Modulhandbuch

Compilation of Modules

Engineering Science

Inhaltsverzeichnis / Table of Contents

Modulübersicht / Abstract of Modules

Programming	Programming	11	**Part 1:** Prof. Dr. Philipp Neumann **Part 2:** Prof. Dr. Oliver Niggemann **Part 3:** Prof. Dr. Oliver Niggemann	C in ES	53
Programming and Computational Methods for Data Science	Programming and Computational Methods for Data Science	11	**Part 1:** Prof. Dr. Philipp Neumann **Part 2:** Prof. Dr. Oliver Niggemann **Part 3:** Prof. Dr. Oliver Niggemann	C in ES	57
Quality and Knowledge Management	Quality and Knowledge Management	4	Prof. Dr.-Ing. Jens Wulfsberg	CEC in ES	61
Sensors and Actuators	Sensors and Actuators	4	Prof. Dr. Alexander Fay	CEC in ES	63
Sensor Systems	Sensor Systems	8	**Part 1:** Prof. Dr.-Ing. Gerd Scholl **Part 2:** PD Dr.-Ing. Thomas Fickenscher	C in ES	65
Students Project	Students Project	6	Profs-EE, Profs-ME	E in B.Sc. ES	68
Thermal/Fluids Engineering	Thermal/Fluids Engineering	12	**Part 1:** Prof. Dr.-Ing. Karsten Meier **Part 2:** Prof. Dr.-Ing. habil. Michael Breuer	C in ES	69
Vehicle Dynamics	Vehicle Dynamics	4	Prof. Dr.-Ing. Martin Meywerk	CEC in ES	73

Modul Academic English and Skills AcadEngSki

Academic English and Skills
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Petra Harder

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

petra.harder@hsu-hh.de +49 40 6541 2298

Qualifikationsziel / Module Objectives and Competencies

Objectives of the module Academic English and Skills include further enhancing students´ research and scientific writing as well as presentation skills for an academic environment, thus enabling students to prepare better for their Bachelor´s degree.

Inhalte / Content

- critical thinking
- conducting research
- scientific writing
- referencing/avoiding plagiarism
- giving presentations

Modulbestandteile / Composition of Module

Module Part	Type Computer Training (CT) Exercises (E) Lecture (L) Laboratory (Lab)	Contact Hours per Week	AT/WT/ST
Academic English and Skills 1	E	2	AT
Academic English and Skills 2	E	2	WT
Academic English and Skills 3	E	2	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Students will learn individually and collaborately both in a classroom setting as well as outside develoving student autonomy features strongly in this module.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Academic English and Skills	-	-

Verwendbarkeit des Moduls / Usability of Module

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Academic English and skills 1	12	2	24
Academic English and skills 2	12	2	24
Academic English and skills 3	12	2	24
Project paper			48
TOTAL			**120**

Prüfung und Benotung / Evaluation

Project paper according to FSPO EngSci, Re Section 13(4)
This module requires compulsory attendance in accordance with Section 10 Paragraph 3 APO.

Dauer in Trimestern / Duration of Module

Three terms: terms 4,5,6

Teilnehmer(innen)zahl / Number of Participants

Max. 20 participants

Anmeldeformalitäten / Registration

Registration takes place only via the Campus Management System. Further information on the homepage of the Language Centre: http://www.hsu-hh.de/sprachen

Literatur / Bibliographical References and Course Material

McCormack, J & Slaght, J (2012) English for Academic Study: Extended Writing and Research Skills. Reading, Garnet Education.

Modul Artificial Intelligence: Algorithms and Applications LO-ING-211

Artificial Intelligence: Algorithms and Applications
Leistungspunkte / Credit Points: 4

Zugeordnete Module	4110	Artificial Intelligence: Algorithms and Applications Prüfung

Modulverantwortlicher / Contact Person

Prof. Dr. Stiemer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

marcus.stiemer@hsu-hh.de
+49 40 6541 2769

Qualifikationsziel / Module Objectives and Competencies

After attending the course students will be able to
- analyse critically the potential (and the risk) to support the solution of a logistic or technical problem with the help of AI-based methods
- choose from a bunch of different algorithms an adequate method to treat a given logistic or technical problem by AI methods
- implement and adjust a chosen AI procedure and organize its proper use including the allocation and the assessment of learning data etc.
- analyse and validate the success of AI methods based on data statistics

Inhalte / Content

The following program is used to train the students to achieve the above defined competences:
1. An overview, a short history and some definitions
2. Introduction to some examples of classical machine learning methods
3. A short introduction to Python and some AI libraries
4. Neural Networks and Deep Learning (concepts, design, learning theories, applications)
5. Convolutional Neural Networks
6. Reinforcement Learning
7. Transfer Learning
8. Assessment of learning data and the success of automated learning
9. Applications: image recognition / games with complete or incomplete information / automated design problems

Modulbestandteile / Composition of Module

Lecture Title	Type	TWS	Compulsory (C) or elective (E)	AT/ST/WT
Artificial Intelligence: Algorithms and Applications	L	2	E	WT
Artificial Intelligence: Algorithms and Applications	E	2	E	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially exercises organized in small study groups

Voraussetzungen für die Teilnahme / Requirements

Basics of computer programming, engineering mathematics

Verwendbarkeit des Moduls / Usability of Module

WPF im M.Sc. LO, B.Sc. EngSci und in den Masterstudiengängen der Fakultät für ET

Arbeitsaufwand / Work Load

	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	2	24
Preparation and follow-up	12	4	36
Preparation for exam			36
Total			120

Prüfung und Benotung / Evaluation

Das Modul wird mit einer Klausur (120 Minuten) oder einer mündlichen Prüfung oder einer Projekt-/ Seminarleistung beendet.

Dauer in Trimestern / Duration of Module

One trimester (WT)

Teilnehmer(innen)zahl / Number of Participants

Unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Set of slides and a large number of programming examples will be handed to the participants

Modul Artificial Intelligence: Algorithms and Applications
Prüfung LO-ING-211
Artificial Intelligence: Algorithms and Applications (Examination)
Leistungspunkte / Credit Points: 4

Modul Bachelor-Thesis BachThes

Bachelor Thesis

Leistungspunkte / Credit Points: 12

Modul Calculus and Linear Algebra 1 Algeb1

Calculus and Linear Algebra 1
Leistungspunkte / Credit Points: 6

Modulverantwortlicher / Contact Person

Prof. Dr. Markus Bause
Prof. Dr. Thomas Carraro

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bause@hsu-hh.de +49 40 6541 2721
carrarot@hsu-hh.de +49 40 6541 3878

Qualifikationsziel / Module Objectives and Competencies

Participants learn elementary structures and principles of mathematics. They are enabled to perform and employ fundamental techniques in the fields of linear algebra and calculus. They are able to formulate and solve problems in these fields and understand the application of the mathematical methods in modern engineering.

Inhalte / Content

1) Numbers
   a. Natural and real numbers
   b. Complex numbers
2) Linear Algebra
   a. Linear systems of equations
   b. Vector spaces and inner products
   c. Matrices
   d. Analytical geometry
3) Calculus of functions in one variable
   a. Convergence
   b. Continuity
   c. Differentiation and applications
   d. Integration
4) Applications
5) Usage of mathematical software

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Calculus and Linear Algebra 1	L	2	AT
Calculus and Linear Algebra 1	E	2	AT
Calculus and Linear Algebra 1	CT	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture, and especially exercises and computer training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Calculus and Linear Algebra 1	-	-

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	2	24
Computer Training	12	1	12
Preparation and follow-up	12	6	72
Preparation for exam			48
Total			**180**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Bibliographical references and course materials are provided by the instructor.

Modul Calculus and Linear Algebra 2 Algeb2

Calculus and Linear Algebra 2
Leistungspunkte / Credit Points: 12

Modulverantwortlicher / Contact Person

Prof. Dr. Markus Bause
Prof. Dr. Thomas Carraro

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bause@hsu-hh.de +49 40 6541 2721

Qualifikationsziel / Module Objectives and Competencies

Participants learn structures and principles of calculus for functions of several variables and ordinary differential equations. These methods are extended further to vector calculus and Fourier analysis. Participants are enabled to perform and employ the mathematical techniques in these fields. They are able to formulate and solve problems and understand the application of the conveyed mathematical tools in modern engineering.

Inhalte / Content

Part I

1) Differential equations
   a. First order differential equations
   b. Higher order linear differential equations
   c. Laplace transform
   d. Determinants, eigenvalues and eigenvectors
   e. First order linear systems of differential equations
2) Calculus of functions in severable variables
   a. Continuity
   b. Differentiation and applications
   c. Integration
3) Applications
4) Usage of mathematical software

Part II

1) Vector calculus
   a. Line and surface integrals
   b. Integral theorems of Gauss and Stokes
   c. Potential theory
2) Fourier analysis and partial differential equations
   a. Fourier series expansion
   b. Fast Fourier transform
   c. Partial differential equations
3) Applications
4) Usage of mathematical software

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Calculus and Linear Algebra 2	L	2	WT, ST

Calculus and Linear Algebra 2	E	2	WT, ST
Calculus and Linear Algebra 2	CT	1	WT, ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture, and especially exercises and computer training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Calculus and Linear Algebra 2	-	Calculus and Linear Algebra 1

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	2*12	2	48
Exercises	2*12	2	48
Computer Training	2*12	1	24
Preparation and follow-up	2*12	6	144
Preparation for exam			96
Total			**360**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (180 minutes).

Dauer in Trimestern / Duration of Module

Trimester 2, 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Bibliographical references and course materials are provided by the instructor.

Modul Control Systems ContrSys

Control Systems
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr.-Ing. Joachim Horn
Part 2:
Prof. Dr. Oliver Niggemann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Joachim.Horn@hsu-hh.de +49 40 6541 3593

oliver.niggemann@hsu-hh.de, 040 / 6541-2722

Qualifikationsziel / Module Objectives and Competencies

To develop a broad appreciation of the fundamentals of continuous and discrete-event models of dynamical systems and the model-based design of feedback control systems.

