THU

Technische Hochschule Ulm
University of Applied Sciences

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IMEP – INTERNATIONAL MECHANICAL AND MANUFACTURING ENGINEERING PROGRAM

Technische Hochschule Ulm
University of Applied Sciences

IMEP - International
Mechanical and Manufacturing Engineering Program

Student Exchange Program
Fall 2020

Contents

Important Dates

- **For participants of German Language Intensive Course and/or Mathematics for Engineers Intensive Course**

The German intensive language course is ONLY offered for students without any or with little knowledge of German.

Arrival:	**September 1st, 2020**
	Please arrange your arrival on September 1st between 9:00 a.m. and 3:00 p.m.
Registration and orientation:	**September 2nd – 13th, 2020** Campus Prittwitzstraße 10, Room E 03a
German Language Intensive Courses:	**September 14th – September 28th, 2020**
Mathematics for Engineers Intensive Course:	**September 9th – October 1st, 2020**

- **For students who will arrive in October**

Arrival:	**October 1st, 2020**
	Please arrange your arrival on October 1st between 9:00 a.m. and 3:00 p.m.
Registration and orientation:	**October 2nd, 2020, 9:00 a.m.** Campus Prittwitzstraße 10, Room E 03a

!!!! October 3rd, national holiday !!!!

Beginning of classes:	October 5th, 2020
Breaks:	
German Unification Day:	October 3rd, 2020
All Hallows:	November 1st, 2020
Christmas:	December 24th, 2020 - January 6th, 2020
Final exams:	December 14th – 22nd, 2020
Departure:	December 23rd, 2020

Coordination

Faculty of Production Engineering and Production Economics

- Prof. Dr. rer. nat. A. Beckmann
  Academic Director of the IMEP
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  E-Mail: Anette.Beckmann@thu.de

International Office (Akademisches Auslandsamt)
Room E 03
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Course tutors: t.b.a.

Application

- Students have to be nominated by their home university
  The home university sends an e-mail with names & email-addresses to Stephanie.Wagner.thu.de
- Students receive a link for the online-application

Accommodation

Accommodations will be booked by the international office upon receipt of the housing request form. All students will stay in student residences, depending on availability. All rooms are single rooms. Kitchen and bathrooms are to be shared with other students. Please note: in Germany accommodation is not separated by gender. Bed sheets etc. will be provided. There will be no equipment for cooking. We recommend to bring or to buy a small amount of personal kitchenware.

Housing prices are between €350 and €400 per month. Students will be placed by the housing office (Studierendenwerk Ulm) on availability basis, unfortunately preferences cannot be considered. If you accept the room assigned, you have to sign the contract. A security deposit of €300 must be made upon arrival. The money will be withdrawn from your German bank account which you will need to open during the first days of stay. We will assist you in doing so.

The checking-in into the dorms is possible from **Monday through Friday, 9:00 a.m. to 4:00 p.m.**

Please note that check-in and check-out are **only** possible Monday-Friday. We will assign student tutors to assist you when checking-in. For check-out please make an appointment with the janitor in your dorm **at least 10 days before you plan to leave** in order to have your room inspected.

Exams

Final exams: December 14th – 22nd, 2020

In case a student fails a course, i.e. is awarded a grade of 4.7 or worse, a re-examination may be done within 2 weeks after the announcement of the exam results. The examiner decides both the date and the form of the re-examination.
For conducting the re-examination the candidate has to be present in person. The exam may not be taken at the home university.

How to get to Ulm

<u>From Stuttgart Airport:</u>
Take the underground (S-Bahn) S2 or S3 to Stuttgart main train station (Hauptbahnhof – Hbf). It will take you about 30 minutes. At the main train station take a train to Ulm. Trains leave to Ulm about every hour. It will take you about one hour to get to Ulm.

<u>From Munich Airport:</u>
Take the underground to Munich main train station (Hauptbahnhof – Hbf). It will take you about 40 minutes. At the main train station take a train to Ulm. Trains leave to Ulm about every hour. It will take you about 1.20 hours to get to Ulm. Important: if you take IRE/RB/RE trains, be sure to get in the front part of the train since the train splits and only the front part goes to Ulm.

<u>From Frankfurt Airport:</u>
There are direct trains to Ulm from Frankfurt Airport. Trains leave to Ulm about every hour.
It will take you about 2.15 hours to get to Ulm.

<u>From Ulm main train station to Technische Hochschule Ulm</u>
If you give us a call (Anita Everett: +49 731 5028457) we will send a student tutor to pick you up at the main train station. Otherwise take bus no. 7 to bus stop “Kliniken Michelsberg” and walk down the hill.

Check **www.bahn.de** for train connections.

After you arrive

Tutors will help you organizing your stay in Ulm. They will show you the university, the city and they will accompany you to the different offices.

The Activity fee for each student is currently €93 (subject to change). You are allowed to take the city busses in Ulm and its surroundings every evening after 6 p.m. and on Saturdays, Sundays and public holidays free of charge by showing your Student ID card.

All European students please bring your EHIC-Card!

If you stay more than 3 months in Germany you have to go to the registration office in Ulm or Neu-Ulm and register in Germany. Student tutors will help you in filling out the needed forms and will accompany you to the registration office.

