Syllabus

International Summer University

German Engineering and Language

June 06 – July 16, 2021

1. Program Goal

The International Summer University 2022 is an intensive interdisciplinary program where students will take academic courses in different fields of German engineering, while simultaneously attending intensive German Language classes. This program is primarily designed to provide an insight into the broad field of German cutting-edge engineering, help improve the participants' German language skills and to allow students to discover and understand more about the German culture. Students will focus on selected and highly relevant problem areas, whereby tailor-made modules allow students to develop a deeper understanding in the chosen field of study by focusing specifically in these areas of engineering.

While students take weekly Intensive German Language Classes – STEM, a Cross-Cultural Competencies Training for Engineers, they will be able to choose two courses between different engineering courses in the field of Mechanical or Electrical Engineering. In the field of Mechanical Engineering, students can choose between Automotive Engineering, Aeronautical Engineering, Mechatronic Engineering and Production Engineering. In the field of Electrical Engineering students will participate in two courses: Electromagnetic Field Simulation and Microfluidics + BioMEMS.

During the International Summer University Program, students will work together with other students from around the world to enhance their communication, problem-solving and team-working skills to find solutions to complex practical tasks. The various engineering courses offer students the opportunity to gain an insight into the latest research findings by combining lectures with interactive workshops and group presentations. In addition, students will have several opportunities during virtual company visits, such as *Mercedes Benz*, *Continental AG* or *Merck Chemical Engineering Company* to get hands on experience within the field of engineering. By participating in such activities, students are able to not only improve their cross-cultural communication skills but also get a first look into future employment opportunities within the field of German engineering.

2. Program Prerequisites

The International Summer University: German Engineering and Language Program has no formal pre-requisites, however, please note the following:
The participants must be enrolled as students at their home university.

German Language

No German language skills are required. However, for participants with advanced German language skills, classes with a higher level of German will be offered.

Lecture Series: Engineering Courses

This program will be most useful to undergraduate students with an interest or previous knowledge in Mechanical Engineering or Electrical Engineering. Students studying in similar subject areas within the field of Engineering and Sciences are however also welcome.

3. Program Structure and Course Descriptions

Outside of class time, students are expected to complete the assigned reading and complete homework assignments as well as prepare for workshops and final examinations.

German Language – CEFR Level A1, A2 & B1 / 4 ECTS – 2 US/CAN Credits

Course Description:
This language course is designed especially for STEM-students of levels Beginner to Pre-Intermediate who want to improve their prospective careers with a German language course. Here you will learn basic German communication skills through the lens of the academic world.

German Language Course STEM: A1 / Beginners
…is a German language course that assumes no prior knowledge of German. <u>Note</u>: If you have prior knowledge of German, get in touch with the instructor to determine which course provides the best fit for you. The Beginners course introduces students to the language and culture of the modern German-speaking world in the interdisciplinary context of STEM.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. That means, students are actively engaged with the available material on the learning platform(s) during the virtual course period and come prepared for the synchronous live elements of the class (group, partner and individual conversations) during the on-site period. **This is a preparation-intensive course.** Students should expect to spend 5-6 hours per week during the virtual course period engaging with the course material and the other students.

Students will be able to introduce themselves and others and can ask and answer questions about personal details such as, where they live, people they know and things they have. Students will be able to interact through basic conversation in a simple way, provided the other person talks slowly and clearly and is prepared to help.

German Language Course STEM: A2 / Beginners with prior Knowledge
…is a German language course that assumes some prior knowledge of German. The course introduces students to the language and culture of the modern German-speaking world in the interdisciplinary context of STEM.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. That means, students are actively engaged with the available material on the learning

platform(s) during the virtual course period and come prepared for the synchronous live elements of the class (group, partner and individual conversations) during the on-site period. This is a preparation-intensive course. Students should expect to spend 5-6 hours per week during the virtual course period engaging with the course material and the other students.

Students will be able to converse about themselves, their families, shopping, work and their environment. Students will be able to exchange information in routine situations about their basic needs in a grammatically simple yet efficient way.

German Language Course STEM: B1 / Intermediate

…is a German language course that assumes prior knowledge of German. The course enhances students' language and culture skills of the modern German-speaking world in the interdisciplinary context of STEM.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. That means, students are actively engaged with the available material on the learning platform(s) during the virtual course period and come prepared for the synchronous live elements of the class (group, partner and individual conversations) during the on-site period. This is a preparation-intensive course. Students should expect to spend 5-6 hours per week during the virtual course period engaging with the course material and the other students.

Students will be able to deal with most situations that are likely to arise in every day routines and situations likely to arise whilst travelling in an area where the language is spoken. Students will be able to produce simple connected texts on topics, which are familiar, or of personal interest. They will also be able to describe experiences and events, dreams, hopes and ambitions, and briefly give reasons and explanations for opinions and plans.

Required Course Materials

1. Access to a computer or phone with headset for virtual course period as well as assignments.
2. Textbook: ***Implus Deutsch 1***. *Intercultural. Interdisciplinary. Interactive*. MACHEN (online copy, provided by course administration)
3. Workbook: ***Implus Deutsch 1***. *Intercultural. Interdisciplinary. Interactive*. LERNEN & ZEIGEN (online copy, provided by course administration)

    https://www.klett-usa.com/impuls-deutsch

Assessment

5%	Participation and Attendance
15%	Homework, Quantity: Have you done 80% of the exercises?
15%	Homework, Quality: How (well) have you done them?
15%	Chapter Tests/Quizzes (1x per week)
25%	Speaking Task (2x per week)
25%	Writing Task (2x per week)

Participation and Attendance (synchronous sessions)

Students are expected to attend the synchronous sessions during the virtual course period. Please make sure to give notice when you will not be able to attend. During these synchronous online class sessions,

attendance will be taken. If you are more than 5 minutes late, your attendance will be marked as absent. Absences will be excused only if you have documentation for medical or family emergencies, religious holidays, or military service. **Note: After three unexcused absences, you may be dropped from the course**.

