automation
11. Examples of cryoplants (among others at CERN)
12. Cryocoolers
13. Production of extremely low temperatures

Literature

1. Technische Thermodynamik, beliebig
2. Tieftemperaturtechnologie, H. Frey und R. Haefer, VDI-Verlag, 1981
3. Handbook of Cryogenic Engineering, J. Weisend II, Verlag Taylor&Francis, 1998

Course: Applied Tribology in Industrial Product Development [2145181]

Coordinators: A. Albers, W. Burger
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 47: Tribology (p. 163)[SP_47_mach]

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

Learning Control / Examinations
oral exam

Conditions
compulsory preconditions: none

Learning Outcomes
Combustion engines, injection systems, auxiliaries and transmissions have one in common:
Highly stressed lubricated working surface pairs.
The trend in automotive engineering tends to higher power density and extended service intervalls and at the same time reduced weight and constructed space, leading to new challenges to the lubricants and contact partners such as journal bearing, roller bearings, cam-shaft-systems and gears.
Focus of this lecture is to to show the range of tribology and elaborate the characteristics of lubricated working surface pairs by using examples from automobile industrie.

Content

- Friction, Wear, Wear Measurement
- Lubricant (Oil, Grease, etc.)
- Hydrodynamic and elastohydrodynamic Lubrication
- Design of Tribologic Working Surface Pairs
- Technique of Measurement in Lubricated Contacts
- Prevention of Maschine Failure
- Protective Surface Layers
- Journal Bearings, Roller Bearings
- Gear Wheels and Transmissions

Literature
The lecture script will be allocated at Ilias

Course: Drive Train of Mobile Machines [2113077]

Coordinators: M. Geimer
Part of the modules: SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations

- general basics of mechanical engineering
- basic knowledge in hydraulics
- interest in mobile machines

Learning Outcomes
Get to know all relevant aspects and components of a drive train of a mobile machine and also the construction of various drive trains. Knowing and understandung interactions and independancies of components on a besic level.

Content
In this course will be discussed the different drive train of mobile machinerys. The fokus of this course is:
- improve knowledge of fundamentals
- mechanical gears
- torque converter
- hydrostatic drives
- continuous variable transmission
- eletrical drives
- hybrid drives
- axles
- terra mechanic

Media
projector presentation

Literature
download of scriptum via ILIAS

Course: Drive Systems and Possibilities to Increase Efficiency [2133112]

Coordinators: H. Kollmeier
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach]

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

Learning Control / Examinations
Oral examination, time duration 30 min., no aids

Conditions
none

Recommendations
Verbrennungsmotoren A

Learning Outcomes
The student has an overview about possibilities for increasing the efficiency of propulsion systems. He understands the basics of waste heat recovery and knows the required technology therefore. He has an overview about systems for storage electrical energy, heat energy and mechanical energy. The student understands the technical contexts of combined propulsions systems of internal combustion engine and electric motor/generator. The student understands the necessary of lightweight construction systems and knows the material basics therefore.

Content
The students attend to propulsion systems and possibilities for increasing efficiency and get an overview about the demand of energy of stationary and mobile propulsion systems. Furthermore they get an overview about possibilities for increasing efficiency by the use of storage systems, systems of waste heat recovery and lightweight construction systems. There is also a view on complete systems for increasing efficiency as combined heat and power plant and hybrid propulsion systems.

Media
Lecture with powerpoint slides

Literature
Download of powerpoint slides

Remarks
none

Course: Powertrain Systems Technology A: Automotive Systems [2146180]

Coordinators: A. Albers, S. Ott

Part of the modules: SP 47: Tribology (p. 163)[SP_47_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 12: Automotive Technology (p. 126)[SP_12_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. 123)[SP_10_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 02: Powertrain Systems (p. 113)[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. 123)[SP_10_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach], SP 44: Technical Logistics (p. 160)[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. Föller
Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 44: Technical Logistics (p. 160)[SP_44_mach]

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

Learning Control / Examinations
oral 30 min

Conditions
None.

Recommendations
None.

Learning Outcomes
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: Application of advanced programming languages in mechanical engineering [2182735]

Coordinators: D. Weygand
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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
The student will lear to program in Fortran 95/2003, to use script languages (e.g. awk or python) and to implement simple simulations.

Content
This lecture gives an introduction to advances programming and scripting languages and numerical methods under UNIX/Linux:

* Fortran 95/2003
- structure of source code
- progamming
- compiling
- debugging
- parallelization with OpenMP
* numerical methods
* script languages: Python, awk
* visualisation

Literature
[1] fortran 95/2003 explained, M. Metcalf, J. Reid, M. Cohen, Oxford University Press 2004.
[2] Intel Fortran compiler handbook.

Course: Computer-Supported Operations Planning (in German) [2110038]

Coordinators: B. Deml
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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
None.

Recommendations

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

Learning Outcomes

- Get deeper insights within production management
- Increase knowledge of the planning of working and production systems
- Understanding of methods for modelling and simulation of production systems
- Understand the importance and the benefit of informatics within mechanical engineering

Content

1. Introduction to the course
2. Terminology of operations planning
3. Operations planning
4. Development of a machining plan
5. Development of a operation sheet
6. Workplace design
7. Basics of the simulation of production systems
8. Material-oriented simulation
9. Personnel-oriented simulation
10. Planning and simulation of assembly systems
11. Enterprise-oriented simlulation
12. Digital Factory as a planning tool

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

Literature:

- WIENDAHL, Hans-Peter: Betriebsorganisation für Ingenieure. München, Wien: Carl Hanser Verlag, 5. Auflage 2004.
- EVERSHEIM, Walter: Organisation in der Produktionstechnik 3: Arbeitsvorbereitung. Düsseldorf: VDI-Verlag, 4. Auflage 2002.
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Ausgewählte Methoden der Planung und Steuerung. München: Carl Hanser Verlag, 1993.
- KIEF, Hans B.: NC/CNC Handbuch 2003/04. München, Wien: Carl Hanser Verlag, 2003.
- KOŠTURIAK, Ján; GREGOR, Milan: Simulation von Produktionssystemen. Wien, New York: Springer, 1995.
- LIEBL, Franz: Simulation. München, Wien: Oldenbourg, 2. Auflage 1995.
- VDI 4499, Blatt 1: Digitale Fabrik - Grundlagen. Berlin: Beuth-Verlag, 2008.

Please refer to the latest edition.

Course: Occupational Safety and Labour Legislation (in German) [2109024]

Coordinators: B. Deml
Part of the modules: SP 03: Work Science (p. 115)[SP_03_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

- Module course: Combination of the lectures "Arbeitsschutz und Arbeitsschutzmanagement (2109030)" and the last part of "Arbeitswissenschaft (2109026)" (i.e. combination with one of those lectures is not possible)
- **The exams "Arbeitsschutz und Arbeitsrecht (2109024)" and "Arbeitswissenschaft (2109026)" are mutually exclusive.**
- **The exams "Arbeitsschutz und Arbeitsrecht (2109024)" and "Arbeitsschutz und Arbeitsschutzmanagement (2109030)" are mutually exclusive.**

Recommendations

- Willingness to learn interdisciplinarily (Technology, Economy, Legal regulations, Informatics . . .)
- Knowledge of Work Science is usefull

Learning Outcomes

- Know relevant laws and regulations of occupational safety and labour legislation as well as elementary methods
- Ability to integrate the occupational safety within the operational processes
- Awarness of the interrelation to other management systems and techniques

Content

1. Introduction to the course
2. Terminology and legal regulations
3. Structural organisation of occupational safety
4. Processes in occupational safety
5. Office workplaces and visual display units
6. Computer-supported risk analysis
7. Risk evaluation within the occupational safety
8. Occupational safety management systems
9. Integrated management systems
10. Individual labour legislation
11. Collective labour legislation

12. Representation of interests groups

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

Literature:

- SKIBA, Reinald: Taschenbuch Arbeitssicherheit. Bielefeld: Erich Schmidt Verlag, 10. Auflage 2000.
- SCHLIEPHACKE, Jürgen: Führungswissen Arbeitssicherheit. Berlin: Erich Schmidt Verlag, 2000.
- RITTER, Albert; LANGHOFF, Thomas: Arbeitsschutzmanagementsysteme: Vergleich ausgewählter Standards.Bremerhaven: Wirtschaftsverlag NW, 2. Auflage 1998. (Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Forschung Fb 792)
- ZÜLCH, Gert; BRINKMEIER, Bernd (Hrsg.): Arbeitsschutz-Managementsysteme: Realisierungsformen und Entwicklungsbedarf. Aachen: Shaker Verlag, 2000.
- Beck-Texte: Arbeitsgesetze. München: Deutscher Taschenbuch Verlag, 77. Auflage, 2010. (Beck-Texte im dtv, 5006)
- ZÖLLNER, Wolfgang; LORITZ, Karl-Georg; HERGENRÖDER, Wolfgang: Arbeitsrecht. München: C. H. Beck, 6. Auflage 2007.
- MEISEL, Peter G.: Arbeitsrecht in der betrieblichen Praxis. Köln: Deutscher Instituts Verlag, 10. Auflage 2002.
- MÜLLER-JENTSCH, Walter: Soziologie der industriellen Beziehungen. Frankfurt/M., New York: Campus Verlag, 1986. (Campus Studium, Band 566).

Please refer to the latest edition.

Course: Occupational Health and Safety Management (in German) [2109030]

Coordinators: B. Deml
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 37: Production Management (p. 152)[SP_37_mach]

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

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

Allowed resource materials: none

Conditions
The exams "Arbeitsschutz und Arbeitsschutzmanagement (2109030)" and "Arbeitsschutz und Arbeitsrecht (2109024)" are mutually exclusive.

Recommendations

- Willingness to learn interdisciplinarily (Technology, Economy, Legal regulations, Informatics . . .)
- Knowledge of Work Science is usefull

Learning Outcomes

- Know relevant laws and regulations of occupational safety
- Ability to integrate the occupational safety within operational processes
- Awareness of the interrelation to other management systems and techniques

Content

1. Introduction to the course
2. Terminology and legal regulations
3. Structural organisation of occupational safety
4. Processes in occupational safety
5. Office workplaces and visual display units
6. Computer-supported risk analysis
7. Risk evaluation within the occupational safety
8. Occupational safety management systems
9. Integrated management systems

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

Literature:

- SKIBA, Reinald: Taschenbuch Arbeitssicherheit. Bielefeld: Erich Schmidt Verlag, 10. Auflage 2000.
- SCHLIEPHACKE, Jürgen: Führungswissen Arbeitssicherheit. Berlin: Erich Schmidt Verlag, 2000.

- RITTER, Albert; LANGHOFF, Thomas: Arbeitsschutzmanagementsysteme: Vergleich ausgewählter Standards.Bremerhaven: Wirtschaftsverlag NW, 2. Auflage 1998. (Schriftenreihe der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin, Forschung Fb 792)
- ZÜLCH, Gert; BRINKMEIER, Bernd (Hrsg.): Arbeitsschutz-Managementsysteme: Realisierungsformen und Entwicklungsbedarf. Aachen: Shaker Verlag, 2000.
- Beck-Texte: Arbeitsgesetze. München: Deutscher Taschenbuch Verlag, 77. Auflage, 2010. (Beck-Texte im dtv, 5006)

Please refer to the latest edition.

Course: Work Science [2109026]

Coordinators: B. Deml
Part of the modules: SP 03: Work Science (p. 115)[SP_03_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 usefull

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

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: Work Science Laboratory Course (in German) [2109033]

Coordinators: P. Stock
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach]

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

Learning Control / Examinations

- Compulsory attendence during the whole lecture
- Colloquium in the beginning of each laboratory
- No exam

Conditions

- Compulsory attendence during the whole lecture
- Limited number of participants

Recommendations

- Willingness to learn interdisciplinarily (Technology, Economy, Legal regulations, Informatics . . .)
- Knowledge of Work Science is necessary

Learning Outcomes

- Know elementary methods and procedures of work science
- Become proficient in applying ergonomic evaluation and judgement

Content

1. Statical and dynamical muscle work
2. Measurement of mental stress and strain
3. Measurement and evaluation of noise
4. Measurement and evaluation of illumination
5. Measurement and evaluation of room climate
6. Measurement and evaluation of air pollution
7. Work studies following REFA
8. Time and movement studies following MTM
9. Ergonomic design of workplaces
10. Working with visual display units

Literature

Learning material:
The handout will be distributed within the first lecture. Additional information may be found on: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_cat_29099.html

Literature:
Zülch, Kiparski: Messen, Beurteilen, Gestalten von Arbeitsbedingungen. Heidelberg: Curt Haefner Verlag, 2. Auflage 1999.

Course: Atomistic simulations and molecular dynamics [2181740]

Coordinators: P. Gumbsch
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 47: Tribology (p. 163)[SP_47_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach]

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

Learning Control / Examinations
oral exam 30 minutes

Conditions
compulsory preconditions: none

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)

[2] Computer simulation of liquids, M. P. Allen and Dominic J. Tildesley (Clarendon Press, Oxford, 1996)

Course: Constitution and Properties of Wear resistant materials [2178643]

Coordinators: S. Ulrich
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 47: Tribology (p. 163)[SP_47_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. 139)[SP_26_mach]

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

Learning Control / Examinations
oral examination (30 min)

no tools or reference materials

Conditions
None

Recommendations
None

Learning Outcomes
Transfer of the basic knowledge of surface engineering, of the relations between constitution, properties and performance, of the manifold methods of modification, coating and characterization of surfaces.

Content
introduction and overview

concepts of surface modification

coating concepts

coating materials

methods of surface modification

coating methods

characterization methods

state of the art of industrial coating of tools and components

new developments of coating technology

Literature
Bach, F.-W.: Modern Surface Technology, Wiley-VCH, Weinheim, 2006

Copies with figures and tables will be distributed

Course: Selected Applications of Technical Logistics [2118087]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

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

Conditions
look at Empfehlungen (en)

Recommendations
GTL/ESTL should be visited in advance, knowledge out of GTL/ESTL preconditioned

Learning Outcomes
Based on the knowledge from GTL/ESTL to be able to work on specific taks 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 44: Technical Logistics (p. 160)[SP_44_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

Learning Control / Examinations
Lesson: after each lesson period; oral / written (if necessary) => (look at "Studienplan Maschinenbau"); (counts two-thirds);
Project: presentation, marked (counts one third)

Conditions
none

Recommendations
GTL/ESTL should be visited in advance, knowledge out of GTL/ESTL preconditioned

Learning Outcomes
The student

- is able to work on specific taks 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: Selected Topics in Aeronautics and Astronautics I [2170454]

Coordinators: S. Wittig
Part of the modules: SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
oral
Duration: approximately 30 minutes

Supporting material: none

Conditions
Basic Principles of Mathematics, Thermodynamics, Fluid Mechanics, Mechanics

Learning Outcomes
Central topics are the analysis of space systems and of the air traffic with its impact on modern mobility requirements. The unterstanding of the fundamentals - physical and technological - is essential fo the de-sign and application of space vehicles as well as of an economi-cally and ecologically efficient air transport. Based on recent develop-ments the main components of the various systems and their design principles are introduced.
In the fall/winter-semester an additional lecture-course is offered.

Content
I. Space Systems
Applications
Space Programms

Economical Aspects
Main Components
Influence Parameters
Space Missions
Launches
Satellites

II. Air Transport
Development: State of the art
Economical Aspects
Aircraft Design and Development
Aerodynamics
New Materials
Future Developments

Literature
Messerschmidt, Ernst: Raumfahrt-systeme, Springer-Verlag 2005

Griffin, Michael D.: Space Vehicle Design; AIAA Education Series 2004

Hünecke, Klaus: Die Technik des modernen Verkehrsflugzeuges, Motorbuch-Verlag 2004

Course: Selected Topics in Aeronautics and Astronautics II [2169486]

Coordinators: S. Wittig
Part of the modules: SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
oral
Duration: approximately 30 minutes

Supporting material: none

Conditions
Basic Principles of Mathematics, Fluid Mechanics, Thermodynamics, Mechanics

Learning Outcomes
The main topics in the first half of the course is the civil aircraft design. Based on the analysis of the general requirements, design principles for aircraft fuselage and the engines are introduced. Various - including insteady - loads during operation are discussed. The second part is directed towards the basic principles of orbital mechanic and maneu-verability of satellites in space . Launcher design and re-entry problems with ground and space-segments are introduced. In the spring/summer semester an additional lecture-course is offered.

Content
I. Aircraft Design
Mission Envelope
Aircraft Engines
Design Concepts
Aerodynamic Loads

II. Space Systems and
Satellites
Orbital Mechanics
Orbital Transfer
Rocket Systems
Ground- and Space Segements
Re-entry
Future Missions

Literature
Hünecke, Klaus: Die Technik des modernen Verkehrsflugzeuges, Motorbuch-Verlag, 2004

Hull, David, G.:Fundamentals of air-plane flight mechanics; Springer 2007

Messerschmid, Ernst: Raumfahrt-systeme, Springer-Verlag 2005

Griffin, Michael D.: Space Vehicle Design, AIAA Education Series 2004

Course: Selected Topics on Optics and Microoptics for Mechanical Engineers [2143892]

Coordinators: T. Mappes
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
oral

duration: 20 minutes

aids: none

Conditions
None.

Learning Outcomes
The lecture introduces to the basics of optics and presents optical effects and methods used research and industry. Optical elements, optical effects, and optical instruments are introduced by discussing selected examples of each field. Fabrication processes for optical devices in macroscopic and microscopic scales are presented.

Content
The first part of the lecture deals with:

laws of optics
linear optics
abberations of opt. systems
wave optics & polarization

Based on the introduction to the basics in the first part, the second half of the lecture deals with the discussion of

optical instruments
contrast enhancement
optical position control

Different fabrication methods for macroscopic and microscopic optical elements are discussed

Literature
Hecht Eugene: Optik; 4., überarb. Aufl.; Oldenbourg Verlag, München und Wien, 2005

Lecture script as *.pdf

Course: Selected chapters of the combustion fundamentals [2167541]

Coordinators: U. Maas
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min

Conditions
None

Recommendations
None

Learning Outcomes
The attendance of this course enables students to:

- gain a deeper understanding of the mechanisms involved in the chemistry of combustion, droplet and spray combustion and the statistical modelling of turbulent combustion.

Content
Depending on the lecture: Fundamentals of chemical kinetics, of statistical modeling of turbulent flames or of droplet and spray combustion.

Media
Blackboard and Powerpoint presentation

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

Course: Design of combustion chamber in gas turbines (Project) [22509]

Coordinators: N. Zarzalis
Part of the modules: SP 24: Energy Converting Engines (p. 137)[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 23: Power Plant Technology (p. 136)[SP_23_mach], SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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. 123)[SP_10_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
homework in small groups during the semester + oral examination

Conditions
None.

Recommendations
Knowledge in Fluid Technology (SoSe, LV 21093)

Learning Outcomes
Students will learn:
1. How to develop a mobile working machine
2. How to apply existing knowledge on a specific problem
3. How to break down and structure a complex task
4. How knowledge of different courses can be brought together

Content
Wheel loaders and excavators are highly specialized mobile machines. Their function is to detach, pick up and deposit materials near by. Significant size for dimensioning of the machines is the content of their standard shovel. In this lecture the main steps in dimensioning a wheel loader or excavator are beeing thought. This includes among others:

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

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

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

Literature
None.

Course: Automated Production Line [2150904]

Coordinators: J. Fleischer
Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam of 45 min during the lecture-free period. The exam may be repeated at every ordinary exam date.

Conditions
none

Learning Outcomes
The student

- has knowledge of the content of automation tasks in manufacturing systems
- comprehends the assembly and the operation purpose of the major components of automated manufacturing systems and their interactions.
- has knowledge of the required control peripheries which are necessary for automated manufacturing systems.
- is able to evaluate a given production-technical process which is implemented in a certain automated production unit

Content
The course consists of
- 4 hours per week lecture
- 1 hour per week exercise.
The course is structured into two parts. The introduction part procures the basics to comprehend automated manufacturing systems. This includes:
- handling of work pieces and tools
- material flows in manufacturing systems
- robots as handling devices
- control engineering
- quality management
- automated assembly
During the second part the procured basics will be illustrated by reference to the conducted production processes of the manufacturing of cars. Both, the production fields of body construction and drive technology will be considered. The drive technology regards the automated production process of the manufacturing of conventional combustion engines as well as the prospective electric motor as engine drive in a vehicle.
The body construction focuses on the consideration of automated manufacturing systems to manufacture conventional sheet metal body parts as well as body parts consisting of the more frequently used fiber-reinforced plastic.
A exercise as well as an excursion may be visited optionally.

Media
Lecture notes relating to the course Automated manufacturing systems are provided on the ILIAS platform.

Literature
Lecture notes.

Course: Automation Systems [2106005]

Coordinators: M. Kaufmann
Part of the modules: SP 04: Automation Technology (p. 116)[SP_04_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of measuring and control engineering

Learning Outcomes
Students have fundamental knowledge about functionality, composition, components and development of industrial automation systems.

Content

- Introduction: Terms and definitions, examples, requirements
- Industrial processes: classification, process conditions
- Automation tasks
- Components of industrial automation systems: control functions, data acquisition, data output equipment, Programmable Logic Controllers, PC-based control
- Industrial communication, classification, topology, protocols, bus systems for automation systems
- Engineering: plant engineering, composition of control systems, programming
- Requirements on equipment, documentation, identification
- Dependability and safety
- Diagnosis
- Application examples

Literature

- Gevatter, H.-J., Grünhaupt, U.: Handbuch der Mess- und Regelungstechnik in der Produktion. 2. Auflage, Berlin, Heidelberg: Springer-Verlag, 2006.
- Langmann, R.: Taschenbuch der Automatisierung. München: Fachbuchverlag Leipzig, 2010.
- Strohrmann, G.: Automatisierung verfahrenstechnischer Prozesse: eine Einführung für Ingenieure und Techniker. München, Wien: Oldenbourg-Industrieverlag, 2002.
- Wellenreuther, G., Zastrow, D.: Automatisieren mit SPS: Theorie und Praxis. 4. Auflage, Wiesbaden: Vieweg+Teubner, 2009.

Course: Automobile and Environment [2186126]

Coordinators: H. Kubach, U. Spicher, U. Maas, H. Wirbser
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 12: Automotive Technology (p. 126)[SP_12_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
After completion of the course students can:

- depict the governing processes in engine combustion.
- enumerate the mechanisms involved in pollutant fomation.
- describe the setup and the working principle of piston engines.
- explain means of reducing pollutant emissions.
- discuss the impact of combustion engines on the environement.
- accomplish a technical task in a team.
- orally present their results to the teacher and the other attendents.

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. 167)[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: Computational methods for the heat protection of a full vehicle [2157443]

Coordinators: H. Reister

Part of the modules: SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations

oral examination, 30 minutes, no aids

Conditions

basics in fluid mechanics and thermodynamics recommended

Recommendations

none

Learning Outcomes

Basics in order to evaluate the thermal situation in vehicles

Content

Course: Fuels and Lubricants for Combustion Engines and their Testing [2133109]

Coordinators: J. Volz
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_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 knowledgement about composition and meaning of fuels, lubricants and coolants as important components in the system of todays Otto and Diesel engines. Content of this lecture are definition and chemical composition of fuels and lubricants, the meanig of crude oil as basic primary product, production processes, major properties, standards and specifications, testing methods. Furthermore future worldwide trenfd 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: [23261]

Coordinators: O. Dössel
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of a written exam (approx. 120 minutes) according to sec. 4 subsec. 2 no. 1 study and examination regulations.

Conditions
None.

Learning Outcomes

Content

Course: [23262]

Coordinators: O. Dössel
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of a written exam (approx. 120 minutes) according to sec. 4 subsec. 2 no. 1 study and examination regulations.

Conditions
None.

Learning Outcomes

Content

Course: Bioelectric Signals and Fields [23264]

Coordinators: G. Seemann
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (approx. 20 minutes) according to sec. 4 subsec. 2 no. 2 study and examination regulations.

Conditions
None.

Learning Outcomes

Content

Course: Biomechanics: design in nature and inspired by nature [2181708]

Coordinators: C. Mattheck
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
participation at excursion

Conditions
None.

Learning Outcomes
The student know to recognize mechanical optimization schemes in nature and its application to the design in mechanical engineering.

Content
* mechanics and growth laws of trees
* failure criteria and safety factors
* computer simulation of adaptive growth
* notches and damage case studies
* optimization inspired by nature
* structural shape optimization without computers
* universal shapes of nature
* fibre reinforces materials
* failure of trees, hillsides, dikes, walls and pipes

Course: [23269]

Coordinators: A. Bolz
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (approx. 20 minutes) according to sec. 4 subsec. 2 no. 2 study and examination regulations.

Conditions
None.

Learning Outcomes

Content

Course: [23270]

Coordinators: A. Bolz
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (approx. 20 minutes) according to sec. 4 subsec. 2 no. 2 study and examination regulations.

Conditions
None.

Learning Outcomes

Content

Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine I [2141864]

Coordinators: A. Guber
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
Oral examination: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: none

Conditions
None.

Learning Outcomes
The lecture will first address relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Introduction into various microtechnical manufacturing methods: LIGA, Micro milling, Silicon Micromachining, Laser Microstructuring, µEDM, Metal-Etching
Biomaterials, Sterilisation.
Examples of use in the life science sector: basic micro fluidic strucutures: micro channels, micro filters, micromixers, micropumps, microvalves, Micro and nanotiter plates, Microanalysis systems (µTAS),
Lab-on-chip applications.

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2001

Lecture script

Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine II [2142883]

Coordinators: A. Guber
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
Oral: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: none

Conditions
None.

Learning Outcomes
The lecture will first address relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in Life-Sciences and biomedicine: Microfluidic Systems:
LabCD, Protein Cristallisation
Microarrys
Tissue Engineering
Cell Chip Systems
Drug Delivery Systems
Micro reaction technology
Microfluidic Cells for FTIR-Spectroscopy
Microsystem Technology for Anesthesia, Intensive Care and Infusion
Analysis Systems of Person´s Breath
Neurobionics and Neuroprosthesis
Nano Surgery

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2001

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

Lecture script

Course: BioMEMS - Microsystems Technologies for Life-Sciences and Medicine III [2142879]

Coordinators: A. Guber
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
Oral: Elective Course (Duration: 30 minutes) or Main Course in combination with other lectures (Duration: 60 minutes)

Aids: None

Conditions
None.

Learning Outcomes
The lecture will first address relevant microtechnical manufacturing methods. Then, selected biomedical applications will be presented, as the increasing use of microstructures and microsystems in Life-Sciences und in medicine leads to improved medico-technical products, instruments, and operation and analysis systems.

Content
Examples of use in minimally invasive therapy
Minimally invasive surgery (MIS)
Endoscopic neurosurgery
Interventional cardiology
NOTES
OP-robots and Endosystems
License of Medical Products and Quality Management

Literature
Menz, W., Mohr, J., O. Paul: Mikrosystemtechnik für Ingenieure, VCH-Verlag, Weinheim, 2001

Buess, G.: Operationslehre in der endoskopischen Chirurgie, Band I und II;
Springer-Verlag, 1994

Lecture script

Course: BUS-Controls [2114092]

Coordinators: M. Geimer
Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 34: Mobile Machines (p. 148)[SP_34_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
Part of the modules: SP 35: Modeling and Simulation (p. 149)[SP_35_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
Part of the modules: SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 31: Mechatronics (p. 145)[SP_31_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)
- stess and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to topology and shape optimization
- creation and calculation of various optimization models with the optimization package TOSCA and the Abaqus solver

Content in the winter semester:

- introduction to the finite element analysis (FEA)
- stress and modal analysis of finite element models using Abaqus/CAE as a preprocessor and Abaqus solver
- introduction to multi-body simulation (MBS)
- preparation and running of multi-body simulation models. Coupling of the MBS and FEA to calculate hyprid multi-body simulation problems.

Literature
The workshop script will be allocated at Ilias.

Course: CFD for Power Engineering [2130910]

Coordinators: I. Otic
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 53: Fusion Technology (p. 169)[SP_53_mach]

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

Learning Control / Examinations
Oral exam, length: 30 minutes

Conditions
None.

Learning Outcomes

- theory and application of computational fluid dynamics (CFD)

Content
This course is specified for both Bachelor and Master students, Power and Nuclear Engineering.
The course is aimed of giving the fundamental of Computational Fluid Dynamics (CFD) for energy technologies. Starting from the basic physical phenomena equations an overview on computational methods and turbulence modeling is given.

Course: CFD-Lab using Open Foam [2169459]

Coordinators: R. Koch
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_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.open foam.com/docs

Remarks

- Number of participants is limited
- Priority for students of the lecture “Numerische Simulation reagierender Zweiphasenströmungen” (Vorl.-Nr. 2169458)

Course: Chemical, physical and material scientific aspects of polymers in microsystem technologies [2143500]

Coordinators: H. Moritz, M. Worgull, D. Häringer
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
Oral examination, 30 minutes

Conditions
Intermediate examination or bachelor degree of mach/wing necessary.

Recommendations
Basic knowledge of the micro-system technology (but not a requirement) and interdisciplinary interest are favourable.

Learning Outcomes
The lecture is to obtain an overview of the increasing meaning of plastics in the micro-system technology. The interdisciplinary aspect of the polymer science is the centre of attention concerning chemistry, physics and the micro-system technology. The plastics are described regarding their synthesis, their chemical and physical characteristics. Base on the fundamentals the variety of the polymers and their characteristics are introduced and the processing methods of the micro technology are described. The importance of the polymers in the micro-system technology as construction material and as photoresist are described and finally current polymere-based applications like e.g. semi conducting organic plastics are introduced.

Content

- **Introduction to the world of the plastics**
- **Chemistry of the polymers - synthesis and chemical characteristics**
- **Tailor-made composite / polymer blends**
- **Physical characteristics of plastics and their description**
  - Morphologic structure
  - Thermal behaviour
  - Time temperature - equivalence
  - Rheology of polymer melts
  - Thermo analysis
- **Plastics processing in the micro technology**
- **Application of polymers as construction material in the micro-system technology**
  - Composites / Compounds
  - MID – injection moulding of circuit carriers
  - Assembling and welding of plastics
  - Engineering with plastics
  - Environmental problems - biological degradable polymers
- **Meaning of the plastics in the micro technology explained by examples of current developments of polymer-based applications**
  - Semi conducting organic plastics
  - Nano-structured polymer surfaces
  - Polymer sensors (biologically, chemically, optically)

Media
Printouts of the lecture presentation, if applicable further scientific articles.

Course: Computational Intelligence I [2106004]

Coordinators: G. Bretthauer, R. Mikut
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of fuzzy logic and fuzzy control efficiently. They know the basic mathematical foundations for the model design using fuzzy logic (membership functions, inference methods, defuzzification). In addition, they are able to design fuzzy controllers (Mamdani controllers and hybrid controllers with fuzzy-adaptive components) for practical applications.

Content
Terms and definitions Computational Intelligence, application fields and examples

Fuzzy logic and fuzzy sets

Fuzzification and membership functions

Inference: T-norms and -conorms, operators, aggregation, activation, accumulation

Defuzzification methods

Structures for fuzzy control

Software practice (fuzzyTECH) and applications (crane control)

Literature
Kiendl, H.: Fuzzy Control. Methodenorientiert. Oldenbourg-Verlag, München, 1997

Bandemer, H.; Gottwald, S.: Einführung in Fuzzy Methoden. Akademie-Verlag, Berlin, 1993

Zadeh, L.A.: Fuzzy Sets. Information and Control, 8, 338-353, 1965

Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe, Kapitel 5.5; 2008 (Internet)

Software: FuzzyTech (für die Übung)

Course: Computational Intelligence II [2105015]

Coordinators: G. Bretthauer, MIkut
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of Artificial Neural Networks and Evolutionary Algorithms efficiently. They know the basic mathematical foundations and the goal-oriented design and the problem formulation for technical applications (selection of net structures for Artificial Neural Networks, optimization using Evolutionary Algorithms with coding of potential solutions for real-world applications as individuals).

Content
Terms and definitions, application fields and examples

Biological foundations of neural nets

Artificial Neural Nets: neurons, Multi-Layer-Perceptrons, Radial-Basis-Function nets, Kohonen maps,
training strategies (Backpropagation, Levenberg-Marquardt)

Evolutionary Algorithms: Genetic Algorithms and Evolution Strategies, mutation, recombination, evaluation, selection, integration of local search strategies

Software practice (Gait-CAD, GLEAMKIT) and applications

Literature
S. Haykin: Neural Networks: A Comprehensive Foundation. Prentice Hall, 1999

T. Kohonen: Self-Organizing Maps. Berlin: Springer-Verlag, 1995

R. Rojas: Theorie der Neuronalen Netze. Berlin: Springer-Verlag, 1995

W. Jakob: Eine neue Methodik zur Erhöhung der Leistungsfähigkeit Evolutionärer Algorithmen
durch die Integration lokaler Suchverfahren. Forschungszentrum Karlsruhe, 2004

H.-P. Schwefel: Evolution and Optimum Seeking. New York: John Wiley, 1995

H.J. Holland: Adaptation in Natural and Artificial Systems. Ann Arbor, 1975

R. Mikut: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe, 2008 (Internet, Kapitel 5.6)

Course: Computational Intelligence III [2106020]

Coordinators: R. Mikut

Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 32: Medical Technology (p. 146)[SP_32_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
Oral examination (1 hour)

Duration: 1 hours, also possible as an optional or part of a major subject

Auxilary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students are able to apply the methods of data analysis efficiently. They know the basic mathematical foundations for the analysis of single features and time series using classifiers, clustering and regression approaches. They are able to use various relevant methods as Bayes classifiers, Support Vector Machines, decision trees, fuzzy rulebases and they can adapt application scenarios (with data preprocessing and validation techniques) to real-world applications.