Inhalte / Content

Part 1:

1) Introduction to Control Systems
   Fundamental control problem, feedforward control, feedback control, design objectives
2) Modeling in the Frequency Domain
   Laplace transform, dynamic response of linear, time-invariant systems, transfer function, impulse response, step response, frequency response, Nyquist diagram, Bode diagram
3) Stability of Linear Feedback Systems
   Asymptotic stability, BIBO stability, fundamental stability criterion, Hurwitz stability criterion, standard control loop, Nyquist stability criterion, phase margin, gain margin
4) Frequency-Response Design Method
   Bode diagrams for elementary frequency responses, design objectives (stability, steady-state error, transient response), standard controllers and compensators
5) Modelling in the Time Domain
   State-space representation of linear, time-invariant systems, controller canonical form, observer canonical form, Jordan canonical form, state-transition matrix, solution of state and output equations, linearization of a nonlinear system
6) State-Space Control
   full-state feedback, pole placement, controllability, Ackermann’s formula, Luenberger observer, observability, observer design, separation theorem
7) z-transform, discrete transfer function, Tustin's approximation, anti-alias prefilters

Part 2:

1) Introduction, motivation, fundamental of plant functionalities and control structures, requirements to automation and control, purpose of discrete control, terms and notions, typical applications and challenges
2) Finite State Machines FSMs, Timed FSMs, Probabilistic FSMs, understand the concept of languages and complexity classes, understanding FSMs and their variants, understanding grammars, understanding probabilistic FSMs, understanding timed FSMs, understanding hybrid FSMs
3) Learning of Finite State Machines, understanding the challenge of learning FSMs, the RPNI algorithm, the BUTLA algorithm
4) Analysis of FSMs, Markovian Chains, Observation and Diagnosis of FSMs, Markovian chain and their variants, Learning transition probabilities, Analyzing Markovian Chains

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Continuous Control	L	2	AT
Continuous Control	E	1	AT
Discrete Control	L	2	AT
Discrete Control	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1:

Terminology and basic principles are explained in the lecture, also applications of the principles are exemplified. In the exercises the students should solve engineering problems by themselves.

Part 2:

Lecture in the lecture hall: Tablet PC-based projection and interactive explanation of lecture slides, possibly blackboard

Exercise: Working with programming languages, possibly blackboard, in addition, each student has a PC available to program independently. Additional teaching / learning offers will be announced by the respective teacher at the beginning of the event.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	Mathematics
2	-	Mathematics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2*2	48
Exercises	12	2*1	24
Preparation and follow-up	12	2*5	120
Preparation for exam			48
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (180 minutes).

Dauer in Trimestern / Duration of Module

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1:
- Gene F. Franklin, J. David Powell, Abbas Emami-Naeini: Feedback Control of Dynamic Systems. Seventh Edition.
- Norman S. Nise: Control Systems Engineering. Sixth Edition. International Student Version.

Part 2:
- C. G. Cassandras, S. Lafortune: Introduction to Discrete Event Systems, Springer.
- J. Lunze: Control Theory of Digitally Networked Dynamic Systems, Springer.

Modul Digital Communication Systems DigComSys

Digital Communication Systems
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Udo Zölzer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

zoelzer@hsu-hh.de / +49 40 6541 2761

Qualifikationsziel / Module Objectives and Competencies

To develop a broad understanding of the fundamentals of digital communication over computer networks and mobile communication systems

Inhalte / Content

• Introduction to Digital Communication Systems: basic principles, packet switching, layering, simplified reference model
• Basics of continuous-time signal processing: test signals and systems, convolution, impulse response and frequency response, continuous-time Fourier transform, modulation and demodulation
• Basics of digital signal processing: sampling, quantization, reconstruction, digital test signals and digital systems, impulse response and frequency response, discrete-time Fourier transform, Discrete Fourier Transform, Fast Fourier Transform
• Multimedia Communication: media streaming, speech, audio, and video coding
• Mobile communications: basics and cellular networks
• Military communications: basics and tactical data links

Modulbestandteile / Composition of Module

Module Part	**Type** Computer Training CT Exercises E Lecture L Laboratory Lab	**Contact Hours per Week**	**AT/WT/ST**
Digital Communication Systems	L	2	AT
Digital Communication Systems	E/Lab	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lectures and especially Exercises, Lab & Computer Training are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	**formal**	**content**
	-	Skills learned in Mathematics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	**Weeks**	**Hours/Week**	**Hours** **Total**

Lectures	12	2	24
Exercises/Lab	12	1	12
Preparation and follow-up	12	4	48
Preparation for exam			36
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (90 minutes).

Dauer in Trimestern / Duration of Module

1 Trimester

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

• Kurose, James F. & Ross, Keith W., "Computer Networking: A Top-Down Approach”
• Tannenbaum, Andrew S. & Wetherall, David J.,”Computer Networks”

Modul Drives and Propulsion DrivProp

Drives and Propulsion
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr.-Ing. Christian Kreischer
Part 2:
Prof. Dr.-Ing. Markus Schatz
Part 3:
Prof. Dr. Wolfgang Thiemann
Dr.-Ing. Michael Sturm

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Part 1:
christian.kreischer@hsu-hh.de
+49 40 6541 2751

Part 2:
markus.schatz@hsu-hh.de
+45 40 6541 2725

Part 3:
wolfgang.thiemann@hsu-hh.de
+49 40 6541 2727

Qualifikationsziel / Module Objectives and Competencies

Part 1: Electrical Drives
– Insight into the physical laws that govern the operation of electrical machines and drives
– Mathematical modelling of electrical drives
– Design of electrical drives tailored to specific applicational needs

Part 2: Aerospace Propulsion
Participants learn
– the thermodynamically and aerodynamically fundamentals of aerospace propulsion
– the design and technique of different propulsion systems

Part 3: Combustion Engine Powered Drive Systems
The module aims to provide a solid understanding of thermodynamics and mechanics of internal combustion engines and basic principles of operation of internal combustion engines relevant to automotive engineering.

Inhalte / Content

Part 1: Electrical Drives

1) **Characterics of electrical drives**
System architecture, constituent components, features, comparison with alternatives – e.g. combustion engines, energy conversion scheme from primary to mechanical energy
2) **Electromechanical power conversion**
Faraday´s Law, Ampere´s Law, energy balances, force, torque, Newtonian mechanics
3) **Motors and generators**
Induction machines, synchronous machines, permanent magnet machines, reluctance machines

Part 2: Aerospace Propulsion

1) Fundamentals of engineering of aerospace propulsion;
2) introduction in propulsion,
3) atmospheric flight,

4) propeller,
5) pulsjet engine,
6) gas turbine fundamentals,
7) turbofan engines,
8) turboprop and turboshaft engines,
9) rocket propulsion,
10) introduction in space flight,
11) solid propellant rocket motors,
12) liquid propellant rocket engines,
13) hybrid rocket engines,
14) air-breathing rocket engines

Part 3: Combustion Engine Powered Drive Systems

1) Introduction
2) Thermodynamics of the Ideal or Air Processes
3) Geometric Data / Kinematics
4) Mean Pressure and Efficiencies
5) Measurements on the engine test
6) Fuels
7) Air fuel ratio, volumetric- & charging efficiency
8) 4 & 2-stroke gasexchange
9) Charging of ICEs
10) Kinematics and Forces
11) Drivetrain
12) Combustion, exhaust emissions

Modulbestandteile / Composition of Module

Choose 2 out of 3 parts

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or Elective (E)	AT/WT/ST
Part 1: Electrical Drives	L	2	E	ST
Part 1: Electrical Drives	E	1	E	ST
Part 2: Aerospace Propulsion	L	2	E	ST
Part 2: Aerospace Propulsion	E	1	E	ST
Part 3: Combustion Engine Powered Drive Systems	L	2	E	ST
Part 3: Combustion Engine Powered Drive Systems	E	1	E	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1, 2 and 3:
Lecture and especially Exercises will be organized in small study groups

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
Part 1	-	Skills acquired in basic modules
Part 2	-	Skills acquired in the modules "Thermodynamics" and "Fluid Dynamics
Part 3	-	Skills acquired in the fields of thermodynamics and mechanics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Part 1: Lectures	12	2	24
Part 1: Exercises	12	1	12
Part 1: Preparation and follow-up	12	4	48
Part 1: Preparation for exam	5	10	36
Subtotal Part 1:			**120**
Part 2: Lectures	12	2	24
Part 2: Exercises	12	1	12
Part 2: Preparation and follow-up	12	4	48
Part 2: Preparation for exam			36
Subtotal Part 2:			**120**
Part 2: Lectures	12	2	24
Part 2: Exercises	12	1	12
Part 2: Preparation and follow-up	12	4	48
Part 2: Preparation for exam			36
Subtotal Part 3:			**120**
Total (Choose 2 out of 3 module parts)			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (180 minutes).

Dauer in Trimestern / Duration of Module

One Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Electrical Drives

– Will be provided on the professorship´s website
– J.A. Melkebeek, Electrical Machines and Drives Fundamentals and Advanced Modelling , Springer, 2018.
– W. Leonhard, Control of Electrical Drives, Springer, 1996.

Part 2: Aerospace Propulsion

– David R. Greatrix, Powered Flight, The Engineering of Aerospace Propulsion, Springer-Verlag London Limited 2012.