Within the first 2 weeks of your stay you will be provided with an e-mail account at Technische Hochschule Ulm. The computer rooms are open from Monday through Thursday from 7:30 a.m. until 8:00 p.m. and on Friday from 7:30 a.m. – 7:00 p.m. during the semester.

Some more useful information

For the Fall Term

We recommend bringing winter clothes and also proper clothes for rainy days. In Ulm we face temperatures between 10° Celsius and minus 10° Celsius in the winter. The location of Ulm offers plenty of opportunities to go skiing on a weekend.

Ulm has some indoor swimming pools that you can visit. Therefore swim clothes might be a good idea for those who enjoy swimming.

In general

For company visits we recommend dress clothes.

When living in a student dorm, you do not need to bring bed linen. Blankets, sheets and pillows will be provided by the dorms but please bring your own towels. The floors will be shared with other students. Each floor has its own kitchen. The voltage in Germany is 230 Volt (50 Hz). You may buy an adapter to use electrical appliances here.

Copies of your passport, credit cards, driver's license etc. are very useful in case they are lost or stolen. The easiest thing is to send you copies by e-mail or scan them in before you leave your home country.

Most shops open at 8:00 a.m. and close normally at 8.00 p.m. There are some shops that are open until 9 p.m. or later, especially grocery stores. On Sundays every shop is closed.

Money

You will need a minimum of approximately € 860 for living expenses per month. Credit cards (most common is MasterCard and Visa) are honored in many places throughout Europe. Do not count on having your credit cards taken in every shop, but they are good to have in case of an emergency.

You will be required to open a German bank account in order to pay your rent and other expenses. This bank account is free of charge for students younger than 27 years and we will assist you in opening it. You can also use it to receive money from your parents, sponsor etc. via bank transfer. You may collect money at the automatic teller machine (ATM) using an ATM card with your personal identification number (PIN). Furthermore, the bank account will allow online banking.

Food

As the Technische Hochschule Ulm and your dorms are not far away from the city center there will be some supermarkets and grocery stores nearby to buy food and drinks. The student canteen (Mensa) offers two menus (one vegetarian) every day from Monday to Friday.

Dates

You may find the German way of writing dates is different from that which you are used to. To avoid any confusion when you are filling in documents, you should write dates as follows:

12th November 2020 = 12.11.2020 (12 = day, 11 = month, 2020 or 20 = year)

Some safety tips

Ulm is a safe city to live in and you should feel able to go out and about without fear. However as in most cities and countries throughout Europe you must use your common sense and be aware of your surroundings, particularly at night. Whenever possible, you should avoid walking alone at night and keep out of badly lit streets and lonely areas. Do not accept lifts from strangers and lock your room when you leave it. Let a friend or roommate know where and with whom you will be and do not leave your belongings unattended.

Field trips

Cultural field trips for example to Munich to visit the German Museum or to the Christmas market in Nuremberg (in German: Nürnberg) will be organized by the International Office.

There will be several field trips to industrial companies (e.g. Porsche, BMW or Daimler, Zwick-Roell) some of them combined with places of general interest. Attendance is required. If students have special interests, we will try to arrange a visit. The dates are mainly given by the visited company and may include Monday mornings or Friday afternoons.

We are looking forward to seeing you in Ulm!
Your International Office Team

Stephanie Wagner + Anita Everett + Jeanette Kolb

IMEP Courses - Overview

It is necessary to coordinate the courses that students want to take, with the corresponding department at their home University. Courses can be either compulsory, elective or just optional.

IMEP Course at Technische Hochschule Ulm	Member of the Faculty	Credits
Mathematics for Engineers Intensive Course	Prof. Dr. Anette Beckmann Dr. Nicola Peranio	1
CAD / CAM	Prof. Dr. Manfred Wehrheim Prof. Dr. Franz Böhm	4
Dynamics 1: Systems with Vibrations	Prof. Dr. Anette Beckmann	4
Dynamics 2: Systems with Controls	Prof. Dr. Anette Beckmann	4
Dynamics Computerlab	Prof. Dr. Anette Beckmann	2 / 4
Fuel Cell Principles	Dr. Alexander Kabza	4
Applied Thermal-Fluid Systems	Prof. Dr. Peter Renze	4
Lean Production Systems	Prof. Dr. Helmut Hartberger Prof. Dr. Manfred Hüser	4
System Automation	Prof. Dr. Walter Commerell	4
Collaborative Product Development	Prof. Dr. Robert Watty	4
Fluid Mechanics	Prof. Dr. Raphael Arlitt	4
Germany within Europe	Ms. Roswitha McLeod	4
German Intensive Course 1 (A1.1)	Language Department Prof. Dr. Dippe	2
Ankommen in Deutschland - Language and Culture (Previous knowledge of A2 required)	Language Department Prof. Dr. Dippe	3
German as a Foreign Language Beginner Level 1 (A1.1)	Language Department Prof. Dr. Dippe	2
German as a Foreign Language Beginner Level 2 (A1.2)	Language Department Prof. Dr. Dippe	3
German as a Foreign Language Elementary Level 1 (A2.1)	Language Department Prof. Dr. Dippe	5
German as a Foreign Language Elementary Level 2 (A2.2)	Language Department Prof. Dr. Dippe	5
German as a Foreign Language Intermediate Level 1 (B1.1)	Language Department Prof. Dr. Dippe	5
German as a Foreign Language Intermediate Level 2 (B1.2)	Language Department Prof. Dr. Dippe	5
Project Work	N.N.	6

Courses take place between Mondays at 8:00 a.m. and Fridays 1:00 p.m.
Attendance at the lectures is required.