Content
Introduction and motivation

Terms and definitions (types of multidimensional features - time series and images, problem classes)

Application scenario: Problem formulation, feature extraction, evaluation, selection and transformation, distance measures, Bayes classifiers, Support-Vector-Machines, decision trees, clustering, regression, validation

Application (Software practice with Gait-CAD): Control of hand prostheses, energy prediction

Literature
Lecture notes (Internet)

Mikut, R.: Data Mining in der Medizin und Medizintechnik. Universitätsverlag Karlsruhe.
2008 (Internet)

Backhaus, K.; Erichson, B.; Plinke, W.; Weiber, R.: Multivariate Analysemethoden: Eine anwendungsorientierte Einführung. Berlin u.a.: Springer. 2000

Burges, C.: A Tutorial on Support Vector Machines for Pattern Recognition. Knowledge
Discovery and Data Mining 2(2) (1998), S. 121–167

Tatsuoka, M. M.: Multivariate Analysis. Macmillan. 1988

Mikut, R.; Loose, T.; Burmeister, O.; Braun, S.; Reischl, M.: Dokumentation der MATLAB-Toolbox Gait-CAD. Techn. Ber., Forschungszentrum Karlsruhe GmbH. 2006 (Internet)

Course: Controlling and Simulation of Production Systems [2109040]

Coordinators: B. Deml
Part of the modules: SP 16: Industrial Engineering (p. 130)[SP_16_mach]

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
None.

Recommendations

- Knowledge of Industrial Engineering / Production Management
- Basics of mathematical statistics

Learning Outcomes

- Insights into controlling approaches or production enterprises
- Knowledge about controlling aspects of resources, structural organisation and processes
- Initial knowledge about evaluation and judgment procedures in production logistics
- Basic insights into the possibilities of simulation tools for the prognosis of production performance

Content

1. Introduction to the course
2. Basic terms of production controlling
3. Production management controlling
4. Controlling of materials and products
5. Controlling of machinery resources
6. Controlling of human resources
7. Basics of simulation technique
8. Simulation of manufacturing systems
9. Simulation of human resources and assembly systems
10. Controlling of process structures
11. Controlling and simulation of departmental structures
12. Management systems

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

Literature:

- WOMACK, J. P.; JONES, D. T.; ROOS, D.: The Machine That Changed the World. New York, NY: Rawson Associates, 1990.
- ROMMEL, Günther; KLUGE, Jürgen; KEMPIS, Rolf-Dieter; DIEDERICHS, Raimund;BRÜCK, Felix: Simplicity Wins. Boston, MA: Harvard Business School Press, 1995.
- IDW - Institut der deutschen Wirtschaft Köln (Edt.): Deutschland in Zahlen 2006. Köln: Deutscher Instituts-Verlag, 2006.
- VDMA - Verband Deutscher Maschinen- und Anlagenbau (Edt.) (BANKI, Karin): Kennzahlenkompass. Frankfurt/M.: VDMA-Verlag, 2005.(Betriebswirtschaft)
- LAW, Averill; KELTON, David: Simulation Modeling and Analysis. New York, NY: McGraw-Hill, 2000.
- KOŠTURIAK, Ján: GREGOR, Milan: Simulation von Produktionssystemen. Wien, New York: Springer-Verlag, 2005.
- LIEBL, Franz: Simulation. München, Wien: R. Oldenbourg Verlag, 2nd ed. 1995.
- VDI 3633, Blatt 6: Simulation von Logistik-, Materialfluss- und Produktionssystemen – Abbildung des Personals in Simulationsmodellen. Berlin: Beuth-Verlag, 2001.

Please refer to the latest edition.

Course: Finite Difference Methods for numerial solution of thermal and fluid dynamical problems [2153405]

Coordinators: C. Günther
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 06: Computational Mechanics (p. 119)[SP_06_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 student can apply the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. They are familiar with the most relevant properties of difference schemes on one side such as consistency, stability and convergence, and on the other side the order of the numerical error and non-appearance of numerical oscillations.

Content
The lecture initially presents an overview and then the most important difference schemes for the numerical solution of steady and transient problems which are typical for thermal and fluid flow problems. The most relevant properties of difference schemes at one side as consistency, stability and convergence, at the other side the order of the numerical error and non-appearance of numerical oscillations are described. Algorithms for the solution of coupled systems of equations, characteristic for fluid flow and thermal problems, are reviewed.

- Spatial and temporal discretization
- Properties of difference schemes
- Numerical stability, consistency, convergence
- Nonhomogeneous meshes
- Coupled and noninteracting calculation methods

Course: Digital Control [2137309]

Coordinators: M. Knoop

Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach]

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

Learning Control / Examinations
Oral examination; duration: 30 minutes; no tools or reference materials may be used during the exam.

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
The lecture intoduces key methods for the analysis and design of digital feedback control systems. Starting point is the discretisation of linear, continuous-time models. State space based and z-transform based controller design techniques are presented for discrete-time, single-input single-output systems. Furthermore, plants with dead-time and deadbeat design are covered.

Content
1. Introduction into digital control:
Motivation for digital implementation of controllers Structure of digital feedback control loops Sample and hold units
2. State space analysis and design:
Discretisation of continuous-time systems Discrete-time state space equations Stability - definition and criteria State feedback design by eigenvalue assignment PI state feedback controller Luenberger observer, separation theorem Systems with dead-time Deadbeat design
3. Analysis and design based on z-transform: z-transform - definition and theorems Control loop description in the z domain
Stability criteria Root locus controller design Transfer of continuous-time controllers into discrete-time controllers

Literature

- Lunze, J.: Regelungstechnik 2, 3. Auflage, Springer Verlag, Berlin Heidelberg 2005
- Unbehauen, H.: Regelungstechnik, Band 2: Zustandsregelungen, digitale und nichtlineare Regelsysteme. 8. Auflage, Vieweg Verlag, Braunschweig 2000
- Föllinger, O.: Lineare Abtastsysteme. 4. Auflage, R. Oldenbourg Verlag, München Wien 1990
- Ogata, K.: Discrete-Time Control Systems. 2nd edition, Prentice-Hall, Englewood Cliffs 1994
- Ackermann, J.: Abtastregelung, Band I, Analyse und Synthese. 3. Auflage, Springer Verlag, Berlin Heidelberg 1988

Course: Designing with numerical methods in product development [2161229]

Coordinators: E. Schnack
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 10: Engineering Design (p. 123)[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 25: Lightweight Construction (p. 138)[SP_25_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

Learning Control / Examinations
oral exam., 30min

Conditions
None.

Learning Outcomes
This lectures gives an introduction in to basic aspects of mechanical systems with contacts. Here, the tribological contact properties must be respected as well, since it affects the contact behaviour.
The course begins with the phyisical-mathematical description and adresses common solution strategies. By several example problems typcial dynamic phenomena are discussed.

Content
* Introduction into contact kinematics
* kinetics of mechanical systems with frictional unilateral contacts
* mathematical solution strategies
* introduction into contact mechanics
* normal contact (Hertzian contact, rough surfaces, constitutive contact laws)
* impacts (Newton's Impact law, wave effects)
* friction induced vibrations (stick-slip, squeal, ...)
* lubricated contacts: Reynold's Equation, rotors in fluid film bearings, EHD-contacts

Literature
list of literature will be handed out

Course: Dynamics of the Automotive Drive Train [2163111]

Coordinators: A. Fidlin

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach]

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

Learning Control / Examinations

Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions

None.

Recommendations

Powertrain Systems Technology A: Automotive Systems
Machine Dynamics
Vibration theory

Learning Outcomes

- To obtain the basic skills in dynamic modelling of the vehicle powertrain including the most important components, driving situations and requirements

Content

- Main components of the vehicle powertrain and their modelling
- Typical driving situations
- Problemoriented models for particular driving situations
- System analysis and optimization with respect to dynamic behavior

Literature

- Dresig H. Schwingungen mechanischer Antriebssysteme, 2. Auflage, Springer, 2006
- Pfeiffer F., Mechanical System Dynamics, Springer, 2008
- Laschet A., Simulation von Antriebssystemen:Modellbildung der Schwingungssysteme und Beispiele aus der Antriebstechnik, Springer, 1988

Course: Efficient creativity - Processes and Methods within the automotive industrie [2122371]

Coordinators: R. Lamberti
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach]

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

Learning Control / Examinations
Oral examination, Durations: 25 min, Auxiliary Means: none

Conditions
None.

Learning Outcomes
Students know the market-related and technical challenges of developing innovative products and they know the characteristics of the product development process and reasons for the need of standardization.
Students understand the concepts, methods and approaches to process design and have exemplary knowledge of the methods, processes and systems: for project management, design and designing, requirements management, change management, cost management and controlling, the design, calculation and protection, production planning, data management, integration platforms, version control mechanisms, quality management, knowledge management, visualization technologies, and are able to put them in relation to each other and understand about their interaction.

Content
In this module, the teaching of processes and methods in the systematic development of innovative, complex and more varied products is focused. Tasks, design, interaction and coordination of these processes and methods are illustrated using the example of the automotive industry.
Students are introduced to the systematic variations of the product development process based on historical, current and foreseeable technological and market-related developments in the automotive sector.
Based on the standardized product development process, the specific and comprehensive processes and methods and their IT-page illustrations are closely examined.

Media
Lecture slides

Course: Introduction to Industrial Engineering [2109041]

Coordinators: B. Deml
Part of the modules: SP 16: Industrial Engineering (p. 130)[SP_16_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

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 25: Lightweight Construction (p. 138)[SP_25_mach], SP 36: Polymer Engineering (p. 151)[SP_36_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 50: Rail System Technology (p. 167)[SP_50_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: Biomedical Instrument Engineering [2106006]

Coordinators: H. Malberg
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations

Conditions

None.

Learning Outcomes

Content

Course: Introduction to Ergonomics [2110033]

Coordinators: B. Deml
Part of the modules: SP 16: Industrial Engineering (p. 130)[SP_16_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

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

Learning Outcomes

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

Content

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

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

Literature:

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

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

Please refer to the latest edition.

Course: Introduction to the Finite Element Method [2162282]

Coordinators: T. Böhlke
Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach]

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

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites are met by attestations during the associated lab course.

Conditions
The institutes decides about registration for the lab course (restricted number of participants).

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.
During the associated lab course, the students learn to use the commercial FE-software tool Abaqus. They know how to perform simple FE analyses using Abaqus.

Content

- introduction and motivation
- elements of tensor calculus
- the initial-boundary-value-problem of linear thermoconductivity
- the boundary-value-problem of linear elastostatic
- spatial discretization for 3D problems
- solution of the boundary-value-problem of elastostatic
- numerical solution of linear systems
- element types
- error estimation

Literature
lecture notes
Fish, J., Belytschko, T.: A First Course in Finite Elements, Wiley 2007 (*enthält eine Einführung in ABAQUS*)

Course: Introduction to Nuclear Engineering [2130974]

Coordinators: X. Cheng
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
oral examination; duration: 20 minutes

Conditions
None.

Learning Outcomes
This lecture is dedicated to students of mechanical engineering and other engineering bachelor or master degree courses. Goal of this lecture is it to get fundamental understanding of major aspects in nuclear engineering and nuclear energy.

Content

1. Fission and energy production
2. fundamentals in reactor physics
3. classification and design of nuclear facilities
4. nuclear materials
5. reactor safety
6. radiation protection
7. fuel cycle
8. economical aspects
9. development tendencies in nuclear engineering

Course: Introduction to Theory of Materials [2182732]

Coordinators: M. Kamlah

Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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 constituve 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. 139)[SP_26_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_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. 167)[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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 31: Mechatronics (p. 145)[SP_31_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 virtuel power, Lagrange's equations, Kane's equations, structure of the equations of motion

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

Course: Introduction to modeling of aerospace systems [2154430]

Coordinators: G. Schlöffel
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min
no auxiliary means

Conditions
none

Learning Outcomes
The lecture gives an introduction to the fundamentals of modeling aerospace systems. Beside the mathematical and physical foundations the flight of an aerospace vehicle through the atmospheric is treated intensively usually examining the example of a generic aerospace vehicle starting from the surface of a planet exhibiting an atmosphere (typically the earth) into orbit and space trajectory, respectively.
The concepts treated are presented consequently in a form which leads to the state of the art numerical method of simulation of aerospace systems. The implementation of a Matlab/Simulink model from scratch during the lecture completes the theoretical parts with some related practical skills.

Content

- Introduction – short overview of the history of space flight, aerospace systems and space missions
- Coordinate systems – definition, reference systems and coordinate system transformations
- Equations of motion – rigid-body principal, rotating reference system, Newton's laws, Euler equations and Newton-Euler-Equations
- Gravitation – introduction, gravity field of the earth, Kepler mechanics and ballistic trajectories
- Propulsion of aerospace systems – fundamentals, propulsion technologies, thrust-vector-control and modeling
- Aerodynamics – atmosphere, fundamentals and forces and moments
- Trajectories and Orbits – orbits, orbit maneuvers, Oberth effect and ascent trajectories
- Re-entry – hypersonic flow and aerothermodynamic effects
- Implementation of a Matlab/Simulink model

Literature

- P. H. Zipfel: Modeling and Simulation of Aerospace Vehicle Dynamics. American Institute of Aeronautics and Astronautics (AIAA), Reston 2007. ISBN 978-1563478758
- A. Tewari: Atmospheric and Space Flight Dynamics. Birkhäuser, Boston 2007. ISBN 978-0-8176-4373-7
- W. Ley, K. Wittmann, W. Hallmann (Hrsg.): Handbuch der Raumfahrttechnik. Hanser, München 2011. ISBN 978-3446424067
- W. Büdeler: Geschichte der Raumfahrt. Edition Helmut Sigloch, Künzelsau 1999. ISBN 978-3893931941

Course: Numerical Methods in Mechanics I [2161226]

Coordinators: E. Schnack
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach]

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

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
None.

Recommendations
None.

Learning Outcomes
Introduction to the numerical treatment of mechanical problems with finite element methods (FEM) based on technical mechanics. Derivation of spring, rod and beam systems. Development of simple elements of continuum mechanics, more advanced finite element techniques such as hybrid methods and boundary element methods. Through detailed deductions in the lectures, the students are then able to develop their own codes for engineering software. The specific aim of this course is a deeper understanding of the construction of numerical processes, so that the students are able to develop software independently. The aim is not to learn how to work with existing software, as this is an area which is continually developing. The emphasis will therefore be placed on the detailed theoretical calculations behind the methods.

Content
Spring, rod and beam elements. Introduction to matrix calculations. Derivation of numerical process. Principles of virtual work. Variation principles. Finite element algorithms, boundary element algorithms.

Literature
Script (available in administration office, building 10.91, rm. 310).

Course: Wave propagation [2161216]

Coordinators: W. Seemann
Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach]

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

Learning Control / Examinations
Optional subject: oral exam, 30 min.
Major subject: oral exam, 20 min.

Conditions
Vibration theory

Learning Outcomes
The course gives an introduction into wave propagation phenomena. This contains both onedimensional continua (beams, rods, strings) as well as two- and threedimensional continua. Initial condition problems are treated. Fundamental effects like phase velocity, group velocity or dispersion are explained. Wave propagation is used to show the limits of structural models like beams. In addition surface waves and acoustic waves are covered.

Content
Wave propagation in strings and rods, d'Alembert's solution, initial value problem, boundary conditions, excitation at the boundary, energy transport, wave propagation in beams, Bernoulli-Euler beams, group velocity, beams with changing cross-section, reflexion and transmission, Timoshenko beam theory, wave propagation in membranes and plates, acoustic waves, reflexion and refraction, spherical waves, s- and p-waes in elastic media, reflexion and transmission at bounding surfaces, surface waves

Literature
P. Hagedorn and A. Dasgupta: Vibration and waves in Continuous Mechanical Systems, Wiley, 2007

Course: Introduction to Nonlinear Vibrations [2162247]

Coordinators: A. Fidlin

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach]

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

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory, dynamic stability

Learning Outcomes

- to learn the most usual nonlinear effects
- to learn the minimal models for these effects
- to be able to apply perturbation methods for the analysis of nonlinear systems
- to learn basics of the bifurcation theory
- to be able to identify dynamic chaos

Content

- dynamic systems
- basic ideas of asymptotic methods
- perturbation methods: Linstedt-Poincare, averaging, multiple scales
- limit cycles
- nonlinear resonance
- basics of the bifurcation analysis, bifurcation diagrams
- types of bifurcations
- discontinuous systems
- dynamic chaos

Literature

- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Nayfeh A.H., Mook D.T. Nonlinear Oscillation. Wiley, 1979.

- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.
- Fidlin A. Nonlinear Oscillations in Mechanical Engigeering. Springer, 2005.
- Bogoliubov N.N., Mitropolskii Y.A. Asymptotic Methods in the Theory of Nonlinear Oscillations. Gordon and Breach, 1961.
- Nayfeh A.H. Perturbation Methods. Wiley, 1973.
- Sanders J.A., Verhulst F. Averaging methods in nonlinear dynamical systems. Springer-Verlag, 1985.
- Blekhman I.I. Vibrational Mechanics. World Scientific, 2000.
- Moon F.C. Chaotic Vibrations – an Introduction for applied Scientists and Engineers. John Wiley & Sons, 1987.

Course: Processes and Methods for efficient product development [2154448]

Coordinators: F. Ohle
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min
no auxiliary means

Conditions
None.

Learning Outcomes
The students are familiar with the relevant success factors of an innovation and technology strategy that is required to successfully transfer new ideas in the field of fluid mechanics to practical applications.

Content
Product development in the field of Fluid Mechanical Application
Best practice companies are transferring 5 to 6 times more ideas into profitable products than less successful operations. This is not only because such companies do not only invest continuously into R+D, but their higher success rate is mainly driven by the applicability of a systematic innovation process. By the use of fluid mechanical applications, the lecture will give a brought overview on how innovation driven companies are successfully investing into the development of new products. The Innovations are systematically extracted by a clear technology and R+D planning process taking into account market trends, technology roadmaps and results from a detailed analysis of main competitors.
The core of the course is focussed on the discussion of the relevant success factors of an innovation and technology strategy. The theoretical aspects will be verified with fluid mechanical products and applications.
Content of the lecture

1. Requirements of efficient R+D processes,
2. Methods for systematic R+D planning and control
3. Fluid mechanical application,
4. Requirements and tools for successful project management
5. Experimental verification within an industrial packaging operation

Media
Black board, beamer

Literature
Documentation will be available in the lecture

Remarks
Block course at the end of the summer semester.
After the course, a 1-day tour to one of the German production sides of the STI Group is provided to discuss and verify the learnings in an industrial environment.
Additionally, students can apply for a practical 4- to 8-weeks study at one of the German production sides of the STI Group.

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. 167)[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. Pachl: 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. 167)[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: Electric Rail Vehicles [2114346]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 167)[SP_50_mach]

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

Learning Control / Examinations

- Oral examination
- Duration: 20 minutes
- No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes

- The students know the history of electric traction in railway transportation from the very beginning to modern vehicles with three-phase traction drives.
- They know the basics of railway transportation, vehicle dynamics and wheel-rail-contact and can deduct the requirements for electric rail vehicles out of it.
- They understand design and functionality of electric traction drives.
- They learn about the different systems of traction power supply with its advantages and disadvantages.
- They are informed about actual concepts and new developments in the field of electric railway vehicles.

Content

- History of electric traction with railway vehicles
- Basics of railway transportation
- Transmission of tractive effort to the rails
- Electric traction drives
- Traction power supply
- Vehicle concepts for mass transit and main line

Media
All slides are available for download (Ilias-platform).

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

Course: Elements of Technical Logistics [2117096]

Coordinators: M. Mittwollen, Madzharov
Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

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

Conditions
None.

Recommendations
previous / parallel visit of LV 21177095 "Grundlagen der Technischen Logistik"

Learning Outcomes
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: Elements of Technical Logistics and Project [2117097]

Coordinators: M. Mittwollen, Madzharov

Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations

after each lesson period; oral / written (if necessary) => (look at “Studienplan Maschinenbau”, latest version) Projektarbeit

Conditions

None.

Recommendations

previous / parallel visit of LV 21177095 “Grundlagen der Technischen Logistik”

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
- is able to work on and to present a related topic in a small team

Content

mechanical behaviour of conveyors;
structure and function of conveyor machines; elements of intralogistics (belt conveyor, racks, automatic guided vehicles, fan-in, bifurcation, and etc.)
sample applications and calculations in addition to the lectures inside practical lectures

Media

supplementary sheets,projector, blackboard

Literature

recommendations during lectures

Course: Energy efficient intralogistic systems [2117500]

Coordinators: F. Schönung

Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 34: Mobile Machines (p. 148)[SP_34_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 I: Renewable Energy [2129901]

Coordinators: R. Dagan
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach]

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

Learning Control / Examinations
Oral examination – as an elective course 30 minutes, in combination with Energiesysteme II or other courses within the energy courses, as a major course 1 hour

Conditions
None.

Learning Outcomes
The student knows the principles of the feasibility of energy gain by means of renewable energies, in particular the solar energy.

Content
The course deals with fundamental aspects of renewable energies.

1. The first part deals with the basic concepts of absorbing solar beans, in an efficient manner accounting for the minimization of heat losses. In this context, selective topics on Thermodynamics as well as fluid dynamics are introduced. In the second part few applications are discussed and optimizations techniques of solar collectors construction and their heat transfer are presented.
2. The use of solar energy as a source for heat generation is followed by the idea of electricity generation. Introductive aspects of Photovoltaic technologies are illuminated.
3. The last part presents additional regenerative energy sources such as wind and geothermal energy.

Course: Energy systems II: Nuclear Energy Fundamentals [2130929]

Coordinators: F. Badea, D. Cacuci
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The goal is to get experienced with nuclear, cooling and control engineering calculation methods for the design of nuclear power plants with nuclear fission reactors and with the safety standards in the nuclear industry.

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

Course: Energy Systems II: Nuclear Power Technology [2130921]

Coordinators: F. Badea
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach]

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

Learning Control / Examinations

Conditions
none

Learning Outcomes
The goal is to get experienced with nuclear, cooling and control engineering calculation methods for the design of nuclear power plants with nuclear fission reactors and with the safety standards in the nuclear industry.

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

Course: Development Project for Machine Tools and Industrial Handling [2149903]

Coordinators: J. Fleischer
Part of the modules: SP 39: Production Technology (p. 153)[SP_39_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: Ergonomics and Work Economics (in German) [2109029]

Coordinators: B. Deml
Part of the modules: SP 37: Production Management (p. 152)[SP_37_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

- Module course: first part of the lecture “Arbeitswissenschaft (2109026)”
- **The exams ”Ergonomie und Arbeitswirtschaft (2109029)” and “Arbeitswissenschaft (2109026)” are mutually exclusive.**

Recommendations

- Willingness to learn interdisciplinarily (Technology, Legal regulations Work physiology, Work psychology . . .)
- Knowledge of Production Management is usefull

Learning Outcomes

- Become proficient within the general terms of ergonomics and time study
- Know elementary methods and procedures of work science
- Become proficient in applying ergonomic evaluation and judgment

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 psychology (first part of “Work structuring”)

Literature
Learning material:
Handout online on: 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: Ersatz menschlicher Organe durch technische Systeme [2106008]

Coordinators: C. Pylatiuk
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of medicine

Learning Outcomes
Students have fundamental knowledge about functionality of organ support systems and its components. An analysis of historical developments can be done and limitations of current systems can be found. The limits and possibilities of transplantations can be elaborated.

Content

- Introduction: Definitions and classification of organ support and replacement.
- Special topics: acoustic and visual prostheses, exoskeletons, neuroprostheses, tissue-engineering, hemodialysis, heart-lung machine, artificial hearts, biomaterials.

Literature

- Jürgen Werner: Kooperative und autonome Systeme der Medizintechnik: Funktionswiederherstellung und Organersatz. Oldenbourg Verlag.
- Rüdiger Kramme: Medizintechnik: Verfahren - Systeme – Informationsverarbeitung. Springer Verlag.
- E. Wintermantel, Suk-Woo Ha: Medizintechnik. Springer Verlag.

Course: Metallographic Lab Class [2175590]

Coordinators: A. Wanner
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[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 is 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 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
Certificate to be issued after evaluation of the lab class report

Conditions
Certtificate of attendance for Welding technique I

Learning Outcomes
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 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 12: Automotive Technology (p. 126)[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. Heißing, 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 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 12: Automotive Technology (p. 126)[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. Heißing, 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 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 42: Technical Acoustics (p. 158)[SP_42_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 chasis for the acoustic and mechanical driving comfort:
phenomena, influencing parameters, types of construction, optimization of components and systems, conflict of goals, methods of development

An excursion will give insights in the development practice of a car manufacturer or a system supplier.

Literature
1. Michael Möser, Technische Akustik, Springer, Berlin, 2005

2. Russel C. Hibbeler, Technische Mechanik 3, Dynamik, Pearson Studium, München, 2006

3. Manfred Mitschke, Dynamik der Kraftfahrzeuge, Band B: Schwingungen, Springer, Berlin, 1997

The script will be supplied in the lectures

Course: Vehicle Comfort and Acoustics II [2114825]

Coordinators: F. Gauterin
Part of the modules: SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 42: Technical Acoustics (p. 158)[SP_42_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 04: Automation Technology (p. 116)[SP_04_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach]

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

Learning Control / Examinations
Oral examination

Duration: 30 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the system science field of mechatronics and its application in the area of vehicle conception, especially in the context of vehicle system dynamics. They know the tools and methods for a systemactical analysis, conception, and design of mechatronic systems, focussing on mechatronically extended suspension systems.

Content
1. Introduction: Mechatronics in vehicle technology
2. Vehicle Control systems
Brake- and traction controls (ABS, ASR, automated power train controls)
Active and semiactive suspension systems, active stabilizor bars
Vehicle dynamics controls, driver assistence systems
3. Modelling technology
Mechanics - multi body dynamics
Electrical and electronical systems, control systems
Hydraulics
Interdisciplinary coupled systems
4. Computer simulation technology
Numerical integration methods
Quality (validation, operating areas, accuracy, performance)
Simulator-coupling (hardware-in-the-loop, software-in-the-loop)
5. Systemdesign (example: brake control)
Demands, requirements (funktion, safety, robustness)
Problem setup (analysis - modelling - model reduction)
Solution approaches
Evaluation (quality, efficiency, validation area, concept ripeness)

Literature
1. Ammon, D., Modellbildung und Systementwicklung in der Fahrzeugdynamik, Teubner, Stuttgart, 1997
2. Mitschke, M., Dynamik der Kraftfahrzeuge, Bände A-C, Springer, Berlin, 1984ff
3. Miu, D.K., Mechatronics - Electromechanics and Contromechanics, Springer, New York, 1992
4. Popp, K. u. Schiehlen, W., Fahrzeugdynamik - Eine Einführung in die Dynamik des Systems Fahrzeug-Fahrweg, Teubner, Stuttgart, 1993
5. Roddeck, W., Einführung in die Mechatronik, Teubner, Stuttgart, 1997
6. Zomotor, A., Fahrwerktechnik: Fahrverhalten, Vogel, Würzburg, 1987

Course: Automotive Vision [2138340]

Coordinators: C. Stiller, M. Lauer

Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 50: Rail System Technology (p. 167)[SP_50_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach]

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

Learning Control / Examinations

Oral examination

Duration: 30 minutes

no reference materials

Conditions

Fundamentals in measurement, system and control theory, e.g. from the lecture “Measurement and Control Systems”

Learning Outcomes

Machine perception and interpretation of the environment for the basis for the generation of intelligent behaviour. Especially visual perception opens the door to novel automotive applications. First driver assistance systems can already improve safety, comfort and efficiency in vehicles. Yet, several decades of research will be required to achieve an automated behaviour with a performance equivalent to a human operator. The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision, vehicle kinematics and advanced information processing techniques are presented to provide a broad overview on ßeeing vehicles’. Application examples from cutting-edge and future driver

assistance systems illustrate the discussed subjects.

Content

1. Driver assistance systems
2. Image acquisition and discretization
3. Image signal processing
4. Stochastic image models
5. Stereo vision and image sequence processing
6. Tracking
7. Lane recognition
8. Obstacle recognition

Literature

TBA

Course: Industrial Management Case Study [3109033]

Coordinators: P. Stock
Part of the modules: SP 16: Industrial Engineering (p. 130)[SP_16_mach]

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

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: Composites for Lightweight Design [2114052]

Coordinators: F. Henning
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 36: Polymer Engineering (p. 151)[SP_36_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 50: Rail System Technology (p. 167)[SP_50_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: FEM Workshop – constitutive laws [2183716]

Coordinators: K. Schulz, D. Weygand, M. Weber
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
no grading
solving of a FEM problem
preparation of a report
preparation of a short presentation

Conditions
None.

Recommendations
Engineering Mechanics; Advanced Mathematics; Introduction to Theory of Materials

Learning Outcomes
Deepening of experience and knowledge of the fundamental theory of materials; classification of characteristic material behavior; students learn how to generate own numerical models as well as how to choose and to apply adequate constitutive equations. Acquirement of basic knowledge of ABAQUS

Content
The course repeats the fundamentals of the theory of materials. It leads to the characterization and classification of material behavior as well as the specification by adequate material models. Here we focus on elastic, viscoelastic, plastic, and viscoplastic deformation behavior. Introducing the finite element program ABAQUS, the students learn how to analyze the material models numerically. Therefore ABAQUS-own and continuative constitutive equations are chosen.

Literature
Peter Haupt: Continuum Mechanics and Theory of Materials, Springer; ABAQUS Manual; Lecture notes

Course: Fabrication Processes in Microsystem Technology [2143882]

Coordinators: K. Bade
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
Oral examination

Conditions
Bachelor mach., wing.

Learning Outcomes

Content

Literature
Fundamentals of Microfabrication, M. Madou, CRC Press, Boca Raton 1997.

Course: Manufacturing Technology [2149657]

Coordinators: V. Schulze
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 39: Production Technology (p. 153)[SP_39_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: Solid State Reactions and Kinetics of Phase Transformations (with exercises) [2193003]

Coordinators: D. Cupid, P. Franke
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach]

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

Learning Control / Examinations
Oral examination (30 min)

Conditions

- Bacic course in materials science and engineering
- physical chemistry

Recommendations
none

Learning Outcomes
diffusion mechanisms, Fick's laws, basic solutions of the diffusion equation, evaluation of diffusion experiments, interdiffusion, thermodynamic factor, parabolic growth of layers, pearlite, transformations of microstructure according to Avrami and Johnson-Mehl

Content
1. Crystal Defects and Mechanisms of Diffusion
2. Microscopic Description of Diffusion
3. Phenomenological Treatment
4. Diffusion Coefficients
5. Diffusion Problems; Analytical Solutions
6. Diffusion with Phase Transformation
7. Kinetics of Microstructural Transformations
8. Diffusion at Surfaces, Grain Boundaries and Dislocations

Literature
1. J. Crank, „The Mathematics of Diffusion", 2nd Ed., Clarendon Press, Oxford, 1975.
2. J. Philibert, „Atom Movements", Les Éditions de Physique, Les Ulis, 1991.
3. D.A. Porter, K.E. Easterling, M.Y. Sherif, „Phase Transformations in Metals and Alloys", 3rd edition, CRS Press, 2009.
4. H. Mehrer, „Diffusion in Solids", Springer, Berlin, 2007.

Course: Finite Element Workshop [2182731]

Coordinators: C. Mattheck, D. Weygand
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
certificate of attendance

Conditions
Continuum Mechanics

Learning Outcomes
The student will learn to use a commercial finite elemet software package and to perform stress analysis.

Content
The students will learn the foundations of the FEM stress analysis and the optimization methode 'Zugdreiecke'.

Course: Finite Volume Methods for Fluid Flow [2154431]

Coordinators: C. Günther
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 06: Computational Mechanics (p. 119)[SP_06_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
Students are familiar with the fundamental aspcets of the finite volume methods which form the basis for a number of different commerical CFD codes.

Content
The Finite Volume Method (=FVM) is nowadays of great interest, as it guarantees conservation of all relevant variables and as it can be used on nearly arbitrary meshes. By this it is a fundamental tool for numerical simulation of flows, which plays an ever growing role for construction and engineering and is the basis of several commercial or research codes as CFX, STAR-CD, FLUENT or OpenFOAM. The lecture is concerned with all aspects of FVM, mesh generation is also included. Newer developments as CVFEM (control volume based FEM) are described.