Part 3: Combustion Engine Powered Drive Systems

– Script with additional references will be provided by the professorship

Modul Electrical Engineering ElecEng

Electrical Engineering
Leistungspunkte / Credit Points: 12

Modulverantwortlicher / Contact Person

Part 1:
Dr.-Ing. Stefan Schenke
Part 2:
Prof. Dr.-Ing. Holger Goebel

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

stefan.schenke@hsu-hh.de +49 40 6541 2149
holger.goebel@hsu-hh.de +49 40 6541 2752

Qualifikationsziel / Module Objectives and Competencies

Part 1: Electric Circuits

Participants learn to

- describe, analyze and design DC and AC electric circuits

- use mathematics to model engineering systems

solve complex problems systematically

Part 2: Electronic Systems

On completion of the module, students will be able to design basic analog and digital circuits and systems using bipolar and CMOS technology

Inhalte / Content

Part 1: Electric Circuits

Circuit Variables: Charges, Voltage and Current, Power and Energy

Circuit Elements: Voltage and Current Sources, Electrical Resistance, Ohm's Law, Kirchhoff's Laws

Simple Resistive Circuits: Resistors in Series and in Parallel, Voltage-Divider and Current-Divider Circuits, Delta-to-Wye Equivalent Circuits, Measuring Voltage and Current, Measuring Resistance, The Wheatstone Bridge

Techniques of Circuit Analysis: Thevenin and Norton Equivalents, Source Transformation, Maximum Power Transfer, Superposition

Sinusoidal Steady-State Analysis: Use of Complex Numbers; Phasor and Phasor Diagram; Circuits Including Resistors, Inductors, Capacitors and Sinusoidal Sources; Effective, Apparent and Idle Power; Oscillating Circuits

Transient Effects

Part 2: Electronic Circuits

1) Analog circuit design
   Operational amplifier (OP), circuits with ideal OPs
2) Electronic devices
   The fluid-model of electronic devices, MOSFET, diode, BJT
3) Basic Amplifiers
   Common-emitter, -base, -collector-amplifier. Common-source, -gate, -drain-amp. Multistage, differential and operational amps.

4) Logic Design
Elementary gates: Inverter, NAND, NOR, design of complex gates.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Electric Circuits	L	4	AT
1: Electric Circuits	E	2	AT
2: Electronic Systems	L	3	WT
2: Electronic Systems	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1: Electric Circuits

Lectures and exercises in small study groups

Part 2: Electronic Systems

Lectures and exercises using circuit simulation tools in the computer lab

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	-
2	-	-

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lecture	12	4	48
1: Exercises	12	2	24
1: Preparation and follow-up	12	10	120
1: Preparation for exam			48
Subtotal Part 1:			**240**
2: Lecture	12	3	36
2: Exercises/Lab	12	1	12
2: Preparation and follow-up	12	4	48
2: Preparation for exam			24
Subtotal Part 2:			**120**

Total			**360**

Prüfung und Benotung / Evaluation

The module concludes with two exams (of 120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1,2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Electric Circuits

W. Nilsson, S. Riedel: Electric Circuits. Pearson Education International

Part 2: Electronic Systems

Literature recommendations will be given in the lectures

Modul Eletromagnetics ElecMagn

Eletromagnetics
Leistungspunkte / Credit Points: 10

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr. Stefan Dickmann
Part 2:
Prof. Dr. Marcus Stiemer
Lehrbeauftragter: Dr. Lars-Ole Fichte

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

stefan.dickmann@hsu-hh.de +49 40 6541 3019
marcus.stiemer@hsu-hh.de +49 40 6541 2769
lars-ole.fichte@hsu-hh.de +49 40 6541 2460

Qualifikationsziel / Module Objectives and Competencies

Part 1: Electromagnetic Compatibility
Participants learn to
- be aware of parasitic effects of electronic systems
- design electronic systems for EMC

Part 2: Electromagnetic fields and waves
The students will be instructed to understand the principles based on which military and civil systems can be influenced by electromagnetic fields. This comprises the competence to judge what kind of electromagnetic model is relevant for a particular technical situation as well as to conceive the electromagnetic fields of basic devices used in electrical engineering, such as, e.g., capacitors, dipoles, inductors, transformers, electromechanical energy converters, waveguides, etc. In addition, the students will learn how the device's characteristic electric quantities can be derived from the electromagnetic field distribution. The students are instructed to basic principles like Maxwell's equations, fundamental solutions, the superposition principle, the reflection principle, etc. Further, they learn how these principles can be employed for electromagnetic field computation. Amongst others, the students are educated to work with numerical programs to compute electromagnetic fields and characteristic quantities of electrical systems and to visualize the determined fields

---

Inhalte / Content

Part 1: Electromagnetic Compatibility

1) Introduction
2) Classification of Disturbances
3) Ideal and Nonideal behaviour of components
4) Conducted emissions and susceptibility
5) Radiated emissions and susceptibility
6) EMC Measurements

Part 2: Electromagnetic fields and waves

1) Maxwell's equations (global version, simple consequences, e.g., interface relations, charge conservation, etc.)
2) Systematics of electromagnetic fields
3) Electrostatic fields (sources and sinks, scalar potential, fundamental solution, superposition principle, boundary conditions, electric dipoles, reflection principle, capacitors, capacitance electric properties of polarized matter)
4) Stationary current fields (relaxation time, continuity equation, boundary conditions, reflection

---

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Electromagnetic Compatibility	L	2	AT
2: Electromagnetic Fields and Waves	L	2	AT
2: Electromagnetic Fields and Waves	E	1	AT
2: Electromagnetic Fields and Waves	Lab	3	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1: Electromagnetic Compatibility
Lecture

Part 2: Electromagnetic Fields and Waves
Lecture with exercises in small groups accompanied by a computer training with software for field computation and visualization: The lecture is accompanied by exercises, in which the students are trained to solve problems by applying the theory. In an additional computer training students are instructed to use a computer program to visualize electromagnetic fields under different conditions. They can change boundary conditions, material properties and geometric conditions and observe how this influences the electromagnetic field distribution as well as characteristic electrical properties.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	Skills acquired in the module Electrical Engineering and Mathematics
2	-	Skills acquired in the module Electrical Engineering and Mathematics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	2	24
1: Preparation and follow-up	12	3	18
1: Preparation for exam			18
Subtotal Part 1:			**60**
2: Lectures	12	2	24
2: Exercises	12	1	12

2: Computer Training	12	3	36
2: Preparation and follow-up	12	9	108
2: Preparation for exam	3	20	60
Subtotal Part 2:			**240**
Total			**300**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (180 minutes).

Dauer in Trimestern / Duration of Module

Trimester 4

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Electromagnetic Compatibility
– H. W. Ott: Electromagnetic Compatibility Engineering, Wiley
- C. R. Paul: Introduction to Electromagnetic Compatibility, Wiley

Part 2: Electromagnetic fields and waves
– Will be provided on the professorship's web site (www.hsu-hh.de/tet):
– Lecture notes with additional references
MATLAB computer code for numerical field computation and visualization

Modul Engineering Mechanics EngMech

Engineering Mechanics
Leistungspunkte / Credit Points: 15

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk
Prof. Dr.-Ing. Rolf Lammering
Prof. Dr.-Ing. Dr. rer. nat. Anne Jung

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

martin.meywerk@hsu-hh.de +49 40 6541 2728
rolf.lammering@hsu-hh.de +49 40 6541 2734
junga@hsu-hh.de +49 40 6541 4549

Qualifikationsziel / Module Objectives and Competencies

The students

- know the terminology and the basic concepts and principles of engineering mechanics
- understand the basic concepts and principles of engineering mechanics and are able to solve engineering problem by applying the concepts and principles.

Inhalte / Content

Part 1: Statics; Meywerk

Axioms and principles of mechanics
Forces and moments
Bearings, joints, degrees of freedom
Equilibrium, free-body diagrams
Distributed forces, center of gravity
Trusses
Static and Kinetic Friction

Part 2: Mechanics of Materials; Lammering

Stress and strain
Mechanical properties of materials, Hooke's law
Stresses in beams
Buckling of bars

Part 3: Dynamics; Jung

Kinematics of a particle
Planar kinetics of a particle
Planar kinematics of a rigid body

Modulbestandteile / Composition of Module

Module Part	**Type** Computer Training CT Exercises E Lecture L Laboratory Lab	**Contact Hours per Week**	**AT/WT/ST**
Engineering Mechanics	L	2	AT/WT/ST

Engineering Mechanics	E	2	AT/WT/ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Terminology, concepts and principles are explained in the lectures, in the exercises these are applied to solve engineering problems.

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12*3	2	72
Exercises	12*3	2	72
Preparation and follow-up	12*3	6	216
Preparation for exam	6	15	90
Total			**450**

Prüfung und Benotung / Evaluation

The module concludes with three exams (of 120 minutes, 120 minutes, 120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 1, 2, 3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Gross, G. e.a.: Engineering Mechanics 1 – 3, Springer, 2nd ed., 2013.
Additional material is provided electronically

Modul Fundamentals of Photonics FundPhot

Fundamentals of Photonics
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Prof. Dr. Oleg Pronin

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

oleg.pronin@hsu-hh.de / +49 40 6541 2756

Qualifikationsziel / Module Objectives and Competencies

Students will

- obtain a basic understanding of the relationship between geometrical and wave optics
- obtain basic knowledge to design simple optical systems and instruments,
- get an understanding of ray tracing
- learn how to apply wave equations to model the propagation and superposition of waves
- develop competences in the use of optical imaging and spatial filtering of light waves
- obtain a basic understanding of lasers and their modern applications
- obtain a basic knowledge in modern optics including holography and nonlinear optics
- get an understanding of interaction of light and matter including scattering processes

Inhalte / Content

Part I.

1. Geometrical Optics

- Reflection and refraction, Fermat’s principle
- Prisms, lenses and mirrors
- Optical systems
- Analytical ray tracing
- Matrix methods

2. Wave Optics

- Wave equations
- Eikonal equations
- Polarization
- Interference and Interferometry
- Fraunhofer and Fresnel diffraction
- Diffraction gratings
- Optical imaging and spatial filtering

Part II.