Mathematics for Engineers Intensive Course (September)

Catalog Data: 1 credit

The objective of the course is to refresh the student's knowledge and to enhance their skills in mathematics needed in the courses of the IMEP.

The students will apply elementary mathematical methods to solve basic engineering problems which helps them as a bridge to the advanced mathematical problems they will immediately face in other courses of this program and in an engineer's work life. The lecture will briefly refresh the student's knowledge on basic algebra, elementary functions and their curves, calculus with functions with one variable, and vector algebra. Mostly, the students will enhance their skills in solving mathematical problems typical for electrical and mechanical engineering and applied natural science.

Prerequisites: none

Textbook(s): Dr. Nicola Peranio: Moodle Course IMEP Maths

References: Papula, Lothar: Mathematik für Ingenieure und Naturwissenschaftler (Band 1), Lehr- und Arbeitsbuch für das Grundstudium, Springer Vieweg, 2018

Schaum's Outlines series: Precalculus, Calculus, Linear Algebra, McGrawHill

Coordinator: Prof. Dr. Anette Beckmann, Dr. Nicola Peranio

Course Learning Objectives:

Upon completion of this intensive course the student will be able to:

1. Solve basic equations with one unknown and linear systems of equations with several unknowns
2. Understand and apply important mathematical functions
3. Calculate and apply derivatives and integrals of functions commonly used in engineering and natural science
4. Use vectors in engineering problems

Topics covered:

Session	Topics
1/2	Basics algebra • solve polynomial equations with one unknown • solve linear systems of equations with several unknowns • solve fractional equations and equations with roots
3/4	Functions and curves • definition, curves, and properties of elementary functions and their inverse functions • reflection, stretching, and shifting of curves • application of polynomial, trigonometric, and exponential functions in engineering and natural science
5/6	Calculus – Differentiation • derivatives of elementary functions and rules of differentiation • find tangent and normal lines, linearization of functions • discuss curves with respect to characteristic points and solve extreme value problems
7/8	Calculus – Integration • integration of elementary functions and integration rules • calculate areas, surface areas, volumes, center of gravity, moment of inertia, …
9/10	Vector Algebra • definition of Cartesian coordinate system and base vectors • determine position vectors and displacement vectors using basic vector operations • calculate distances, angles, areas, and volumes using dot product, vector product, parallelepipedial product

Schedule: Intensive course in September (07.09. - 01.10.2020)
10 sessions of 90 minutes each

Mode of Evaluation: Attendance required, 1 written test
Distribution: Participation 25%, written test 75%

Prepared by: Prof. Dr. Anette Beckmann, Dr. Nicola Peranio

CAD / CAM

Catalog Data 4 credits
similar to MECH-498

The main subject of this course is the interaction of design (CAD) and manufacturing (CAM), so that this course is useful for both mechanical and manufacturing engineers.

The course starts with higher level concepts and exercises in CAD. Then knowledge of advanced manufacturing processes is provided. Finally the information transfer from CAD to the manufacturing processes is investigated.

Intensive lab work is part of this course.

Prerequisites: Basic course CAD / CAM / CAE

Textbooks: Prof. Dr. Hayri Damaritürk
Script for international students

References: S. Vajna, Ch. Weber, J. Schlingensiepen and D. Schlottmann:
C<u>AD / CAM für Ingenieure</u>, Vieweg-Verlag, Braunschweig 1994

M. Weck: <u>Fertigungssysteme</u>,
VDI-Verlag, Volume 1 to 4

B. Erdel: <u>New Dimensions in Manufacturing</u>, Hanser
Gardner Publications, Cincinnati, USA

Coordinators: Prof. Dr. Manfred Wehrheim, Prof. Dr. Franz Böhm

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Understand the main functions and data models used in CAD systems
2. Apply CAD systems: Design parts in 2D and 3D with parametric and feature based design
3. Understand the design requirements for machining parts on CNC machines
4. Know and apply the advanced manufacturing processes
5. Perform data transfer from CAD to CAM
6. Machine parts using data from CAD

Topics covered:

Week	Topic
1	Introduction to CA-technologies
2	CAD-Software**:** Two and three-dimensional modeling. Parametric and feature based design.
3	Data exchange from CAD to CAM
4 - 5	CAD-Laboratory Work**,** Designing parts and assemblies with Pro/Engineer.
6	Designing parts for NC machining: Milling on CNC-machining center
7 - 8	New emerging manufacturing technologies, programming of numerical controls, rapid prototyping, high speed machining.
9 - 11	Manufacturing Laboratory: Exercises on CNC machine tools, CNC measuring machine and robotics

Schedule: 4 weekly lectures / lab work of 45 minutes each

Computer usage: Work with CAD systems and programming of CNC machines

Mode of Evaluation: Attendance and lab work required, 1 written test
Distribution: Participation 25 %, lab work 25 %, written test 50 %