- Introduction
- Conservative schemes
- Finite volume method
- Analysis of FVM
- CVFEM as conservative FEM
- FVM for Navier-Stokes Equations
- Basics of mesh generation

Remarks
The lecture is recommended for students of mechanical, chemical or electrical engineering and is of interest for people which are interested in FVM in the context with other than fluid flow problems

Course: Fluid Technology [2114093]

Coordinators: M. Geimer
Part of the modules: SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	4	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: Functional Ceramics [2126784]

Coordinators: M. Hoffmann, M. Bäurer
Part of the modules: SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the agreed date.
Auxiliary means: none
The re-examination is offered upon agreement.

Conditions
none

Recommendations
Basics of the course “Introduction to Ceramics” should be known.

Learning Outcomes
The students know the correlation among crystal structure, defect chemistry and electrical, dielectric and piezoelectric properties and are familar with the different methods for powder preparation, shaping and sintering. They know the functionality and application fields of semiconducting, piezoelectric and pyroelectric ceramics.

Content
The course is arranged in the following units:

- Crystal structures and defect chemistry
- Thermodynamic of interfaces and grain boundaries
- Methods for the preparation of functional ceramics
- Dielectric materials and insulators
- Semiconducting ceramics (varistors, PTC- und NTC-ceramics)
- Ion conductive ceramics (oxygen sensors, solid oxid fuel cells)
- Piezoelectric ceramics
- Pyroelectric ceramics
- Elektrooptical ceramics

Media
Slides for the lecture:
available under http://www.iam.kit.edu/km/289.php

Literature
Y.-M. Chiang, D. Birnie III and W.D. Kingery, “Physical Ceramics”, Wiley (1997)
A.J. Moulson, J.M. Herbert, “Electroceramics, Materials - Properties - Applications”, Chapman and Hall (1990)
Y. Xu, “Ferroelectric Materials and Their Applications”, Elsevier (1991)
H. Jaffe, W.R. Cook and H. Jaffe, “Piezoelectric Ceramics”, Academic Press (1971)

Remarks
The course will not take place every year

Course: Fusion Technology A [2169483]

Coordinators: R. Stieglitz
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach]

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

Learning Control / Examinations
oral: Acceptance for the oral test only by certification of attendance of excercises

Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
Basic knowledge in fluid mechanics, material sciences and physics

Learning Outcomes
The lecture describes the functional principle of a fusion reactor, starting from the plasma, the magnets and the core components as the blankets and divertors with the associated material sciences. The physical principles are discussed and scaling laws are formulated. One major emphasis is directed towards the interface between the individual fields of disciplines which to a large extend determines the technological scaling of a fusion facility

Content
Acutal energy situation and perspectives, physical description structure of matter, fusion and fission, plasma. Ignition conditions of a plasma, plasma instabilities, control of a plasma and transport in plasmas. Magnet technology, super-conduction, materials in super-conduction, fabrication and design of magnets. Blankets and divertors, disgn and challenges. Fusion materials and introduction in crucial design criteria for materials, characterization of fusion materials, material damage by irradiation and calculation methods for nuclear materials.

Literature
Within each subblock an adequate selection of literature is given. At the end of the lecture the lecture content will be distributed by a CD containing all relevant information of the given lecture.

Course: Fusion Technology B [2190492]

Coordinators: R. Stieglitz
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach]

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

Learning Control / Examinations
oral
Completed set of practical courses within lecture

Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The lecture comprising two semesters is addressing students of engineering science and physics after a successfull intermediate diploma. It intends to give a introduction to current fusion research and development and to the long term target of fusion as a promising energy source. After a short insight into fusion physics the lecture concentrates on key technologies for future fusion reactors. The lectures will be complemented by exercises in the Forschungszentrum Karlsruhe (two to three afternoons per subject).

Content
Introduction to basics of fusion and fusion technologies

Superconducting magnets

Breeding blanket/divertor integration in a fusion reactor

Development of high duty and low activating structural materials

Neutronics and activation analysis

Fuel cycle (cryo pumps and tritium plant)

Plasma heating techniques (ECRH, ICRH, NBI, LH)

Literature
Lecture notes

McCracken, Peter Scott, Fusion, The Energy of Universe, Elsevier Academic Press, ISBN: 0-12-481851-X

Course: Combined Cycle Power Plants [2170490]

Coordinators: T. Schulenberg
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
Oral Examination 30 min

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

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

Learning Outcomes
Design and operation principles of major components of advanced combined cycle power plants including their control. Dynamic response of combined cycle power plants to grid requirements.

Content
Layout of a combined cycle power plant, design and operation of gas turbines, of the heat recovery steam generator, of the feedwater system and cooling systems. Design and operation of steam turbines, of the generator and its electrical systems. System response to challinging grids, protection systems, water make-up and water chemistry. Design concepts of different power plant manufacturers, innovative power plant concepts.

Media
Lecture with English Power Point Presentation

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

Course: Gas Engines [2134141]

Coordinators: R. Golloch
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach]

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

Learning Control / Examinations
Oral examination, duration 30 min., no aid allowed

Conditions
none

Recommendations
Knowledge about „Verbrennungsmotoren A und B“

Learning Outcomes
The student knows about the function, characteristics and application areas of gas and dual fuel engines. He is able to distinguish from engines using liquid fuels. The student has knowledge about gaseous fuels, engine subsystems, combustion processes and exhaust gas aftertreatment technologies. He is capable to evaluate current development areas and technical challenges.

Content
Based on the basics of internal combustion engines the students learn about functions of modern gas and dual fuel engines. Core learning areas are gaseous fuels, combustion processes including abnormal combustion characteristics, subsystems like gas admission, ignition, safety and control systems. Further knowledge will be teached on emissions, exhaust gas aftertreatment, applications and operation characteristics.

Media
Lecture with PowerPoint slides

Literature
Lecture Script, prepared by the lecturer. Obtainable at the Institut für Kolbenmaschinen
Recommended:
- Merker, Schwarz, Teichmann: Grundlagen Verbrennungsmotoren, Vieweg + Teubner Verlag 2011;
- Zacharias: Gasmotoren, Vogel Fachbuch 2001

Course: Building- and Environmental Aerodynamics [19228]

Coordinators: B. Ruck, Ruck
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
Graded: oral examination, 30 minutes

Conditions
none

Recommendations
Fluid mechanics, Hydromechanics

Learning Outcomes
The students are able to analyse and calculate steady and unsteady wind loading on technical and natural structures. They know the fundamentals of wind load assessment and flow induced vibrations as well as methods to estimate their influence. Typical applications will be demonstrated linking theory to practice.

Content
The lecture gives an introduction to the field of buidling- and environmental aerodynamics. Part 1 is dedicated to building aerodynamics and to the assessment of wind loads, whereas part 2 deals with aspects of flows in natural environments.
Topics: Atmospheric boundary layer and natural wind, Wind loads on technical and natural structures, Wind induced vibrations, Wind shelter, Wind tunnel modelling

Course: Appliance and Power Tool Design [2145164]

Coordinators: S. Matthiesen
Part of the modules: SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach]

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

Learning Control / Examinations
oral examination
duration: 30 min.
auxiliary means: none
combined examination of lecture and project work

Conditions
In Masters Course:
The participationin " Appliance and power tool design"" requires the concurrent project work.
Due to organizational reasons, the number of participants is limited. At the beginning of august, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous.

Recommendations
CAE Workshop is recommended as elective course or complementary subject.

Learning Outcomes
The superior learning objective is to prepare for the tasks of a design engineer. Therefore the central activities of design are imparted. The theory and foreknowledge will be transferred into real technical appliances and power tools.

Content
Operation system, system of objects and system of objectives of mechatronic appliances and power tool designs. Mode of operation as enabler of design, components of mechatronic systems, application oriented design, guidelines for appliance and power tool design.
Part of the lecture are exercises, in which theory will be reprocessed and presented in a practical way. In such exercises the students also will present their results developed in project teams.

Course: Global vehicle evaluation within virtual road test [2114850]

Coordinators: B. Schick
Part of the modules: SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 12: Automotive Technology (p. 126)[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.: Scriptum zur Vorlesung “Fahreigenschaften I”
3. Unrau, H.-J.: Scriptum zur Vorlesung “Fahreigenschaften II”
4. IPG: User Guide CarMaker

Course: Foundry Technology [2174575]

Coordinators: C. Wilhelm
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 26: Materials Science and Engineering (p. 139)[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 develoment.

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 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 39: Production Technology (p. 153)[SP_39_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 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.6.2011)

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 (Neuauflage 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. 139)[SP_26_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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
lecture slides

Course: Fundamentals of Energy Technology [2130927]

Coordinators: F. Badea, D. Cacuci
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach]

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

Learning Control / Examinations

Conditions
none

Learning Outcomes
The students will receive state of the art knowledge about the very challenging field of energy industry and the permanent competition between the economical profitability and the long-term sustainability.

Content
The following relevant fields of the energy industry are covered:
- Energy forms
- Thermodynamics relevant to energy industry
- Energy sources: fossil fuels, nuclear energy, renewable sources
- Energy industry in Germany, Europe and worldwide
- Power generation and environment
- Evaluation of energy conversion processes
- Thermal/electrical power plants and processes
- Transport of energy / energy carriers
- Energy storage
- Systems utilizing renewable energy sources
- Basics of economic efficiency and calculus / Optimisation
- Future of the energy industry

Course: Automotive Engineering I [2113805]

Coordinators: F. Gauterin, H. Unrau
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 48: Internal Combustion Engines (p. 164)[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. Engines: combustion engine, alternative drives (e.g. gas turbine, fuel cell)

3. Transmission: clutches (e.g. friction clutch, visco clutch), transmission (e.g. mechanical transmission, hydraulic fluid transmission)

4. Power transmission and distribution: drive shafts, cardon joints, differentials

Literature
1. 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 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach]

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

Learning Control / Examinations
Written Examination

Duration: 90 minutes

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students have an overview of the modules, which are necessary for the road holding of a motor vehicle and the power transmission between vehicle bodywork and roadway. They have knowledge of different wheel suspensions, the tyres, the steering elements and the brakes. They know different execution forms, the function and the influence on the driving or brake behavior. They are able to 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. 139)[SP_26_mach], SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed

Learning Outcomes
The students know the basics of characterization of powders, pastes and suspensions. They have a fundamental understanding of the process technology for shaping of particulate systems. They are able to use these fundamentals to design selected wet- and dry forming processes.

Content
The course covers fundamentals of the process technology for shaping of ceramic or metal particle systems. Important shaping methods are reviewed. The focus is on characterization and properties of particulate systems, and, in particular, on process technology for shaping of powders, pastes, and suspensions.

Literature

- R.J.Brook: Processing of Ceramics I+II, VCH Weinheim, 1996
- M.N. Rahaman: Cermamic Processing and Sintering, 2nd Ed., Marcel Dekker, 2003
- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Fundamentals of catalytic exhaust gas aftertreatment [2134138]

Coordinators: E. Lox
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 12: Automotive Technology (p. 126)[SP_12_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 helth-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. Schaeder, R. van Basshuysen, Springer Verlag Wien New York, 1995 ISBN 3-211-82718-8
6. "Autoabgaskatalysatoren : Grudlagen - Herstellung - Entwicklung - Recycling - Ökologie" Ch. Hagelüken und 11 Mitautoren, Expert Verlag, Renningen, 2001 ISBN 3-8169-1932-4

Course: [2105992]

Coordinators: C. Pylatiuk
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Organ support systems

Learning Outcomes
Students have fundamental knowledge about functionality of organ support systems and its components. An analysis of historical developments can be done and limitations of current systems can be found. The limits and possibilities of transplantations can be elaborated.

Content

- Introduction: Definitions of "health" and "disease". History of medicine and paradigm shift towards evidence based medicine and personalized medicine.
- Special topics: nervous system, saltatory conduction, musculoskeletal system, cardio-circulatory system, narcosis, pain, respiratory system, sensory organs, gynaecology, digestive organs, surgery, nephrology, orthopaedics, immune system, genetics.

Literature

- Adolf Faller, Michael Schünke: Der Körper des Menschen. Thieme Verlag.
- Renate Huch, Klaus D. Jürgens: Mensch Körper Krankheit. Elsevier Verlag.

Course: Introduction to Microsystem Technology I [2141861]

Coordinators: A. Last
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In analogy to processes employed in fabrication of microelectronics circuits the core technologies as well as materials for producing microstructures and components are presented. Finally, various techniques for Silicon micromachining are explained and illustrated with examples for micro-components and micro-systems.

Content
- Introduction in Nano- and Microtechnologies
- Silicon and processes for fabricating microelectronics circuits
- Basic physics background and crystal structure
- Materials for micromachining
- Processing technologies for microfabrication
- Silicon micromachining
- Examples

Literature
Fundamentals of Microfabrication, M. Madou, CRC Press, Boca Raton 1997.

Course: Introduction to Microsystem Technology II [2142874]

Coordinators: A. Last
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes
The lecture gives an introduction into the basics of microsystems technology. In the first part, methods for lithographic pattern transfer are summarized. Then specific techniques such as the LIGA process, micro-machining, and laser-patterning are explained and examples are given. Finally assembly and packaging methods are presented leading into a discussion of entire microsystems.

Content
- Introduction in Nano- and Microtechnologies
- Lithography
- LIGA-technique
- Mechanical microfabrication
- Patterning with lasers
- Assembly and packaging
- Microsystems

Literature
Fundamentals of Microfabrication, M. Madou, CRC Press, Boca Raton 1997.

Course: Foundations of nonlinear continuum mechanics [2181720]

Coordinators: M. Kamlah
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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, derformation 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 44: Technical Logistics (p. 160)[SP_44_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach]

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

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

Conditions
None.

Recommendations
None.

Learning Outcomes
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: Fundmentals of Combustion I [2165515]

Coordinators: U. Maas
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach]

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

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

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students are able to:

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

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

Media
Blackboard and Powerpoint presentation

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

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

Course: Fundamentals of combustion II [2166538]

Coordinators: U. Maas
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing the course attendents are able to:

- explain the processes involved in ignition (auto-ignition and induced ignition).
- describe the governing mechanisms in combustion of liquid and solid fuels.
- understand the mechanisms governing pollutant formation.
- describe turbulent reacting flows by means of simple models.
- explain the occurence of engine knock.
- outline the basic numerical schemes applied in the simulation of reacting flows.

Content
Ignition processes
Three dimensional Navier-Stokes equations for reacting flows
Tubulent reactive flows
Turbulent non-premixed flames
Turbulent premixed flames
Combustion of liquid and solid fuels
Engine knock
NOx formation
Formation of hydrocarbons and soot

Media
Blackboard and Powerpoint presentation

Literature
Lecture notes;
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation,Experiments, Pollutant Formation; Authors: U. Maas, J. Warnatz, R.W. Dibble, Springer; Heidelberg, Karlsruhe, Berkley 2006

Course: Basics of Ground Born Guided Systems [19066]

Coordinators: E. Hohnecker, P. Gratzfeld, Hohnecker
Part of the modules: SP 50: Rail System Technology (p. 167)[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: Optical Flow Measurement: Fundamentals and Applications [2153410]

Coordinators: F. Seiler
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_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
Optical measuring techniques are both in science and technology, for example in wind tunnels, a non-negligible tool for experimental determination of the behaviour of fluid flows. The fundamentals necessary for understanding the working mechanisms of the optical techniques presented are explained in detail in this lecture. The functioning of the most important registration and visualization methods working with tracer scattering on the one hand and on the other one with the information obtained with light passing directly the measuring regime is shown and discussed by newest experiments carried out with shock tunnels. The light scattering techniques are explained by means of the classical single-beam and cross-beam anemometry as well as by interference velocimetry used for flow velocity measurements. Also the classical tools for flow density measurement, i.e. the Mach/Zehnder- and the Differential interferometer as well as the shadowgraph technique and the Schlieren method are discussed by means of visualisations of density fields as well as by recent examples of density recordings. Finally, the laser-induced fluorescence (LIF) method and the CARS-method are presented for measuring on an elementary basis the gas density and gas temperature.

Content
Visualisations techniques
Techniques for local point-wise measurement
Techniques using light scattering methods
Laser-induced fluorescence

Literature
H. Oertel sen., H. Oertel jun.: Optische Strömungsmeßtechnik, G. Braun, Karlsruhe

F. Seiler: Skript zur Vorlesung über Optische Strömungsmeßtechnik

Course: Basics and Methods for Integration of Tires and Vehicles [2114843]

Coordinators: G. Leister
Part of the modules: SP 12: Automotive Technology (p. 126)[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 presssure: Indirect and direct measuring systems
8. Tire testing subjective and objective

Literature
Manuscript to the lecture

Course: Fundamentals for Design of Motor-Vehicles Bodies I [2113814]

Coordinators: H. Bardehle
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[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. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[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. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 34: Mobile Machines (p. 148)[SP_34_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. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 34: Mobile Machines (p. 148)[SP_34_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., Strifler, P. (Hrsg. Institut für Kraftfahrwesen RWTH Aachen): Industrielle Nutzfahrzeugentwicklung, Schriftenreihe Automobiltechnik, 1993

Course: Fundamentals of Automobile Development I [2113810]

Coordinators: R. Frech
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[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. 123)[SP_10_mach], SP 12: Automotive Technology (p. 126)[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

Literature
The scriptum will be provided during the first lessons.

Course: High Performance Computing [2183721]

Coordinators: B. Nestler, M. Selzer
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach]

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

Learning Control / Examinations
We regularly discuss excercises at the computer.
At the end of the semester, there will be a written exam.

Conditions
None.

Learning Outcomes
The students should develop abilities and expertise in the field of concurrent programming, they should be able to use high performance computing resources and the growing performance of multi core processors efficiently. Additionaly, they should know different high performacne computer architectures and be able to use different parallelization models. Applications from different scientific fields with different requirements are going to be developed to build a base of strategies for problem solving and of thougth patterns. The aim is to prepare the students for scientific and industrial tasks in the field of concurrent programming and high performance computing.

Content
Topics of the high performance computing courde are:
- achitectures of parallel platforms
- parallel programming models
- performance analysis of concurrent programs
- parallelization models
- MPI and OpenMP
- Monte-Carlo method
- 1D & 2D heat diffusion
- raycasting
- n-body problem
- simple phase-field models

Media
Slides of the lecture, excercise sheets, solution files of the computer excercises.

Literature
Lecture Notes; Problem Sheets;
Program templates;
Foundations of Multithreaded, Parallel, and Distributed Programming, Gregory R. Andrews; Addison Wesley 2000

Course: Advanced Methods in Strength of Materials [2161252]

Coordinators: T. Böhlke

Part of the modules: SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
depending on choice according to acutal version of study regulations
Additives as announced
Prerequisites have to be met by attestations during the associated lab course

Conditions
The institutes decides about registration for the lab course (restricted number of participants).

Recommendations
None.

Learning Outcomes
The students can 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.
During the associated lab course the students apply the theoretical concepts to distinguished examples. Moreover, the students have first experience in working with the commercial FE-software Abaqus.

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
lecture notes
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Gross, D.; Seelig, T.: Bruchmechanik. Springer 2002.
Hibbeler, R.C: Technische Mechanik 2 - Festigkeitslehre. Pearson Studium 2005.

Course: Hydraulic Fluid Machinery I (Basics) [2157432]

Coordinators: M. Gabi
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_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. Pfleiderer, C.: Die Kreiselpumpen. Springer-Verlag
5. Carolus, T.: Ventilatoren. Teubner-Verlag
6. Kreiselpumpenlexikon. KSB Aktiengesellschaft
7. Zierep, J., Bühler, K.: Grundzüge der Strömungslehre. Teubner-Verlag

Course: Hydraulic Fluid Machinery II [2158105]

Coordinators: S. Caglar, M. Gabi, Martin Gabi
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach]

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

Learning Control / Examinations
Oral examination
Duration: ca. 30 minutes
No tools or reference materials may be used during the exam.

Conditions
Hydraulic Fluid Machinery I (Basics)

Recommendations
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. Pfleiderer, C.: Kreiselpumpen, Springer-Verlag
4. Carolus, T.: Ventilatoren, Teubner-Verlag
5. Bohl, W.: Ventilatoren, Vogel-Verlag
6. Raabe, J.: Hydraulische Maschinen, VDI-Verlag
7. Wolf, M.: Strömungskupplungen, Springer-Verlag
8. Hau, E.: Windkraftanlagen, Springer-Verlag

Course: Hydrodynamic Stability: From Order to Chaos [2154437]

Coordinators: A. Class
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach]

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

Learning Control / Examinations
Oral
Duration: 30 minutes
Auxiliary means: none

Conditions
Mathematics

Learning Outcomes
Increasing a control parameter of a thermohydraulic system,e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).
In the lecture analytic and numerical methods for the evaluation of stability properties will be developed.

Content
Increasing a control parameter of a thermohydraulic system, e.g. the Reynolds number, the initial flow pattern (e.g. stationary flow) can be replaced by a different pattern (e.g. turbulent flow).
Typical hydrodynamic instabilities are summarized in the lecture.
The systematic analysis of thermohydraulic stability problems is developed for the case of Rayleigh-Bernard convection (fluid layer heated from below) and selected examples from fluid dynamics.
Covered is:

- linear stability analysis: determine limiting control parameter value up to which the basic flow pattern is stable against small perturbations.
- nonlinear reduced order modeling, capable to characterize more complex flow patterns
- Lorenz system: a generic system exhibiting chaotic behavior

Media
Black board

Literature
Script

Remarks
Lecture also offered as a block-lecture within the AREVA Nuclear Professional School (www.anps.kit.edu)

Course: Industrial aerodynamics [2153425]

Coordinators: T. Breitling
Part of the modules: SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
oral

Duration: 30 minutes

no auxiliary means

Conditions
None.

Learning Outcomes
Students are familiar with different aerdynamical flows that occur in vehicles. These include external flows around the vehicles, flows in the passenger compartments (thermal comfort), as well as cooling flows, charge motion, mixing and combustion processes in the engine.

Content
This compact lecture deals with flow, mixing and combustion phenomena with significance in vehicle development. A special focus is set on the optimization of external car and truck aerodynamics, thermal comfort in passenger compartments, analyses of cooling flows and improvement of charge motion, mixing and combustion in piston engines. These fields are explained in their phenomenology, the corresponding theories are discussed and the tools for measurement and simulation are introduced and demonstrated. The focus of this lecture is on industry relevant methods for analyses and description of forces, flow structures, turbulence, flows with heat transfer and phase transition and reactive flows. In addition an introduction to modern methods in accuracy control and efficiency improvement of numerical methods for industrial use is given. The integration and interconnection of the methods in the development processes are discussed examplary.
An excursion to the Daimler AG wind tunnel and the research and development centers is planned.

- Industrial flow measurement techniques
- Flow simulation and control of numerical errors, turbulence modeling
- Cooling flows
- Flow mixing and combustation at direct injected Diesel engines
- Flow mixing and combustation at gasoline engine
- Vehicle aerodynamics
- HVAC-Systems and thermal comfort
- Aeroacoustics

Literature
Script

Remarks
Block Course. Details see www.isl.kit.edu

Course: Introduction to Industrial Production Economics [2109042]

Coordinators: S. Dürrschnabel
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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
There is the possibility to acquire the so-called “REFA-Grundschein” (non-academic certificat).

Conditions
Recommendations for the non-academic certificat “REFA-Grundschein”:

- Compulsory attendance during the whole lecture
- Passing the lecture “Arbeitswissenschaft [2109026] at least with the grade 3.0

Learning Outcomes

- The students know the possible organisational structures for enterprises.
- The students learn about the importance of process data as basis for efficient work structuring.
- The students are able to execute and evaluate time studies in industry (e.g. REFA).
- The students know different methods for the evaluation of working places.
- The students know basic techniques for the determination of wages.
- The students are able to make a cost calculation for a specific product.

Content

- Configuration of the departemental organisation and the process organisation
- Execution and evaluation of time studies
- Actual tools for time studies, e.g. Work Sampling, Methods-Time Measurement, Planned times,
- Evaluation of workplaces and determination of wages
- Cost accounting (including Process costs)

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

Literature:

- REFA – Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Ausgewählte Methoden zur prozessorientierten Arbeitsorganisation. Darmstadt: REFA, 2002.
- SCHLICK, Christopher; BRUDER, Ralph; LUCZAK, Holger: Arbeitswissenschaft. Heidelberg u.a.: Springer, 3rd edition 2010.
- EBEL, Bernd: Produktionswirtschaft. Ludwigshafen am Rhein: Kiehl Friedrich Verlag, 9th edition 2009.

Please refer to the latest edition.

Course: Occupational Safety and Environmental Protection (in German) [2110037]

Coordinators: R. von Kiparski
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach]

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

Learning Control / Examinations
Mündliche Prüfung, Dauer: 30 Minuten
(nur in Deutsch)

Hilfsmittel: keine

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 and Economics is usefull

Learning Outcomes
The participant can

- explain the importance of occupational safety and environmental protection as well as their connection to each other.
- describe the influence of human behaviour.
- explain the possibilities and limits for an engineer to influence.
- realise if professional help of an expert of other faculties is needed.
- eveluate and present the results of his work.

Content
The participants have to solve a specific case study within the field of occupational safety and environmental protection. Therefore, the work in a team. The tasks covers the information research as well as the presentation of the results.

Content:

- Occupational Safety and Safety Engineering
- Environmental Protection within a Production Enterprise
- Health Management

Structure:

- Terminology
- Basics of Occupational Safety and Environmental Protection

- Case Study
- Moderated Processing of a Case Stuy within a Small Group

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

Literature:

- HACKSTEIN, R.: Arbeitswissenschaft im Umriß, Bd.1 und 2, Essen, 1977.
- HÜBLER, K.-H.; OTTO-ZIMMERMANN, K.: Bewertung der Umweltverträglichkeit. Taunusstein, 1989.
- KERN, P.; SCHMAUDE, M.: Einführung in den Arbeitsschutz für Studium und Berufspraxis. München: Hanser, 2005.
- KIPARSKI, R. v.: Rechtliche Grundlagen der Arbeitssicherheit Praxishandbuch für den Betriebsleiter. WEKA Verlag: Augsburg, 1997.
- GROB, R.: Erweiterte Wirtschaftlichkeits- und Nutzenrechnung. Köln, 1984.
- o.V.: Gefahrstoffverordnung 2005.
- o.V.: Geräte- und Produktsicherheitsgesetz 2004.
- o.V.: Arbeitssicherheitsgesetz 1973.
- o.V.: Arbeitsschutzgesetz 1996.
- o.V.: Berufsgenossenschaftliche Vorschriften und Regeln für Sicherheit- und Gesundheit bei der Arbeit.
- o.V.: Wörterbuch 'Arbeitssicherheit und Gesundheitsschutz' Wiesbaden, 2007.

Please refer to the latest edition.

Course: Information Systems in Logistics and Supply Chain Management [2118094]

Coordinators: C. Kilger
Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see “Studienplan Maschinenbau”, version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
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: Information Processing in Mechatronic Systems [2105022]

Coordinators: M. Kaufmann
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 18: Information Technology (p. 131)[SP_18_mach]

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

Learning Control / Examinations
Oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Basic knowledge of computer science and programming

Learning Outcomes
Students have fundamental knowledge about selection, conceptual design and development of information processing components in mechatronic systems.

Content
Information processing components – consisting of sensors, actors, hardware and software – are of essential importance for the implementation of mechatronic functions.
Based on requirements on information processing in mechatronic systems typical hardware and software solutions are examined. Characteristics, advantages, disadvantages and application areas are discussed. Solutions are examined regarding real-time capabilities, dependability, safety and fault tolerance. Bus communication in mechatronic systems is examined. Description methods and several approaches of functional description are considered. An approach on the development of information processing components is developed. Lecture topics are complemented by practical examples.
Outline:

- Requirements on information processing components,
- Characteristics of information processing components
- Real-time capabilities, dependability, safety and fault tolerance
- Architectures of information processing components
- Communication in mechatronic systems
- Descriptive models und functional description
- Development of information processing components

Software quality

Literature

- Marwedel, P.: Eingebettete Systeme. Springer: 2007.
- Teich, J: Digitale Hard-, Software-Systeme. Springer: 2007.
- Wörn, H., Brinkschulte, U.: Echtzeitsysteme: Grundlagen, Funktionsweisen, Anwendungen. Springer, 2005.
- Zöbel, D.: Echtzeitsysteme: Grundlagen der Planung. Springer, 2008.

Course: Information Processing in Sensor Networks [24102]

Coordinators: U. Hanebeck, F. Beutler
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 18: Information Technology (p. 131)[SP_18_mach]

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

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Knowledge of the lectures *Localization of Mobile Agents* [IN4INLMA] or *Stochastic Information Processing* [IN4INSIV] will be beneficial.

Learning Outcomes
The student understands the specific challenges of information processing in the area of sensor networks and become acquainted with the different levels of processing procedures for the sensor measurements. The student is able to analyze, compare, and evaluate different approaches towards information processing in sensor networks.

Content
In the lecture, relevant aspects of information processing in sensor networks are considered. First, the technical configuration of a single sensor node is presented. This includes the main components required for information processing, like sensor technology, analog signal processing, analog-to-digital conversion, and digital signal processing. In the second part, approaches for localization, time synchronization, routing, and sensor scheduling are presented. At the end of the lecture, approaches for sensor information fusion as well as the model-based reconstruction of distributed phenomena are discussed.

Media

- Handwritten lecture notes will be made available electronically.
- Figures and application examples on slides.

More information can be retrieved from the information brochure available on the ISAS website.

Literature
Elective literature:
Lecture notes.

Course: Innovative Nuclear Systems [2130973]

Coordinators: X. Cheng
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach]

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

Learning Control / Examinations

- oral examination
- duration 20min

Conditions

None.

Learning Outcomes

This lecture is addressed to students of mechanical engineering, chemical engineering and physics. Goal of the lecture is the explanation of state-of-the-art development of nuclear systems. Nuclear systems, that are from todays point of view promising will be presented and explained. The main characteristics of such systems and the associated challenges are also part of the lecture.

Content

1. state of the art and development tendencies in nuclear systems
2. advanced concepts in light water cooled systems
3. new developments in fast reactors
4. development tendencies in gas-cooled plants
5. transmutation systems for waste management
6. fusionsystems

Course: Integrated measurement systems for fluid mechanics applications [2171486]

Coordinators: H. Bauer, Mitarbeiter
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
Group colloquia for each topic

Duration: approximentely 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 Product Development [2145156]

Coordinators: A. Albers
Part of the modules: SP 20: Integrated Product Development (p. 133)[SP_20_mach]

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

Learning Control / Examinations
oral examination (60 minutes)
combined examination of lectures, tutorials and project work

Conditions
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).
Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations
none

Learning Outcomes
The lecture mediates on the basis of practical experiences and by means of examples from the Industry, the theory of systematic planning, verification and controlling of development and innovation processes as well as the team oriented employment of effective methods for their efficient support. Strategies of development- and innovation management of the technical system analysis and team leadership will be discussed and trained in workshops. Thus the participants are specifically made familiar with the product development process of medium sized companies.

Content
organizational integration: integrated product engineering model, core team management and simultaneous engineering
informational integration: innovation management, cost management, quality management and knowledge management
personal integration: team coaching and leadership management
invited lectures

Literature
none

Remarks
The lecture starts in first week of October.

Course: Integrated production planning [2150660]

Coordinators: G. Lanza
Part of the modules: SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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: Intermodal Transport and Cross-Border Rail Traffic [2114916]

Coordinators: P. Gratzfeld, R. Grube
Part of the modules: SP 50: Rail System Technology (p. 167)[SP_50_mach]

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

Learning Control / Examinations

- Oral examination
- Duration: 20 minutes
- No tools or reference materials may be used during the exam.

Conditions
none

Recommendations
none

Learning Outcomes
The students learn about the entrepreneurial approach and viewpoint of railways. They comprehend key issues of the transport policy, regulatory as well as financial framework, and grasp strategic fields of action in international as well as intermodal market perspectives.

Content
The lecture gives an overview about perspective, challenges and chances of rail systems in the national and European market. Following items will be discussed:

- Current figures and Deutsche Bahn at a glance
- Goals, instruments and outcomes of rail reform
- Infrastructure finance and investment
- Megatrends in the transport market and future of the railways
- Inter- and multimodal transport
- International rail passenger and freight services
- Inter- and intramodal competition
- Key issues of national and European transport policy

Media
All material is available for download (Ilias-platform).

Literature
none

Remarks
For the dates please see special announcement on the website www.bahnsystemtechnik.de

Course: IT for facility logistics [2118083]

Coordinators: F. Thomas

Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
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: Introduction to Ceramics [2125768]

Coordinators: M. Hoffmann
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (30 min) taking place at the agreed date.
The re-examination is offered upon agreement.

Conditions
none

Recommendations
Fundamentals in natural science are recommended for students in mechanical and industrial engineering. The lecture requires the basics of the material science courses in mechanical or industrial engineering for bachelor students.

Learning Outcomes
The students know the most relevant crystal structures and defects of non metallic inorganic materials, are able to read binary and ternary phase diagrams and are familar with powdertechnological shaping techniques, sintering and grain growth. They know the basics of the linear elastic fracture mechanics, are familar with Weibull statistics, K-concept, subcritical crack growth, creep and the opportunities for microstructural reinforcement of ceramics.