1. Modern Optics

- Lasers, laser light.
- Holography
- Nonlinear and ultrafast Optics

2. Optical modulation

- Kerr and Pockels modulators
- Magneto optic and acousto optic effect.

3. Light and matter

- Light scattering in atmosphere

- Light as an electromagnetic wave, refractive index, dispersion and ultrashort pulses.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Fundamentals of Photonics	L	2	ST/AT
Fundamentals of Photonics	E/Lab	1	ST/AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Terminology, concepts and principles are explained in the lectures, in the exercises these are applied to solve problems

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Fundamentals of Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12*2	2	48
Exercises/Lab	12*2	1	24
Preparation and follow- up	12*2	4	96
Preparation for exam			72
Total			**240**

Prüfung und Benotung / Evaluation

Each part of the module concludes with a separate exam, either written (90/90 minutes) or oral.

Dauer in Trimestern / Duration of Module

2 Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

E. Hecht: Optics, Addison-Wesley;

Bahaa E. A. Saleh, Malvin Carl Teich: Fundamentals of Photonics, 2 Volume Set, 3rd Edition

Modul Heat Transfer HeatTrans

Heat Transfer
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Karsten Meier

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

karsten.meier@hsu-hh.de +49 40 6541 2735

Qualifikationsziel / Module Objectives and Competencies

Objectives
On completion of this module students should have developed and be able to demonstrate a thorough understanding of the fundamentals of heat transfer. They should be able to describe the different physical mechanisms of heat transfer and to calculate and evaluate heat transfer processes in technical applications.
Learning outcomes
At the end of the module students should:
• be able to recognize the different mechanisms of heat transfer and to describe them quantitatively.
• to design and calculate heat exchangers.
• to analyze, treat and assess heat transfer problems
Skills outcomes
- Ability to understand underlying physics associated with heat transfer
- Transferable skills in linking fundamental theories to real world processes
- Written communication
- Critical reasoning
- Time and self-management.

Inhalte / Content

1. Introduction to the different mechanisms of heat transfer
2. Design of heat exchangers
3. Steady-state and transient heat conduction
4. Convective heat transfer in single phase flows
5. Heat transfer by radiation

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Heat Transfer	L	2	ST
Heat Transfer	E	1	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Terminology and basic principles are explained in the lecture, the application of the principles is shown for examples, in exercises the students should solve engineering problems by themselves

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Mathematics, Thermodynamics

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	4	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 6

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

F.P. Incropera, D.P. Dewitt, T.L. Bergman, A.S. Lavine: Principles of heat and mass transfer, International students version, 7th ed., Wiley, Singapore, 2013.

Modul Language Training 1 SZ00LT1

Language Training 1
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Petra Harder

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

+49 40 6541 3659

Qualifikationsziel / Module Objectives and Competencies

The objective of the module Language Training I is to enhance students´ language skills. Depending on students´language background, the focus lies either on acquiring functional German (Group 1: students from foreign countries with German language skills not exceeding B2 level) or on improving their foreign language skills in order to excel in an international working environment (Group 2: other students).

Inhalte / Content

Group 1: German vocabulary and grammatical structures/functions and skills as appropriate. Topics: very basic personal and family information, shopping, local geography, employment (CEFR A2).

Group 2: Technical English and one standard module carrying 4 ECTS (e.g. BECK, GET, MIL, French 1, Russian GK) depending on availability. Please refer to the corresponding module descriptions.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Language Training I.1	E	4	AT
Language Training I.2	E	4	WT
Language Training I.3	E	4	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Student-centred integrated skills lessons in the target language

Voraussetzungen für die Teilnahme / Requirements

Verwendbarkeit des Moduls / Usability of Module

C in B.Sc. ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Language Training I.1	12	4	48
preparation and review			24

Language Training I.2 preparation and review	12	4	48 24
Language Training I.3 preparation and review	12	4	48 24
exam preparation			24
			240

Prüfung und Benotung / Evaluation

Course Assessment in the form of "passed" or "not passed".

The module exam is divided into (M) ”Oral” (15 minutes) and (S) ”Writing” (60 minutes) whereby each component of module Language Training I has to be represented.

For group 2, this requires one part test in Technical English, and one in the other chosen focus language (e.g. BEC, GET, MIL, French, Russian, Spanish). The combination (e.g. TEC = M, MIL = S) is to be agreed with the teachers and students involved.

Dauer in Trimestern / Duration of Module

Three terms: terms 1, 2, 3

Teilnehmer(innen)zahl / Number of Participants

Maximum of 16 students

Anmeldeformalitäten / Registration

Participation in the compulsory language training is differentiated according to performance levels and previous language courses. Registration takes place only via the Campus Management System. Further information on the homepage of the Language Centre: http://www.hsu-hh.de/sprachen

Literatur / Bibliographical References and Course Material

Group 1:

- Scripts and subject-specific books.

Group 2:

- BEC Module: Intermediate Market Leader
- GET Module: scripts produced by the Language Centre
- MIL Module : scripts produced by the Language Centre
- French Modul 1: On y Va! A1
- Russian GK Modul: scripts produced by the Language Centre

Modul Language Training 2 SZ00LT2

Language Training 2
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Petra Harder

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

petra.harder@hsu-hh.de +49 40 6541 2298

Qualifikationsziel / Module Objectives and Competencies

The objective of module Language Training II is to further enhance German skills for Group 1 (students from foreign countries with German language skills not exceeding B2 level at the beginning of their studies). For group 2 (Group 2: other students), objectives include enhancing students´ English skills in degree subject relevant topics and competences, expanding their subject-specific vocabulary and improving accuracy. English native speakers in group 2 may be offered an alternative option.

Inhalte / Content

Group 1: Further training and improvement in speaking and writing German. (For students who started at this university as complete beginners, the aim is level B1 according to CEF.)
Group 2: Advanced English vocabulary, skills and grammar with English for Defense components geared towards students of Engineering Science.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or Elective (E)	AT/WT/ST
German Language Training	E	2	E	AT, WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Student-centered integrated skills lessons in the target language incorporating:
- Presentation and report
- Portfolio
- Individual contributions during class
- Home assignments

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
German Language Training 2	SLP1111	German Language Training 1

Verwendbarkeit des Moduls / Usability of Module

C in B.Sc. ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Exercises	12*2	2	48
Weekly homework	12*2	3	72
Total			**120**

Prüfung und Benotung / Evaluation

Course Assessment in the form of "passed" or "not passed".

Dauer in Trimestern / Duration of Module

Trimester 4, 5

Teilnehmer(innen)zahl / Number of Participants

Max. 20 participants

Anmeldeformalitäten / Registration

Participation in the compulsory language training is differentiated according to performance levels and previous language courses. Registration takes place only via Campus Management System. Further information on the homepage of the Language Centre: http://www.hsu-hh.de/sprachen

Literatur / Bibliographical References and Course Material

Scripts and subject-specific books.

Modul Materials Science MatSc

Materials Science
Leistungspunkte / Credit Points: 11

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr.-Ing. Bernd Niemeyer
Part 2:
Prof Dr.-Ing. Thomas Klassen

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bernd.niemeyer@hsu-hh.de +49 40 6541 3500
thomas.klassen@hsu-hh.de +49 40 6541 3617

Qualifikationsziel / Module Objectives and Competencies

Participants should understand the basics in chemistry and should be able to employ them for describing basic phenomena, and for application in material technology. Furthermore they are introduced to mechanical behavior of materials and learn basic concepts and mechanisms of deformation and strengthening for metals and metallic alloys. This represents the basis for a comprehensive understanding of structure-property relationships and related systematic design of materials for a particular structural application. The professional scope of engineers with this education, both theoretical, and practical can be the development and production of new chemicals, as well as new materials, e.g. new machines or apparatusses. Additionally the development, and design of new matter production, and forming processes are also potential fileds.

Inhalte / Content

1. Atom models, and periodic system of the elements (PSE)
2. Chemical equilibrium: Law of mass action
3. Acids and bases (concepts and application of the aqueous chemistry, pH value)
4. Redox reactions and electro chemistry: Leitmotif - Accumulators
5. Selected chemical compounds, and examples of inorganic chemistry
6. Temporal course of chemical reactions: Kinetics
7. Mass transport in porous media, catalysis
8. Complexe reaction systems
9. Chemical reactors: Residence time behavior, modelling
10. Chemistry of carbon: Organic chemistry (basics, and chemistry selected functional groups)
11. Structures of polymers, mechanisms of polymerization
12. Additives and adjuvant compounds for optimal polymer production and utilization
13. Technical processes in chemistry (production of sulfuric acid, and vinyl chloride)
14. Mechanical behavior: quasistatic stress-strain diagrams, elasticity, plasticity
15. Chemical bonding, structure and crystal lattice, dislocations
16. Microstructure, mechanisms of deformation and strengthening
17. Dynamic deformation, failure and fracture
18. Materials at elevated temperatures: diffusion, creep, recrystallization
19. Solidification and phase transformations, nucleation theory
20. Phase diagrams: eutectic and peritectic transformations, microstructure development
21. Steel: phase diagrams, thermodynamics and kinetics, heat treatments
22. Different steels: hardening, alloying elements and properties
23. General phase diagrams, precipitation hardening
24. Selected light metal alloys, intermetallics, ceramics, polymers, composites
25. Joining technology
26. Wear and corrosion, surface technology
27. Physical properties and functional materials
28. Selected materials characterization methods and tools

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Chemistry	L	3	AT
1: Chemistry	E	1	AT
2: Materials Technology	L	3	WT
2: Materials Technology	E	1	WT
2: Materials Technology	Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture including experiments and example problems/exercises, laboratory class

Voraussetzungen für die Teilnahme / Requirements

formal:- content: -

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	3	36
1: Exercises	12	1	12
1: Preparation and follow-up	12	3	36
1: Preparation for exam			36
Subtotal Part 1:			**120**
2: Lectures	12	3	36
2: Exercises and Laboratories	12	1	12
2: Preparation and follow-up	12	3	36
2: Preparation for exam			66
2: Lab	12	1	12
2: Lab: Preparation and follow-up	12	4	48
Subtotal Part 2:			**210**
Total			**330**

Prüfung und Benotung / Evaluation

The module concludes with a written exam (180 minutes) and a laboratory assessment in the form of "passed" or "not passed".