Prepared by: Prof. Dr. Manfred Wehrheim, Prof. Dr. Franz Böhm

Dynamics 1: Systems with Vibrations

Catalog Data similar to MECH-330, 4 credits

In this course the basic methods of modeling and analysis of dynamic systems will be discussed. The focus is on mechanical systems (1st order, 2nd order and higher order systems). Electrical and simple thermal systems are also discussed to show analogies. Newton's method, Lagrange method and Kirchhoff's laws as well as Bond-graphs are used to find the mathematical model of the systems. State-space representation of models and their advantages are discussed. The analysis of the systems is performed in time domain and frequency domain by calculation from transfer function as well as from simulation using MatLab and Simulink. The modeling and analysis techniques are applied to gain deeper understanding of the behavior of free vibrations (damped and undamped), forced vibration for harmonic excitation and multi-degree freedom mass-spring-damper systems including their applications. Live-experiments are shown in the lectures.

Prerequisites: PHYS-114, PHYS-115, MATH-204

Textbook(s): Dynamic Systems for International Students

References: Bangerjee: Dynamics for Engineers
Wiley, 2005

Lobontiu: System Dynamics for Engineering Students
Elsevier, 2018

Coordinator: Prof. Dr. Anette Beckmann

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. identify system components, their symbols, terminology, attributes, constitutive equations and interactions based on a unified approach.
2. model mechanical, electrical and multidiscipline systems.
3. derive the equations of motion of Single Degree of Freedom (SDOF) and a 2DOF mechanical system using Newton Second Law and multi-degree of freedom systems (mass-spring-damper systems) using Lagrange method.
4. find state space representation.
5. determine transfer functions using Laplace transformation.
6. derive the characteristic equation of a first and second order system, solve for the eigenvalues, their natural frequencies (if any) and evaluate the stability of the system.
7. estimate the starting/terminal value of a function using initial/final value theorem.
8. investigate and analyze mechanical systems in time and frequency domain.
10. develop a computer code to simulate and analyze and design real engineering systems using Matlab software.
11. take the second course in systems engineering entitled "MECH 430 – Dynamic Systems with Controls".

Topics Covered:

Week	Topics
1	Mathematical models: differential equation from Newton's Law
2	Lagrange formalism for multi-degree of freedom mechanical systems Dynamic systems in block diagrams; Live-experiment Simulations using MatLab/Simulink
3	Method to derive the diff. eq. for electrical filters and for thermal systems
4	Bond-graph technique / State space representation
5	Characteristic equation of the diff. equation and stability of the system
6	Laplace transform and transfer function
7	Time domain analysis: initial response, impulse response, step response
8	Initial Value Theorem / Final Value Theorem / Stability / Live-experiment
9	Frequency domain analysis / Natural frequencies / Live-experiment
10	System analysis using MatLab and control systems toolbox
11	Advanced systems and block diagrams

Schedule: Four weekly lecture sessions of 45 minutes each,
5 lab sessions of 90 minutes

Computer Usage: Basic computer skills (MS Word, Excel)

Mode of Evaluation: 2 written tests and lab
(midterm 40%, final 40%, Lab 20%)

Prepared by: Prof. Dr. Anette Beckmann (similar to Mech 330)

Dynamics 2: Systems with Controls

Catalog Data similar to MECH-430, 4 credits

The objective of this course is to provide an understanding into basic principles and methods underlying the steady state and dynamic characterization of feedback control systems. The focus is on multi-discipline approach. Construction of mathematical models of systems using block diagrams, Bond graphs and state space models is emphasized. System performance in time and frequency domains as well as stability are derived from transfer function and are studied using computer simulation software tools. Design of controllers is discussed. An introduction to some advanced topics in control systems is also provided. Live-experiments are included.

Prerequisites: Dynamic Systems, PHYS-114, PHYS-115, MATH-204

Textbook(s): Prof. Dr. Beckmann: Control-Lectures for international Students

References: Levine: The Control Handbook, IEEE Press, 1996

Katsuhiko Ogata: Modern Control Engineering,
Prentice Hall, 1997

Lobontiu: System Dynamics for Engineering Students
Elsevier, 2018

Coordinator: Prof. Dr. Anette Beckmann

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Model simple engineering feedback systems (examples are taken from the automotive industry).
2. Analyze the performance in time- and frequency domains;
   Laplace and inverse Laplace transform solutions for simple cases,
   Evaluation of the characteristic equations and discuss stability.
3. Evaluate system performance characteristics in time- and frequency domains, such as stability.
4. Simulate the system performance in time- and frequency domains using Matlab/Simulink.
5. Design simple controllers, such as P, PI, PD, and PID, for systems to meet certain performance objectives using Matlab / Simulink.