Content
The course is arranged in the following units:

- 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 (creep, oxidation)
- Toughening mechanisms
- Methods for microstructural characterization

Media
Slides for the lecture:
available under http://www.iam.kit.edu/km/289.php

Literature

- H. Salmang, H. Scholze, “Keramik“, Springer
- Kingery, Bowen, Uhlmann, “Introduction To Ceramics“, Wiley
- Y.-M. Chiang, D. Birnie III and W.D. Kingery, “Physical Ceramics”, Wiley
- S.J.L. Kang, “Sintering, Densification, Grain Growth & Microstructure”, Elsevier

Course: Nucleaer Power Plant Technology [2170460]

Coordinators: T. Schulenberg
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach]

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

Learning Control / Examinations
oral
Duration: approximately 30 minutes

no tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
This lecture is addressed to students of mechanical engineering. It is complementary to other lectures about power plant technologies as well as steam and gas turbines. The objective is to introduce into design and analysis of pressurized water reactors and boiling water reactors. Included are excercises and a visit of a nuclear power plant.

Content
Physics of nueclear fission and radioactive decay

Basics of the neutron physics for nuclear reactor design

Thermal-hydraulic analysis of pressurized water reactors and boiling water reactors

Design of main components of the power plant

Dynamics of nuclear power plants

Safety systems

Literature
lecture notes

Course: Cogitive Automobiles - Laboratory [2138341]

Coordinators: C. Stiller, M. Lauer, B. Kitt
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 44: Technical Logistics (p. 160)[SP_44_mach]

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

Learning Control / Examinations
Colloquia, final race

Conditions
Lectures "Automotive Vision" and "Behaviour Generation for Vehicles" have to be attended in parallel. Basic knowledge of a programming language is a plus.

Learning Outcomes
The laboratory accompanies the lectures "Automotive Vision" and "Behaviour Generation for Vehicles". It will provide the opportunity of turning theoretical skills taught in the lecture to practice. The laboratory is divided into four groups with a maximum number of five students in each group. During the lessons you will be supervised by scientific staff.
The lecture addresses students in mechanical engineering and related subjects who intend to get an interdisciplinary knowledge in a state-of-the-art technical domain. Machine vision, vehicle kinematics and advanced information processing techniques are presented to provide a broad overview on "seeing vehicles". Each group is given the task to extract lane markings from video images and generate a suitable trajectory which the vehicle should follow. Apart from technical aspects in a highly innovative field of automotive technology, participants have the opportunity of gathering important qualifications as i.e. implementation skills, acquisition and comprehension of suitable literature, project and team work.

Content
1. Lane recognition
2. Object detection
3. Vehicle lateral control
4. Vehicle longitudinal control
5. Collision avoidance

Literature
TBA

Course: Cognitive Systems [24572]

Coordinators: R. Dillmann, A. Waibel, Christian Mohr, Markus Przybylski, Kai Welke
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach]

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

Learning Control / Examinations

Conditions
None.

Recommendations
Basic knowledge in informatics is helpful.

Learning Outcomes

- The relevant elements of technical cognitive systems can be named and their tasks can be described.
- The problems in the relevant areas can be recognized and processed.
- Further approaches and methods can be exploited autonomously and applied successfully.
- Variations of the problems can be solved successfully.
- The educational objectives shall be achieved by visiting the complementary tutorials.

Content

Cognitive systems act on the basis of perception and knowledge. After reception of stimuli through receptors, the signals are processed, and based on a knowledge base actions are triggered. In the lecture, the involved modules of a cognitive system are presented. To these belong in addition to acquisition and processing of environmental information (e.g. images, speech), the representation of knowledge as well as the assignment of features with the aid of classifiers. Further core themes of the lecture will be learning and planning methods, and their implementation. The presented methods and approaches will be deepened in the tutorials by means of exercises.

Media

Slides, lecture notes (available for download)

Literature

„Artificial Intelligence – A Modern Approach“, Russel, S.; Norvig, P.; Prentice Hall. ISBN 3895761656.
Elective literature:
„Computer Vision – Das Praxisbuch“, Azad, P.; Gockel, T.; Dillmann, R.; Elektor-Verlag. ISBN 0131038052.
“Discrete-Time Signal Processing”, Oppenheim, Alan V.; Schafer, Roland W.; Buck, John R.; Pearson US Imports & PHIPEs. ISBN 0130834432.
“Signale und Systeme”, Kiencke, Uwe; Jäkel, Holger; Oldenbourg, ISBN 3486578111.

Course: Coal fired power plants [2169461]

Coordinators: P. Fritz, T. Schulenberg
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_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
None.

Recommendations
None.

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

Content
Steam turbine plants

Integrated gasification combined cycle power plants

Literature
Strauß, K.: Kraftkwerkstechnik, Springer Verlag 1998

Course: Design with Plastics [2174571]

Coordinators: M. Liedel
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 36: Polymer Engineering (p. 151)[SP_36_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 10: Engineering Design (p. 123)[SP_10_mach]

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

Learning Control / Examinations
oral duration: 20 - 30 min. aids: none

Conditions
none, recomm. 'Polymer Engineering I'

Learning Outcomes
Students will be able to
• distinguish polymer compounds from other construction materials regarding chemical differences, thermal behaviour and solid conditions.
• discuss main plastics processes regarding advantages and disadvantages of materials selection and part geometry design and to make appropiate selections.
• analyze complex application requirements concerning material impacts on strength and to use the classic dimensioning method specific to the application to evalute the lifetime part strength limit.
• evaluate part tolerances and geometry by appropiate methods considering molding shrinkage, production tolerances, post shrinkage, heat expansion, swelling, elastic and creep deformation.
• design plastic specific joining geometries like snap fits, screw bosses, weld seams and film hinges.
• detect classic molding failures and understand potential causes as well as to reduce the probability of molding failures by defining an optimized design.
• understand benefits and limits of selected simulation tools in the plastic technology discipline (strength, deformation, filling, warpage).
• assess polymer classes and plastic part designs with respect to suitable recycling concepts and ecological consequences.

Content
Structure and properties of plastics materials,
Processing of plastics,
Behavior of plastics under environmental impacts,
Classic strength dimensioning,
Geometric dimensioning,
Plastic appropriate design,
Failure examples,
Joining of plastic parts,
Supporting simulation tools,
Structural foams,
Plastics Technology trends.

Literature
Scriptum will be handed out during the lecture.
Recommended literature are provided in the lecture.

Course: Lightweight Engineering Design [2146190]

Coordinators: A. Albers, N. Burkardt

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 32: Medical Technology (p. 146)[SP_32_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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 leightweight design. Additionally, guest speakers from industry will present lightweight design from an practical point of view.

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

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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[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 04: Automation Technology (p. 116)[SP_04_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_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: Power and Heat economics [2169452]

Coordinators: H. Bauer
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_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
None.

Recommendations
None.

Learning Outcomes
The goal of this lecture is to get in sight into the structure and practice of the power market and to learn about the economic and political aspects of electricity and heat production. Especially engineering students are going to learn not only the technical but the economical issues related to the international power business.

Content
Introduction

Overview of the power market in Germany and Europe

Costs of electricity generation

Costs of heat generation

Financing: Analysis of profit, liquidity, balance and return on investment

Cost of power production of different power plants and sensitivities

District heating (Example: Aerea Rhein/Ruhr)

Structure of rates and pricing in the German power market

Course: Motor Vehicle Laboratory [2115808]

Coordinators: M. Frey, M. El-Haji
Part of the modules: SP 12: Automotive Technology (p. 126)[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 deepen 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: Cooling of thermally high loaded gas turbine components [2170463]

Coordinators: H. Bauer, A. Schulz
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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
Hot gas temperatures of modern gas turbine engines exceed the maximum tolerable material temperatures by several hundreds of K. To ensure reliability of lifetime, complex cooling technology must be applied. Various cooling methods will be introduced in this lesson. Specific pros and cons will be identified and new concepts for further improvement of cooling will be discussed. Furthermore, the fundamentals of forced convection heat transfer and film cooling wil be imparted and a simplified design process of a cooled gas turbine components will be demonstrated. Finally, experimental and numerical methods for the characterization of heat transfer will be presented.

Content

Course: Warehousing and distribution systems [2118097]

Coordinators: K. Furmans, C. Huber
Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version 29.06.2011)

Conditions
none

Recommendations
logistics lecture

Learning Outcomes
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 25: Lightweight Construction (p. 138)[SP_25_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 26: Materials Science and Engineering (p. 139)[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
Students know the basics of the emission of light, light amplification and the principle layout of Nd:YAG-, CO_2- and High-Power-Diode-laser sources for industrial applications.
Students know the most common types of laser-based materials processing and the essential influences of laser beam, materials and process parameters .
Furthermore students know the essentials of laser safety.

Content
physical basics of laser technology

laser beam sources (Nd:YAG-, CO2-, diode-laser)

beam properties, guiding and shaping

basics of materials processing with lasers

laser applications in automotive engineering

economical aspects

savety 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
T. Graf: Laser - Grundlagen der Laserstrahlquellen, 2009, Vieweg-Teubner Verlag
R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer
W. T. Silfvast: Laser Fundamentals, 2008, Cambridge University Press

Course: Leadership and Product Development [2145184]

Coordinators: A. Ploch
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 02: Powertrain Systems (p. 113)[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, H. Wirbser
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 23: Power Plant Technology (p. 136)[SP_23_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 assistents

Duration: 30 minutes

no tools or reference materials may be used

Conditions
none

Recommendations
none

Learning Outcomes
Attending this course enables the students to:

- accomplish experimental and design related as well as theoretical tasks in a scientific background.
- perform a correct evaluation of the obtained results.
- adequately document and present their results in a scientific framework.

Content

- Micro gas turbine
- Several test rigs for the investigation of heat transfer at thermally high loaded components
- Optimization of components of the internal air and oil system
- Characterization of spray 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 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

examination aids: none

Conditions
None.

Recommendations
None.

Learning Outcomes
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 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see “Studienplan Maschinenbau”, version of 29.06.2011)

Conditions
None.

Recommendations
None.

Learning Outcomes
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: Airport logistics [2117056]

Coordinators: A. Richter
Part of the modules: SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

Conditions
None.

Recommendations
None.

Learning Outcomes
The student:

- knows material handling and informations technology activities on airports
- has an overview of air traffic and the legal situation.

Content
Introduction
airport installations
luggage transport
passenger transport
security on the airport
legal bases of the air traffic
freight on the airport

Media
presentations

Literature
None.

Remarks
none

Course: Localization of Mobile Agents [24613]

Coordinators: U. Hanebeck, M. Baum
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations

Conditions
None.

Recommendations
Basic knowledge of probability theory and linear algebra will be beneficial.

Learning Outcomes

- The student learns the understanding of the problem, solution methods, and the required mathematical background.
- A further objective is to delve into the theoretical foundations, the distinction of the basic localization methods including their advantages and disadvantages. For this purpose, a variety of applications are considered.

Content
This module provides a systematic introduction into the topic of localization methods. In order to facilitate the access, the module is composed into four main topics. Dead reckoning treats the instantaneous determination of a vehicle's position based on dynamic parameters like velocity or steering angel. Localization with the help of measurements of known landmarks is part of the so-called static localization. Besides of closed-form solutions for particular measurements (distances and angels), the least squares method for fusion arbitrary measurements is introduced. Dynamic localization treats the combination of dead reckoning and static localization. The essential part is the derivation of the Kalman filter, which is successfully applied in many practical applications. In the end, simultaneous localization and mapping (SLAM) is introduced, which allows localization in case of (partly) unknown landmark positions.

Media

- Handwritten lecture notes will be made available electronically.
- Figures and application examples on slides.
- More information can be retrieved from the information brochure available on the ISAS website.

Literature
Elective literature:
Lecture notes.

Course: Machine Vision [2137308]

Coordinators: C. Stiller, M. Lauer

Part of the modules: SP 04: Automation Technology (p. 116)[SP_04_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_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: Magnet Technology of Fusion Reactors [2190496]

Coordinators: W. Fietz, K. Weiss
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach]

ECTS Credits	Hours per week	Term	Instruction language
4	2		

Learning Control / Examinations
Oral examination of about 30 minutes

Conditions
None.

Recommendations
Knowledge in energy technology, power plants, material testing is welcomed

Learning Outcomes
The students know:

- Basic knowledge of superconductivity, superconducting cables and magnet construction
- Generation of low temperature, cryostat construction
- Material properties at low temperatures
- Magnet design and magnet safety
- High-temperature superconductor use in power application and magnet construction

Content
The goal of the lecture is to impart the fundamentals of construction of superconducting magnets. Magnet technology is inherently of multidisciplinary character e.g. material properties at low temperature, high voltage and high current technique. The use of superconductors is mandatory to reach highest magnetic fields with comparable small losses. Examples of magnets from power application, basic research and fusion reactor construction are discussed.
Lecture Content:

- Introduction to plasma, fusion and electromagnets
- Introduction superconductivity - basics and materials
- Creation of low temperatures, cryo-technique
- Material properties at low temperature
- Magnet design and calculation
- Magnet stability, quench safety and high voltage protection
- Magnet examples
- High-temperature superconductors (HTS)
- HTS-application (cable, motor/generator, FCL, current leads, fusion reactors)

Course: Magnetohydrodynamics [2153429]

Coordinators: L. Bühler
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 53: Fusion Technology (p. 169)[SP_53_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 gives an introduction to magnetohydrodynamics for students in mechanical engineering, physics or mathematics. Insight is provided into the interaction of electro- and fluid dynamics that is required for modeling of magnetohydrodynamic flows in engineering applications or for phenomena in geo and astrophysics.

Content

- Introduction
- Basics of electro and fluid dynamics
- Exact solutions, Hartmann flow, pump, generator, channel flows
- Inductionless approximation
- Developing flows, change of cross-section, variable magnetic fields
- Alfven waves
- Stability, transition to turbulence
- Liquid dynamos

Literature
U. Müller, L. Bühler,2001,Magnetofluiddynamics in Channels and Containers, ISBN 3-540-41253-0, Springer
R. Moreau, 1990, Magnetohydrodynamics, Kluwer Academic Publisher
P. A. Davidson, 2001, An Introduction to Magnetohydrodynamics, Cambridge University Press
J. A. Shercliff, 1965, A Textbook of Magnetohydrodynamics, Pergamon Press

Course: Service Operations Management [2110031]

Coordinators: B. Deml
Part of the modules: SP 16: Industrial Engineering (p. 130)[SP_16_mach]

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

Learning Control / Examinations
Oral exam, length: 30 minutes
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

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: Leadership and Conflict Management (in German) [2110017]

Coordinators: H. Hatzl
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 37: Production Management (p. 152)[SP_37_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

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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

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

Conditions
none

Recommendations
none

Learning Outcomes
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 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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 dynamcs: Continuum models, fluid structure interaction, stability analyses

Content
- hydrodynamic bearings
- rotating shafts in hydrodynamic bearings
- belt drives
- virbation of turbine blades

Literature
R. Gasch, R. Nordmann, H. Pfützner: Rotordynamik, Springer, 2006

Course: Material flow in logistic systems [2117051]

Coordinators: K. Furmans
Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)

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: D. Steegmüller, S. Kienzle
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral Examination

Conditions
None.

Learning Outcomes
The student

- is able to name the various lightweight approaches and identify possible areas of application
- is able to identify the different production processes for the manufacture of lightweight constructions and explain their functions
- is able to perform a process selection based on the methods he/she has learned about and their characteristics
- is able to evaluate the different methods against lightweight applications on the basis of technical and economical aspects

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 Foundation for Computational Mechanics [2162240]

Coordinators: E. Schnack
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_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 the efficient and targeted application of mathematical methods for modern numerics in mechanical engineering. Students will gain fundamental knowledge of mathematical methods for variational calculus for elastic, dynamic and multi-field continuum calculations. They will gain knowledge of functional analysis which will enable them to understand error estimations in the finite element method (FEM) and the boundary element method (BEM).

Content
Variational formulations. Functional analysis. Lagrange d process.Various function space definitions relating to the elasticity and dynamics of the mechanics. Measurements which enable the field calculation to be defined in applications.

Literature
Script (available in administration office, building 10.91, rm. 310).

Course: Mathematical Methods in Dynamics [2161206]

Coordinators: C. Proppe
Part of the modules: SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach]

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

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

Conditions
none

Recommendations
none

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

Content
Dynamics of continua:
Concept of continuum, geometry of continua, kinematics and kinetics of continua

Dynamics of rigid bodies:
Kinematics and kinetics of rigid bodies

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

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

Applications

Literature
Lecture notes (available online)

J.E. Marsden, T.J.R. Hughes: Mathematical foundations of elasticity, New York, Dover, 1994

P. Haupt: Continuum mechanics and theory of materials, Berlin, Heidelberg, 2000

M. Riemer: Technische Kontinuumsmechanik, Mannheim, 1993

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

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

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

Course: Mathematical Methods in Strength of Materials [2161254]

Coordinators: T. Böhlke
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

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

Conditions
None.

Recommendations
None.

Learning Outcomes
The students can effectively and precise 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.
During the associated tutorials the students apply the theoretical methods to solve concrete problems.

Content
Tensor algebra

- vectors; basis transformation; dyadic product; tensors of 2nd order
- properties of 2nd order tensors: symmetry, anti-symmetry, orthogonality etc.
- eigenvalue problem, theorem of Cayley-Hamilton, invariants; tensors of higher order
- tensor algebra in curvilinear coordinate systems
- tensor analysis in curvilinear coordinate systems
- Differentiation of tensor functions

Application of tensor calculus in strength of materials

- kinematics of infinitesimal and finite deformations
- transport theorem, balance equations, stress tensor
- theory of elasticity
- thermo-elasticity
- 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 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

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

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

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

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

Learning Outcomes
The 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, B. Frohnapfel
Part of the modules: SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
written

Duration: 3 hours

Aux. means: formules, pocket calculator

Conditions
None.

Recommendations
Basic Knowledge about Fluid Mechanics

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

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

Content
The lecture will cover a selection of the following topics

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

Media
Blackboard, Power Point

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

Course: Mathematical Methods in Structural Mechanics [2162280]

Coordinators: T. Böhlke
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

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

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
Ther 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.
During the associated tutorial, the students apply the theoretical concepts to concrete problems.

Content
Basics of variational calculus

- functionals; Frechet-differential; Gateaux-differential; maximum or minimum problems
- lemma of variational calculus and Lagrange delta-process; Euler-Lagrange-equations

Applications: Principals of continuums mechanics

- variational principals in mechanics; variational formulierung of boundary value problem of elastostatic
- method of Ritz; finite element method

Applications: Homogenization methods for materials with microstructure

- mesoscopic and macroskopic stress and strain measures
- Mean values of ensembles, ergodicity
- effective elastic properties
- Homogenization of thermo-elastic properties
- Homogenization of plastic and visco-plastic properties
- Fe-based homogenization

Literature
Vorlesungsskript
Gummert, P.; Reckling, K.-A.: Mechanik. Vieweg 1994.
Gross, D., Seelig, T.: Bruchmechanik – Mit einer Einführung in die Mikromechanik. Springer 2002.
Klingbeil, E.: Variationsrechnung, BI Wissenschaftsverlag, 1977
Torquato, S.: Random Heterogeneous Materials. Springer, 2002.

Course: Mathematical models and methods in combustion theory [2165525]

Coordinators: V. Bykov, U. Maas
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_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
The attendance of this course enables students to:

- apply the fundamental concepts of combustion modelling.
- develop ideal models for the description of auto-ignition, explosions, flame quenching and detonations.
- understand the basic mathematical (asymptotic) methods applied in the analysis of these models.
- perform a mathematical analysis of the models.
- determine the mathematical properties of the solutions obtained from the models.

Content
The lecture shall introduce the basics of the mathematical modeling and the analysis of reacting flows. The fundamental methods of the modeling of combustion processes are outlined and asymptotical methods, which deliver reasonable approximations for numerous combustion processes will be applied. Further more examples of simplified models for the description of autoignition, explosions, flame quenching and detonations will be discussed. Furhtermore the main analytical methods will be illustrated using simple examples.

Literature
Combustion Theory, F A Williams, (2nd Edition), 1985, Benjamin Cummins.
Combustion - Physical and Chemical Fundamentals, Modeling and Simulation, Experiments,
Pollutant Formation, J. Warnatz, U. Mass and R. W. Dibble, (3nd Edition),
Springer-Verlag, Heidelberg, 2003.
The Mathematical Theory of Combustion and Explosions, Ya.B. Zeldovich, G.I. Barenblatt,
V.B. Librovich, G.M. Makhviladze, Springer, New York and London, 1985.

Course: Mechanics of laminated composites [2161983]

Coordinators: E. Schnack
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach]

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

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
none

Recommendations
none

Learning Outcomes
In the first part of the course the students are introduced to the definition of modern composites. The terms 'lamina', 'laminae' and 'laminate' are explained in detail with reference to examples. The students are then able to classify modern composites, particularly when they use these materials to design machine structures. As by definition the material data are directionally dependent, different transformations are discussed so that the students can understand the structural behaviour and participate in the design of the materials.

Content
Definition of composites, definition of static and kinematic groups. Definition of material laws. Transformation of the state values of composites and transformation of the material properties for the coordinate systems in the design of machine structures.

Literature
Lecture notes (available in the administration office, building 10.91, rm. 310)

Course: Mechanics and Strengths of Polymers [2173580]

Coordinators: B. von Bernstorff (Graf), von Bernstorff
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 36: Polymer Engineering (p. 151)[SP_36_mach]

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

Learning Control / Examinations
oral examination

Duration: 20 - 30 minutes

no notes

Conditions
basic knowledge in materials science (e.g. lecture materials science I and II)

Learning Outcomes
The students are prepared to

- repeat the calculus on strength and design of engineering parts exposed to complex loadings,
- estimate the influence of time and temperature on the strength of polymeric materials,
- relate the strength of materials to their molecular structure, morphology and processing parameters and
- derive failure mechanisms for homogenuous polymers and composite materials therefrom.

Content
Molecular structure and morphology of polymers, temperature- and time dependency of mechanical behavior, viscoelasticity, time/temperature- superposition principle, yielding, crazing and fracture of polymers, failure criterions, impact and dynamic loading, corresponding principle, tough/brittle-transition, introduction to the principles of fiber reinforcement and multiple cracking in composites

Literature
A literature list, specific documents and partial lecture notes shall be handed out during the lecture.

Course: Mechanics in Microtechnology [2181710]

Coordinators: C. Eberl, P. Gruber
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_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 Mechnical Parameters such as Young'sModulus and YieldDtrength; Thin Film Adhesion and Stiction
7. Transduction: Piezo-resistivity, Piezo-electric Effect, Elektrostatics,...
8. Aktuation: Inverse Piezo-electric Effect, Shape Memory, Elektromagnetic Actuation,. . .

Literature
Folien,
1. M. Ohring: „The Materials Science of Thin Films“, Academic Press, 1992
2. L.B. Freund and S. Suresh: „Thin Film Materials“
3. M. Madou: Fundamentals of Microfabrication“, CRC Press 1997
4. M. Elwenspoek and R. Wiegerink: „Mechanical Microsensors“ Springer Verlag 2000
5. Chang Liu: Foundations of MEMS, Illinois ECE Series, 2006

Course: Laboratory mechatronics [2105014]

Coordinators: A. Albers, G. Bretthauer, C. Proppe, C. Stiller

Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach]

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

Learning Control / Examinations
Certification of participation or oral examination depending on the “Studienplan” resp. “Prüfungs- und Studienordnung (SPO)” / IPEK: partial exmanination with grade

Conditions
Compulsory preconditions: none

Learning Outcomes
A manipulator as an examplary 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: Human-Mashine-Interaction [24659]

Coordinators: M. Beigl, Takashi Miyaki
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Learning Outcomes
-

Content

Literature
David Benyon: Designing Interactive Systems: A Comprehensive Guide to HCI and Interaction Design. Addison-Wesley Educational Publishers Inc; 2nd Revised edition edition; ISBN-13: 978-0321435330
Steven Heim: The Resonant Interface: HCI Foundations for Interaction Design. Addison Wesley; 1 edition (March 15, 2007) ISBN-13: 978-0321375964

Course: Man-Machine Systems in Automation Systems and Analysis of Scenes [24648]

Coordinators: E. Peinsipp-Byma, O. Sauer
Part of the modules: SP 04: Automation Technology (p. 116)[SP_04_mach]

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

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Knowledge of the lecture *Human-Machine-Interaction in Anthropomatics: Basics* [24100] is helpful.

Learning Outcomes

- Methods and procedures for design and evaluation of man-machine systems are imparted to the students with well-chosen examples.
- At the end of the lectures, the students should be able to chose and also to use an appropriate method for the design and the evaluation of a man-machine system in the fields of automation techniques and scene analysis

Content
Man-machine systems in automation systems and scenes analysis

- Architecture and main characteristic of man-machine systems (MMS)
- Usability of MMS
- Design methods for MMS
- Evaluation methods for MMS
- Application examples for MMS in scene analysis
- Survey of automated production processes
- Preliminary studies for the introduction and design of IT-systems closed to production
- Manufacturing execution systems
- Modelling methods
- Situation of the user in automated systems
- Characteristics of MMS in industrial automation
- Case studies in the field of automation

Media
Slides (pdf).

Literature
Elective literature:

- Czichos, H.; Hennecke, M.: HÜTTE – Das Ingenieurwissen. 33. Auflage, Springer, Berlin, 2008, Kapitel 6.
- Johannsen, G.: Mensch-Maschine-Systeme. Springer, Berlin, Heidelberg, 1993.

- H.J. Charwat: Lexikon der Mensch-Maschine-Kommunikation. Oldenbourg Verlag, München, 1994. (very comprehensive).
- B. Preim: Entwicklung interaktiver Systeme. Springer-Verlag, Berlin u.w., 1999. (combination of fundamentals, current methods and case studies).
- K.-P. Timpe, T. Jürgensohn, H. Kolrep (Hrsg.): Mensch-Maschine-Systemtechnik - Konzepte, Modellierung, Gestaltung, Evaluation. Symposion Publishing GmbH, Düsseldorf, 2000. (global, qualitative, instance-oriented).
- Beyerer, J.; Sauer, O. (Hrsg.): Karlsruher Leittechnisches Kolloquium 2006, Stuttgart: Fraunhofer IRB-Verlag 2006.
- Draht, R.: Die Zukunft des Engineering – Herausforderungen an das Engineering von fertigungs- und verfahrenstechnischen Anlagen; in: Sauer, O.; Sutschet, G.: Karlsruher Leittechnisches Kolloquium 2008, S. 33-40.
- Ebel, M.; Draht, R.; Sauer, O.: Automatische Projektierung eines Produktionsleitsystems der Fertigungstechnik mit Hilfe des Datenaustauschformates CAEX, atp (Automatisierungstechnische Praxis) 5.2008, S. 40-47.
- Kerz, H.: Leitsysteme und Digitale Fabrik wachsen zusammen; MM (Maschinenmarkt) 15/2008, S. 46-48.
- Kletti, J. (Hrsg.): Manufacturing Execution Systeme, Springer, 2006.
- Mertins, K.; Süssenguth, W.; Jochem, R.: Modellierungsmethoden für rechnerintegrierte Produktionsprozesse. Hanser Verlag, 1994.
- Polke, M.: Prozeßleittechnik. Oldenbourg-Verlag, 1994.
- Pritschow, G.: Einführung in die Steuerungstechnik. Hanser, München, 2006.
- Sauer, O.; Sutschet, G.: Karlsruher Leittechnisches Kolloquium 2008, Fraunhofer IRB-Verlag.
- Sauer, O.: Integriertes Leit- und Auswertesystem für Rohbau, Lackierung und Montage. Automatisierungstechnische Praxis atp 48 (2006), Heft 10, S. 38-43.
- Spur, G.: Fabrikbetrieb. Hanser, München, 1994; (Band 6 im Handbuch der Fertigungstechnik).
- Thiel, K.; Meyer, H.; Fuchs, F.: MES – Grundlage der Produktion von morgen. Oldenbourg Industrieverlag, 2008.
- VDI 4499, Blatt 2: Digitaler Fabrikbetrieb.
- VDI 5600: Fertigungsmanagementsysteme, Beuth-Verlag, 2007.
- Weller, W.: Automatisierungstechnik im Überblick. Beuth-Verlag, 2008.

Course: Measurement II [2138326]

Coordinators: C. Stiller
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_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 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_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 34: Mobile Machines (p. 148)[SP_34_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_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 boarders 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: Microoptics and Lithography [2142884]

Coordinators: T. Mappes
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

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

Conditions
Basics in optics

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

Content

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

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

Course: Microactuators [2142881]

Coordinators: M. Kohl
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature

- Microactuators, M. Tabib-Azar, Kluwer Academic Publishers London, 1998.
- Shape Memory Microactuators, M. Kohl, Springer-Verlag Berlin, 2004.

Course: Microstructure characterization and modelling [2161251]

Coordinators: T. Böhlke, F. Fritzen
Part of the modules: SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students know the basic measures to describe the geometry of microstructured materials. They know which distribution functions are suitable for describing fibre or particle reinforced or plycrystalline materials. The student s know algorithms for generation of synthetic structures and know how they are used in the framework of nmerical multi-scale simulations.

Content
An introduction to the statistical description of geometric properties of microstructured materials is given. Typically, particle or fibre reinforced materials and polycrystalline materials are considered. The statistical description using n-point-correlation functions is described as well as characteristic measures and distribution functions (fibre or crystal orientation distribution functions) are discussed. Additionally, methods for generation of synthetic structures are considered which are typical input data for numerical multiscale simulations.

Literature
Torquato, S.: Random heterogeneous materials: microstructure and macroscopic properties, Springer, New York, 2002.
Ohser, J., Mücklich, F.: Statistical Analysis of Microstructures in Materials Science, Statistics in Practice, John Wiley & Sons, 2000.

Course: Modelling of Microstructures [2183702]

Coordinators: B. Nestler, D. Weygand, A. August

Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

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

Conditions
None.

Recommendations
materials science
fundamental mathematics

Learning Outcomes
The students are introduced into the thermodynamic and statistic fundamentals of liquid-solid and solid-solid phase transformations. We present microstructures such as dendrites, eutectics and peritectics. The sense and the significance of equilibrium in alloys and the determination of phase diagrams is worked out. The motion of interface under a driving force is studied. Next, we learn the method of phase-field modeling for simulation of microstructure formation processes – by means both the classic ansatz and the models of the recent research in our group. The course will be combined with practical exercises.

Content
-Brief Introduction in thermodynamics
-Statistical interpretation of entropy
- Gibbs free energy and phase diagrams
- Free energy functional
- Phasefield equation
- Gibbs-Thomson-equation
- Driving forces
- Grand chemical potential functional and the evolution equations
- For compare: Free energy functional with driving forces

Media
Black board and slides.

Literature

- Gottstein, G. (2007) Physikalische Grundlagen der Materialkunde. Springer Verlag Berlin Heidelberg
- Kurz, W. and Fischer, D. (1998) Fundamentals of Solidification. Trans Tech Publications ltd, Switzerland Germany UK USA
- Porter, D.A. Eastering, K.E. and Sherif, M.Y. (2009) Phase transformation in metals and alloys (third edition). CRC Press, Taylor & Francis Group, Boca Raton, London, New York
- Gaskell, D.R., Introduction to the thermodynamics of materials
- Problem sheets

Course: Mobile Machines [2114073]

Coordinators: M. Geimer
Part of the modules: SP 10: Engineering Design (p. 123)[SP_10_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
oral examination.

Conditions
Knowledge in Fluid Power is required.

Recommendations
It is recommended to attend the course *Fluid Power Systems* [2114093] beforehand.

Learning Outcomes
After completion of the course the students have knowledge of:

- a wide range of mobile machines
- operation modes and working cycles of important mobile machines
- selected subsystems and components

Content

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

Media
Lecture notes.

Course: Mobility Concepts of Rail Transportation in 2030 [2115915]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 167)[SP_50_mach]

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

Learning Control / Examinations
Written report and oral exam

Conditions
Attendance is mandatory during the whole seminar.

Recommendations
none

Learning Outcomes

- The students learn about the innovationprocess of an international company in rail industry.
- They exercise advanced creativity techniques.
- They learn and deepen key qualifications like communication skills, presentation skills, moderation techniques and team work.

Content

- Company presentation
- Long term development of society and environment (megatrends), impact on railways and rail industry
- Creating, elaborating and discussing innovative ideas by using the tool "Zukunftswerkstatt"
- Final presentations

Media
All material is available for download (Ilias-platform).

Literature
Literatur will be provided during the course.

Remarks

- This seminar is a 5-day block course.
- Number of participants is limited.
- A registration is necessary.
- For further information please look at the website www. bahnsystemtechnik.de .

Course: Model based Application Methods [2134139]

Coordinators: F. Kirschbaum
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach]

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

Learning Control / Examinations
take-home exam, short presentation with oral examination

Conditions
none

Recommendations
Basics of combustion engines, vehicualr systems, control theorie and statistics.