Dauer in Trimestern / Duration of Module

Trimester 1, 2

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Citation list is delivered at the 1st lecture; scripts are available
- Callister: ”Materials Science and Engineering” (Wiley)
- Ashby and Jones: „Engineering Materials” (Butterworth Heineman, Oxford, 1996)
- Presentations and additional materials provided on the Institute’s web site (www.hsu-hh.de/werkstoffkunde/)

Modul Mechatronics/Multibody Simulation MechMulSim

Mechatronics/Multibody Simulation
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Delf Sachau

Dr.-Ing. Sergej Jukkert

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

delf.sachau@hsu-hh.de +49 40 6541 2733

Sergej.Jukkert@rheinmetall.com

Qualifikationsziel / Module Objectives and Competencies

General:
The students should know the terminology, understand the principles and are able to apply these principles to engineering problems, especially for system dynamics in engineering

Mechatronics / Multibody Simulation (MBS)
The students learn how to model and simulate the dynamics of mechatronic multibody systems

Inhalte / Content

1) Fundamentals: non-linear kinematics and dynamics
2) Multibody system elements: body, joint, constraint, force element, actuator, sensor, electrical component, controller
3) System equations: Principle of d'Alembert, state space form of equations of motion
4) Computational mechanics: simulation software examples: from military vehicle, military robot

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Mechatronics / Multibody Simulation (MBS)	L	2	WT
Mechatronics / Multibody Simulation (MBS	E	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Terminology and basic principles are explained in the lecture, the application of the principles is shown for examples, in exercises the students should solve engineering problems by themselves.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Mathematics, Engineering Mechanics

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lectures	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 5

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

- Shabana: Dynamics of multibody systems, John Wiley & Sons
- Hibbeler: Engineering Mechanics - Dynamics, Pearson Prentice Hall
- P. Flores: Concepts and Formulations for Spatial Multibody Dynamics
- K. Janschek: Mechatronic Systems Design

Modul Practical Training Pract

Practical Training
Leistungspunkte / Credit Points: 3

Modulverantwortlicher / Contact Person

Dr.-Ing. Stefan Schenke (Organisation), Profs MB / Profs ET

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

stefan.schenke@hsu-hh.de
+49 40 6541 2149

Qualifikationsziel / Module Objectives and Competencies

By executing experiments in the laboratories of the mechincal or electrical engineering institutes the students gain an deepr insight in the topics of different modules. They learn how to handle different measuremrnt equipment, and how experiments are planned, executed, and documented.

Inhalte / Content

The students have to choose 6 experimental blocks out of:

Chemistry (1 block): Fundamental measuring methods in chemistry and handling of simple equipment (burette, pH-value measurement); fundamental chemical reactions (redox reactions) and chemical reactors (stirrer vessel, stream pipe reactor).

Thermodynamics(1 block): thermal equation of state of real fluids; saturated steam region; vapour pressure; critical point; conversion of energy and energy balance, example: compression refrigeration machine

Machine Dynamics (1 block): mechanical oscillations; vibration absorber; system identification using a free oscillation test

Engineering Mechanics (2 blocks): Distribution of forces in trusses; static and dynamic friction; elasticity theory (examples of loaded maetrials, e.g. tensile test, orthotropic material model, relaxation, creeping); verification of engineering mechanics models (Bernoulli's hypothesis, grey value correlation technique)

Materials Technology (2 blocks): structure of condensed matter using X-ray structual analysis; grain size and residual stress; micostructure and phase transition; phase diagram, especially iron-carbon diagram; mechanisms of hardening; corrosion; behaviour of loaded materials and corresponding experimental setups; non-destructive materials testing; microscopy: optical and scanning tunnel

Soil mechanics (1 block): sedimentation and sieving analysis; cone index and vehicle cone index (WES) and shear test

Electrical Engineering: (1 block): Electrochemical elements

Electrical Engineering: (1 block): mearuring linear resistors

Electrical Engineering: (1 block): voltage divider

Electrical Engineering: (1 block): Wheatstone bridge

Electrical Engineering: (1 block): oscilloscope,

Electrical Engineering: (1 block): RC-Circuits in time-domain.

Modulbestandteile / Composition of Module

Module Part	Type	Contact Hours per Week	AT/WT/ST

	Computer Training CT Exercises E Lecture L Laboratory Lab		
Practical Training	Lab	3	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Practical Training in Labs is organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
-	-	Skills from basic modules

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Practical Training	12	3	36
Preparation and follow-up	12	4 1/2	54
Total			**90**

Prüfung und Benotung / Evaluation

The module concludes with a laboratory assessment in the form of "passed" or "not passed".

Dauer in Trimestern / Duration of Module

Trimester 6

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Course material will be provided before the lab session.

Modul Preliminary Online Mathematics Course MathCourse

Preliminary Online Mathematics Course
Leistungspunkte / Credit Points: 6

Modulverantwortlicher / Contact Person

Prof. Dr. Markus Bause

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

bause@hsu-hh.de
+49 40 6541 2721

Qualifikationsziel / Module Objectives and Competencies

The course aims to strengthen and homogenize the foundation in mathematics to prepare participants for university education in the field of engineering. It is designed to bridge the gap between the calculus at school level and the introductory calculus at the university level. The module is designed to help participants improve and develop their skills in mathematics.

On completion of this module participants should be able using basic algebra and calculus, polynomial, exponential and logarithmic functions, geometry, trigonometry, solving equations of various type and applying the mathematical techniques to problems of engineering

Inhalte / Content

I. Basic Algebraic Techniques
I.1. Fractions
I.2. Multiplication, division, factoring
I.3. Symbolic terms
I.4. Changing the form of expressions
I.5. Powers and logarithms
I.6. Trigonometric expressions
I.7. Applications in engineering
II. Solving Equations
II.1. Quadratic equations
II.2. Solving fractional and rational equations
II.3. Exponential, logarithmic and trigonometric equations
II.4. Systems of linear equations
II.5. Applications in engineering
III. Miscellaneous
III.1. Vector algebra
III.2. Geometry and analytical geometry
III.3. Basic functions of engineering
III.4. Applications in engineering

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	Compulsory (C) or Elective (E)	AT/WT/ST
Preliminary Online Mathematics Course	L (online explanatory material)		E	Before AT

Preliminary Online Mathematics Course	E (online test units)		E	Before AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

The course uses a series of online, self-guided modules, which allow participants to move at their own pace, and repeat lessons and exercises until the material is learned. Each module contains explanatory material with examples and comprehensive questions as well as extended practical test units. Instructors are available via discussion forums and electronic mail to answer questions and guide participants.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
-	**-**	**-**

Verwendbarkeit des Moduls / Usability of Module

E in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture (online explanatory material)	12	4	48
Exercises (online test units)	12	8	96
Preparation for exam	3	12	36
Total			**180**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (120 minutes).

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

All course materials are provided in the online modules. Further references can be obtained from the instructors on request.

Modul Production Engineering ProdEng

Production Engineering
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Jens Wulfsberg

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

jens.wulfsberg@hsu-hh.de +49 40 6541 2720

Qualifikationsziel / Module Objectives and Competencies

General
The students should know the terminology, understand the principles and are able to apply these principles to engineering problems, especially for methodical approaches in designing systems.

Production Engineering
The students will gain deeper insights into manufacturing processes. They will know the most important manufacturing processes for manufacturing workpieces with geometrically defined shapes. And they will know the basic principles of machine tools which are necessary for the application of manufacturing processes.

Furthermore the students will be enabled to:
- select suitable manufacturing processes for the production of a given workpiece,
- evaluate and compare manufacturing processes in terms of their technological performance,
- evaluate and compare manufacturing processes in terms of economic efficiency, ergonomics and environmental sustainability,
- calculate input, process and outcome variables of important processes.

Inhalte / Content

- Definitions, terms, objectives of production technology.
- Classification of production technology within the system "company".
- Assessment and comparison of manufacturing processes and machine tools according to the criteria: Main technology, error technology, economic efficiency, ergonomics / environmental sustainability.
- Calculation of the relationship of production costs, manufacturing costs, machine hour rate; application of the quantities for different procedures.
- Differentiation of production by imaging procedures, controlled tool movement and material growth procedures.
- Presentation of the important manufacturing processes according to DIN 8580 (casting, forming, separating, mating (welding only).
- Construction and use, preparation of tools in the production technology (geom. determinate, geom. indeterminate, forming).
- Tool life and wear of tools.
- Physical, analytical and empirical modelling of the correlation between input, process and outcome variables for machining processes and forming processes (force, work, output, stresses, wear, tool life,...).
- Mechanical and thermal causes for the development of residual stresses in the surface are of the workpiece, mechanisms of formation.
- Properties, production, use of laser radiation, laser-based manufacturing processes.
- Processes and process chains of rapid prototyping, rapid manufacturing, e-Manufacturing.
- Introduction to machine tool construction and CNC.

Modulbestandteile / Composition of Module

Module Part	Type	Contact Hours per Week	AT/WT/ST
	Computer Training CT Exercises E Lecture L		

	Laboratory Lab		
Production Engineering	L	2	AT
Production Engineering	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

The main component of the module is the lecture in the lecture hall. The material is conveyed through a mixture of Powerpoint files, blackboard descriptions, animations and videos. The students are asked to actively participate in the lecture in form of own contributions. The exercises are generally conducted as lecture hall exercises with student participation. If a critical number of participants is exceeded, the exercises are offered redundantly.