Topics Covered:

Week	Topics
1	Introduction to feedback control systems / time domain parameters
2	Mathematical models / transfer function /state space representation
3	Plants: dynamics of a car, car suspension system, DC-motor
4	Analysis in time domain / live-experiment
5	Analysis in frequency / live-experiment / simulations with MatLab
6	Modeling of feedback systems / Bond graphs
7	Stability / Simulations with LTI-viewer
8	Controller task / controller architecture
9	Controller types: P, I, PI, D, PD, PID / live-experiment
10	Control loop / controller tuning with MatLab
11	Controller design rules / stability of the closed loop

Schedule: Four weekly lecture sessions of 45 minutes each, One weekly lab session of 90 minutes

Computer Usage: Basic computer skills (MS Word, Excel) and some familiarity with Matlab/ Simulink are helpful

Mode of Evaluation: Attendance and 2 written tests. (midterm 40%, final 40%, lab 20%)

Prepared by: Prof. Dr. Anette Beckmann

Dynamics Computerlab

Catalog Data 2 credits / 4 credits with presentation of project work

The objective of this course is to learn how to use MatLab and Simulink for the simulation of dynamic systems. The emphasis here is “learning by doing”.

Simulink models are build up from the blocks of the library and the time domain response is studied and analyzed. System performance is also studied using computer simulation in MatLab code both in time and frequency domains.

MatLab software tools are used for system analysis (LTI-viewer) and controller design. The results shall be documented and presented by the students. Project work can be included.

Prerequisites: none

Textbook(s): Prof. Dr. Beckmann: Tutorials Dynamics Computerlab

References: Lobontiu: System Dynamics for Engineering Students
Elsevier, 2018

Coordinator: Prof. Dr. Anette Beckmann

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Model simple engineering systems using Simulink.
2. Analyze the performance in time domains and interpret the results.
3. Simulate the system performance in time domain and frequency domain by using Matlab commands as well as by using tools, such as LTI-Viewer.
5. Evaluate system performance characteristics and assess the stability of system using MatLab commands and MatLab tools.
7. Estimate plant parameters from system response.
8. Design simple controllers, such as P, PI, PD, and PID, for systems to meet a specified performance using the tools offered in Matlab (such as pidtuner) and in the Simulink library.
9. Document and present the results.

Topics Covered:

Week	Topics
1	Introduction to Simulink
2	Modeling of simple automotive systems in Simulink
3	Time domain analysis of the systems in Simulink and documentation of the results
4	Introduction to MatLab Commands and Tools for dynamic system analysis; LTI-viewer
5	MatLab code for analysis of a given system in time domain and frequency domain; Interpretation of the results
6	Determination of system performance in time domain, stability, gain and phase margins
7	LTI-Viewer and application to different systems
8	Manual and automated PID-Controller design; PID-Tuner
9	Tuning of a PID-Controller to meet rise-time and settling time requirements
10	Root-locus-design; use of control system designer of MatLab
11	Presentations of project work

Schedule: One weekly lab session of 90 minutes

Computer Usage: Basic computer skills (MS Word, Excel)
Some familiarity with Matlab/ Simulink is useful but not necessary

Mode of Evaluation: Attendance and written lab reports required
2 credits: Participation 30% and lab reports 70%
or
4 credits: Participation 30 %, lab reports 30%, presentation of project work 40%

Prepared by: Prof. Dr. Anette Beckmann

Fuel Cell Principles

Catalog Data: 4 credits
similar to MECH-498 / MECH-526

This course convers the following topics of fuel cell technology:

1. Electrochemical fundamentals: Basics of electrochemistry are explained for batteries and fuel cells with thermodynamic and kinetic fundamentals
2. Fuel Cell Stack: The individual components inside the fuel cell stack are explained in detail with their key properties and their impact regarding robustness, lifetime and operation of stacks
3. Fuel Cell Testing and Characterization: Before fuel cells stack are integrated in systems they need to be characterized and tested. How this works and the role of fuel cell test stations is discussed here
4. Fuel cell system fundamentals and hydrogen: The basics of fuel cell system technology are part of this section. Also the properties of hydrogen and hydrogen infrastructure is explained here
5. Automotive and stationary fuel cell systems: Here the details of fuel cell vehicle and stationary application is explained, a generic automotive system is used to discuss key system components, and some basic MATLAB/Simulink simulation aspects are discussed
6. Market situation and cost models

Two excursion are scheduled, one to the ZSW facilities in Ulm, the second to an industrial automotive OEM.

References: Fuel Cell Handbook, U.S. DOE, November 2004
G. van Wylen, R. Sonntag, C. Borgnakke

J. Larminie, A. Dicks: Fuel Cell Systems Explained, John Wiley & Sons, Ltd, England 2000

Coordinator: Dr. Alexander Kabza

Course learning objectives:

Students will be able to:

1. Apply the entire basic rules of a working fuel cell process in order to describe the stoichiometric equation, the change of the entropy, the Gibbs function and the cell voltage output of the cell.
2. Calculate the theoretical cell voltage as a function of pressure and operating temperature at different reactants.
3. Understand the difference between theoretical and practical fuel cell process.
4. See the big benefit of fuel cell technology today and in the future.

Prerequisites by topics:

Chemical fundamentals of thermodynamics and kinetics
Interest in interdisciplinary aspects of fuel cells like mechanics, physics, chemistry, material properties etc.