Learning Outcomes
The student gets to know the most important methods for model-based calibration of powertrain ECUs. Particulary he can choose and apply the correct approach for empirical modeling for a given powertrain calibration task (fuel consumption, emissions, air path, driveability, etc.) and type of plant (linear-nonlinear, static-dynamic, etc.). He is capable to work as a calibration engineer for automotive OEMs or whose suppliers.

Content
The efforts for the calibration of automotive powertrain ECUs are increasing due to new engine or powertrain technologies and tightening emission laws. From a present view only model based calibration methods are capable to handle this situation. The lecture presents a selection of practice-proofed model-based calibration methods.

Media
Lecture notes, blackboard, presentations and life demonstrations via projector

Remarks
The computer exercises take place in one block at the end of the semester.

Course: Modeling of Thermodynamical Processes [2167523]

Coordinators: R. Schießl, U. Maas
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

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

- formulate thermodynamical basics in a mathematical scheme.
- abstract and modell complex thermodynamic processes.
- determine and implement adequate numerical schemes for the solution of the resulting systems of equations.

Content
Thermodynamical basics
Numerical solver strategies for algebraic equations
Optimization issues
Ordinary and partial differential equations
Application to various problems in thermodynamics (engine processes, determination of equilibrium states, unsteady processes in inhomogeneous systems)

Literature
Lecture notes
Numerical Recipes {C, FORTRAN}; Cambridge University Press
R.W. Hamming; Numerical Methods for scientists and engineers; Dover Books On Engineering; 2nd edition; 1973
J. Kopitz, W. Polifke; Wärmeübertragung; Pearson Studium; 1. Auflage

Course: Modelling and Simulation [2183703]

Coordinators: B. Nestler, P. Gumbsch

Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

Learning Control / Examinations

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

Conditions

None.

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 04: Automation Technology (p. 116)[SP_04_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
oral, also possible as an optional or part of a major subject

Conditions
None.

Recommendations
Fundamentals of measurement and control

Learning Outcomes
Students have enlarged knowledge about control theory and they implement controllers for different problems in Matlab.

Content

- Reference feedforward control (2-DOF control)
- Qualitative theory of ordinary differential equations
- PID control
- Augmented control structures
- State space and state feedback control
- Input-output linearization
- Lyapunov theory

Literature

- Aström, K.-J., Murray, R.M.: Feedback Systems. Princeton University Press, 2009.
- Khalil, H.K.: Nonlinear Systems. Prentice Hall, 2002.

Course: Engine Laboratory [2134001]

Coordinators: U. Spicher
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[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 are abele to transfer their theoretical knowledge to practical problems and to perform engine tests on stat-of-the-art test benches.

Content
5 engine experiments in up-to-date development projects

Literature
Description of experiments

Course: Engine measurement techniques [2134137]

Coordinators: S. Bernhardt
Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 48: Internal Combustion Engines (p. 164)[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
The students understand the principles of modern measuring devices and are able to determin the right device for a certain problem. The are able to interprete the results.

Content
Students get to know state-of-the-art measurement techniques for combustion engines. In particular basic techniques for measuring engine operating parameters such as torque, speed, power and temperature.

Possible measurement errors and abberations are discussed.

Furthermore techniques for measuring exhaust emissions, air/fuel ratio, fuel consumption as well as pressure indication for thermodynamic analysis are covered.

Literature
Lecture notes available in the lectures or in the 'Studentenhaus'

1. Grohe, H.:Messen an Verbrennungsmotoren
2. Bosch: Handbuch Kraftfahrzeugtechnik
3. Veröffentlichungen von Firmen aus der Meßtechnik
4. Hoffmann, Handbuch der Meßtechnik
5. Klingenberg, Automobil-Meßtechnik, Band C

Course: Nanoanalytics [2125762]

Coordinators: M. Bäurer
Part of the modules: SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
oral exam
20 min
Auxiliary means:none

Conditions
None.

Learning Outcomes
By understanding the basic principles of the analytical Methods students are able to select an analytical method appropreate for the material under investigation and that are able to interpred results from measurements.

Content

1. Basic principles of electron microscopy
2. Scanning Electron Microscopy (SEM) and Transmission electron Microscopy (TEM):
   Application, sample preparation and resolution limits
3. Analytical methods with electron microscopes
   - EDX, WDX, Micropope analysis
   - Auger electron spectroscopy
   - Electron diffraction
   - Electron energy loss spectroscopy (EELS)
4. Methods with x-ray as exitation source
5. Atom probe tomographie
6. Atomic force microscopy

Literature

1. L. Reimer: Transmission Electron Microscopy. Springer-Verlag 2008.
2. D. B. Williams, C. B. Carter: Transmission Electron Microscopy, 2nd edition, A Textbook for Materials Science. 2009

Course: Nanotechnology with Clusterbeams [2143876]

Coordinators: J. Gspann
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
written examination
presence in more that 70% of the lectures
Duration: 1 h

aids: none

Conditions
None.

Learning Outcomes
Nanotechnology is presented on the basis of a technology for nano- and microstructuring by accelerated nanoparticles (clusters), mainly in view of nanomechanics.

Content
Nanotechnology in biology
Nanosystemstechnology
Cluster beam generation, ionisation and acceleration; cluster properties
Structure generation using accelerated metal clusters
Structuring via gas cluster impact; reactive accelerated cluster erosion (RACE)
Atomic force microscopy of impact structures; nanotribology
Comparison with femtosecond laser machining (Winter term only)
Simulations; Fullerene synthesis, impact structures, visionary nanomachinery

Literature
Foil copies with short commentaries are distributed during the lectures.

Course: Scanning probe microscopy [2142860]

Coordinators: H. Hölscher, M. Dienwiebel, Stefan Walheim
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 47: Tribology (p. 163)[SP_47_mach]

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

Learning Control / Examinations
80% attendance, oral examination

Conditions
Physics
Fundamental mathematics

Learning Outcomes
Introduction into the main measurement principles of scanning probe methods for the analysis of the physical and chemical properties of surfaces

Content
1) Introduction into nanotechnology
2) History of scanning probe techniques
3) Scanning tunneling microscopy (STM)
4) Atomic force microscopy (AFM)
5) Dynamic Modes (DFM, ncAFM, MFM, KPFM, ...)
6) Friction force microscopy & nanotribology
7) Nanolithography
8) Other families of the SPM family

Literature
Lecture notes, slides, script
Scanning Probe Microscopy – Lab on a Tip: Meyer, Hug, Bennewitz, Springer (2003)

Course: Nanotribology and -Mechanics [2181712]

Coordinators: M. Dienwiebel, H. Hölscher
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 47: Tribology (p. 163)[SP_47_mach]

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

Learning Control / Examinations
80% attendance, oral examination

Conditions
physics
fundamental mathematics

Learning Outcomes
The course gives an introduction into the modern field of Nanotribology and -mechanics. Students learn the physical basics and simple models used in Nanotribology. In the second part of the lecture students learn to discuss scientific results using recent exemplary publications.

Content
Part 1: Basics:

- Nanotechnology
- Forces at nanometer scale
- contact mechanics models (Hertz, JKR, DMT)
- Experimental methods (SFA, QCM, FFM)
- Prandtl-Tomlinson model
- Superlubricity
- Atomic-Scale Wear

Part 2: Topical papers

Literature
Lecture notes, slides and copies of articles

Course: Novel actuators and sensors [2141865]

Coordinators: M. Kohl, M. Sommer

Part of the modules: SP 40: Robotics (p. 155)[SP_40_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 02: Powertrain Systems (p. 113)[SP_02_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: Neutron physics of fusion reactors [2189473]

Coordinators: U. Fischer
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 21: Nuclear Energy (p. 134)[SP_21_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
None.

Learning Outcomes
The aim of this lecture is to provide the neutron physics principles required for analysis of nuclear fission and fusion reactors. First of all, the basic nuclear interaction processes are presented which are important for the physical behaviour of the reactors. Next the neutron transport phenomenon in matter is described by means of the Boltzmann transport equation. Suitable mathematical solution methods are presented such as the diffusion approximation for nuclear fission reactors and the Monte Carlo method for fusion reactors. The knowledge acquired will eventually be used to solve neutron physics problems related to the design and optimization of the reactors.

Content
Nuclear interaction processes and energy release

Chain reaction and criticality

Neutron transport, Boltzmann equation

Diffusion approximation, Monte Carlo method

Neutronic reactor design

Literature
K. H. Beckurts, K. Wirtz, Neutron Physics, Springer Verlag, Berlin, Germany (1964)

W. M. Stacey, Nuclear Reactor Physics, John Wiley & Sons, Wiley-VCH, Berlin(2007)

J. Raeder (Ed.), Kontrollierte Kernfusion. Grundlagen ihrer Nutzung zur Energieversorgung, Teubner, Stuttgart (1981)

Course: Nuclear Thermal-Hydraulics [2189908]

Coordinators: X. Cheng
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
oral examination; duration: 30 minutes

Conditions
None.

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

Content

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

Literature

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

Course: [23289]

Coordinators: F. Maul, H. Doerfel
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (approx. 20 minutes) according to sec. 4 subsec. 2 no. 2 study and examination regulations.

Conditions
None.

Learning Outcomes
Die Studenten kennen den Zusammenhang zwischen klinischen Problemen und deren messtechnischen Lösung aufgrund von nuklearmedizinischen Beispielen aus der Funktionsdiagnostik und Therapie.

Content

- Virtueller Rundgang durch eine nuklearmedizinische Abteilung und Einführung in die kernphysikalischen Grundlagen
- Physikalische und biologische Wechselwirkungen von ionisierenden Strahlen
- Aufbau von nuklearmedizinischen Detektorsystemen zur Messung von Stoffwechselvorgängen am Beispiel des Jodstoffwechsels
- Biokinetik von radioaktiven Stoffen zur internen Dosimetrie und Bestimmung der Nierenclearance
- Beeinflussung eines Untersuchungsergebnisses durch statistische Messfehler und biologische Schwankungen
- Qualitätskontrolle: messtechnische und medizinische Standardisierung von analytischen Methoden
- Epidemiologische Daten und Modelle zur Risiko-Nutzenabwägung

Course: [01874]

Coordinators: C. Wieners, Neuß, Rieder
Part of the modules: SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach]

ECTS Credits	Hours per week	Term	Instruction language
4,5	2/1	Summer term	de

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Literature
Elective literature:
- lecture notes (N. Neuß)
- W. Dahmen/A. Reusken: Numerik für Ingenieure und Naturwissenschaftler

Course: Numerical Methods in Mechanics II [2162298]

Coordinators: E. Schnack
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach]

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

Learning Control / Examinations
Oral examination. Duration: 30 minutes.

Conditions
None.

Recommendations
None.

Learning Outcomes
Variation priniciples are derived in detail on the basis of the principles of virtual work. This provides students with the fundamental knowledge necessary to construct calculus of variations as a basis for numerical mechanics, and consequently derive fundamental equations for finite element methods (FEM) and boundary element methods (BEM). In the lectures, the algorithms for higher-grade finite element processes are deduced, and the numerics for boundary element methods (BEM) are derived in detail. Students will develop an understanding for Cauchy prinicple values, and the integration of singular integrals will be carried out. In addition, derived methods will be extended to tasks such as plasticity. Numerical mechanics I is not a requirement for Numerical mechanics II. At the end of the course students will be able to derive algorithms for FEM and BEM independently, and evaluate short codes, so that they are better able to manage industrial software.

Content
Brief overview of finite element methods. Structure of boundary element methods (BEM). Explanation of hybrid tension methods. Higher-grade finite element processes. Non-linear FEM processes.

Literature
Script (available in administration office, building 10.91, rm. 310).

Course: Computational Methods in Fluid Mechanics [2157441]

Coordinators: F. Magagnato

Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_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 Smulation 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

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 Modeling of Multiphase Flowsf Multi-phase Flows [2130934]

Coordinators: M. Wörner
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
Oral examination (in German or English language)
Duration: 30 minutes
Auxiliary means: none

Conditions
none

Learning Outcomes
This lecture gives an introduction in the physical fundamentals of multiphase flows (with focus on gas-liquid flows) and provides an overview on various methods and models for their numerical computation. The specific advantages, disadvantages and restrictions of each method are discussed. Paramount learning target is to enable the student to select for multiphase flow applications in energy and process engineering appropriate numerical methods and physical models, and to critically evaluate the simulation results.

Content

1. Introduction in the subject of mult-phase flows (terms and definitions, examples)
2. Physical fundamentals (dimensionless numbers, phenomenology of single bubbles, conditions at fluid interfaces, forces on a suspended particle)
3. Mathematical fundamentals (governing equations, averaging, closure problem)
4. Numerical fundamentals (discretization in space and time, truncation error and numerical diffusion)
5. Models for interpenetrating continua (homogeneous model, algebraic slip model, standard two-fluid model and its extensions)
6. Euler-Lagrange model (particle equation of motion, particle response time, one-/two-/four-way coupling)
7. Interface resolving methods (volume-of-fluid, level-set and front-capturing method)

Literature
A brief script can be downloaded fromhttp://bibliothek.fzk.de/zb/berichte/FZKA6932.pdf.
Powerpoint presentations can be downloaded after each lecture from the ILIAS system.
A list of recommended books is provided in the first lecture.

Remarks
For some topics of the lecture exercises are provided (working on them is optional).

Course: Numerical simulation of reacting two phase flows [2169458]

Coordinators: R. Koch
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 06: Computational Mechanics (p. 119)[SP_06_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 predicitng of liquid disintegration (VoF, SPH), Numerical methods for secondary atomisation; Droplet evaporation

3. Reacting flows: Combustion models; Single droplet combustion, Spray combustion.

Literature
Lecture notes

Course: Numerical Simulation of Turbulent Flows [2154449]

Coordinators: G. Grötzbach
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
oral;

Duration: 30 minutes

no auxiliary means

Conditions
None.

Recommendations
basics in fluid mechanics

Learning Outcomes
Students are familiar with the fundamentals of direct numerical simulation (DNS) and large eddy simulation (LES) of turbulent flows. They have obtained the knowledge required to decide which of the mentioned methods, which all are available in modern CFD codes, is adequate for which task.

Content
The lecture gives an introduction into the methods of direct numerical simulation and large eddy simulation (LES) of turbulent flows. The promising methods are intensively used for basic research in turbulence. Now, LES is increasingly applied also for those engineering tasks in which e.g. the consequences of large scale velocity or temperature fluctuations have to be investigated on solid structures of for analysing the mixing capabilities in complex conditions. The differences between common statistical turbulence models basing on the Reynolds-equations and subgrid scale models is elaborated and powerful subgrid scale models are discussed. The requirements of suitable numerical solution schemes are formulated. The extraordinary features of the turbulence simulation methods are demonstrated by examples. Thus, the knowledge will be provided which is required to decide which of the mentioned methods, which all are available in modern CFD codes, is adequate for which task.
The requirements for and practical limits of the turbulence simulation method are deduced from the basic features of turbulence. More often practicable is the method of large eddy simulation. The required basic equations for the large turbulence scales are provided by filtering or integration methods. Common closure models for the not resolved fine scales of turbulence are given and are physically motivated. Following the physical und numerical basics of the simulation method, the peculiarities in the numerical formulation of boundary and initial conditions are given, as well as those for finding adequate methods to solve the equations in space and time. Following this background it will also be elaborated which are the required statistical and graphical methods to analyse the numerical results. The power of the method will be shown by simulation examples for turbulence in convection (see e.g. www.iket.kit.edu/322.php) and for some engineering applications.

Media
black board, plus pictures and movies

Literature
J. Piquet, Turbulent Flows – Models and Physics. Springer, Berlin (1999)
G. Grötzbach, M. Wörner, Direct numerical and large eddy simulations in nuclear applications. Int. J. Heat & Fluid Flow 20 (1999), pp. 222 – 240
P. Sagaut, Large-eddy simulation for incompressible flows. Springer Verlag (2000)
G. Grötzbach, Script in English

Course: [2154409]

Coordinators: B. Frohnapfel, T. Baumann
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
Homework

Conditions
None.

Recommendations
Lecture “Mathematical Methods of Fluid Mechanics” or “Fluid-Structure-Interaction”

Learning Outcomes
The students have obtained insight into the numerical computation of flow problems and know how to independently develop solution routines for different flow scenarios using Matlab. The know how to check results in respect to grid resolution independency and stability criteria and how to caryy out are a validation and verfications of the computed results by also taking into account literature data.

Content
Numerical Fluid Mechanics with Matlab

- Introduction to Numerics and Matlab
- Finite-Difference-Method
- Finite-Volume-Method
- boundary conditions and intial conditions
- explicit and implicite schemes
- pressure correction

Media
Power Point, workstations: independent programming

Literature
H. Ferziger, M. Peric, *Computational Methods for Fluid Dynamics*, Springer, 2008

Remarks
Block Course with limited number of participants, Contact person: Thomas Baumann, Institute of Fluid Mechanics (www.isl.kit.edu)

Course: Optofluidics [2142885]

Coordinators: D. Rabus
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations

Conditions
None.

Learning Outcomes

Content

Course: Intellectual Property Rights and Strategies in Industrial Companies [2147161]

Coordinators: F. Zacharias

Part of the modules: SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 32: Medical Technology (p. 146)[SP_32_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 31: Mechatronics (p. 145)[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 aim of this lecture is to outline the fundamental principles of intellectual property and the strategic intellectual property work that can be carried out by innovative companies.

Content
The lecture will describe the requirements to be fulfilled and how protection is obtained for patents, design rights and trademarks, with a particular focus on Germany, Europe and the EU. Active, project-integrated intellectual property management and the use of strategic patenting by technologically oriented companies will also be discussed. Furthermore, the significance of innovations and intellectual property for both business and industry will be demonstrated using practical examples, before going on to consider the international challenges posed by intellectual property and current trends in the sector.
Within the context of licensing and infringement, insight will be provided as to the relevance of communication, professional negotiations and dispute resolution procedures, such as mediation for example. The final item on the agenda will cover those aspects of corporate law that are relevant to intellectual property.
Lecture overview:
1. Introduction to intellectual property
2. The profession of the patent attorney
3. Filing and obtaining intellectual property rights
4. Patent literature as a source of knowledge and information
5. The law regarding employee inventions
6. Active, project-integrated intellectual property management
7. Strategic patenting
8. The significance of intellectual property
9. International challenges and trends
10. Professional negotiations and dispute resolution procedures
11. Aspects of corporate law

Course: Photovoltaics [23737]

Coordinators: M. Powalla
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach]

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

Learning Control / Examinations
Turorials, written exams, alternatively oral exam.

Conditions
Basic knowledge of thermodynamics and solid state physics.

Recommendations
Complement to “Energy Systems” and “Fundamentals of Energy Technology”.

Learning Outcomes
After the course attendants can:

- understand energy conversion in semiconductors.
- discuss emerging technological and production relevant aspects.
- capture the interaction of photovoltaic energy sytems with different system components.
- quantify losses.

Content

- The significance of photovoltaics in national and global energy supply.
- Physical fundamentals of energy conversion.
- Photovoltaic cells (specific parameters, materials, loss assessment).
- Implementation concepts (Sillicon technology, thin layer cells, concentrator cells, dye cells and organic cells).
- Modular technique and production technology.
- Photovoltaic energy systems (Components, alternative current converter, solar tracking, system design).

Literature
P. Würfel, Physik der Solarzellen, 2. Auflage (Spektrum Akademischer Verlag, Heidelberg, 2000)
R. Sauer, Halbleiterphysik, (Oldenburg Wissenschaftsverlag, 2009)
H.J. Lewerenz, H. Jungblut, Photovoltaik (Springer, Berlin, 1995)
H.G. Wagemann, Photovotoltaik, (Vieweg, Wiebaden, 2010)
Tom Markvart, Luis Castaner, Photovoltaics Fundamentals and Applications, (Elsevier, Oxford, 2003)
Heinrich Häberlin, Photovoltaik, (AZ Verlag, Aarau, 2007)

Course: Planning of Assembly Systems (in German) [2109034]

Coordinators: E. Haller
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 37: Production Management (p. 152)[SP_37_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

- 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 or Production Management / Industrial Engineering usefull

Learning Outcomes

- Know planning guidelines
- Know vulnerability analysis
- Become able to plan work systems (e.g. technical or organisational structuring principles, capacity planinng, proceedence diagram, wages system . . .)
- Become able to evaluate a planning solution
- Become able to present results

Content

1. Planning guidelines
2. Vulnerability analysis
3. Planning of work systems (technical and organisational structuring principles, capacity planning, proceedence diagram, wages system . . .)
4. Evaluation
5. Presentation

Literature
Learning material:
The handout will be distributed within the first lecture.

Literature:

- GROB, R.; HAFFNER, H.: Planungsleitlinien Arbeitsstrukturierung. Berlin, München:Siemens AG, 1982.

- GROB, R.: Erweiterte Wirtschaftlichkeits- und Nutzenrechnung. Köln: Verlag TÜV Rheinland, 1984.
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Arbeitsgestaltung in der Produktion. München: Carl Hanser Verlag, 1991. (Methodenlehre der Betriebsorganisation)

Course: Plasticity Theory [2162244]

Coordinators: T. Böhlke
Part of the modules: SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

Learning Control / Examinations
oral examination

Conditions
None.

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students 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 plasicity. In the framework of plasticity the students know the theory of crystal plasticity. During the associated tutorial, the students apply the theoretical concepts to distringuished problems.

Content

- tensor calculus, kinematics, balance equations
- principles of material theory
- finite elasticity
- infinitesimal elasto(visco)plasticity
- exact solutions ov infinitesimal Platicity
- finite elasto(visco)plasticity
- infinitesimal and finite crystal(visco)plasticity
- hardening and failure
- strain localization

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

Course: PLM for Product Development in Mechatronics [2122376]

Coordinators: M. Eigner
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (30 min.).

Conditions
None.

Learning Outcomes
Students have a basic overview about product data management and product lifecycle management.
Students know components and core functions of PLM solutions
Students can describe trends in research and practice in the environment of PLM

Content
Product Data Management
Product Lifecycle Management

Course: PLM in the Manufacturing Industry [2121366]

Coordinators: G. Meier
Part of the modules: SP 39: Production Technology (p. 153)[SP_39_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 form 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 28: Lifecycle Engineering (p. 142)[SP_28_mach]

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

Learning Control / Examinations
Evaluation of Project Management, presentation of final results and demonstration of the vehicle in practice

Conditions
None

Recommendations
None

Learning Outcomes
The overall objective is to depict usage of collaborative product development in terms of product lifecycle management (PLM) and to accent additional benefit contrary to classic CAD driven development processes as well as comprehensive management of product and variant structures. Students will be presented in detail how product specific data like e.g. bill-of-materials or sketches can transparently and holisticly managed by the use of PLM and moreover, they will be taught how to automatize workflow management in product development.

Content
In the Workshop a LEGO vehicle will be conceived and developed within a project order through usage of modern PLM and CAD systems in the field of lifecycle engineering.
main topics are:

- Autonomous design in development teams with LEGO Mindstorms NXT
- 3D-CAD conceptual design of the vehicle using Siemens UGS NX
- Simulation of realistic product development by forming disjunct project teams extending cross locations
- Solving communication problems, inconsistencies of product models, unregulated data access a.s.o.
- Product Lifecycle oriented development using market-leading Siemens UGS Teamcenter Engineering PLM system

Literature
Script on-site only in german

Remarks
Conditions for participation are a short letter of motivation and a short CV covering information of previously performed studies resp. education as well as practical experience

Course: Polymer Engineering I [2173590]

Coordinators: P. Elsner
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 47: Tribology (p. 163)[SP_47_mach], SP 36: Polymer Engineering (p. 151)[SP_36_mach]

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

Learning Control / Examinations
Oral examination

Duration: 20-30 Minutes

Conditions
None.

Learning Outcomes
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, to equip the students with knowledge and technical skills, and to use the material "polymer" meeting its requirements in an economical and ecological way.
The students

- are familiar
  to describe and classify polymers
  with the fundamental synthesis
  processing techniques
- learns practical applications of polymer parts
- has fundamental knowledge of processing and application of polymers and polymer composites
- has knowledge about the special mechanical, chemical and elctrical prooperties of polymers
- has knowledge about application areas and the limitation in the use of polymers

Content
1. Economical aspects of polymers
2. Introductiom of mechanical,
chemical end electrical properties
3. Processing of polymers
(introduction)
4. Material science of polymers
5. Synthesis

Literature
Recommended literature and selected official lecture notes are provided in the lecture

Course: Polymer Engineering II [2174596]

Coordinators: P. Elsner
Part of the modules: SP 36: Polymer Engineering (p. 151)[SP_36_mach]

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

Learning Control / Examinations
Oral examination

Duration: 20-30 Minutes

Conditions
Polymerengineering I

Learning Outcomes
The field of Polymer Engineering includes synthesis, material science, processing, construction, design, tool engineering, production technology, surface engineering and recycling. The aim is, to equip the students with knowledge and technical skills, and to use the material "polymer" meeting its requirements in an economical and ecological way.
The students

- are familiar
  with different processing techniques
  mould details
- learns practical applications and processing of polymer parts
- has fundamental knowledge of polymer part design
- has knowledge about the application of polymers regarding the technical requirements
- has knowledge about to use polymers regarding the production, economical and ecological requirements

Content
1. Processing of polymers
2. Properties of polymer components
Based on practical examples and components
2.1 Selection of material
2.2 Component design
2.3 Tool engineering
2.4 Production technology
2.5 Surface engineering
2.6 Sustainability, recycling

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. 139)[SP_26_mach], SP 39: Production Technology (p. 153)[SP_39_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
Within the frame of eight half-day experiments students learn about various aspects of laser-based metal, ceramic and polymer 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
H. Hügel, T. Graf: Laser in der Fertigung, 2009, Vieweg+Teubner
R. Poprawe: Lasertechnik für die Fertigung, 2005, Springer

Course: Lab Computer-aided methods for measurement and control [2137306]

Coordinators: C. Stiller, P. Lenz
Part of the modules: SP 04: Automation Technology (p. 116)[SP_04_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach]

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

Learning Control / Examinations
Colloquia

Conditions
Basic studies and preliminary examination; basic lectures in automatic control

Learning Outcomes
Powerful and cheap computation resources have led to major changes in the domain of measurement and control. Engineers in various fields are nowadays confronted with the application of computer-aided methods. This lab tries to give an insight into the modern domain of measurement and control by means of practically oriented and flexible experiments. Based on experiments on measurement instrumentation and digital signal processing, elementary knowledge in the domain of visual inspection and image processing will be taught. Thereby, commonly used software like MATLAB/Simulink will be used in both simulation and realization of control loops. The lab closes with selected applications, like control of a robot or supersonic computer tomography.

Content
1. Digital technology
2. Digital storage oscilloscope and digital spectrum analyzer
3. Supersonic computer tomography
4. Lighting and image acquisition
5. Digital image processing
6. Image interpretation
7. Control synthesis and simulation
8. Robot: Sensors
9 Robot: Actuating elements and path planning
The lap comprises 9 experiments.

Literature
Instructions to the experiments are available on the institute's website

Course: Mobile Robot Systems Lab [2146194]

Coordinators: A. Albers, W. Burger
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 02: Powertrain Systems (p. 113)[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 omniweehl 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: Practical Course Technical Ceramics [2125751]

Coordinators: F. Porz
Part of the modules: SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
Certificate to be issued after evaluation of the lab class report or oral examination

duration 30 minutes.

No tools or reference materials may be used during the exam.

Conditions
Lab class report

Recommendations
Courses in ceramic materials

Learning Outcomes
The aim of the curse is to learn learn the eperimental techniques and to understand the scientific background. In a report the results heve to be discussed. The practical course takes place during the week after the end of the semester.

Content
The course is focused on aspects of processing of a ceramic part. Characterisation of starting powder, forming and sintering, microstructural and mechanical characterisation are the basic topics

Literature
Porz, F.: Praktikum Technische Keramik, Schriftenreihe des Instituts für Keramik im Maschinenbau, IKM 012, Karlsruhe, 1994

Salmang, H., Scholze, H.: Keramik, Teil 2 - Keramische Werkstoffe, Spinger-Verlag, Berlin-Heidelberg, 1983

Richerson, D. R.: Modern Ceramic Engineering, Marcel Dekker, New York-Basel, 1992

Course: Lab course experimental solid mechanics [2162275]

Coordinators: T. Böhlke, Mitarbeiter
Part of the modules: SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[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: Introduction to Microsystem Technology - Practical Course [2143875]

Coordinators: A. Last
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
non-graded: preparation of the experiments
graded (together with the lecture MST I resp. II): 50% questions concerning the practical training in the written 2h-exam of the lecture 'Grundlagen der Mikrosystemtechnik I resp. II'

Conditions
pre-condition: attendance of the lecture 'Grundlagen der Mikrosystemtechnik I bzw. II'

Learning Outcomes

- Deepening of the contents of the lecture MST I resp. II
- Understanding the technological processes in the micro system technology
- Experience in lab-work at real workplaces where normally research is carried out

Content
In the practical training includes nine experiments:
1. Hot embossing of plastics micro structures
2. Micro electroforming
3. Mikro optics: „LIGA-micro spectrometer“
4. UV-lithography
5. Optical waveguides
6. Capillary electrophoresis on a chip
7. SAW gas sensor
8. Metrology
9. Atomic force microscopy

Each student takes part in only five experiments.
The experiments are carried out at real workstations at the IMT and coached by IMT-staff.

Course: Computational Methods in Fluid Mechanics (Exercise) [2157442]

Coordinators: B. Pritz
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 23: Power Plant Technology (p. 136)[SP_23_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
Students

- know the three components of CFD: mesh generation, calculation and evaluation.
- will be able to create simple geometries and generate mesh.
- can set up and carry out simulations.
- know the ways of evaluating the results and the possibilities of flow visualization.
- know how to analyze flow situations.

Content
1. Brief introduction into Linux
2. Mesh generation for an example geometry
3. Data visualisation and interpretation of preset calculation results
4. Handling of the flow solver
5. Full calculation cycle I: Flat plate
6. Further calculation cycles

Literature
1. Lecture notes/handout
2. See literature list of lecture „Numerische Methoden der Strömungstechnik“

Course: Product Lifecycle Management [2121350]

Coordinators: J. Ovtcharova
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_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. 126)[SP_12_mach]

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

Learning Control / Examinations
Oral examination, Durations: 20 min, Auxiliary Means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
A considerable aspect of this lecture is to combine engineering knowledge with the practical, real industrial problems and applications.
Thus, the objectives of the lecture are:

- collaborative drafting of industrial and academic state of the art regarding the basics.
- specification of exigencies, requirements and concepts for an integrated CAx-process chain,
- introduction in the paradigms of the integrated process-oriented product development
- to convey practical industrial knowledge about the integrated product development in the automotive sector

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 word and distributed development.

Literature
Lecture slides

Remarks
Max. 20 students, registration necessary (ILIAS)

Course: Project Work in Product Development [2145300]

Coordinators: A. Albers
Part of the modules: SP 20: Integrated Product Development (p. 133)[SP_20_mach]

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

Learning Control / Examinations
oral examination (60 minutes)
combined examination of lectures, tutorials and project work

Conditions
The participation in "Integrated Product Development" requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).
Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations
none

Learning Outcomes
The center of "Integrated Product Development" constitutes itself in the development of a technical product within independent working student teams on the basis of the market situation up to virtual and real prototypes. Thereby the integrate treatment of the product development process is of importance. The project teams hereby represent development departments of medium sized companies, in which the presented methods and tools are field - experienced applied and ideas are transformed into concrete product models.
For the preparation of this development project the basics of 3D-CAD-modelling (Pro/ENGINEER) as well as different tools and methods of creative designing, of sketching and solution finding are mediated in workshops. Special events impart an insight of presentation techniques and the meaning of technical design.

Content
The project work begins with the early stages of product development, i.e. the identification of market trends and needs. Based on this information the students develop scenarios for future markets and create product profiles, which describe the customers and their demands without anticipating possible product solutions. After having passed several following milestones for ideas, concepts and designs, virtual prototypes and function prototypes are presented to an audience.
The project work is supported by coaching through skilled faculty staff. Additionally weekly tutorials, respectively workshops are given. For doing the project the teams gain access to team workspaces featuring IT-infrastructure and relevant software, such as office, CAD or FEA. Further on the teams learn how team cooperation and knowledge management can be supported in design project by using a wiki system.

Course: Product Ergonomics (in German) [2109025]

Coordinators: B. Deml

Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 10: Engineering Design (p. 123)[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

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: B. Deml
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 37: Production Management (p. 152)[SP_37_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

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: Industrial Engineering II [2110028]

Coordinators: B. Deml
Part of the modules: SP 37: Production Management (p. 152)[SP_37_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
None.