The content of the lectures will be presented from a theoretical as well as a practice-oriented perspective by inviting guest lecturers from the industry, conducting excursions to innovative manufacturing companies as well as letting the students work on different case examples. In this sense, the transfer of theoretical knowledge within the lectures serves as a basis for the transfer and development of rather tacit, procedural knowledge within accompanying seminars and exercises.

Additional teaching and learning offers will be announced by the teacher at the beginning of the course.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	-

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 4 or 7

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Will be announced in the first session.

Modul Programming Program
Programming
Leistungspunkte / Credit Points: 11

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr. Philipp Neumann
Part 2:
Prof. Dr. Oliver Niggemann
Part 3:
Prof. Dr. Oliver Niggemann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Part 1:
philipp.neumann@hsu-hh.de +49 40 6541 2723
Part 2:
oliver.niggeman@hsu-hh.de +49 40 6541 2722

Part 3:
oliver.niggeman@hsu-hh.de +49 40 6541 2722

Qualifikationsziel / Module Objectives and Competencies

Part 1: Introduction to Computer Science
This course provides the most fundamental terms and the associated knowledge for any successful work in the computer field: History, Digital Number Representation, Hardware, Software, Algorithms, Programming, Database Systems, Computer Networks.

Part 2: Programming in C
- Basic knowledge of the structure and function of a computer, including: computer architecture, hardware, operating systems, and file management
- Basics of programming in C with the associated concepts and structures
- Introduction to procedural programming in C

Part 3: Objected Oriented Programming
The students
- understand the motivation and the benefits of object-orientation,
- know the principles of object-oriented software,
- know the diagrams and methods to describe object-oriented systems,
- know the elements of object-oriented programming in a particular programming language,
- are able to analyze a given use case and to design an appropriate object-oriented model,
- are able to turn an object-oriented model into an object-oriented program,
- are capable of using an object-oriented development environment.

Inhalte / Content

Part 1: Introduction to Computer Science

1) Overview of the History of Computers and Basic Digital Computer Concepts
2) Number systems and Boolean Algebra
3) Computations using the Arithmethic Logic Unit (ALU)
4) Types of Computer Memory and its Hierarchy
5) Secondary Storage and its Types, Input and Output Devices
6) Computer Architectures
7) Programming Tools I: Representations of Algorithms
8) Programming Tools II: Programming Languages
9) Operating Systems
10) Data Communication and Computer Networks
11) Database Management Systems

Part 2: Programming in C
Processing of information, coding, number systems, representation of characters, basic programming structures, operating systems, file management and structures, physical realization of memory, solid state memory, magnetomotive memory, optical memory, data communication, graphical data processing and output.
C language: character scheme, data types, arrays, identifiers, literals, functions and procedures, structures, operators, error handling, and basics of procedural programming

Part 3: Object Oriented Programming
Principles of object-orientation. Object-oriented analysis and design: UML diagrams, design methods. Classes, objects, attributes, methods. Inheritance and abstract classes. Interfaces, structures, operator overloading, exception handling. Use of the .NET-Plattform, .NET-Framework, C#.
Definition and creation of a class, constructors and destructors, instantiation. Access rules.
Automatic storage management. Polymorphism, dynamic binding, encapsulation.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Introduction to Computer Science	L	2	AT
2: Programming in C	L	2	WT
2: Programming in C	E/CT	1	WT
2: Object Oriented Programming	L	1	ST
2: Object Oriented Programming	E/CT	2	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1: Introduction to Computer Science
Lecture

Part 2: Programming in C
Auditorium based lecture (L): PC-based projection and interactive explanation of lecture slides, working with MS Visual Studio C
The lecture is accompanied by exercises (Ex) in groups in the computer lab: each student has a PC available for programming and gets trained to solve problems by applying the theory
Homework with review / correction
Colloquium for questions and answers

Part 3: Object Oriented Programming
Lecture accompanied by exercises. During exercises, students solve object oriented design problems and practice object oriented programming tasks, the latter using computers with a programming environment

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	-
2	-	Skills acquired in Mathematics

3	-	Knowledge about C programming (as taught in the module ”Programming in C”)

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	2	24
1: Preparation and follow-up	12	4	48
1: Preparation for exam			18
Subtotal Part 1:			**90**
2: Lectures	12	2	24
2: Exercises	12	1	12
2: Preparation and follow-up	12	5	60
2: Preparation for exam			24
Subtotal Part 2:			**120**
3: Lecture	12	1	12
3: Lecture preparation and follow-up	12	2	24
3: Exercise in the laboratory	12	2	24
3: Exercise preparation and follow-up	12	4	48
3: Preparation for exam	1	12	12
Subtotal Part 3:			**120**
Total			**330**

Prüfung und Benotung / Evaluation

Each part of the module concludes with a separate exam, either written (90/120/120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 1,2,3

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Introduction to Computer Science
P. K. Sinha, Computer Fundamentals, Pearson Education India, 2nd Edition, 2011
R. Thareja, Fundamentals of Computers, OUP India, 2014.

Part 2: Programming in C
- Will be provided on the professorship's web site (www.hsu-hh.de/mit)
- Lecture notes with additional references

Part 3: Object Oriented Programming
- Will be provided on the professorship's web site (www.hsu-hh.de/aut):
- Lecture notes with additional references

Modul Programming and Computational Methods for Data Science ProDatSci

Programming and Computational Methods for Data Science
Leistungspunkte / Credit Points: 11

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr. Philipp Neumann
Part 2:
Prof. Dr. Oliver Niggemann
Part 3:
Prof. Dr. Oliver Niggemann

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

Part 1:
philipp.neumann@hsu-hh.de, +49 40 6541 2723
Part 2:
oliver.niggemann@hsu-hh.de, +49 40 6541 2722
Part 3:
oliver.niggemann@hsu-hh.de, +49 40 6541 2722

Qualifikationsziel / Module Objectives and Competencies

Part 1: Introduction to Computer Science
This course provides the most fundamental terms and the associated knowledge for any successful work in the computer field: History, Digital Number Representation, Hardware, Software, Algorithms, Programming, Database Systems, Computer Networks.

Part 2: Programming in C
- Basic knowledge of the structure and function of a computer, including: computer architecture, hardware, operatingsystems, and file management
- Basics of programming in C with the associated concepts and structures- Introduction to procedural programming in C

Part 3: Computational Methods of Data Science
Goal of the lecture is to teach the fundamentals of computational methods for data science. The students learn (in detail) data analysis methods and their mathematical background

- Students have knowledge about data preparation and data visualization. They know how to analyze data manually and how to exploratively draw conclusions from the data.
- Students now about the workflow for data analysis. Students can evaluate results of data analysis methods.
- Students understand regression problems and simple regression algorithms.
- Students understand classification problems and simple classification algorithms.
- Students can use Python to implements the methods.

Inhalte / Content

Part 1: Introduction to Computer Science
1) Overview of the History of Computers and Basic Digital Computer Concepts
2) Number systems and Boolean Algebra
3) Computations using the Arithmethic Logic Unit (ALU)
4) Types of Computer Memory and its Hierarchy
5) Secondary Storage and its Types, Input and Output Devices
6) Computer Architectures
7) Programming Tools I: Representations of Algorithms
8) Programming Tools II: Programming Languages
9) Operating Systems
10) Data Communication and Computer Networks

11)Database Management Systems
12)Basic Internet Structures, Processes and Big Data

Part 2: Programming in C
Processing of information, coding, number systems, representation of characters, basic programming structures, operating systems, file management and structures, physical realization of memory, solid state memory, magnetomotive memory, optical memory, data communication, graphical data processing and output.
C language: character scheme, data types, arrays, identifiers, literals, functions and procedures, structures, operators, error handling, and basics of procedural programming

Part 3: Computational Methods of Data Science
1) Data preparation, data visualization, correlation measures
2) Regression: linear regression, logistic regression
3) Training methods such as cross-evaluation, Evaluation measures such as F1, AUC-ROC
4) Dimension reduction, (probabilistic) Principle Component Analysis, Singular value decomposition
5) Classification: decision trees, random forests, k-means
6) Introduction to Python, Scipy and visualization libraries

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Introduction to Computer Science	L	2	AT
2: Programming in C	L	2	WT
2: Programming in C	E/CT	1	WT
3: Computational Methods of Data Science	L	1	ST
3: Computational Methods of Data Science	E/CT	2	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1: Introduction to Computer Science
Lecture

Part 2: Programming in C
Auditorium based lecture (L): PC-based projection and interactive explanation of lecture slides, working with MS Visual Studio C
The lecture is accompanied by exercises (Ex) in groups in the computer lab: each student has a PC available for programming and gets trained to solve problems by applying the theory
Homework with review / correction
Colloquium for questions and answers

Part 3: Computational Methods of Data Science
Lecture in the lecture hall: Tablet PC-based projection and interactive explanation of lecture slides, possibly blackboard
Exercise: Working with programming languages, possibly blackboard, in addition, each student has a PC available to program independently. Additional teaching / learning offers will be announced by the respective teacher at the beginning of the event.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	-
2	-	Skills acquired in Mathematics
3	-	Skills acquired in Mathematics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	2	24
1: Preparation and follow-up	12	4	48
1: Preparation for exam			18
Subtotal Part 1:			**90**
2: Lectures	12	2	24
2: Exercises	12	1	12
2: Preparation and follow-up	12	5	60
2: Preparation for exam			24
Subtotal Part 2:			**120**
3: Lecture	12	1	12
3: Exercises	12	2	24
3: Preparation and followup	12	5	60
3: Preparation for exam			24
Subtotal Part 3:			**120**
Total			**330**

Prüfung und Benotung / Evaluation

Each part of the module concludes with a separate exam, either written (90/120/120 minutes) or oral.