Topics covered:

Week	Topics
1	Fundamentals
2	Components
3 - 4	Testing I and II
5	Fuel Cell Systems I (automotive)
6	Visit ZSW labs
7	Fuels for Fuel Cells
8	Excursion
9	Fuel Cell Systems II (stationary)
10	Fuel Cell Market situation
11	Exam

Schedule: 4 lecture sessions of 45 min per week
with integrated excursions

Computer Usage: Pocket calculator, MS PowerPoint (or similar tool)

Laboratory project: none

Mode of Evaluation: Attendance required, 1 written test

Distribution: Participation 25 %, written test 75%

Prepared by: Dr. Alexander Kabza

Applied Thermal-Fluid Systems

Catalog Data: 4 credits
similar to MECH-422

In this course the physical laws of thermodynamics and fluid mechanics will be applied to industrial components and equipment. The governing equations will be summarized prior to the lab exercise. The students will learn to describe the behavior of the equipment by means of these equations and verify it by operating the equipment. The fundamentals of the measuring technique are applied, in order to be able to determine pressures, temperatures, mass flows and amounts of heat. At selected machines complete energy balances and efficiency are calculated. The influence of friction effects is studied.

Prerequisites: Thermodynamics, Fluid mechanics
Especially:
First and second law of thermodynamics,
Conservation of mass,
Momentum and energy,
Bernoulli´s equations,
Properties of substances,
Basic computer skills (MS Word, Excel)

Textbooks: Energy Systems Laboratory: Script for international Students

References: Moran and Shapiro: Fundamentals of Engineering Thermodynamics, Wiley, 2000
Roberson and Crowe: Engineering Fluid Mechanics, Wiley, 1997

Coordinator: Prof. Dr. Peter Renze

Course learning objectives:

Upon completion of this course the student will be able to:

1. Apply the laws of thermodynamics and fluid mechanics to actual industrial equipment
2. Evaluate machines, which operate with combined techniques from the field of fluid mechanics and thermodynamics.
3. Apply modern measurement techniques and measuring methods.
4. Learn the use of computers during the measuring process and with the analysis of the measurements.
5. Gain experiences at real machines.
6. Apply team working skills

Topic covered:

Week	Topics
1 – 3	Safety guidelines Diesel engine and turbo charger; Performance characteristics Work and reaction of the turbo charger
4 – 5	Heat pump and air conditioner, MOLLIER – diagram lg(p),h – diagram of R134a
6 – 7	Centrifugal pump; Principles of operations Cavitation performance map Characteristics of the pump
8 – 9	Condensing boiler
10 – 11	Natural gas-fired unit heat and power station for cogeneration Performance characteristics

Schedule: Four lessons per week of 45 minutes

Computer Usage: Basic computer skills (Excel, MS Word)

Laboratory project: One experiment in every laboratory session

Mode of Evaluation: Attendance and written lab reports required, one written test

Distribution: Participation 33 %, lab reports 33 %, written test 33 %

Prepared by: Prof. Dr. Peter Renze

Lean Production Systems

Catalog Data: 4 credits

The objective of this course is to introduce the basic models and tools used in designing, building and operating a production system of bulk manufacturing.

Components of this class will be team projects involving Enterprise-level evaluation of value streams from concept development through product delivery and support. These term-long projects will include an assessment of current company process / information flows, resource requirements, technology utilization, and cycle-times.

Key elements will be a planning game and case studies.

The course requires active participation in classroom exercises as well as reading and presentation of the results of team exercises.

Prerequisites: Manufacturing processes

Textbooks: Rother & Shook: Learning to See, Enterprise Institute
Rother, M.: Creating Continuous Flow

References: Shingo: A Study of the Toyota Production System. Productivity Press, 1989

Coordinators: Prof. Dr. Hüser, Prof. Dr. Hartberger

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. understand the basic principles of production system design.
2. apply tools for analysis of production systems
3. measure production system performance
4. design and improve production systems

Topics covered:

Week	Topics
1	Goals and organizational structures of manufacturing companies
2 – 4	Value stream mapping of production systems including customer focus JIT-System principles
5 – 9	Fulltime block seminar 3 days planning game bulk manufacturing
10 – 11	Case studies onsite in German production companies

Schedule: Four lessons per week of 45 minutes in the beginning
Block seminar of a planning game 3 days fulltime
Field studies onsite

Computer Usage: Basic computer skills (PowerPoint, Excel, Word)

Mode of Evaluation: Attendance, team work presentation, written test

Distribution: 20 %, 30 %, 50%

Prepared by: Prof. Dr. Hüser, Prof. Dr. Hartberger

System Automation

Catalog Data: 4 credits

The objective of the lecture is to give an overview on different system with their behavior and to provide an understanding of the system. The students gain the knowledge how to describe the behavior of the system and design a model of the system on the computer. To model the system the same software as in the lecture “Dynamic Systems” will be used.

The students learn how to structure and analyze the system and design the required automation solution. The students learn how to control event systems and continuous systems. Therefore, the overall design process and the design steps are discussed and realized on practical examples.

Prerequisites: Dynamic Systems I

Textbook: Prof. Dr. Walter Commerell
System Automation

References: Levine: The Control Handbook, IEEE Press, 1996
Katsuhiko Ogata: Modern Control Engineering,
Prentice Hall, 1997

Coordinator: Prof. Dr. Walter Commerell

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Structure a multi domain system. Examples from automotive industry and common process industry will be used
2. Analyze multi domain systems with continuous and discrete parts as well as hybrid systems with both parts.
3. Understand and work on base of a model based design process using an accepted professional simulation tools, such as Matlab/Simulink
4. Design a concept on base or the user requirements
5. Design automation solutions on base of standard automation components as PLC or continuous controller.