Recommendations

- Willingness to learn interdisciplinarily (Technique, Economy, Legal regulations, Informatics . . .)
- Knowledge of the lecture “Production Management I” (2109028) is usefull
- Otherwise: Study Terminology in “Wiendahl, Betriebsorganisation für Ingenieure”

Learning Outcomes

- Know methods and strategies for indirect production areas
- Ability to manage projects in factory planning
- Know about the importance of management systems

Content

1. Manufacturing organisation (Manufacturing, Assembly, Maintenance)
2. Quality control
3. Recycling
4. Management systems
5. Factory planning
6. Project management

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

Literature:

- BULLINGER, Hans-Jörg (Hrsg.): Systematische Montageplanung. München, Wien: Hanser, 1986.
- EVERSHEIM, Walter: Organisation in der Produktionstechnik. Band 4: Fertigung und Montage. Düsseldorf: VDI, 1981.
- REFA - Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Planung und Gestaltung komplexer Produktionssysteme. München: Hanser, 1987. (Methodenlehre der Betriebsorganisation)
- WIENDAHL, Hans-Peter: Betriebsorganisation für Ingenieure. München, Wien: Hanser, 5. Auflage 2004.

Please refer to the latest edition.

Course: Production Planning and Control (Planning Game of a Bicycle Factory; in German) [2110032]

Coordinators: A. Rinn
Part of the modules: SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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
- Registration in the ifab-office necessary
- Compulsory attendance during the whole lecture

Recommendations

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

Learning Outcomes

- Get deeper insights within production management
- Increase knowledge of production planning and control
- Understand basic techniques for the modelling and simulation of production systems

Content

1. Goals and recommanditions for production planning and control
2. Strategies for work control
3. Case study: Manufacturing of bicycles
4. FASI-Plus: Simulation of a bicycle factory for the production planning and control
5. Simulation of the order processing
6. Decision making about order control and procurement of purchased parts
7. Evaluation of the simulation protocols
8. Realisation of production planning and control

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

Literature:

- KOŠTURIAK, Ján; GREGOR, Milan: Simulation von Produktionssystemen. Wien, New York: Springer, 1995.
- LIEBL, Franz: Simulation. München, Wien: Oldenbourg, 2. Auflage 1995.
- VDI 3633, Blatt 6: Simulation von Logistik-, Materialfluss- und Produktionssystemen – Abbildung des Personals in Simulationsmodellen. Berlin: Beuth-Verlag, 2001.
- VDI 4499, Blatt 1: Digitale Fabrik - Grundlagen. Berlin: Beuth-Verlag, 2008.

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. 126)[SP_12_mach], SP 39: Production Technology (p. 153)[SP_39_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, B. Deml, Research assitants of wbk, ifab und IFL
Part of the modules: SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach]

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

Learning Control / Examinations
Participate in practicle exercise courses and complete the colloquia successfully.

Conditions
Participation in the following lectures:
Informationssystems in logistics and supply chain management,
Material flow in logistic systems,
manufacturing technology,
Work Schience

Recommendations
none

Learning Outcomes
The student:

- knows the components of a modern factory are presented,
- ia 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: Controlling of Production Economics (in German) [2110029]

Coordinators: B. Deml
Part of the modules: SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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
None.

Recommendations

- Willingness to learn interdisciplinarily (Technique, Economy, Legal regulations, Informatics . . .)
- Knowledge of the lecture "Production Management I" (2109028) is usefull
- Otherwise: Study Terminology in "Wiendahl, Betriebsorganisation für Ingenieure"

Learning Outcomes
The participants of the lecture should:

- Understand the basics of controlling
- Know about the importance of production-oriented controlling
- Know the basics of traditional economic controlling
- Know aspects of production logistics in controlling
- Be able to apply various analysing techniques
- Have seen the mode of operations of measure of production kogistic
- Be able to apply a generic method for the controlling of production economics

Content

1. Basics of the controlling of production economics
2. Development and controlling of organisations
3. Economic controlling
4. Material- and product-oriented controlling
5. Controlling of ressources
6. Controlling of organisation structures
7. Controlling of dynamic production processes
8. Seminar on the static and dynamic analysis of a bicycle factory

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

Literature:

- GROTH, Uwe: Kennzahlensystem zur Beurteilung und Analyse der Leistungsfähigkeit einer Fertigung. Düsseldorf: VDI-Verlag, 1992. (Fortschritt-Berichte VDI, Reihe 16, Nr. 61)
- HORVÁTH, Péter: Controlling. München: Verlag Franz Vahlem, 4. Auflage 1992.
- MCKINSEY (Hrsg.); ROMMEL, Günter; BRÜCK, Felix u.a.: Einfach überlegen. Stuttgart: Schäffer-Poeschel Verlag, 1993.
- REFA – Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Methodenlehre des Arbeitsstudiums. München: Carl Hanser Verlag. - Teil 2: Datenermittlung. 6. Auflage 1978. - Teil 3: Kostenrechnung, Arbeitsgestaltung. 7. Auflage 1985.
- REFA – Verband für Arbeitsstudien und Betriebsorganisation (Hrsg.): Methodenlehre der Planung und Steuerung. - Teil 1: Grundbegriffe. - Teil 2: Programm und Auftrag. München: Carl Hanser Verlag, 4. Auflage 1985.
- WIENDAHL, Hans-Peter: Betriebsorganisation für Ingenieure. München, Wien: Carl Hanser Verlag, 7. Auflage 2010.

Please refer to the latest edition.

Course: Project Workshop: Automotive Engineering [2115817]

Coordinators: F. Gauterin
Part of the modules: SP 12: Automotive Technology (p. 126)[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: Project Mikromanufacturing: Development and Manufacturing of Microsystems [2149680]

Coordinators: V. Schulze, P. Hoppen
Part of the modules: SP 32: Medical Technology (p. 146)[SP_32_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral exam (30 min)

Conditions
Due to organizational reasons the number of participants is limited. If the number of potential participants is too big a selection will be made.

Recommendations
Knowledge of CAD tools is favorable but not necessary. Previous knowledge of manufacturing is reasonable.

Learning Outcomes
The student

- is able to explain micro manufacturing the processes and their application
- can choose the right manufacturing process for a given manufacturing task
- is able to illustrate how to design a product that is suitable for production
- is able to explain why the produced shape of a part differs from the ideal shape
- can point out the CAD-CAM process chain and every single phase
- is able to analyze probleme and develop solutions that are suitable for production

can validate the solutions he/she developed

Content
With the help of an up-to-date task, coming from the industry, the students develop a micro system. The design process begins with the development of ideas and ends with building up a working prototype. Very important are creative solutions as well as constructions that are suitable for production. The end of the course is the production of the parts for the prototype plus its assembly and validation.
Beside the development work the students learn the basics about the micro manufacturing processes micro milling, micro electric discharge machining, micro laser ablation, micro powder injection molding and micro quality assurance in several lectures. Other lecture issues are the CAD-CAM process chain as well as constructions who are suitable for production. Every student has to give a short speech about one micro manufacturing process.

Course: Appliance and Power Tool Design Project Work [2145165]

Coordinators: S. Matthiesen
Part of the modules: SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach]

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

Learning Control / Examinations
Colloquium: 20 min presentation with 10 min discussion.
Colloquium is obligated for examen in Appliance and Power Tool Design.

Conditions
in masters course
The participationin “ Appliance and power tool design”” requires the concurrent project work.
Due to organizational reasons, the number of participants is limited. At the beginning of august, a registration form will be available at the IPEK website. In the case of too many applicants, a selection process will be taking place. An early application is advantageous.

Learning Outcomes
The technical design of technical appliances and power tools will be analyzed in student teams and based on this analysis further developments will be synthesized.

Content
The interaction of analysis and synthesis will be acquired in student teams at the example of different appliances and power tools.

Course: Development of Oil-Hydraulic Powertrain Systems [2113072]

Coordinators: G. Geerling

Part of the modules: SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
oral examination

Conditions
knowledge in the fluidics

Learning Outcomes
The students are able to understand hydraulic systems und to develop them independently. They apply their competences in a simulation of a development project with real hydraulic components within a laboratory tutorial.

Content
The bloc course offered by the Chair of Mobile Machines (Mobima) conveys the basics of planning and development of mobile and industrial hydrostatic systems. The lecturer works for a market leading company producing fluid power drives and controls and gives a deep view into the process of planning and development using real life examples. The contents of the course are:

- marketing, project planning
- hydrostatic circuits
- heat balance, hydraulic accumulators
- filtration, noise lowering
- development exercises + laboratory tutorial

Course: Project Management in Rail Industry [2115995]

Coordinators: P. Gratzfeld
Part of the modules: SP 50: Rail System Technology (p. 167)[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 34: Mobile Machines (p. 148)[SP_34_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 32: Medical Technology (p. 146)[SP_32_mach], SP 37: Production Management (p. 152)[SP_37_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
Oral examination
Duration: 20 minutes
Auxilary means: none

Conditions
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 03: Work Science (p. 115)[SP_03_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 37: Production Management (p. 152)[SP_37_mach], SP 39: Production Technology (p. 153)[SP_39_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 effecitvely 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

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. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_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 aspcets of them. He learns the elementary basis of modelling and simulating as well as of continuum mechanics and material theory. The students knows how to numerically solve initial-boundary-value problems using the finite element method.

Content
The lectures gives an introduction to simulation of formings processes of metallic materials and contains the basics of continuum mechanics, material theory and numerics.

Course: Process Simulation in Cutting [2149668]

Coordinators: A. Zabel
Part of the modules: SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral

Conditions
None.

Learning Outcomes
The student
• is able to name the different methods of process simulation in cutting and to explain their functions
• is able to classify the methods by their general structure and functionality and knows their potentials and limitations
• is able to perform a selection for predetermined boundary conditions based on the methods he/she has learned about and their characteristics
• is able to identify the correlation between different methods

Content
The aim of the lecture is to present the different techniques and potentials of process simulation in cutting.
1. The CAD-CAM-NC-process chain
2. Basics: information technology and geometry
3. Basics: process technology
4. Simulationsystem for three-axial milling
5. FE-modelling of milling processes
6. Simulation and optimization of machine tools
7. Simulationsystem for five-axial milling
8. Simulation of process dynamics at milling
9. Application of the simulationsystems (1)
10. Application of the simulationsystems (2)
11. Methods of visualisation
12. Summary

Media
Slides and lecture notes for the process simulation in cutting lecture will be made available through ilias.

Literature
script

Course: Advanced powder metals [2126749]

Coordinators: R. Oberacker
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (20-30 min) taking place at the agreed date. The re-examination is offered upon agreement.

Conditions
None.

Recommendations
Knowledge of basic material science is assumed.

Learning Outcomes
The students know the basics of powder metallurgy. They are able to asses the conditions for applying either powder metallurgy or competing production methods. They have knowledge on production, properties and application of the most important PM materials.

Content
The lecture gives an overview on production, properties and application structural and functional powder metallurgy material. The following groups of materials are presented: PM High Speed Steels, Cemented Carbides, PM Metal Matrix Composites, PM Secialities, PM Soft Magnetic and Hard Magnetic Materials.

Literature

- W. Schatt ; K.-P. Wieters ; B. Kieback. „Pulvermetallurgie: Technologien und Werkstoffe“, Springer, 2007
- R.M. German. “Powder metallurgy and particulate materials processing. Metal Powder Industries Federation, 2005
- F. Thümmler, R. Oberacker. “Introduction to Powder Metallurgy”, Institute of Materials, 1993

Course: Quality Management [2149667]

Coordinators: G. Lanza

Part of the modules: SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 37: Production Management (p. 152)[SP_37_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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: Quantitative Methods for Supply Chain Risk Management [2118090]

Coordinators: A. Cardeneo
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach]

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

Learning Control / Examinations
presumably oral, duration 20 minutes, in each case at the beginning and at the end of the lecture-free time

Conditions
None.

Recommendations
Basic knowledge in operations research, statistics and logistics are recommended.

Learning Outcomes
The student knows mathematical models and methods to control the various kinds of risks.

Content
The planning and the enterprise of logistics systems are connected in large measure with uncertainty: It is the unknown demand, varying transportation times, unexpected delays, irregularly production yield or volatile rates of exchange: Quantities, times, qualities and prices are uncertain values. Therefore it is necessarily to deal with particular these uncertain values to avoid negative effects.
That logistics systems should be efficiently operated is obvious. But their function must also be reliably. In this lecture we concern with mathematical models and methods with which most different kinds of risks can be controled. Risk analysis, durable location planning, durable transportation networks, Multi Sourcing strategies, Capacity options, infrastructure protection and flexible production planning are parts of it. Topics of the lectures are supplemented and deepened during the exercises.

Media
presentations, black board

Literature
ILIAS-System: https://ilias.rz.uni-karlsruhe.de/goto_rz-uka_crs_7817.html

Remarks
none

Course: Reactor Safety I: Fundamentals [2189465]

Coordinators: V. Sánchez-Espinoza
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_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
None.

Learning Outcomes

- Knowledge of fundamentals of nuclear safety (technology, atomic law, principles)
- Gain understanding of safety features and systems of a nuclear power plant
- Ability to understand the interactions of different areas e.g. thermal hydraulics, neutronics, materials, human factors, organisation and management of a nuclear power plant

Content
The goal of the lecture is to impart the fundamentals of nuclear safety that is needed to assess the safety of nuclear facilities. Nuclear safety is inherently of multidisciplinary character and is based on the following pillars: technology, man, organisation and measures; all together named "Safety Culture".The nuclear facilities, coal-fired power plants, aerospace industry and gen technology for example are connected with a certain risk for the environment and society. Consequently, the erection and operation of nuclear installations needs must undergo a licensing process and a continuous surveillance by the regulatory body. This lecture will be concentrated on the following topics:

- Historical development of nuclear safety
- Risk evaluation for nuclear power plants compared to other technologies
- Scope, principles and structure of the atomic Law (national and international context)
- Fundamentals of nuclear safety
- Safety features and systems of nuclear power plants with Light Water Reactors (Generation 2)
- Safety analysis and methods for safety assessment
- Validation of numerical simulation tools for safety demonstration
- Introduction to probabilistic safety assessment (PSA)
- Nuclear events and accidents
- Safety concepts of reactors of generation 3 and 4

Literature
Lecuture notes

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

Coordinators: V. Sánchez-Espinoza
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

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

Conditions
None.

Learning Outcomes

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

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

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

Course: Computational Dynamics [2162246]

Coordinators: C. Proppe
Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach]

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

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
The lecture teaches the ability to compute solutions for problems in structure dynamics. For this purpose differential equations for the vibration of structure elements are presented and solved by means of numerical methods.

Content
1. Fundamentals of elasto-kinetics (Equations of motion, principle of Hamilton and principle of Hellinger-Reissner)
2. Differential equations for the vibration of structure elements (bars, plates)
3. Numerical solutions of the equations of motion
4. Numerical algorithms
5. Stability analyses

Literature
1. Lecture notes (in German) will be provided!
2. M. Géradin, B. Rixen: Mechanical Vibrations, Wiley, Chichester, 1997

Remarks
The course takes place every two years (in pair years).

Course: Computational Vehicle Dynamics [2162256]

Coordinators: C. Proppe

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 50: Rail System Technology (p. 167)[SP_50_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach]

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

Learning Control / Examinations
Oral examination, no auxiliary means allowed

Conditions
none

Recommendations
none

Learning Outcomes
This course serves as an introduction to the computational modelling and simulation of the technical system road/vehicle. A method based perspective is taken, which allows for a unified treatment of various kinds of vehicles. The vehicle model is obtained by dividing the system into functional subsystems and defining interfaces between these subsystems. In the first part of the course, vehicle models will be developed based on models of the suspensions, the road, and the contact forces between road and vehicle. The focus of the second part of the course is on computational methods for linear and non-linear models of vehicle systems. The third part of the course discusses design criteria for stability, safety and ride comfort.The multi body dynamics software Simpack will be used.

Content
1. Introduction
2. Models of load bearing systems
3. Contact forces between wheels and roadway
4. Simulation of roadways
5. Vehicle models
6. Methods of calculation
7. Performance indicators

Literature
1. K. Popp, W. Schiehlen: Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1993
2. H.-P. Willumeit: Modelle und Modellierungsverfahren in der Fahrzeugdynamik, B. G. Teubner, Stuttgart, 1998
3. H. B. Pacejka: Tyre and Vehicle Dynamics. Butterworth Heinemann, Oxford, 2002
4. K. Knothe, S. Stichel: Schienenfahrzeugdynamik, Springer, Berlin, 2003

Remarks
The course takes place every two years (impair years only).

Course: Computerized Multibody Dynamics [2162216]

Coordinators: W. Seemann

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach]

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

Learning Control / Examinations
Oral exam

Conditions
Knowledge of EM III, EM IV

Learning Outcomes
Goal of the course is to understand to analyse the spatial motion of a rigid body or of a system of rigid bodies by using computer programs. By doing the puzzling mathematical reformulations and evaluations by the computer code it is possible to concentrate on the 'Mechanics which is behind it'. At the end of the course the student should be able to understand the principles which are used in commercial computercodes to generate the equations of motion and to do a numerical integration.

Content
Description of the orientation of a rigid body, angular velocity, angular acceleration, derivatives in different referrence frames, derivatives of vectors, holonomic and nonholonomic constraints, derivation of the equations of motion using d'Alembert's principle, the principle of virtual power, Lagrange's equations or Kane's equations. Structure of the equations of motion, foundations of numerical integration.

Media
Following Programs are used: AUTOLEV, MATLAB, MATHEMATICA/MAPLE

Literature
Kane, T.: Dynamics, Theory and Applications, McGrawHill, 1985
AUTOLEV: User Manual

Course: Computer Integrated Planning of New Products [2122387]

Coordinators: R. Kläger
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_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 06: Computational Mechanics (p. 119)[SP_06_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach]

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

Learning Control / Examinations
oral examination
Prerequisites by attestations during associated tutorials

Conditions
None.

Recommendations
Lectures “Mathematical Methods in Strength of Materials” and “Introduction to the Finite Element Method”
This course is geared to MSc students.

Learning Outcomes
The students know the principles and the theory of the linear finite element method. They master die 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.
During the associated tutorials the students implement the numerical concepts.

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 06: Computational Mechanics (p. 119)[SP_06_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach]

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

Learning Control / Examinations
oral examination

Conditions
Successful participation in lecture “Computational Mechanics I”

Recommendations
This course is geared to MSc students.

Learning Outcomes
The students can 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 obatin a numerical solution of the discretized equations using the Finite-Element-Method. They know the basics of numerics of nonlinear systems, kinematics and balanve 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 plasicity
- linear and gemetrically nonlinear thermoelasticity

Literature
Simó, J.C.; Hughes, T.J.R.: Computational Inelasticity. Springer 1998.Haupt, P.: Continuum Mechanics and Theory of Materials. Springer 2002.Belytschko, T.; Liu,W.K.; Moran, B.: Nonlinear FE for Continua and Structures. JWS 2000.

Course: Reduction methods for the modeling and the simulation of combustion processes [2166543]

Coordinators: V. Bykov, U. Maas
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students can:

- explain the fundamental mathematical concepts in model reduction for reacting flows.
- perform an analysis of kinetic models of reacting flows.
- analyse ideal and reduced models used to describe different combustion regimes
- understand and asses the predominant methods for the mathematical analysis of reduced models.

Content
Fundamentals of the mathematical methods and the analysis of chemical kinetics
Methodology of model reduction and its implementation
Description of different combustion regimes (e.g. auto-ignition, steady flames, flame quenching) with simplified and idealised models
Examples of reduction strategies

Literature
Course notes
N. Peters, B. Rogg: Reduced kinetic mechanisms for aplication in combustion systems, Lecture notes in physics, 15, Springer Verlag, 1993

Course: Replication Technologies in Microsystem Technology [2143893]

Coordinators: M. Worgull
Part of the modules: SP 33: Microsystem Technology (p. 147)[SP_33_mach]

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

Learning Control / Examinations
Oral examination (30 minutes)

Conditions
Intermediate examination or bachelor degree of mach/wing necessary.

Recommendations
Basic knowledge of the micro-system technology (but not a requirement) and interdisciplinary interest are favourable

Learning Outcomes
The lesson gives an overview over the different kinds of replication technologies in the science of microsystem technology. Fundamentals like replication materials, processes and it's technologies, and a process simulation based on hot embossing will be presented. The aim of the lesson is to give the students the knowelge to decide which materials and processses are required to replicate a desired microstructured design. The theoretical aspects of the lesson will be supported by a large diversity of of examples in science and industry. Finally a visit of the selected labs at the Forschungszentrum Karlsruhe will give a detailed view to the topics of the lesson.
The students will finally having an expertise to compare the different processes based on scientific and technical items. This includes also aspects of

- quality of the moulded parts,
- material properties,
- technologies,
- mould design,
- cost efficiency.

Content
Replication - Introduction and Overview

- Diversity of Replication - A short definition
- Historic examples
- Materials for replication
- Overveiw over the different replication processes

Polymers – Properties and tehoretical description

- Classification of polymers
- Mechanical and thermal behaviour
- Rheology of polymer melts
- Measurement system for characterisation of polymers
- Approachens for the theoretical description of vicoelastic behaviour

Microstructured replication tools

- Requirements on microstructured mould inserts

- Fabrication methods
- Electroplation of mould inserts
- Materials and coatings
- Design rules

Replikation processes and technologies

- Overview and charactistics of all processes
- Micro injection moulding
- Injection compression moulding
- Reaction injection moulding
- Thermoforming / Blow moulding
- Micro hot embossing / Nanoimprint
- Comparison of processes

Charakterisation of replicated parts

- Quality of replicated parts - definition of critera
- Lateral accuracy
- Surface quality
- Classification of cases of damage

Simulation of replication processes - hot embossing

- Process simulation based on analytic models
- Process simulation based on FEM systems
- Simulation of a hot embossing cycle
- Heating / Cooling - Effects of heat conduction, heat transfer, and convection
- Embossing based on an two stpe embossing cycle
- Cooling of a moulded part
- Demoulding - Stress on moulded parts

Presentation of actual research topics in micro replication

- lab tour Campus North

Media
Printouts of the lecture presentation, if applicable further scientific articles

Course: Robotics I – Introduction to robotics [24152]

Coordinators: R. Dillmann, Welke, Do, Vahrenkamp
Part of the modules: SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 31: Mechatronics (p. 145)[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: Robotics II - Programming of industrial and autonomous service robots [24712]

Coordinators: R. Dillmann, Schmidt-Rohr, Jäkel
Part of the modules: SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Previous attendance of the lecture „Robotics I" is helpful, but not mandatory.

Learning Outcomes
The student understands the main principles and differences concerning methods for programming industrial robots on the one hand and autonomous service robots on the other hand. The student is able to present and describe applicable programming concepts for realistic robotic application scenarios

Content
Complementary to the lectures „Robotik I" and „Robotik III", the programming and task modeling aspects of robotics are presented more closely. Different methods like manual, textual and graphic programming of robots as well as the necessary tools are discussed. Furthermore, the internal modeling of environment and task knowledge in the robot as well as suitable planning methods are presented. Finally, decision making and planning approaches for autonomous service robots are discussed with a focus on dynamic, real world settings and the latest state of the art.

Media
Slides, script, work sheets

Course: Robotik III - Sensors in Robotics [24635]

Coordinators: R. Dillmann, Meißner, Gonzalez, Aguirre
Part of the modules: SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
The assessment is explained in the module description.

Conditions
None.

Recommendations
Previous attendance of the lecture „Robotik I" is helpful, but not mandatory.

Learning Outcomes
The student has to understand the principles of sensors that are essential and common in robotics. The student has to understand the data flow, starting from the physical measurement, over digitization, application of the sensor model to image processing, feature extraction and the integration of the information in an environment model. The student has to be able to propose suitable sensor concepts for simple tasks and to justify them.

Content
The lecture Robotics III complements the lecture Robotics I with a broad overview over sensors used in robotics and the interpretation of their data. One focus of the lecture is on the topic of computer vision, which is being dealt with from data aquisition, over calibration to object recognition and localization.
Sensors are important subcomponents of control circuits and enable robots to perform their tasks safely. Furthermore sensors serve to capture the environment as well as dynamical processes and actions in the surroundings of the robots. The topics that are addressed in the lecture, are as follows: Sensor technology for a whole taxonomy of sensor systems (including image and 3D sensors), sensor modeling (including color calibration and hdr imaging), theory and practice of digital signal processing, machine vision, multi-sensor integration and fusion.
Among others, sensor systems such as relative position sensors (optical encoders, potentiometer), velocity sensors (encoder, tachometer), acceleration sensors (piezo-resistive, piezo-electric, optical and others), inertial sensors (gyroscope, gravitometer and others), tactile sensors (foil sensors, pressure sensitive materials and others), proximity sensors, distance sensors (ultrasonic, laser, time-of-flight, interferometry, structured light, stereo camera systems and others), image sensors (photodiode, CCD and others), absolute position sensors (GPS, fiducial markers). Laser sensors as well as image sensors are dealt with priority.

Media
Slides, script.

Course: Decommissioning of Nuclear Facilities I [19435]

Coordinators: S. Gentes
Part of the modules: SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
Oral examination

Conditions
none

Learning Outcomes
Understanding Germany's authorization/licensing process, designing decommissioning concepts, basics and application of technologies and processes required for the decommissioning of nuclear facilities as well as the legal framework required for decommissioning processes

Content
State of the science and technical knowledge of mechanical process engineering for decommissioning (e.g. decontamination, separation of steel and reinforced concrete, demolition of highly reinforced concrete, management of the entire decommissioning process, etc.) as well as modern management methods required for the complex handling of decommissioning projects.
In addition, basic knowledge of the approval chain and the legal framework will be taught. To see the work put into practice a nuclear facility currently under decommissioning will be visited.

Literature
NomosGesetze: „Atomgesetz mit Verordnungen“, ISBN: 978-3-8329-2833-9
atw – International Journal of Nuclear Power, ISSN: 1431-5254

Course: Failure Analysis [2173562]

Coordinators: K. Poser
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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. 167)[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 25: Lightweight Construction (p. 138)[SP_25_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach]

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

Learning Control / Examinations
oral

Duration: 30 minutes
(Welding Technology I+II)

no auxiliary material

Conditions
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.

Learning Outcomes
knowledge and understanding of the most important welding processes and its industrial application.

recognition, understanding and handling of problems occuring during the application of different welding processes relating to design, material and production.

classification and importance of welding technonolgy within the scope of connecting processes (advantages/disadvantages, alternatives).

Content
definition, application and differentiation: welding,
welding processes,
alternative connecting technologies.
history of welding technology
sources of energy for welding processes

Survey: fusion welding,
pressure welding.
seam preparation/design
welding positions
weldability
gas welding, thermal cutting

manual metal-arc welding
submerged arc welding
IV characteristics: arc/sources of energy
gas-shielded metal-arc welding

Literature
Handbuch der Schweißtechnik I bis III
Werkstoffe
Verfahren und Fertigung
Konstruktive Gestaltung der Bauteile
Jürgen Ruge
Springer-Verlag GmbH & Co, Berlin

Schweißtechnische Fertigungsverfahren 1 bis 3
Schweiß- und Schneidtechnologien
Verhalten der Werkstoffe beim Schweißen

Gestaltung und Festigkeit von Schweißkonstruktionen
Ulrich Dilthey (1-3), Annette Brandenburger(3)
Springer-Verlag GmbH & Co, Berlin

Fachbuchreihe Schweißtechnik Band 76/I und II
Killing, R.; Böhme, D.; Hermann, F.-H.
DVS-Verlag

DIN/DVS -TASCHENBÜCHER
Schweißtechnik 1,2 ff...
Beuth-Verlag GmbH, Berlin

Course: Welding Technology II [2174570]

Coordinators: B. Spies
Part of the modules: SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach]

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

Learning Control / Examinations
oral

Duration: 30 minutes (Welding Technology I + II)

no auxiliary material

Conditions
lecture on Welding Technology I.
basics of material science (iron- and non-iron alloys), of electrical engineering, of production processes.

Learning Outcomes
recognition, understanding and handling of problems occuring during the application of different welding processes relating to design, material and production.

consolidation of and amplification to the knowledge of Welding Technology I

consolidation of knowledge of material behaviour during welding
design and properties of welded constructions
quality assurance for welding processes

Content
narrow gap welding
TIG-welding
plasma arc welding
electron beam welding
laser welding

spot welding / projection welding
heat flow at welding

welding of low-alloy steel / time-temperature-transformation curve.
welding of high-alloy steel / austenite / Schaefflerdiagramm
low temperature steels
welding of cast iron

heat treatment for welding
welding of aluminium alloys
residual welding stress
methods of testing
design of welded constructions

Literature
Handbuch der Schweißtechnik I bis III
Werkstoffe
Verfahren und Fertigung
Konstruktive Gestaltung der Bauteile
Jürgen Ruge
Springer-Verlag GmbH & Co, Berlin

Schweißtechnische Fertigungsverfahren 1 bis 3
Schweiß- und Schneidtechnologien
Verhalten der Werkstoffe beim Schweißen
Gestaltung und Festigkeit von Schweißkonstruktionen
Ulrich Dilthey (1-3), Annette Brandenburger(3)
Springer-Verlag GmbH & Co, Berlin

Fachbuchreihe Schweißtechnik Band 76/I und II
Killing, R.; Böhme, D.; Hermann, F.-H.
DVS-Verlag

DIN/DVS -TASCHENBÜCHER
Schweißtechnik 1,2 ff...
Beuth-Verlag GmbH, Berlin

Course: Fatigue of Metallic Materials [2173585]

Coordinators: K. Lang

Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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. 122)[SP_09_mach], SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_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: Failure Analysis Seminar [2173577]

Coordinators: K. Poser
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
participation, report

Conditions
knowledge in 'failure analysis'

Learning Outcomes
The seminar deals with real failed parts. The students will carry out complete failure analyses incl. appropiate reporting. It starts with the basic failure mechanisms of machanically, chemically, and thermally induced failures and it failure appearances. After the failure mechanisms are known possible counters to measure are presented and discussed.

Content
analyse of real failed parts

failure appearances

mechanisms of failure

prevention of failure

writing a report

Course: Safety engineering [2117061]

Coordinators: H. Kany
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
oral / written (if necessary) => (see "Studienplan Maschinenbau", version of 29.06.2011)
examination aids: none

Conditions
none

Recommendations
none

Learning Outcomes
The student:

- has basic knowledfe 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: [23109]

Coordinators: F. Puente, F. Puente León
Part of the modules: SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 31: Mechatronics (p. 145)[SP_31_mach]

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

Learning Control / Examinations
The assessment consists of a written exam (approx. 120 minutes) according to sec. 4 subsec. 2 no. 1 study and examination regulations.
The grade of the course corresponds to the grade of the written exam.

Conditions
Knowledge of higher mathematics and probability theory (1305) is required.

Learning Outcomes

Content

Media
Slides
work sheets

Literature
Prof. Dr.-Ing. Kiencke: Signale und Systeme; Oldenbourg Verlag, 2008
Elective literature:
Will be announced in the lecture.

Course: Simulation of Coupled Systems [2114095]

Coordinators: M. Geimer
Part of the modules: SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place in the recess period. The exam takes place in every semester. Re-examinations are offered at every ordinary examination date.

Conditions
It is recommended to have:

- Knowledge of ProE (ideally in current version)
- Basic knowledge of Matlab/Simulink
- Basic knowledge of dynamics of machines
- Basic knowledge of hydraulics

Learning Outcomes
After completion of the course, students are able to:

- building a coupled simulation
- parameterize models
- Perform simulations
- do Troubleshooting
- check results for plausibility

Content

- Knowledge of the basics of multi-body and hydraulic simulation programs
- Possibilities of coupled simulations
- Development of a simulation model by using the example of a wheel loader
- Documentation of the result in a short report

Literature
Elective literature:

- miscellaneous guides according the software-tools pdf-shaped
- information to the wheel-type loader

Course: Simulation in product development process [2185264]

Coordinators: A. Albers, T. Böhlke, J. Ovtcharova

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 32: Medical Technology (p. 146)[SP_32_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_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, P. Stock
Part of the modules: SP 37: Production Management (p. 152)[SP_37_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_mach], SP 33: Microsystem Technology (p. 147)[SP_33_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

ECTS Credits	Hours per week	Term	Instruction language
5	4	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 consideres 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

Course: Simulation of spray and mixture formation processes in combustion engines [2133114]

Coordinators: C. Baumgarten
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_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 decelleration, droplet collision, ignition etc. are discussed. Last but not least trend-setting mixture formation strategies and their potential for engines with direct injection are discusses.

Content
Fundamentals of mixture formation in combustin 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: Simulator Exercises Combined Cycle Power Plants [2170491]

Coordinators: T. Schulenberg
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
Certificate of participation in case of regular attendance.
Oral examination on request.

Conditions
Participation at the lecture Combined Cycle Power Plants (2170490) is required.

Learning Outcomes
The simulator exercise offers the opportunity to run an advanced combined cycle power plant with a realistic user surface including all plant details at real time. Participant shall get a deeper understanding of the design of combined cycle power plants and their operation.

Content
Exemplary programming of an own I&C modul; start-up of the power plant from scratch; load changes and shut down; dynamic response of the power plant in case of malfuctions and of sudden load changes; manual operation of selected components.
The simulator exercise includes a tour to a combined cycle power plant at the end of the semester.

Media
The power plant simulator is based on the control system of a real SIEMENS power plant. The English user surface is based on US standard.

Literature
Slides and other documents of the lecture Combined Cycle Power Plants.