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Introduction to Computer Science

P. K. Sinha, Computer Fundamentals, Pearson Education India, 2nd Edition, 2011

R. Thareja, Fundamentals of Computers, OUP India, 2014.

Part 2: Programming in C

- Will be provided on the professorship's web site (www.hsu-hh.de/mit)
- Lecture notes with additional references

Part 3: Computational Methods of Data Science

Scripts, lecture slides, exercises and programming examples are provided electronically.
Literature:
P. N. Tan, M. Steinbach, A. Karpatne, V. Kumar: Introduction to Data Mining, Pearson
T. M. Mitchell: Machine Learning, McGraw-Hill

Modul Quality and Knowledge Management QualKnoMan

Quality and Knowledge Management
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Jens Wulfsberg

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

jens.wulfsberg@hsu-hh.de +49 40 6541 2720

Qualifikationsziel / Module Objectives and Competencies

General:
The students should know the terminology, understand the principles and are able to apply these principles to engineering problems, especially for methodical approaches in designing systems.

Quality and Knowledge Management

Students will gain a deeper understanding of the important role that quality and knowledge management play within a changing economic environment from traditional industrial production to a more open bottom-up oriented economic system, thereby focusing especially on the interrelations between production Engineering, manufacturing technologies and the manufacturing industry/ economics.
Students will be enabled to:
- compare and evaluate different forms of process-oriented and structure-oriented forms of organization within Production Engineering
  and Production Management
- evaluate the advantages and disadvantages of different organizational forms in the manufacturing process
- choose the optimal process for production planning and control as well as an appropriate organizational form from
  different given time specifications and indications for quantity
- a deeper understanding of the structure, methods and elements of quality management systems and are able to analyze, evaluate and apply them
  within an organization (e.g. company).

Inhalte / Content

1) Process- and structure-related organizational forms of the enterprise
2) Organizational forms of the production process (traditional and distributed manufacturing)
3) Basics of operational information systems
4) Methods and procedures of production planning and control
5) Definition and classification of quality management in machine engineering
6) Units and methods within the field of quality management
7) Different paradigms of value creation in manufacturing
   - Changing paradigms: from industrial corporations to bottom-up economics
   - Theory of openness
8) Managing knowledge and inter-organizational cooperation in modern value creation systems
   - Holistic, socio-technical approach
   - The role of network and knowledge intermediaries
9) Business model development

Modulbestandteile / Composition of Module

Module Part	Type	Contact Hours per Week	AT/WT/ST
	Computer Training CT Exercises E Lecture L Laboratory Lab		

Quality and Knowledge Management	L	2	AT
Quality and Knowledge Management	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

The content of the lectures will be presented from a theoretical as well as a practice-oriented perspective by inviting guest lecturers from the industry, conducting excursions to innovative manufacturing companies as well as letting the students work on different case examples. In this sense, the transfer of theoretical knowledge within the lectures serves as a basis for the transfer and development of rather tacit, procedural knowledge within accompanying seminars and exercises.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	-

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	2	24
Exercises	12	1	12
Preparation and follow-up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 4 or 7

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Will be announced in the first session.

Modul Sensors and Actuators SensAct

Sensors and Actuators
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr. Alexander Fay

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

alexander.fay@hsu-hh.de, 040 / 6541-2719

Qualifikationsziel / Module Objectives and Competencies

Goal of the lecture is to teach the fundamentals of the application of sensors and actuators. Students know physical principles to measure physical variables in technical systems, know a variety of physical means to influence technical systems and are capable to deliberately choose suitable sensors and actuators for a given problem.

Inhalte / Content

Introduction to the roles of sensor and actuators in technical systems.

Sensor principles to measure important physical (mechanical, electrical, thermal) variables, such as acceleration, fluid velocity, temperature, and pressure.

Approaches to a systematic assessment and choice of sensor principles.

Actuator principles, e.g. pneumatic, hydraulic and piezoelectric actuators.

Approaches to a systematic assessment and choice of actuator principles.

Methods for the integration of sensors and actuators into technical systems.

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Sensors and Actuators	L	1	WT
Sensors and Actuators	E	1	WT
Sensors and Actuators	Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Lecture in the lecture hall: Tablet PC-based projection and interactive explanation of lecture slides, possibly blackboard

Exercise: Tablet PC-based projection and interactive solution of sensor and actuator design questions, possibly blackboard

Laboratory: Experimental investigation of sensors and actuators.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Skills acquired in Mathematics

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Lecture	12	1	12
Exercises	12	1	12
Laboratory	12	1	12
Preparation and follow-up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Duration: 1 Trimester (preferably in Trimester 5)

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Scripts, lecture slides, exercises and examples are provided electronically.

Literature:

E. Hering et al. (Eds.): Sensors in Science and Technology - Functionality and Application Areas. Springer-Verlag, 2022. eBook at https://link.springer.com/book/10.1007%2F978-3-658-34920-2

H. Janocha: Actuators - Basics and Applications. Springer-Verlag.
eBook at https://link.springer.com/book/10.1007%2F978-3-662-05587-8

Modul Sensor Systems SensSys

Sensor Systems
Leistungspunkte / Credit Points: 8

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr.-Ing. Gerd Scholl
Part 2:
PD Dr.-Ing. Thomas Fickenscher

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

gerd.scholl@hsu-hh.de +49 40 6541 3341
thomas.fickenscher@hsu-hh.de +49 40 6541 2770

Qualifikationsziel / Module Objectives and Competencies

Part 1: Inertial Sensors, Sensor Signals and Global Navigation Systems
The students
- get a feeling about the magnitude of sensor effects which can be exploited technically
- will see that most of the desired sensor effects are superimposed by unwanted parasitic effects
- learn how to interface analog sensors to computers and microcontrolles working in the digital domain
- learn to think in the time and frequency domain
- learn how inertial sensor systems are integrated into navigation systems

and will see that global navigation systems are the interplay between many subsystems

Part 2: Antennas and Radar
To develop a broad appreciation of the fundamentals of radio wave propagation, antennas, and radar systems

Inhalte / Content

Part 1: Inertial Sensors, Sensor Signals and Global Navigation Systems

1) Inertial Sensors
   Accelerometer and Gyroscope Technologies, Coordinate Systems, Strapdown Attitude Representations, Error Characteristics, System Alignment, Strapdown Navigation System Computation, Applications
2) Sensor Signals
   A/D- and D/A-Conversion, Analog and Discrete Signal Processing in the Time and Frequency Domain, Fourier Series Expansion, Fourier Transform, Correlation, Power Density Spectrum
3) Global Navigation Systems
   Functional Segments and Interplay, GNSS Signal Acquisition and Tracking, Navigation (Position, Velocity and Time Estimation), Receiver Design, Accuracy and Integrity, Augmentation Methods, Applications

Part 2: Antennas and Radar

1) Radar basics
   Principle of radar, early days of radar, applications
2) Fundamentals of radio wave propagation
   Elementary electromagnetics, free space propagation, radar range equation, reflection, refraction, diffraction, atmospheric attenuation, ionospheric propagation
3) Fundamental parameters of antennas
   Radiation pattern, directivity, gain, beamwidth, aperture, input impedance, radiation efficiency, noise temperature
4) Linear antennas
   Infinitesimal dipole, finite length dipole, ground effects, monopole
5) Antenna arrays
   Linear array, planar array, electronic beamsteering, synthetic aperture radar (SAR)

6) Aperture antennas
   Huygens-Fresnel principle, aperture excitation distribution and amplitude radiation pattern, parabolic reflector, Cassegrain reflector, feeds
7) Radar cross section (RCS)
   RCS of simple objects, RCS of typical targets, stealth techniques, clutter
8) Waveforms and signal processing
   Unmodulated CW radar, pulsed fixed frequency radar, FMCW radar, intra-pulse and pulse-to-pulse modulated radar, receiver chain, range-Doppler processing, SNR, detection
9) Electronic countermeasures (EMC)
   Mainlobe jamming, sidelobe jamming, masking, deception, destruction, electronic counter counter measures (ECCM)

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Sensor Signal Processing in Navigation	L	2	WT
1: Sensor Signal Processing in Navigation	E/Lab	1	WT
2: Antennas and Radar	L	2	WT
2: Antennas and Radar	E/Lab	1	WT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

L and especially E/Lab are organized in small study groups.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
1	-	Skills acquired in Mathematics and Electrical Engineering
2	-	Mathematics & Electromagnetics

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	2	24
1: Exercises/Lab	12	1	12
1: Preparation and follow-up	12	4	48

1: Preparation for exam			36
Subtotal Part 1:			**120**
2: Lectures	12	2	24
2: Exercises/Lab	12	1	12
2: Preparation and follow-up	12	4	48
2: Preparation for exam			36
Subtotal Part 2:			**120**
Total			**240**

Prüfung und Benotung / Evaluation

The module concludes with a final written exam (180 minutes).

Dauer in Trimestern / Duration of Module

One Trimester

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Inertial Sensors, Sensor Signals and Global Navigation Systems

- D.H. Titterton, J.L. Weston: Strapdown Inertial Navigation Technology. Progress in Astronautics and Aeronautics.
- Alan V. Oppenheim, Alan S. Willsky: Signals and Systems. Pearson Education Limited.
- S. Gleason, D. Gebre-Egziabher: GNSS Applications and Methods. Artech House.
- Additional material will be provided on the Professorship’s web site.

Part 2: Radar and Antennas

- J.C. Toomay, Paul J. Hannen: Radar Principles for the Non-specialist, *SciTech Publishing Inc* .
- Constatine A. Balanis: Antenna Theory, *John Wiley & Sons* .