Topics covered:

Week	Topics
1	Introduction to System Automation
2	Description of different Systems
3	View on continuous Systems
4	View on discrete Systems
5	Analysis of Systems
6	Structure of Systems
7	Automation Process
8	Requirements Process
9	Design of Automation Solutions
10	Examples
11	Examples

Schedule: Four weekly lecture sessions of 45 minutes each
One weekly lab session of 90 minutes

Computer Usage: You'll gain knowledge in PLC Programming and Controller design using MatLab/Simulink

Mode of Evaluation: Attendance and written lab reports required
1 written test

Distribution: Written mid-term test 50%, written final test 50%

Prepared by: Prof. Dr. Walter Commerell

Collaborative Product Development (CPD)

Catalog Data: 4 credits

The global world is becoming increasingly connected, raising new challenges in product development and collaboration. Collaborative Product Development (CPD) is a new way of organizing and managing product development in an international and interdisciplinary context to design and manufacture internationally competitive products.

This course enables students to develop products in internationally distributed teams. Students are introduced to the engineering design process for worldwide product development and management, including concept creation and creativity for practical product engineering, embodiment and detailed design. This is followed by the planning of the manufacturing process and the manufacturing and quality assessment of the product.

The course has been developed in cooperation with our international partners and it is a main part of the course that students at partner universities develop a product (e. g. a gear box) that is manufactured by a different student group at the other university. Thus students are able to apply their skills in a hands-on mini project that culminates in the physical generation of a real industrial product.

It is also possible to add a more extensive “Design project” if needed by the students.

Prerequisites: Machine elements, Basics of product design, CAD

Textbook: Prof. Dr-Ing. Robert Watty:
Collaborative product development

References:

Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H.
Engineering Design -A Systematic Approach.
3rd ed. Springer, Berlin, 2007

Haik, Y., Shahin, T.
Engineering Design Process.
Cengage Learning, Stamford, USA, 2nd Ed. 2011

Niku, S.: Creative Design of Products and Systems. Wiley, USA, 2009

Dym, C., Little, P.
Engineering Design: A Project-Based Introduction. Wiley, New York, 2000

Coordinator: Prof. Dr-Ing. Robert Watty

Course Learning Objectives:

1. Understand and apply the product development process in an international context
2. Design a product, plan the manufacturing process, assure product quality
3. Organize teamwork in an international distributed team

Topics covered:

Week	Topics
1	Introduction of the project and the partners
2	Project work in an cooperative international context
3	Methodological product development in an cooperative international context
4	Tools for collaborative product development
5	Cultural aspects of product development
6	Collaboration in distributed locations and organizational structures
7 - 9	Project work, Scrum-approach
10 - 11	Manufacturing, Quality assurance and management

Schedule: Four weekly lecture sessions of 45 minutes each
one weekly project work session of 90 minutes

Computer Usage: Basic computer skills (MS Word, Excel) and CAD

Mode of Evaluation: Attendance and project report, 1 written test
Distribution: project 50%, written test 50%

Prepared by: Prof. Dr.-Ing. Robert Watty

Fluid Mechanics

Catalog Data: 4 credits
similar to MECH-322 Fluid Mechanics

This is a first course in Fluid Mechanics that involves the study of the nature of fluid flow in ducts and over objects. The course introduces the fundamental aspects of fluid motion, fluid properties, flow regimes, pressure variations, fluid kinematics, and methods of flow description and analysis. The course presents the general conservation laws in their differential forms and their use in analyzing and solving fluid flow problems. In addition, the concept of measuring principles in fluid dynamics is demonstrated in laboratory tests. The effects of fluid friction on pressure and velocity distributions are also discussed. The effects of compressibility of gas flow with variable density are also included.

Prerequisites: ME 304 Thermodynamics

(1) Integration and Differentiation
(2) Dot Product and Cross Product of Vectors
(3) Moment of Inertia and Centroids
(4) Concepts of Control Volume and System
(5) Basic Computer Skills (MS Word and Excel)

Textbook: Fundamentals of Fluid Mechanics,
by Munson, Young and Okishi,
Fourth Edition, John Wiley and Sons, Inc.

R. Ruderich, Script “Fluid Mechanics”
for international students

References: Roberson and Crowe: Engineering Fluid Mechanics,
7th Edition, John Wiley & Sons, Inc. 2001

Pijush K. Kundu and Ira M. Cohen: Fluid Mechanics
2th Edition, Academic Press, 2002

Coordinator: Prof. Dr. Raphael Arlitt

Course Learning Objectives:

Upon completion of this course the student will be able to:

1. Determine pressure distribution in fluids at rest and to calculate hydrostatic forces (magnitude and line of action) acting on plane and curved surfaces.
2. Draw streamlines in a given flow field and to determine pressure variations along and normal to streamlines.
3. Determine the velocity and acceleration of the fluid for steady and unsteady flow.
4. Apply the control volume concept to describe fluid flow through the application of conservation of mass, momentum, and energy.