Course: Scaling in fluid dynamics [2154044]

Coordinators: L. Bühler
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_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 definition of nondimensional groups ensures the transfer of results from model experiments to real applications. Moreover, these groups reduce the number of experimental parameters and thereby the direct experimental effort. Scaling laws allow the identification of essential. They form the base for meaningful simplifications (modeling) of fluid dynamics equations as a starting point for efficient solution strategies.

Content

- Introduction
- Similarity rules (examples)
- Dimensional analysis (Pi-theorem)
- Scaling in differential equations
- Scaling in boundary layers
- Self-similar solutions
- Scaling in turbulent shear layers
- Rotating flows
- Magnetohydrodynamic flows

Literature
G. I. Barenblatt, 1979, Similarity, Self-Similarity, and Intermediate Asymptotics, Plenum Publishing Corporation (Consultants Bureau)
J. Zierep, 1982, Ähnlichkeitsgesetze und Modellregeln der Strömungsmechanik, Braun
G. I. Barenblatt, 1994, Scaling Phenomena in Fluid Mechanics, Cambridge University Press

Course: Mechatronic Softwaretools [2161217]

Coordinators: C. Proppe
Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 50: Rail System Technology (p. 167)[SP_50_mach], SP 06: Computational Mechanics (p. 119)[SP_06_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 31: Mechatronics (p. 145)[SP_31_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: Theory of Stability [2163113]

Coordinators: A. Fidlin

Part of the modules: SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach]

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

Learning Control / Examinations
Oral examination

Duration: 30 min (optional subject)
20 min (major subject)

Means are not allowed

Conditions
None.

Recommendations
Vibration theory, mathematical methods of vibration theory

Learning Outcomes

- to learn the most important methods of the stability analysis
- to apply the stabiliy analysis for equilibria
- to apply the stabiliy analysis for periodic solution
- to apply the stabiliy analysis for systems with feedback control

Content

- Basic concepts of stability
- Lyapunov's functions
- Direct lyapunov's methods
- Stability of equilibria positions
- Attraction area of a stable solution
- Stability according to the first order approximation
- Systems with parametric excitation
- Stability criteria in the control theory

Literature

- Pannovko Y.G., Gubanova I.I. Stability and Oscillations of Elastic Systems, Paradoxes, Fallacies and New Concepts. Consultants Bureau, 1965.
- Hagedorn P. Nichtlineare Schwingungen. Akademische Verlagsgesellschaft, 1978.
- Thomsen J.J. Vibration and Stability, Order and Chaos. McGraw-Hill, 1997.

Course: Control engineering [2150683]

Coordinators: C. Gönnheimer

Part of the modules: SP 18: Information Technology (p. 131)[SP_18_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 04: Automation Technology (p. 116)[SP_04_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: [23271]

Coordinators: M. Urban
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (approx. 20 minutes) according to sec. 4 subsec. 2 no. 2 study and examination regulations.

Conditions
None.

Learning Outcomes
The Students know about the basics of radiation protection concerning ionizing radiation.

Content
The lecture shows the basics of radiation protection concerning ionizing radiation.

Course: Strategic Product Planing [2146193]

Coordinators: A. Siebe
Part of the modules: SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 51: Development of innovative appliances and power tools (p. 168)[SP_51_mach], SP 20: Integrated Product Development (p. 133)[SP_20_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
Succesful 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 underlieing 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: Flows in rotating systems [2154407]

Coordinators: R. Bohning
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach]

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

Learning Control / Examinations
Oral examination

Duration: 30 minutes (optional subject), 20 minutes (major subject)

No tools or reference materials may be used during the exam

Conditions
None.

Learning Outcomes
The students can treat rotating fluid flows which occur in a wide variety of technical contexts and in geophysics, particularly in the atmosphere and in the oceans. They are familiar with the fundamental phenomena involved as well as with the mathematical and physical aspects and can transfer the obtained knowledge for characteristic flow problems of this field to practical examples.

Content

- Introduction
- Governing equations in a rotating System
- Exact solutions (circular flows)
- Dynamic similarity (Rossby Number Ekman Number)
- Hyperbolicity (Inertia waves, Rossby waves)
- Taylor Proudman theorem
- Ekman-layer
- Instabilities in rotating systems

Literature
Greenspan, H. P.: The Theory of Rotating Fluids

Lugt, H. J.: Wirbelströmungen in Natur und Technik, Braun Verlag, Karlsruhe, 1979

Lugt, H. J.: Vortex Flow in Rotating Fluids (with Mathematical Supplement),
Wiley Interscience

Pedlovsky, J.: Geophysical Fluid Dynamic

Course: Flows with chemical reactions [2153406]

Coordinators: A. Class

Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations
Oral examination

Duration: 30 min
as WF NIE
written homework

Lecture

Conditions
Mathematics

Learning Outcomes
Chemical reactions of liquid or gaseous media are tightly coupled to the underlying fluid flow. Often they even drive the flow.

Some typical examples are combustion (laminar and turbulent gas premixed or diffusion flames), the processes within the industrial reactors of chemical industry, the directional polymerization of plastics, the burning of a cigar, the high temperature synthesis of new materials, and also the explosion of a star as a supernova.

Content
In the lecture we mainly consider problems, where chemical reaktion is confined to a thin layer. The problems are solved analytically or they are at least simplified allowing for efficent numerical sollution procedures. We apply simplified chemistry and focus on the fluid mechanic aspects of the problems.

Media
Black board

Literature
Lecture

Buckmaster, J.D.; Ludford, G.S.S.: Lectures on Mathematical Combustion, SIAM 1983

Course: [2189910]

Coordinators: X. Cheng
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
oral examination; duration: 20min

Conditions
None.

Learning Outcomes
This lecture is dedicated to students of mechanical engineering and other engineering Bachelor or Master degree courses. Goal of the lecture is the understanding of major processes in fluid dynamics and heat transfer in energy engineering. The corresponding phenomena and the methods to analyse are described and explained. In addition the lecture will be supplemented by convenient examples.

Content

1. collection of sample applications
2. heat transfer and its application
3. convective fluid dynamics and heat transfer
4. thermal radiation and its application
5. special cases

Literature

- Bahr, H.D., Stephan, K., Wärme- und Stoffübertragung, 3. Auflage Springer Verlag, 1998
- Mueller, U., Zweiphasenströmung, Vorlesungsmanuskript, Februar 2000, TH Karlsruhe
- Mueller, U., Freie Konvektion und Wärmeübertragung, Vorlesungsmanuskript, WS1993/1994, TH Karlsruhe
- W. Oldekop,„Einführung in die Kernreaktor und Kernkraftwerktechnik,“Verlag Karl Thiemig, München, 1975
- Cacuci, D.G., Badea, A.F., Energiesysteme I, Vorlesungsmanuskript, 2006, TH Karlsruhe
- Jones, O.C., Nuclear Reactor Safety Heat Transfer, Hemisphere Verlag, 1981
- Herwig, H., Moschallski, A., Wärmeübertragung, 2. Auflage, Vieweg + Teubner, 2009

Course: [2154445]

Coordinators: B. Frohnapfel, T. Baumann
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_mach]

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

Learning Control / Examinations
Homework

Conditions
None.

Recommendations
Fundamental Knowledge about Fluid Flows

Learning Outcomes
Students have learned to carry out numerical simulations with OpenFOAM: They are able are able to extract the essential features of the flow problem, generate the corresponding mesh, define initial and boundary conditions and carry out the simulation. They are also in a position to interpret and critically discuss the obtaind results.

Content
Flow Simulations with OpenFOAM

- grid generation, grid dependency of the solution
- initial and boundary conditions
- stationary and instationary flows
- interpretation of generated data
- turbulence modelling
- comparison of laminar and turbulent flows
- understanding the structure of OpenFOAM and how to extend it for specific applications

Literature
H. Ferziger, M. Peric, *Computational Methods for Fluid Dynamics*, Springer, 2008

Remarks
Block Course with limited number of participants, Contact person: Thomas Baumann, Institute of Fluid Mechanics (www.isl.kit.edu)

Course: Structural and phase analysis [2125763]

Coordinators: S. Wagner
Part of the modules: SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_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

1. Understanding of the fundamentals of X-ray generation as well as their interaction with crystalline materials
2. Basics of different methods of X-ray crystallography.
3. It is demonstrated, how the detected X-ray spectra can be analyzed by qualitative and quantitative phase analysis. Furthermore texture analysis will be explained.

Content

1. Production and properties of X-Ray's
2. Fundamentals and application of different measuring methods
3. Qualitative and quantitative phase analysis
4. Texture analysis (pole figures)
5. Residual stress measurements

Literature

1. B.D. Cullity and S.R. Stock: Elements of X-ray diffraction. Prentice Hall New Jersey, 2001.

Course: Structural Ceramics [2126775]

Coordinators: M. Hoffmann
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach]

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

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the agreed date.
Auxiliary means: none
The re-examination is offered upon agreement.

Conditions
none

Recommendations
Basics of the course "Introduction to Ceramics" should be known.

Learning Outcomes
The students know the most relevant structural ceramics (silicon carbide, silicon nitride, alumina, boron nitride, zirconia, fibre-reinforced ceramics) and their applications. They are familar with the microstructural features, fabrication methods, and mechanical properties.

Content
The lecture gives an overview on structure and properties of the technical relevant structural ceramics silicon nitride, silicon carbide, alumina, zirconia, boron nitride and fibre-reinforced ceramics. All types of structural ceramics will be discussed in detail in terms of preparation methods of the raw materials, shaping techniques, densification, microstructural development, mechanical properties and application fields.

Media
Slides for the lecture:
available under http://www.iam.kit.edu/km/289.php

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

E. Dörre, H. Hübner, "Aluminia", Springer Verlag Berlin, (1984)

M. Barsoum, "Fundamentals of Ceramics", McGraw-Hill Series in Material Science and Enginewering (2003)

Remarks
The course will not take place every year.

Course: Superhard Thin Film Materials [2177618]

Coordinators: S. Ulrich
Part of the modules: SP 47: Tribology (p. 163)[SP_47_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
Superhard materials are solids with a hardness higher than 4000 HV 0,05. The main topics of this lecture are modelling, deposition, characterization and application of superhard thin film materials.

Content
Introduction

Basics

Plasma diagnostics

Particle flux analysis

Sputtering and ion implantation

Computer simulations

Properties of materials, thin film deposition technology,
thin film analysis and modelling of superhard materials

Amorphous hydrogenated carbon

Diamond like carbon

Diamond

Cubic Boronnitride

Materials of the system metall-boron-carbon-nitrogen-silicon

Literature
G. Kienel (Ed.): Vakuumbeschichtung 1 - 5, VDI Verlag, Düsseldorf, 1994

Copies with figures and tables will be distributed

Course: Supply chain management [2117062]

Coordinators: K. Alicke
Part of the modules: SP 19: Information Technology of Logistic Systems (p. 132)[SP_19_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 29: Logistics and Material Flow Theory (p. 143)[SP_29_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 02: Powertrain Systems (p. 113)[SP_02_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 20: Integrated Product Development (p. 133)[SP_20_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 40: Robotics (p. 155)[SP_40_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 ökologichen 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 simulationduring the process of developement of technical products
- delivery of key skills such as team skills / project / self / presentation based on realistic projects

Course: Technical Acoustics [2158107]

Coordinators: M. Gabi

Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 10: Engineering Design (p. 123)[SP_10_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 15: Fundamentals of Energy Technology (p. 129)[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
none

Recommendations
none

Learning Outcomes
First, the students get to know the fundmental 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. Furtheron 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 acoustice 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. 131)[SP_18_mach], SP 40: Robotics (p. 155)[SP_40_mach]

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

Learning Control / Examinations
Written examination

Duration: 2 hours (compulsory subject)

Auxiliary means: none

Conditions
None.

Recommendations
None.

Learning Outcomes
The students possess essential knowledge about information processing in digital computers. Based on information representation and calculations of complexity, students are capable to design algorithms efficiently. The students are able to apply the knowledge about efficient algorithm design to important numerical computation methods in mechanical engineering. Students understand the importance of software quality in mechanical engineering and know basic concepts and important measures of quality assurance.

Content
Introduction: definitions, basic concepts, introductory examples

Information coding on finite automata: numbers, characters, commands, examples

Algorithm design: definitions, complexity of algorithms, complexity classes P and NP, examples

Sorting algorithms: relevance, algorithms, simplifications, examples

Software quality assurance: terms and measures, errors, phases of quality assurance, constructive measures, analytical measures, certification

Lectures are complemented by an exercice course.

Literature
Vorlesungsskript (Internet)

Becker, B., Molitor, P.: Technische Informatik : eine einführende Darstellung. München, Wien : Oldenbourg, 2008.

Hoffmann, D. W.: Grundlagen der Technischen Informatik. München: Hanser, 2007.

Balzert, H.: Lehrbuch Grundlagen der Informatik : Konzepte und Notationen in UML, Java und C++, Algorithmik und Software-Technik, Anwendungen. Heidelberg, Berlin : Spektrum, Akad. Verl., 1999.

Trauboth, H.: Software-Qualitätssicherung : konstruktive und analytische Maßnahmen. München, Wien : Oldenbourg, 1993.

Course: Vibration Theory [2161212]

Coordinators: W. Seemann

Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 05: Calculation Methods in Mechanical Engineering (p. 117)[SP_05_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 42: Technical Acoustics (p. 158)[SP_42_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach]

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

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

Conditions
None.

Recommendations
Examen in Engineering Mechanics 3 + 4

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

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

Content
Concept of vibration, superposition of vibration with equal and with different frequencies, complex frequency response.

Vibration of systems with one dof: Free undamped and damped vibration, forced vibration for harmonic, periodic and arbitrary excitation. Excitation of undamped vibration in resonance.

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

Vibration of systems with distributed parameters: Partial differential equations as equations of motion, wave propagation, d'Alembert's solution, Ansatz for separation of time and space, eigenvalue problem, infinite number of eigenvalues and eigenfunctions.

Introduction to rotor dynamics: Laval rotor in rigid and elastic bearings, inner damping, Laval rotor in anisotropic bearings, synchronous and asynchronous whirl, rotors with asymmetric shaft.

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

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

Wittenburg: Schwingungslehre, Springer-Verlag, Berlin, 1995

Course: Technical Design in Product Development [2146179]

Coordinators: M. Schmid, Dr. -Ing. Markus Schmid
Part of the modules: SP 03: Work Science (p. 115)[SP_03_mach], SP 10: Engineering Design (p. 123)[SP_10_mach]

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

Learning Control / Examinations
For the reason of high sutdent number the exam is a written exam.
Only dictionnary is allowed.

Conditions
Authorisation by the Examination Office.

Recommendations
None

Learning Outcomes
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 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral
duration 20 minutes
No tools or reference materials may be used during the exam

Conditions
Materials Science and Engineering I & II

Learning Outcomes
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 state on mechanical properties
Stability of component states
Steel manufacturing
Component states due to forming
Component states due to heat treatments
Component states due to surface hardening
Component states due to machining
Component states due to mechanical surface treatments
Component states due to joining
Summarizing evaluation

Literature
Script will be distributed within the lecture
VDEh: Werkstoffkunde Stahl, Bd. 1: Grundlagen, Springer-Verlag, 1984
H.-J. Eckstein: Technologie der Wärmebehandlung von Stahl, Deutscher Verlag Grundstoffindustrie, 1977
H.K.D.H. Badeshia, R.W.K. Honeycombe, Steels - Microstructure and Properties, CIMA Publishing, 3. Auflage, 2006
V. Schulze: Modern Mechanical Surface Treatments, Wiley, Weinheim, 2005

Course: Technologies for energy efficient buildings [2158106]

Coordinators: F. Schmidt
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[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.; Wambsganß, 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: Ten lectures on turbulence [2189904]

Coordinators: I. Otic
Part of the modules: SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 53: Fusion Technology (p. 169)[SP_53_mach]

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

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

Conditions
None.

Recommendations

- Fundamentals of fluid dynamics

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

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

Course: Materials under high thermal or neutron loads [2194650]

Coordinators: A. Möslang, Dr. Michael Rieth
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach]

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

Learning Control / Examinations
Oral Examination (20 min)

Conditions
Materials science I

Recommendations
none

Learning Outcomes
Advanced structural and functional materials for thermally or neutronically highly loaded systems. The students learn property profiles, applications and the interaction between atomic structure, microstructure and macroscopic materials behaviour.

Content
- Introduction and basics
- Metallic and ceramic solid state structure
- Transport of mater and conversion in solid state
- Material properties at high heat leoads
- Interaction between energetic particles and condensed matter, irradiation damage
- Nanoscaled modelling of damage relevant properties
- State-of-the-art analytical methods with particles
- Highly heat resistant Steels
- Nanoscaled, oxide dispersion strengthened alloys
- Super alloys
- Refractory metals and laminates
- Fibre reinforced structural ceramics
- Light high strength Beryllium alloys
- Oxides and functional materials
- Joining technologies
- Strategies of materials development
- Applications in Fusion, fission, large scale accelerators and concentrated solar power

Literature
Presentation with figures and tables, Exercise sheets

Course: Thermal Solar Energy [2169472]

Coordinators: R. Stieglitz
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 23: Power Plant Technology (p. 136)[SP_23_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 phyical content such as radiation, thermal use, insulation etc.. Further the design of solar collectors for different purposes is discussed and analyzed. The functional principle of solar plants is elaborated before at the ende the ways for solar climatization is 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 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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 indi-vidual components and assamblies, 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 be-comes 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 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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: Fundamentals in Materials Thermodynamics and Heterogeneous Equilibria (with exercises) [2193002]

Coordinators: H. Seifert
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach]

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

Learning Control / Examinations
Oral examination (30 min)

Conditions

- basic course in materials science and engineering
- physical chemistry

Recommendations
none

Learning Outcomes
This class deals with the heterogeneous phase equilibria of binary, ternary and multicomponent materials systems. The thermodynamic properties of multiphase engineering materials and their reactions with gas and liquid phases are analyzed.

Content
1. Binary phase diagrams
2. Ternary phase diagrams
- Complete solubility
- Eutectic systems
- Peritectic systems
- Systems with transition reactions
- Systems with intermetallic phases
3. Thermodynamics of solution phases
4. Materials reactions involving pure condensed phases and a gaseous phase
5. Reaction equilibria in systems containing components in condensed solutions
6. Thermodynamics of multicomponent multiphase materials systems
7. Calculation of Phase Diagrams (CALPHAD)

Literature
1. Phase Equilibria, Phase Diagrams and Phase Transformations, Their Thermodynamic Basis; M. Hillert, University Press, Cambridge (2007)
2. Introduction to the Thermodynamics of Materials; D.R. Gaskell, Taylor & Francis (2008)

Course: Tractors [2113080]

Coordinators: M. Kremmer
Part of the modules: SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
oral examination

Conditions
basic knowledge in mechanical engineering

Learning Outcomes
After completion of the course the Students know:

- important problems in agritechnological developments
- Customer requirements and their implementation in tractors
- Tractor technology in width and depth

Content
Tractors are one of the most underestimated vehicles in regard to performance und technics. Almost none vehicle is as multifunctional and fullfilled with high-tec as a tractor. Automatic guidance, special chassis suspension or special concepts of power trains are one of the topics where tractors are in leading position in technologies

During the lecture an overview about the design and construction and application area is given. A close look will be taken on the historical backround, legal requirements, ways of development, agricultural organizations and the proces of development itself.

In detail the following topics will be dealt with:

- agricultural organization / legal requirements
- history of tractors
- tractor engineering
- tractor mechanics
- chassis suspension
- combustion engine
- transmission
- interfaces
- hydraulics
- wheels and tyres
- cabin
- electrics and electronics

Literature

- K.T. Renius: Traktoren - Technik und ihre Anwendung; DLG Verlag (Frankfurt), 1985
- E. Schilling: Landmaschinen - Lehr- und Handbuch für den Landmaschinenbau; Schilling-Verlag (Köln), 1960

Course: Tribology A [2181113]

Coordinators: M. Scherge, M. Dienwiebel
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 47: Tribology (p. 163)[SP_47_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 science

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, evironmental influences, tribological age, contact models, Simulation of contacts, roughness.

* Chapter 2: Wear, plastic deformation at the asperity level, dissipation modes, mechanical mixing, Dynamics of the third body, running-in, running- in dynamics, shear stress.

* Chapter 3: Lubrication, base oils, Stribeck plot, lubrication regimes (HD, EHD, mixed lubrication), additives, oil characterization, solid lubrication.

Literature
[1] Fleischer, G. ; Gröger, H. ; Thum: Verschleiß und Zuverlässigkeit. 1. Auflage. Berlin : VEB-Verlag Technik, 1980

[2] Persson, B.J.N.: Sliding Friction, Springer Verlag Berlin, 1998

[3] M. Dienwiebel, and M. Scherge, Nanotribology in automotive industry, In:Fundamentals of Friction and Wear on the Nanoscale; Editors: E. Meyer and E. Gnecco, Springer, Berlin, 2007.

[4] Scherge, M., Shakhvorostov, D., Pöhlmann, K.: Fundamental wear mechanism of metals. Wear 255, 395–400 (2003)

[5] Shakhvorostov, D., Pöhlmann, K., Scherge, M.: An energetic approach to friction, wear and temperature. Wear 257, 124–130 (2004)

Course: Tribology B [2182139]

Coordinators: M. Scherge, M. Dienwiebel
Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 47: Tribology (p. 163)[SP_47_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, ist consequences as well as the prevention of defects and breakdown

On the basis of a wide physikal 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 23: Power Plant Technology (p. 136)[SP_23_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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 Turbomaschines, general overview

Design of a turbomachine: Criteria and development

Radial machines

Transonic compressors

Combustion chambers

Multi-spool installations

Literature
Münzberg, H.G.: Gasturbinen - Betriebsverhalten und Optimierung, Springer Verlag, 1977

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

Course: Turbo Jet Engines [2170478]

Coordinators: H. Bauer, A. Schulz
Part of the modules: SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_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 fluidmechanics 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: metal forming [2150681]

Coordinators: T. Herlan, Dr. Herlan
Part of the modules: SP 39: Production Technology (p. 153)[SP_39_mach]

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

Learning Control / Examinations
oral, duration 30 min., no resources

Conditions
None.

Learning Outcomes
The lecture introduces into the basics of metal forming. Processes, tools, tool machines and equipment are presented in a systematic and integrated way. The student should be placed in a position to understand metal forming processes, to identify contexts and to transfer knowledge onto other metal forming problems.

Content
1. Basics
2. Definition of forming
3. Metallographic fundamentals
4. Plasto mechanics
5. Tribology
6. Dimensioning of metal forming processes
7. Processes
8. Extrusion
9. Sheet forming
10. Deep drawing

Literature
Lecture notes

Course: Combustion diagnositics [2167048]

Coordinators: R. Schießl, U. Maas
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach]

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

Learning Control / Examinations
Oral
Duration: 30 min.

Conditions
None

Recommendations
None

Learning Outcomes
After completing this course students can:

- understand the specific requirements for diagnostic techniques in combustion applications.
- explain the physical fundamentals of diagnostic techniques, in particular of laser diagnostics.
- assess the potentials and the limits of the different diagnositc methods.

Content
Diagnostical methods: Laser induced fluorescence, Rayleigh-scattering, Raman-scattering
Chemoluminescence.
Reduced description of combustion processes and measurements.
Discussion of the potential and limits of specific strategies in different combustion systems.

Literature
Lecture notes
A.C. Eckbreth, Laser Diagnostics for Combustion Temperature and Species,
Abacus Press, 2nd ed. (1996)
W. Demtröder, Laser Spectroscopy: Basic Concepts and Instrumentation,
Springer, 3rd ed., 2003
Hollas J.M. Modern Spectroscopy, Wiley, 3rd ed., 1996
K. Kohse-Höinghaus, J. B. Jeffries (ed.), Applied Combustion Diagnostics,
Taylor and Francis
Atkins P., Paula, J., Physical Chemistry, 8th ed., Oxford University Press,
2006

Course: Combustion Engines A with tutorial [2133101]

Coordinators: U. Spicher

Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 45: Engineering Thermodynamics (p. 161)[SP_45_mach], SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 02: Powertrain Systems (p. 113)[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 student understands the working princile of combustion engines. He is able to understand, analyse and judge the combustion process. He is able to evaluate influences of gas exchange, mechanics and exhaust gas aftertreatment on the combustion performance. He can contribute to basic research work in the field of engine development.

Content
The students get basic knowledgement in construction, thermodynamic process, main concepts of gasoline and Diesel engines, driving gear dynamics and design of combustion engines. In particular the thermodyanamical processes and the problems of exhaust gas emissions are discussed.
Also, this lecture provides fundamentals for continuative lectures in the field of combustion engines.

Literature
Lecturer notes available in the 'Studentenhaus'

Remarks
weekly exercises to consolidate the content of the lecture

Course: Combustion Engines B with Tutorial [2134135]

Coordinators: U. Spicher

Part of the modules: SP 48: Internal Combustion Engines (p. 164)[SP_48_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
oral examination, Duration: 0,5 hours, no auxiliary means

Conditions
None.

Recommendations
Combustion Engines A helpful

Learning Outcomes
The students deepen and complement their knowledgement from the lecture combustion engines A. The 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 content of the lecture

Course: Behaviour Generation for Vehicles [2138336]

Coordinators: C. Stiller, T. Dang
Part of the modules: SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach], SP 22: Cognitive Technical Systems (p. 135)[SP_22_mach], SP 40: Robotics (p. 155)[SP_40_mach], SP 18: Information Technology (p. 131)[SP_18_mach], SP 11: Vehicle Dynamics, Vehicle Comfort and Acoustics (p. 125)[SP_11_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 44: Technical Logistics (p. 160)[SP_44_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 09: Dynamic Machine Models (p. 122)[SP_09_mach], SP 34: Mobile Machines (p. 148)[SP_34_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. 139)[SP_26_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

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 DEsciption 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. 139)[SP_26_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 25: Lightweight Construction (p. 138)[SP_25_mach], SP 43: Technical Ceramics and Powder Materials (p. 159)[SP_43_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_mach]

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

Learning Control / Examinations
oral exam 30 minutes
no tools or reference materials

Conditions
compulsory preconditions: none

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 elasic fracture mechanics
6.3 crack resitance
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: M. Klaiber
Part of the modules: SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 39: Production Technology (p. 153)[SP_39_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 wheeles
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 for Mechatronic Products [2121370]

Coordinators: S. Rude
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 34: Mobile Machines (p. 148)[SP_34_mach]

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

Learning Control / Examinations
Oral examination, Duration: 20 min, Auxiliary Means: none

Conditions
None.

Recommendations
Knowledge of CAx is assumed. Therefore it is recommended to attend the course Virtual Engineering I [2121352] beforehand.

Learning Outcomes
Students should be able to apply the procedure of integrating mechatronic components in products.
Students should understand special requirements of functional networked systems.
Practical relevance of the methods are communicated with examples from automotive industry.

Content
The integration of mechatronic components in all products changes geometry-oriented construction activities in function-oriented activities. In this context, the application of IT systems needs to be realigned. The lecture deals with the following issues from the perspective of the automobile industry:

- challenges in the construction process concerning the integration of mechatronic components in products,
- support of task clarification through requirements management,
- problem-solving on the basis of functionally networked systems,
- implementation of solutions on the basis of electronics (sensors, actuators, networked control devices),
- control of distributed software systems through software engineering and
- challenges in tests and backups, concerning the system quality that needs to be achieved.

Literature
Lecture slides

Course: Virtual Engineering I [2121352]

Coordinators: J. Ovtcharova
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach]

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

Learning Control / Examinations
Oral examination
Duration: 30 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. They will be able to utilize CAD/PLM systems in different phases of the product development process.
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 different types of integration of CAD/CAE systems with their advantages and disadvantages.
They will know how to integrate CAM modules (or systems) with CAD systems and will be able to define and simulate production processes in CAM modules. They will have an understanding of the Virtual Engineering philosophy and virtual factory. They will be able to clearly identify the advantages of Virtual Engineering compared with the conventional approach.

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 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 system along with praxis-oriented exercises.

Literature
Lecture slides

Course: Virtual Engineering II [2122378]

Coordinators: J. Ovtcharova
Part of the modules: SP 28: Lifecycle Engineering (p. 142)[SP_28_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 09: Dynamic Machine Models (p. 122)[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. The 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
Part of the modules: SP 40: Robotics (p. 155)[SP_40_mach], SP 04: Automation Technology (p. 116)[SP_04_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 31: Mechatronics (p. 145)[SP_31_mach], SP 27: Modeling and Simulation in Energy- and Fluid Engineering (p. 141)[SP_27_mach], SP 28: Lifecycle Engineering (p. 142)[SP_28_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: Heatpumps [2166534]

Coordinators: H. Wirbser, U. Maas
Part of the modules: SP 45: Engineering Thermodynamics (p. 161)[SP_45_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
The attendance of this course enables students to:

- describe the setup and the working principle of heat pumps.
- specify the various types of heat pumps.
- discuss the energetic requirements.
- enumerate the advantages and drawbacks of heat pumps as heating system.

Content
The aim of this lecture is to promote heat pumps as heating systems for small an medium scale facilities and to discuss their advantages as well as their drawbacks. After considering the actual energy situation and the political requirements the different aspects of heat pumps are elucidated. The requirements concerning heat sources, the different components and the various types of heat pumps are discussed. In addition ecological and economical aspects are taken into consideration. The coupling of heat pumps with heat accumulators in heating systems will also be part of the lecture.

Literature
Vorlesungsunterlagen
Bach, K.: Wärmepumpen, Bd. 26 Kontakt und Studium, Lexika Verlag, 1979
Kirn, H., Hadenfeldt, H.: Wärmepumpen, Bd. 1: Einführung und Grundlagen, Verlag C. F. Müller, 1987
von Cube, H.L.: Lehrbuch der Kältetechnik, Verlag C.F. Müller, Karlsruhe, 1975.
von Cube, H.L., Steimle,F.: Wärmepumpen, Grunglagen und Praxis VDI-Verlag, Düsseldorf, 1978.

Course: Hydrogen Technologies [2170495]

Coordinators: T. Jordan
Part of the modules: SP 23: Power Plant Technology (p. 136)[SP_23_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 course content is the cross-cutting issue of hydrogen as energy carrier. The basic hydrogen technologies will be presented in order to analyse and substantiate the idea of a hydrogen economy. The physical properties of hydrogen will be introduced. The production, distribution, storage and applications are explained. The latter comprise hydrogen utilization in combustion engines and in fuel cells. The safety asepcts will be treated as a cross-cutting issue by comparing with hazards of conventional energy carriers.

Content
Basic concepts
Production
Transport and storage
Application
Safety aspects

Literature
Ullmann's Encyclopedia of Industrial Chemistry
http://www.hysafe.net/BRHS

Course: Wellenausbreitung [2161219]

Coordinators: W. Seemann
Part of the modules: SP 04: Automation Technology (p. 116)[SP_04_mach], SP 01: Advanced Mechatronics (p. 111)[SP_01_mach], SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 08: Dynamics and Vibration Theory (p. 121)[SP_08_mach]

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

Learning Control / Examinations
Oral

30 minutes (optional subject), 20 minutes (major subject)

no means

Conditions
EM III, EM IV, Control theory

Learning Outcomes
The development of new products by spatial and functional integration of mechanical, electrical or electronical and computational components is a rapidly increasing trend in many technical areas. The system-theoretical analysis of such mechatronical systems is therefore very important. The course focuses on the description of mechatronic systems by physical and mathematical models. Emphasis is put on the complete system which may incorporate different disciplines. Aim of the course is to provide principles and tools to derive the mathematical models of mechatronic systems.

Content
Basics for the theoretical modelling by synthetic and analytical methods. Classification of elements of the system, fundamental equations, constitutive equations. Kinetic potential, virtual work, systems with distributed parameters, Hamilton's principle, all for mechatronic systems. Background for experimental modelling of mechatronic systems. Foundations of solid and fluid mechanics. Basics of electronics (Maxwell's equations, electric and magnetic field, modelling of electronic circuits, analogue parts). Sensors and actuators as well as converter principles. Summary of control of mechatronic systems, especially digital control.

Literature
Script of the course.
Isermann, R.: Mechatronische Systeme, Springer, 1999.
Heimann, B., Gerth, W., Popp, K.: Mechatronik, Hanser, 1998
Riemer, M., Wauer, J., Wedig, W.: Mathematische Methoden der Technischen Mechanik, Springer, 1993

Course: Material Analysis [2174586]

Coordinators: J. Gibmeier
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach]

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

Learning Control / Examinations
oral examination
duration: 20 - 30 minutes
no auxillray resources

Conditions
obligation: Material Science I/II

Learning Outcomes
The students have basic knowledge about methods of material analysis. They have a basic understanding to transfer this nasic knowledge on problems in engineering science. Furthermore, the students have the ability to describe technical material by its microscopic and submicroscopic structure

Content
The following methods will be introduced within this module:

microscopic methods: optical microscopy, electron microscopy (SEM/TEM), atomic force microscopy

material and microstructure analyses by means of X-ray, neutron and electron beams

spectroscopic methods

Literature
lecture notes (will be provided at the beginning of the lecture)

literature will be quoted at the beginning of the lecture

Course: Materials 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. 139)[SP_26_mach], SP 02: Powertrain Systems (p. 113)[SP_02_mach], SP 12: Automotive Technology (p. 126)[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 25: Lightweight Construction (p. 138)[SP_25_mach], SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 12: Automotive Technology (p. 126)[SP_12_mach], SP 46: Thermal Turbomachines (p. 162)[SP_46_mach], SP 10: Engineering Design (p. 123)[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-orientied and material aspects of lightweight construction

Aluminium-based alloys
Aluminium wrought alloys
Aluminium cast alloys

Magnesium-based alloys
Magnesium wrought alloys
Magnesium cast alloys

Titanium-based alloys
Titanium wrought alloys
Titanium cast alloys

High-strength steels
High-strength structural steels
Heat-treatable and hardenable steels

Composites - mainly PMC
Matrices
Reinforcements

Literature
Presentation slides and additional lecture notes are handed out during the lecture, additional literature recommendations given

Course: Material Science III [2173553]

Coordinators: A. Wanner
Part of the modules: SP 26: Materials Science and Engineering (p. 139)[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 treatmens and of alloying on the microstructure and the properties of iron-based materials (steels in particular). The can select steels for structural applications in mechanical engineering and subject them to appropriate heat treatmens.