Modul Students Project StudProj

Students Project
Leistungspunkte / Credit Points: 6

Modulverantwortlicher / Contact Person

Profs-EE, Profs-ME

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

gerd.scholl@hsu-hh.de
+49 40 6541 3341

Qualifikationsziel / Module Objectives and Competencies

Supervised by tutors the students are encouraged to apply their theoretical knowledge acquired in the engineering science study programme in typical engineering projects. They are also encouraged to build small groups and to look for an interesting project that will be offered by the chairs participating in the study programme. Projects are preferred where the thinking in systems is promoted and where a close cooperation of the team members is indispensable. Typically these are cross-platform projects with mechanical and/or electrical, hard- and software aspects, which can often be found in mechatronic or embedded systems. All necessary equipment and support is delivered by the chairs, but it is expected that possible approaches to solve the technical problem are formulated by the students, i.e. the student teams. The project can also be carried out outside the Helmut-Schmidt-University (HSU), e.g. in the technical centers of the Bundeswehr. In this case a HSU-Professor has to be found, who will supervise the progress and success of the project.

Inhalte / Content

formal	content
-	Skills acquired in the study modules attended between trimester 1 and trimester 5.

Verwendbarkeit des Moduls / Usability of Module

E in B.Sc. ES

Arbeitsaufwand / Work Load

180 hours

Prüfung und Benotung / Evaluation

The module concludes with a research project.

Dauer in Trimestern / Duration of Module

Trimester 6

Anmeldeformalitäten / Registration

CMS

Modul Thermal/Fluids Engineering ThermFluid

Thermal/Fluids Engineering
Leistungspunkte / Credit Points: 12

Modulverantwortlicher / Contact Person

Part 1:
Prof. Dr.-Ing. Karsten Meier
Part 2:
Prof. Dr.-Ing. habil. Michael Breuer

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

karsten.meier@hsu-hh.de +49 40 6541 2735
breuer@hsu-hh.de +49 40 6541 2724

Qualifikationsziel / Module Objectives and Competencies

Part 1: Thermodynamics
Objectives
On completion of this module students should have developed and be able to demonstrate a thorough understanding of the fundamentals of PVT properties of fluids (equations of state), first and second laws of thermodynamics, relationships among thermodynamic properties, basic components of cycle processes (diffusors, nozzles, compressors, turbines and heat exchangers), Clausius-Rankine and refrigeration cycle processes and thermodynamic analysis of aero engines.

Learning outcomes At the end of the module students should:
- have an understanding of thermodynamic systems (both closed and open) and energy flows, including concepts of enthalpy, entropy, heat, work;
- be able to use thermodynamic relationships to calculate basic thermodynamic properties e.g. specific enthalpies, entropy change etc.;
- be familiar with the equation of state concept and apply it to model ideal gases and incompressible fluids;
- be able to use thermodynamic property tables for real pure substances;
- understand the principles of adiabatic diffusors, nozzles, compressors, turbines and heat exchangers;
- gain an understanding of how cycle processes are designed considering thermodynamic aspects;
- be able to apply thermodynamic principles in process design, including making assumptions and prediction of system properties.

Skills outcomes
- Ability to understand underlying physics associated with thermodynamics
- Transferable skills in linking fundamental theories to real world processes
- Written communication
- Critical reasoning
- Time and self management

Part 2: Fluid Mechanics
Participants of the course on Fluid Mechanics will learn to:
- understand the fundamentals of fluid mechanics and its importance for a variety of technical applications
- read and understand the governing equations of fluid mechanics and its boundary conditions
- solve classical fluid mechanical problems based on simplified governing equations analytically
- gain a deep understanding of fluid mechanics and its underlying principles

Inhalte / Content

Part 1: Thermodynamics

1. Basic concepts: thermodynamic systems, phases, state variables, processes
2. PVT properties of fluids (equation of state)
3. Ideal gases and incompressible fluid
4. Thermodynamic property tables
5. First and second law of thermodynamics for closed and open systems

6. Relationships among thermodynamic properties
7. Adiabatic diffusor and nozzle
8. Adiabatic turbine and compressor
9. Heat exchangers
10. Clausius-Rankine and refrigeration cycle processes
11. Thermodynamic analysis of aero engines

Part 2: Fluid Mechanics

1. Introduction into Fluid Mechanics and its importance
2. Continuum mechanics approach
3. Fundamentals of kinematics of fluids, Eulerian and Lagrangian representation, streamline, pathline, streakline
4. Derivation of the fundamental equations of Fluid Mechanics, (conservation principle of mass and momentum): Navier-Stokes equations and boundary conditions
5. Hydrostatics and aerostatics (theory and applications)
6. Hydrodynamics including Bernoulli equation (theory and applications)
7. Integral form of the governing equations (conservation of mass and momentum) including applications
8. Similarity theory: Method of differential equations and dimensional analysis (theory and applications)
9. Stratified viscous flows: Steady one-dimensional flows of incompressible, viscous fluids, Couette flow, Poiseuille flow, pipe flow, film flow, viscosimeter flow
10. Fluid flows at small Reynolds numbers (creeping flows of incompressible viscous fluids), slide bearing, flow around cylinder and sphere

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
1: Thermodynamics	L	3	WT
1: Thermodynamics	E	2	WT
2: Fluid Mechanics	L	3	ST
2: Fluid Mechanics	E	2	ST

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Part 1: Thermodynamics
Lectures and especially exercises are organized in small study groups.

Part 2: Fluid Mechanics
In the lectures some demonstration experiments are shown to support the theoretical considerations. The exercises are organized in small study groups, in which the students have to solve fluid mechanical problems themselves supported by the research assistants.

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content

1	-	Basic knowledge of elementary calculus and linear algebra is required.
2	-	Basic knowledge of physics and higher mathematics (differential and integral calculus, linear algebra) are urgently required.

Verwendbarkeit des Moduls / Usability of Module

C in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
1: Lectures	12	3	36
1: Exercises	12	2	24
1: Preparation and follow-up	12	7	84
1: Preparation for exam			36
Subtotal Part 1:			**180**
2: Lecture	12	3	36
2: Exercises	12	2	24
2: Preparation and follow-up	12	7	84
2: Preparation for exam			36
Subtotal Part 2:			**180**
Total			**360**

Prüfung und Benotung / Evaluation

The module concludes with two exams (of 120 minutes).

Dauer in Trimestern / Duration of Module

Trimester 5, 6

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Part 1: Thermodynamics

- J.P. O'Connell, J.M. Haile: Thermodynamics – Fundamentals for Applications, Cambridge, 2005
- C. Borgnakke, R.E. Sonntag: Fundamentals of Thermodynamics, Wiley, New York, 2009

Part 2: Fluid Mechanics

- F. Durst, Fluid Mechanics, An Introduction to the Theory of Fluid Flows, ISBN 978-3-642-09048-6, Springer Berlin Heidelberg New York, 2010. German Version on Springer-Link: link.springer.com/
- A list of further appropriate books will be provided on the Ilias platform under https://ilias.hsu-hh.de (> Professur für Strömungsmechanik > Fluid Mechanics)
- Furthermore, additional material (slides, exercises, formulary, old written exams including solutions) will also be made available on Ilias.

Modul Vehicle Dynamics VehDyn

Vehicle Dynamics
Leistungspunkte / Credit Points: 4

Modulverantwortlicher / Contact Person

Prof. Dr.-Ing. Martin Meywerk

E-Mail-Adresse / Telefonnummer des Modulverantwortlichen / Email/Phone

meywerk@hsu-hh.de +49 40 6541 2723

Qualifikationsziel / Module Objectives and Competencies

General:
The students should know the terminology, understand the principles and are able to apply these principles to engineering problems, especially for system dynamics in engineering

Vehicle Dynamics
The students
- know driving resistances, slip, power demand, limits, clutch, gearbox, front/rear weights, basics of mechanics of soils,
- understand longitudinal vehicle dynamics and mechatronic systems,
- are able to apply fundamental longitudinal dynamic equations to mechatronic systems,
- know and understand ABS and ACC,
- know soils and soil classes,
- know and can apply equations for the description of mechanical properties of soils,
- know trafficability estimations with the cone index and vehicle cone index.

Inhalte / Content

1) Driving Resistances: Rolling, grade, acceleration, aerodynamic drag
2) Slip: tractive force, force coefficient
3) Power demand, limits
4) Clutch, transmission
5) Front/rear weights
6) Mechatronics systems: ABS. ACC
7) Trafficability: geometric aspect
8) Soils and their grain size distributions, influence of the moisture content
9) Mechanical properties of soils
10) Cone index, vehicle cone Index, rating cone index

Modulbestandteile / Composition of Module

Module Part	Type Computer Training CT Exercises E Lecture L Laboratory Lab	Contact Hours per Week	AT/WT/ST
Vehicle Dynamics	L	2	AT
Vehicle Dynamics	E	1	AT

Beschreibung der Lehr- und Lernformen / Teaching and Learning Methods

Flipped classroom: Students watch short videos with online quizzes on their own; in the in-class wrap-up points are clarified, the solution of the quizzes are explained and the lecturer summarizes the content; in the in-class exercises the students put into practice what they have learned**.**

Voraussetzungen für die Teilnahme / Requirements

Module Part	formal	content
	-	Mathematics, Engineering Mechanics

Verwendbarkeit des Moduls / Usability of Module

CEC in ES

Arbeitsaufwand / Work Load

Module Part	Weeks	Hours/Week	Hours Total
Video-Lectures, Online-Quizzes	12	1	12
In-class wrap-up	12	1	12
In-class Exercises	6	2	12
Preparation and Follow-Up	12	5	60
Preparation for exam			24
Total			**120**

Prüfung und Benotung / Evaluation

The module concludes with a final examination, either written (120 minutes) or oral.

Dauer in Trimestern / Duration of Module

Trimester 4 or 7

Teilnehmer(innen)zahl / Number of Participants

unlimited

Anmeldeformalitäten / Registration

CMS

Literatur / Bibliographical References and Course Material

Meywerk, M.: Vehicle Dynamics, Wiley, 2015.