5. Apply the governing differential equations (mass, momentum, energy) to analyze fluid flows.
6. Take data of special experiments in laboratory tests and have to correlate these data using the theory of fluid flow.
7. Apply the basic principles to the flow of viscous incompressible fluids in pipes, multiple pipe systems, and ducts, to determine friction losses.
8. Utilize existing experimental and numerical data to analyze external flows, and to calculate drag and lift forces acting on immersed bodies.
9. Study the effect of compressibility on steady, isentropic, one-dimensional flow of an ideal gas in a varying cross-sectional area duct.

Topics Covered & Schedule:

Week	Topic
1 - 2	The Nature of Fluids. The General Description of the Fluid by Introducing the Continuity Equation and the Navier-Stokes Equation in Differential Form in Cartesian Coordinates. Properties of Fluids including Definitions and Units.
3 - 4	Fluid Statics. Pressure Distribution. Hydrostatic Forces on Sloping Walls and Curved Surfaces. Buoyancy. First Laboratory Practice: Static Pressure Measurements.
5 - 7	Fluid Kinematics. Steady and Unsteady Flow. Streamlines and Streamtubes. Flowfield. Bernoulli's Equation for Steady and Unsteady Flow without Friction. Force Balance Across Streamlines. Second Laboratory Practice: Stagnation Pressure, Dynamic Pressure and Velocity Measurements with different methods.
8 - 9	Viscous Incompressible Flow in Pipes and Noncircular Ducts. Laminar and Turbulent Flow. Friction Factor. Moody Diagram. Loss Coefficients from Fittings. Pumps. Pipe Networks and Pressure Losses. Bernoulli's Equation. Laboratory Demonstration.
10	Boundary Layer Theory. Flow Over a Flat Plate. Flow Over an Airfoil. Separation and Reattachment. Drag and Lift. Laboratory Demonstration Including Flow Visualisation
11	Compressible Flow. Speed of Sound and Mach Number. Isentropic Compressible One-Dimensional Flow of Ideal Gases.
12	Comprehensive Final Examination

Computer Usage: Basic computer skills (Maple (no previous experience is needed), MS Word, Excel)

Laboratory: Measuring project

Relationship to Professional Component: This course is 33 % Science and 67 % Engineering

Mode of Evaluation: Attendance, Lab reports 10%, home work 10%,
2 written tests: midterm exam 30 %
final exam 50 %

Prepared by: Prof. Dr. Raphael Arlitt

Germany within Europe

Catalog Data: 4 credits
Similar to SSCI-398

The objective of this course is to give an overall view of Germany, to provide you with an idea of why things are the way they are and an understanding of how people tick here.
The course explores Germany´s historical heritage as well as political and cultural aspects and takes a look at Germany´s position in Europe and the world. Lecture topics also include geography, economy and society.
Several Field trips are part of the class with the goal of connecting theory with real life experience.

Prerequisites: none

Credits 4

Textbooks: Facts about Germany,
Societäts-Verlag, Frankfurt 2000
www.facts-about-germany.de

References: Deutschland: Alles was man wissen muss.
Duden, Berlin 2015

Coordinator: Mrs. Roswitha McLeod

Course learning objectives:

Upon completion of this course the student will be able to:

1. Explain effects of major historical events on German life
2. Demonstrate knowledge of important basic information about Germany
3. Connect personal experiences and class content to give deeper meaning to the experiences during the exchange term

Topics covered:

Week	Topic
1	Geography: Germany and Europe
2 - 4	History and historic sites in Ulm
5	Political System
6	Society and people
7 - 9	Culture
10	Germany within Europe – Alliances
11	One year in Germany - Holidays and festivities

Schedule: 4 sessions of 45 minutes per week

Computer usage: Basic computer skills (MS Word, PowerPoint)

Mode of Evaluation: assignments, one written test, one presentation, attendance
Distribution: Presentation 33 %, Test 33 %,
Assignments/Participation 33 %

Prepared by: Mrs. Roswitha McLeod

German Language

Intensive Course in September (voluntary):

German Language Intensive Course	Lessons per week	Credits
Beginner Level 1 (A1.1)	30 (5 x 6 lessons, 2 weeks)	2
Ankommen in Deutschland Language and Culture (Previous knowledge of A2 required)	30 (5 x 6 lessons, 1 week)	2

Language Courses during term:

German as a Foreign Language	Lessons per week	Credits
Beginner Level 1 (A1.1)	8	2
Beginner Level 2 (A1.2)	4	3
Elementary Level 1 (A2.1)	4	5
Elementary Level 2 (A2.2)	4	5
Intermediate Level 1 (B1.1)	4	5
Intermediate Level 2 (B1.2)	4	5

Textbook: Menschen: Deutsch als Fremdsprache – Kursbuch
Hueber-Verlag

Menschen: Deutsch als Fremdsprache – Arbeitsbuch
Hueber-Verlag

Supplementary material provided by course coordinator

Coordinator: Institute for Foreign Languages and Management
(Prof. Dr. Ben Dippe)

Goals: The courses will provide competence in speaking, reading and writing German according to the respective level of the Common European Framework (CEFR).

Evaluation: Written exam (and course participation where applicable)

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