Content
Properties of pure iron; thermodynamic foundations of single-component and of binary systems; nucleation and growth; diffusion processes in crystalline iron; the phase diagram Fe-Fe3C; effects of alloying on Fe-C-alloys; nonequilibrium microstructures; multicomponent iron-based alloys; heat treatment technology; hardenability and hardenability tests.

Literature
Lecture Notes; Problem Sheets; Bhadeshia, H.K.D.H. & Honeycombe, R.W.K.
Steels – Microstructure and Properties
CIMA Publishing, 3. Auflage, 2006

Course: Materials modelling: dislocation based plasticity [2182740]

Coordinators: D. Weygand

Part of the modules: SP 26: Materials Science and Engineering (p. 139)[SP_26_mach], SP 13: Strength of Materials/ Continuum Mechanics (p. 128)[SP_13_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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 04: Automation Technology (p. 116)[SP_04_mach], SP 39: Production Technology (p. 153)[SP_39_mach], SP 10: Engineering Design (p. 123)[SP_10_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: Wind- and Waterpower [2157450]

Coordinators: M. Gabi, N. Lewald
Part of the modules: SP 24: Energy Converting Engines (p. 137)[SP_24_mach]

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

Learning Control / Examinations
Oral exam, 30 minutes, no means

Conditions
None

Recommendations
Fluid Mechanics

Learning Outcomes
The students know basic fundamentals for the use of wind- and waterpower.

Content
Wind- and waterpower fundamental lecture. Introduction in the basics of fluid machinery.
Windpower:
Basic knowledge for the use of wind power for electricity, complemented by historical development, basic knowledge on wind systems and alternative renewable energies. Global and local wind systems as well as their measurement and energy content are dedicated. Aerodynamic basics and connections of wind-power plants and/or their profiles, as well as electrical system of the wind-power plants are described. Fundamental generator technology over control and controlling of the energy transfer.
Finally the current economic, ecological and legislations boundary conditions for operating wind-power plants are examined.An overview of current developments like super-grids and visions of the future of the wind power utilization will be given.
Waterpower:
Basic knowledge for the use of water power for electricity, complemented by historical development. Description of typical hydropower systems.
Introduction in the technology and different types of water turbines. Calculation of the energy conversion of typical hydropower systems.

Literature

- Erich Hau, Windkraftanlagen, Springer Verlag.
- J. F. Douglas er al., Fluid Mechanics, Pearson Education.
- Pfleiderer, Petermann, Strömungsmaschinen, Springer Verlag.

Course: Windpower [23381]

Coordinators: Lewald
Part of the modules: SP 15: Fundamentals of Energy Technology (p. 129)[SP_15_mach], SP 24: Energy Converting Engines (p. 137)[SP_24_mach]

ECTS Credits	Hours per week	Term	Instruction language
3	2/0	Winter term	de

Learning Control / Examinations
The assessment consists of an oral exam (20 min) taking place at the beginn of the recess period (according to Section 4 (2), 2 of the examination regulation). The exam takes place in every winter semester. Re-examinations are offered at every ordinary examination date.

Conditions
None.

Learning Outcomes
The goal is to relay basic fundamentals for the use of wind power.
Wind Power fundamental lecture. Focus of the lecture is basic knowledge for the use of wind power for electricity, complemented by historical development, basic knowledge on wind systems and alternative renewable energies.

Content
The lecture contacts due to the broadly basic knowledge to all listeners of all terms.
On the basis of an overview of alternative, renewable energy technologies as well as general energy data, the entrance is transacted into the wind energy by means of an overview of the historical development of the wind force.
Since the wind supplies the driving power as indirect solar energy, the global and the local wind systems as well as their
measurement and energy content are dedicated to its own chapter.
Whereupon constructing the aerodynamic bases and connections of wind-power plants and/or their profiles are described. The electrical system of the wind-power plants forms a further emphasis. Begun of fundamental generator technology over control and controlling of the energy transfer.
After the emphasis aerodynamics and electrical system the further components of wind-power plants and their characteristics in the connection are described.
Finally the current economic, ecological and legislations boundary conditions for operating wind-power plants are examined.
In addition to wind-power plants for electricity production, the lecture is also shortly aiming at alternative use possibilities such as pumping systems.
Finally an overview of current developments like super-grids and visions of the future of the wind power utilization will be
given.

Media
A scriptum that has to be overhault is available on http://www.ieh.uni-karlsruhe.de/windkraftanlagen.php
Further book titles or relevant websites will be announced in the lecture.

Course: Vortex Flows [2153428]

Coordinators: K. Bühler
Part of the modules: SP 41: Fluid Mechanics (p. 157)[SP_41_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 sutdents are familiar with the physical basics and the mathematical description of vortex flows as weill as with the definitions of vorticity, circulation and dissipation in vortex flows. They are able to analyze two- and three-dimensional vortex flows in steady and time-dependent form with respect to their structure, time-behaviour and stability.

Content

- Definition of a vortex
- Theoretical description of vortex flows
- Steady and time-dependent solutions of vortex flows
- Stability behavior of vortex flows
- Different types of vortex flows are analyzed: Lamb-, Hamel-, Oseen-, Burgers-, Sullivan-, Rankine-, Hill-, Taylor- and Görtler vortices

Media
Numerical simulations with Computer-Algebra. Practical demonstrations with Mini-experiments.

Remarks
Block Course. Details see www.isl.kit.edu

Course: Scientific computing for Engineers [2181738]

Coordinators: D. Weygand, P. Gumbsch
Part of the modules: SP 30: Engineering Mechanics and Applied Mathematics (p. 144)[SP_30_mach], SP 35: Modeling and Simulation (p. 149)[SP_35_mach], SP 49: Reliability in Mechanical Engineering (p. 165)[SP_49_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 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++
* progamm organization
* data types, operator, control structures
* dynamic memory allocation
* functions
* class
* OpenMP parallelization
5. numeric /algorithms
* finite differences
* MD simulations: 2nd order differential equations
* algorithms for particle simulations
* solver for linear systems of eqns.

Literature
[1] C++: Einführung und professionelle Programmierung; U. Breymann, Hanser Verlag München
[2] C++ and object-oriented numeric computing for Scientists and Engineers, Daoqui Yang, Springer Verlag.
[3] The C++ Programming Language, Bjarne Stroustrup, Addison-Wesley
[4] Die C++ Standardbibliothek, S. Kuhlins und M. Schader, Springer Verlag

Numerik:

[1] Numerical recipes in C++ / C / Fortran (90), Cambridge University Press
[2] Numerische Mathematik, H.R. Schwarz, Teubner Stuttgart
[3] Numerische Simulation in der Moleküldynamik, Griebel, Knapek, Zumbusch, Caglar, Springer Verlag

Course: Workshop Product Development [2145157]

Coordinators: A. Albers
Part of the modules: SP 20: Integrated Product Development (p. 133)[SP_20_mach]

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

Learning Control / Examinations
oral examination (60 minutes)
combined examination of lectures, tutorials and project work

Conditions
The participation in “Integrated Product Development” requires the concurrent participation in lectures (2145156), tutorials (2145157) and project work (2145300).
Due to organizational reasons, the number of participants is limited to 42 persons. Thus a selection has to be made. For registration to the selection process a standard form has to be used, that can be downloaded from IPEK hompage from april to july. The selection itself is made by Prof. Albers in personal interviews.

Recommendations
none

Learning Outcomes
The theoretical background taught in the lecture, is deepened through methodworkshops, business games and case studies. The reflexion of the onself precedure allows for an applicability and practicability of the contents in the accompnying development project as well as for the career entry.

Content
problem solving: analysis techniques, creativity techniques and evaluation methods
professional skills: presentation techniques, moderation and teamcoaching
development tools: MS Project, Szenario-Manager & Pro/Engineer Wildfire

Literature
none

Course: Two-Phase Flow and Heat Transfer [2169470]

Coordinators: T. Schulenberg, M. Wörner
Part of the modules: SP 53: Fusion Technology (p. 169)[SP_53_mach], SP 23: Power Plant Technology (p. 136)[SP_23_mach], SP 21: Nuclear Energy (p. 134)[SP_21_mach], SP 41: Fluid Mechanics (p. 157)[SP_41_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
Bachelor

Learning Outcomes
This lecture is addressed to students of mechanical engineering or chemical engineering. Two-phase flows with eat transfer are phenomena occuring in steam generators and condensers, like in power stations or refrigerators.

Content
Examples for technical applications

Definitions and averaging of two-phase flows

Flow regimes and transitions

Two-phase models

Pressure drop of two phase flows

Pool boiling

Forced convective boiling

Condensation

Two-phase flow instabilities

Literature
lecture notes

Universität Karlsruhe (TH)
Forschungsuniversität · gegründet 1825

Der Rektor

Amtliche Bekanntmachung

2008 Ausgegeben Karlsruhe, den 09. September 2008 Nr. 79

I n h a l t **Seite**

Studien- und Prüfungsordnung der Universität Karlsruhe (TH) für den Masterstudiengang 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 Masterstudiengang Maschinenbau beschlossen.

Der Rektor hat seine Zustimmung am 28. Februar 2008 erteilt.

Inhaltsverzeichnis

In dieser Satzung wurde nur die weibliche Sprachform gewählt. Alle personenbezogenen Aussagen gelten jedoch stets für Frauen und Männer gleichermaßen.

Die Universität Karlsruhe (TH) hat sich im Rahmen der Umsetzung des Bolognaprozesses zum Aufbau eines Europäischen Hochschulraumes zum Ziel gesetzt, dass am Abschluss der Studierendenausbildung an der Universität Karlsruhe (TH) in der Regel der Mastergrad steht. Die Universität Karlsruhe (TH) sieht daher die an der Universität Karlsruhe (TH) angebotenen konsekutiven Bachelor- und Masterstudiengänge als Gesamtkonzept mit konsekutivem Curriculum.

I. Allgemeine Bestimmungen

§ 1 Geltungsbereich, Ziele

(1) Diese Masterprüfungsordnung regelt Studienablauf, Prüfungen und den Abschluss des Studiums im Masterstudiengang Maschinenbau an der Universität Karlsruhe (TH).

(2) Im Masterstudium sollen die im Bachelorstudium erworbenen wissenschaftlichen Qualifikationen weiter vertieft oder ergänzt werden. Die Studentin soll in der Lage sein, die wissenschaftlichen Erkenntnisse und Methoden selbstständig anzuwenden und ihre Bedeutung und Reichweite für die Lösung komplexer wissenschaftlicher und gesellschaftlicher Problemstellungen zu bewerten.

§ 2 Akademischer Grad

Aufgrund der bestandenen Masterprüfung wird der akademische Grad „Master of Science“ (abgekürzt: „M.Sc.“) verliehen.

§ 3 Regelstudienzeit, Studienaufbau, Leistungspunkte

(1) Die Regelstudienzeit beträgt vier Semester. Sie umfasst Prüfungen, ein Berufspraktikum und die Masterarbeit.

(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, Teilmodule 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 120 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 Masterprüfung besteht aus einer Masterarbeit und Modulprüfungen, jede der Modulprüfungen 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 mündlichen Modulteilprüfungen (§ 4 Abs. 2, Nr. 1 und 2) in einem bestimmten Modul zugelassen zu werden, muss die Studentin vor der ersten schriftlichen oder mündlichen Modulteilprüfung in diesem Modul beim Studienbüro eine bindende Erklärung über die Wahl des betreffenden Moduls bzw. der Lehrveranstaltungen, 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 Masterarbeit.

(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

1. die Studentin in einem mit dem Maschinenbau vergleichbaren oder einem verwandten Studiengang bereits eine Diplomvorprüfung, Diplomprüfung, Bachelor- oder Masterprüfung endgültig nicht bestanden hat, sich in einem Prüfungsverfahren befindet oder den Prüfungsanspruch in einem solchen Studiengang verloren hat,
2. die gemäß dem Studienplan für die jeweilige Modulprüfung notwendigen Studienleistungen nicht nachgewiesen werden können,
3. die in § 18 genannte Voraussetzung nicht erfüllt ist.

In Zweifelsfällen entscheidet die 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, 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 zwischen Prüferin und Studentin kann die Art der Erfolgskontrolle auch nachträglich geändert werden. Dabei ist jedoch § 4 Abs. 3 zu berücksichtigen.

(3) Eine schriftlich durchzuführende Prüfung kann auch mündlich, eine mündlich durchzuführende Prüfung kann auch schriftlich abgenommen werden. Diese Änderung muss mindestens sechs Wochen vor der Prüfung bekannt gegeben werden.

(4) Weist eine Studentin nach, 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 der Kommission aufgeschoben werden kann, deren Vorsitzende – gestatten, Erfolgskontrollen in einer anderen Form zu erbringen.

(5) Bei Lehrveranstaltungen in englischer Sprache können mit Zustimmung der Studentin die entsprechenden Erfolgskontrollen in englischer Sprache abgenommen werden.

(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 240 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 Beisitzende anwesend sein, die zusätzlich zur Prüferin die Protokolle zeichnet.

378

§ 7 Bewertung von Prüfungen und Erfolgskontrollen

(1) Das Ergebnis einer Erfolgskontrolle wird von den jeweiligen Prüferinnen in Form einer Note festgesetzt.

(2) Im Masterzeugnis 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 Masterarbeit 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 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 nur einmal angerechnet werden. Die Anrechnung eines Moduls, einer Lehrveranstaltung oder einer Erfolgskontrolle ist darüber hinaus ausgeschlossen, wenn das betreffende Modul, die Lehrveranstaltung oder die Erfolgskontrolle bereits in einem grundständigen Bachelorstudiengang angerechnet wurde, auf dem dieser Masterstudiengang konsekutiv aufbaut.

(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 Lehrveranstaltungsnoten (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 Masterarbeit, 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) Innerhalb der Regelstudienzeit, einschließlich der Urlaubssemester für das Studium an einer ausländischen Hochschule (Regelprüfungszeit), können in einem Modul auch mehr Leistungspunkte erworben werden als für das Bestehen der Modulprüfung erforderlich sind. Bei der Festlegung der Modulnote werden dabei alle Teilmodule gemäß ihrer Leistungspunkte gewichtet.

(13) Die Gesamtnote der Masterprüfung, 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 Modulteilprüfungen, Modulprüfungen und für die Masterprüfung nach folgender Skala vergeben:

ECTS-Note	Definition mit Quote
A	gehört zu den besten 10 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
B	gehört zu den nächsten 25 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
C	gehört zu den nächsten 30 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
D	gehört zu den nächsten 25 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
E	gehört zu den letzten 10 % der Studentinnen, die die Erfolgskontrolle bestanden haben,
FX	*nicht bestanden* (failed) - es sind Verbesserungen erforderlich, bevor die Leistungen anerkannt werden,
F	*nicht bestanden* (failed) - es sind erhebliche Verbesserungen erforderlich.

Die Quote ist als der Prozentsatz der erfolgreichen Studentinnen definiert, die diese Note in der Regel erhalten. Dabei ist von einer mindestens fünfjährigen Datenbasis über mindestens 30 Studentinnen auszugehen. Für die Ermittlung der Notenverteilungen, die für die ECTS-Noten erforderlich sind, ist das Studienbüro der Universität zuständig.

§ 8 Erlöschen des Prüfungsanspruchs, Wiederholung von Prüfungen und Erfolgskontrollen

(1) Studentinnen können eine nicht bestandene mündliche Prüfung (§ 4 Abs. 2, Nr. 2) einmal wiederholen.

(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) Wiederholungsprüfungen nach Absatz 1 und 2 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.

(4) Die Wiederholung einer Erfolgskontrolle anderer Art (§ 4 Abs. 2, Nr. 3) wird im Studienplan geregelt.

(5) Eine zweite Wiederholung derselben schriftlichen oder mündlichen Prüfung ist nur in Ausnahmefällen zulässig. Einen Antrag auf Zweitwiederholung hat die Studentin schriftlich bei der Prüfungskommission zu stellen. Über den ersten Antrag einer Studentin auf Zweitwiederholung entscheidet die Prüfungskommission, wenn sie den Antrag genehmigt. Wenn die Prüfungskommission diesen Antrag ablehnt, entscheidet die Rektorin. Über weitere Anträge auf Zweitwiederholung entscheidet nach Stellungnahme der Prüfungskommission die Rektorin. Absatz 2, Satz 2 und 3 gilt entsprechend.

(6) Die Wiederholung einer bestandenen Erfolgskontrolle ist nicht zulässig.

(7) Eine Modulprüfung ist endgültig nicht bestanden, wenn mindestens ein Teilmodul des Moduls endgültig nicht bestanden ist.

(8) Die Masterarbeit kann bei einer Bewertung mit „nicht ausreichend" einmal wiederholt werden. Eine zweite Wiederholung der Masterarbeit ist ausgeschlossen.

(9) Ist gemäß § 34 Abs. 2, Satz 3 LHG die Masterprüfung bis zum Beginn der Vorlesungszeit des achten Fachsemesters einschließlich etwaiger Wiederholungen nicht vollständig abgelegt, so erlischt der Prüfungsanspruch im Studiengang Maschinenbau, es sei denn, dass die Studentin die Fristüberschreitung nicht zu vertreten hat. Die Entscheidung darüber trifft die Prüfungskommission.

§ 9 Versäumnis, Rücktritt, Täuschung, Ordnungsverstoß

(1) Die Studentin kann bei schriftlichen Modulprüfungen ohne Angabe von Gründen bis zur Ausgabe der Prüfungsaufgaben zurücktreten. Bei mündlichen Modulprüfungen 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.

(2) Eine Modulprüfung 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 Masterarbeit 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 Prüfungskommission unverzüglich schriftlich angezeigt und glaubhaft gemacht werden. Bei Krankheit der Studentin bzw. 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 seiner Modulprüfung durch Täuschung oder Benutzung nicht zugelassener Hilfsmittel zu beeinflussen, gilt die betreffende Modulprüfung als mit „nicht ausreichend" (5.0) bewertet. Bei Modulprüfungen, die aus mehreren Teilprüfungen 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 Aufsicht Führenden von der Fortsetzung der Modulprüfung ausgeschlossen werden.

In diesem Fall gilt die betreffende Prüfungsleistung als mit „nicht ausreichend“ (5.0) bewertet. In schwerwiegenden Fällen kann die 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 Prüfungskommission überprüft werden. Belastende Entscheidungen der Prüfungskommission sind der Studentin unverzüglich schriftlich mitzuteilen. Sie sind zu begründen und mit einer Rechtsbehelfsbelehrung zu versehen. Der Studentin ist vor einer Entscheidung Gelegenheit zur Äußerung zu geben.

(7) Näheres regelt die Allgemeine Satzung der Universität Karlsruhe (TH) zur Redlichkeit bei Prüfungen und Praktika (‚Verhaltensordnung’).

§ 10 Mutterschutz, Elternzeit

(1) Auf Antrag einer Studentin 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 Prüfungskommission unter Beifügung der erforderlichen Nachweise schriftlich mitteilen, in welchem Zeitraum sie die Elternzeit in Anspruch nehmen will. Die 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 der Masterarbeit kann nicht durch eine Elternzeit unterbrochen werden. Die gestellte Arbeit gilt als nicht vergeben. Nach Ablauf der Elternzeit erhält die Studentin ein neues Thema.

§ 11 Masterarbeit

(1) Voraussetzung für die Zulassung zur Masterarbeit ist grundsätzlich, dass die Studierende alle Modulteilprüfungen bis auf maximal ein Modul des ersten Abschnitts laut § 17 sowie das Berufspraktikum nach § 12 absolviert hat. Der Antrag auf Zulassung zur Masterarbeit ist innerhalb von drei Monaten nach Ablegung der letzten Modulprüfung zu stellen. Versäumt die Studentin diese Frist ohne triftige Gründe, so gilt die Masterarbeit im ersten Versuch als mit „nicht ausreichend“ (5.0) bewertet. Im Übrigen gilt §18 entsprechend. Auf Antrag der Studentin sorgt ausnahmsweise die Vorsitzende der Prüfungskommission dafür, dass die Studentin innerhalb von vier Wochen nach Antragstellung von einer Betreuerin ein Thema für die Masterarbeit erhält. Die Ausgabe des Themas erfolgt in diesem Fall über die Vorsitzende der Prüfungskommission.

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

(3) Die Masterarbeit soll zeigen, dass die Studentin in der Lage ist, ein Problem aus dem Maschinenbau selbstständig und in begrenzter Zeit nach wissenschaftlichen Methoden, die dem Stand der Forschung entsprechen, zu bearbeiten. Der Masterarbeit werden 20 Leistungspunkte zugeordnet. Die Bearbeitungsdauer beträgt vier Monate. Im Anschluss an die Masterarbeit, spätestens vier Wochen nach Abgabe, findet am Institut der Prüferin ein Kolloquium von etwa 30 Minuten Dauer über das Thema der Masterarbeit und deren Ergebnisse statt.

(4) Die Masterarbeit kann von jeder Prüferin nach § 15 Abs. 2 vergeben werden. Die Prüferin muss dabei der gewählten Vertiefungsrichtung zugeordnet sein. Die Zuordnung der Institute zu den jeweiligen Vertiefungsrichtungen findet sich im Studienplan. Soll die Masterarbeit außerhalb der Fakultät für Maschinenbau angefertigt werden, so bedarf dies der Genehmigung der Prüfungskommission. Der Studentin ist Gelegenheit zu geben, für das Thema Vorschläge zu machen.

Die Masterarbeit 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. Die Masterarbeit kann im Einvernehmen mit den Prüferinnen auch auf Englisch oder Französisch geschrieben werden.

(5) Bei der Abgabe der Masterarbeit hat die Studentin schriftlich zu versichern, dass sie die Arbeit selbstständig verfasst hat und keine anderen als die von ihr 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 Masterarbeit mit „nicht ausreichend“ (5.0) bewertet.

(6) Der Zeitpunkt der Ausgabe des Themas der Masterarbeit und der Zeitpunkt der Abgabe der Masterarbeit sind aktenkundig zu machen. Die Studentin kann das Thema der Masterarbeit nur einmal und nur innerhalb der ersten zwei Monate der Bearbeitungszeit zurückgeben. Auf begründeten Antrag der Studentin kann die Prüfungskommission die in Absatz 3 festgelegte Bearbeitungszeit um höchstens zwei Monate verlängern. Wird die Masterarbeit nicht fristgerecht abgeliefert, gilt sie als mit „nicht ausreichend“ bewertet, es sei denn, dass die Studentin dieses Versäumnis nicht zu vertreten hat. § 7 und § 8 gelten entsprechend.

(7) Die Masterarbeit wird von einer Betreuerin sowie in der Regel von einer weiteren Prüferin aus der Fakultät für Maschinenbau begutachtet und bewertet. Eine der beiden muss Juniorprofessorin oder Professorin sein. Bei nicht übereinstimmender Beurteilung der beiden Prüferinnen setzt die Prüfungskommission im Rahmen der Bewertung der beiden Prüferinnen die Note der Masterarbeit fest. Der Bewertungszeitraum soll sechs Wochen nicht überschreiten.

§ 12 Berufspraktikum

(1) Während des Masterstudiums ist ein mindestens sechswöchiges Berufspraktikum abzuleisten, welches geeignet ist, der Studentin eine Anschauung von berufspraktischer Tätigkeit im Maschinenbau zu vermitteln. Dem Berufspraktikum 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) Bei der Anmeldung zum zweiten Abschnitt der Masterprüfung muss das komplette Berufspraktikum anerkannt sein.

(4) 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 im Umfang von höchstens 20 Leistungspunkten unterziehen. § 3 und § 4 der Prüfungsordnung bleiben davon unberührt.

(2) Das Ergebnis maximal zweier Module, die jeweils mindestens 3 Leistungspunkte umfassen müssen, wird auf Antrag der Studentin in das Masterzeugnis 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 nach § 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 Modulteilprüfung in einem Modul diese als Zusatzleistung zu deklarieren.

§ 14 Prüfungskommission

(1) Für den Masterstudiengang im Maschinenbau wird eine Prüfungskommission gebildet. Sie besteht aus vier stimmberechtigten Mitgliedern: zwei Professorinnen, Juniorprofessorinnen, Hochschul- oder Privatdozentinnen, zwei Vertreterinnen der Gruppe der wissenschaftlichen Mitarbeiterinnen nach § 10 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 Prüfungskommission sowie deren Stellvertreterinnen werden vom Fakultätsrat bestellt, die Mitglieder der Gruppe der wissenschaftlichen Mitarbeiterinnen nach § 10 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 Prüfungskommission ist zuständig für 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 Masterarbeiten 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 der Studentin 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 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 Fakultät für Maschinenbau, denen die Prüfungsbefugnis übertragen wurde. Zur Prüferin und Beisitzenden darf nur bestellt werden, wer mindestens die dem jeweiligen Prüfungsgegenstand entsprechende fachwissenschaftliche Qualifikation erworben hat. Bei der Bewertung der Masterarbeit 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 jeweilige 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, Modulprüfungen und Modulteilprüfungen, die in gleichen oder anderen Studiengängen an anderen Hochschulen erbracht wurden, werden von Amts wegen angerechnet. Gleichwertigkeit ist festzustellen, wenn Leistungen in Inhalt, Umfang und in den Anforderungen denjenigen des Studiengangs 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, Modulprüfungen und Modulteilprüfungen, 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, Modulprüfungen und Modulteilprüfungen, die in staatlich anerkannten Fernstudien- und an anderen Bildungseinrichtungen, insbesondere an staatlichen oder staatlich anerkannten Berufsakademien erworben wurden.

(5) Die Anerkennung von Teilen der Masterprüfung 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 Masterarbeit anerkannt werden soll/en. Dies gilt sowohl bei einem Studiengangwechsel als auch bei einem Studienortwechsel.

(6) Zuständig für die Anrechnungen ist die Prüfungskommission. Vor Feststellungen über die Gleichwertigkeit können die zuständigen Fachvertreterinnen gehört werden. Die Prüfungskommission entscheidet in Abhängigkeit von Art und Umfang der anzurechnenden Studien- und Prüfungsleistungen über die Einstufung in ein höheres Fachsemester.

II. Masterprüfung

§ 17 Umfang und Art der Masterprüfung

(1) Im Masterstudiengang Maschinenbau besteht die Möglichkeit der Wahl einer Vertiefungsrichtung. Die möglichen Vertiefungsrichtungen sind im Studienplan angegeben.

(2) Die Masterprüfung gliedert sich in zwei Abschnitte. Der erste Abschnitt besteht aus den Modulteilprüfungen in den Modulen nach Absatz 3 sowie dem Berufspraktikum nach § 12. Die Masterarbeit bildet den zweiten Prüfungsabschnitt.

(3) In den beiden Studienjahren sind die Modulteilprüfungen aus folgenden Modulen abzulegen:

1. Drei Wahlpflichtfächer: im Umfang von je 5 Leistungspunkten,
2. Mathematische Methoden: im Umfang von 6 Leistungspunkten,
3. Produktentstehung: im Umfang von 15 Leistungspunkten,
4. Modellbildung und Simulation: im Umfang von 7 Leistungspunkten,
5. Fachpraktikum: im Umfang von 3 Leistungspunkten,
6. Wahlfach: im Umfang von 4 Leistungspunkten,
7. Fachübergreifendes Wahlfach Bereich Naturwissenschaften/Informatik/Elektrotechnik: im Umfang von 6 Leistungspunkten,
8. Fachübergreifendes Wahlfach Bereich Wirtschaft/Recht: im Umfang von 4 Leistungspunkten,
9. Zwei Schwerpunkte, bestehend aus je einem Kern- und Ergänzungsmodul, wobei in jedem Schwerpunkt ein Umfang von insgesamt mindestens 16 Leistungspunkten absolviert werden muss.

Neben den in Absatz 3 genannten Modulen findet die Vermittlung von Schlüsselqualifikationen im Umfang von 6 Leistungspunkten im Rahmen der fachwissenschaftlichen Übungen und Projekte statt.

(4) Die den Modulen zugeordneten, wählbaren Lehrveranstaltungen und Leistungspunkte, die Erfolgskontrollen und Studienleistungen sowie die für die Schwerpunkte zur Auswahl stehenden Module sind im Studienplan festgelegt. Die Wahlmöglichkeiten richten sich dabei nach der gewählten Vertiefungsrichtung. Zu den entsprechenden Modulteilprüfungen kann nur zugelassen werden, wer die Anforderungen nach § 5 erfüllt.

(5) Im vierten Semester ist als eine weitere Prüfungsleistung eine Masterarbeit gemäß § 11 anzufertigen.

§ 18 Leistungsnachweise für die Masterprüfung

Voraussetzung für die Anmeldung zur letzten Modulprüfung der Masterprüfung ist die Bescheinigung über das erfolgreich abgeleistete Berufspraktikum nach § 12. In Ausnahmefällen kann die Prüfungskommission die nachträgliche Vorlage dieses Leistungsnachweises genehmigen.

§ 19 Bestehen der Masterprüfung, Bildung der Gesamtnote

(1) Die Masterprüfung ist bestanden, wenn alle in § 17 genannten Prüfungsleistungen mindestens mit „ausreichend“ bewertet wurden.

(2) Die Gesamtnote der Masterprüfung errechnet sich als ein mit Leistungspunkten gewichteter Notendurchschnitt.

(3) Hat die Studentin die Masterarbeit mit der Note 1.0 und die Masterprüfung mit einem Durchschnitt von 1.2 oder besser abgeschlossen, so wird das Prädikat „mit Auszeichnung“ (with distinction) verliehen.

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

(1) Über die Masterprüfung wird nach Bewertung der letzten Prüfungsleistung eine Masterurkunde und ein Zeugnis erstellt. Die Ausfertigung von Masterurkunde und Zeugnis soll nicht später als sechs Wochen nach der Bewertung der letzten Prüfungsleistung erfolgen. Masterurkunde und Masterzeugnis werden in deutscher und englischer Sprache ausgestellt. Masterurkunde und

Zeugnis tragen das Datum der erfolgreichen Erbringung der letzten Prüfungsleistung. Sie werden der Studentin gleichzeitig ausgehändigt. In der Masterurkunde wird die Verleihung des akademischen Mastergrades beurkundet. Die Masterurkunde wird von der Rektorin und der Dekanin unterzeichnet und mit dem Siegel der Universität versehen.

(2) Das Zeugnis enthält den Namen der gewählten Vertiefungsrichtung, die zugeordneten Modulprüfungen mit Noten und Modulteilbezeichnungen, Note und Thema der Masterarbeit, deren zugeordnete 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 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 von der Studentin erbrachten Prüfungsleistungen sowie die der jeweiligen Vertiefungsrichtung zugeordneten Module mit den Modulnoten, entsprechender ECTS-Note und 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 Tanscript of Records aufzunehmen.

(5) Die Masterurkunde, das Masterzeugnis 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 Masterprüfung wird der Studentin in schriftlicher Form erteilt. Der Bescheid ist mit einer Rechtsbehelfsbelehrung zu versehen.

(2) Hat die Studentin die Masterprüfung endgültig nicht bestanden, wird ihr auf Antrag und gegen Vorlage der Exmatrikulationsbescheinigung eine schriftliche Bescheinigung ausgestellt, die 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 Ungültigkeit der Masterprüfung, Entziehung des Mastergrades

(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 deren Erbringung die Studentin getäuscht hat, berichtigt werden. Gegebenenfalls kann die Modulprüfung für „nicht ausreichend“ (5.0) und die Masterprüfung für „nicht bestanden“ erklärt werden.

(2) Waren die Voraussetzungen für die Zulassung zu einer Prüfung nicht erfüllt, ohne dass die 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 Masterprüfung für „nicht bestanden“ erklärt werden.

(3) Vor einer Entscheidung der 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 Masterurkunde einzuziehen, wenn die Masterprüfung 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 Masterprüfung wird der Studentin auf Antrag innerhalb eines Jahres Einsicht in ihre Masterarbeit, 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 außer Kraft.

(3) 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.

Karlsruhe, den 28. Februar 2008

Professor Dr. sc. tech. Horst Hippler
(Rektor)

Index

A

B

C

D

E

F

G

H

I

O

P

Q

R

S

T

V

W