Tasks/Assignments (asynchronous)

Asynchronous tasks/assignments provide regular occasions to prepare and practice your German skills. **Especially in an online blended learning context, it is key to your language development**. Remember that you will spend most time of this class (5-6hrs/week) in self-study. It is therefore highly recommended that you develop a weekly routine.

Most of the homework can be done online through *Impuls Deutsch. Workbook*. LERNEN & ZEIGEN.

LERNEN (to learn) prepares for the next unit, while ZEIGEN (to show) allows you to prove what you have learned already. You are required to complete the assigned LERNEN exercises as well as the assigned ZEIGEN exercises each week.

Complete the assigned LERNEN exercises as well as the assigned ZEIGEN exercises each week.

Chapter Tests/Quizzes

Each of the tests covers material from a week's units. The quizzes test your vocabulary and your ability to use it as introduced in the chapters. Listening and reading comprehension will be integrated in the tests. **No make-ups will be given for missed tests** unless you have documentation for medical or family emergencies, religious holidays, or military service.

Speaking Tasks / Audio

You will have regular speaking tasks / audios for different purposes. You may be reading a text for pronunciation feedback, responding to a prompt, or having a conversation with a classmate or other German speaker. You will get feedback regarding pronunciation, content, and grammar.

Writing Task / Text

You will have regular writing tasks / texts for different purposes. You will get feedback on content and grammar.

Mini Projects

You will have two mini projects at the end of each chapter. You will be expected to hand them in prior to the synchronous meeting for feedback and present them during the synchronous sessions.

MAKE MISTAKES/ MACHT FEHLER!

Errors and mistakes are what drives innovation, learning and development. They are proof that we build a system of the new language and apply the rules we inferred. Language learning requires playing with and extending those rules in a group of people. Please keep in mind that language learning is a long-term process and necessarily involves making mistakes. The Goethe Institute USA named their new online magazine #FEHLER because many "mistakes" have driven the most amazing innovations. Check it out: https://www.goethe.de/prj/mis/en/index.html

Using online translation packages (e.g., Google Translate) is not permissible – and will be found out.
Unlike dictionaries and grammar references, such programs simply provide ONE translation, rather than allowing you to choose among various words/tenses, etc. to come up with the best word or phrase on your own. Moreover, translation programs very often produce inaccurate, incorrect translations, and are easy to identify. Students will learn far more by doing their own work and will avoid risking serious academic consequences.

Grading Scale

Grade/Mark	Percentage	Verbal Grade German	Grade German	Grade English	Verbal Grade English
1.0	≥ 95	Sehr gut	1.0	A	Excellent
1.3	≥ 90	Sehr gut	1.3-1.5	A	Excellent
1.7	≥ 85	Gut	1.6-1.7	B	Very good
2.0	≥ 80	Gut	2.0	B	Very good
2.3	≥ 75	Gut	2.1-2.3	C	Good
2.7	≥ 70	Befriedigend	2.7-2.9	C	Good
3.0	≥ 65	Befriedigend	3.0	D	Satisfactory
3.3	≥ 60	Befriedigend	3.3-3.5	D	Satisfactory
3.7	≥ 55	Ausreichend	3.6-3.7	E	Sufficient
4.0	≥ 50	Ausreichend	4.0	E	Sufficient
5.0	≤ 50	Nicht ausreichend	4.1-5.0	FX / F	Fail

Cross-Cultural Competencies Training for Engineers / 2 ECTS – 1 US/CAN Credit

Course Description:
Multicultural and often virtual teams have become an indispensable part of the professional life of engineering graduates. Cross-cultural negotiation games from business-related contexts are enjoying increasing popularity in professional and educational contexts, especially in higher education. These negotiation simulations represent a profitable as well as innovative action-oriented learning experience to not only broach the issue of cross-cultural competence in the field of work but also to practice it oneself. Together with all actors involved, plausible rules must be formulated across cultural boundaries to enable them to act in a constructive manner. In this seminar, we reflect upon these cross-cultural negotiation processes and then analyze these in order to be able to develop optimal strategies for cultural overlapping situations in a professional engineering contexts. This serves to secure results and transfer learning to other future negotiation situations.

Heterogeneous groups of engineering students must be able to act cross-culturally competent in any international setting to achieve among others the following goals: to negotiate and define cooperation conditions with team members from other cultures and at the same time being able to joint projects virtual cross-cultural meetings.

The aim of this training session is to make people aware of the opportunities, potentials and possible problems of cross-cultural interaction in everyday international engineering life. To this end, we address aspects that are necessary for improving cross-cultural interaction competencies (e.g. recognition of misunderstanding and synergy potentials, ability to conduct multilingual negotiations, empathy). The training language will be mainly in English, sometimes German or Chinese, depending on the group composition of the students and their language preferences.

An additional aim of this training session is introducing students from all over the world to the study engineering experience at German universities and the unique and interesting lifestyle of the Germans in Germany.

Part 1: Cross-Cultural Competence – An Introduction
- Culture with an upper-case or lower-case "C?"
- Dimensions of culture and cultural standards
- Culture shock - myth or fact?
- Cultural competence – how to get along

Part 2: Working in Germany
- German time management – a key to success
- Integration, inclusion or segregation, how to meet local people and to take part in non-university events and activities
- Topics and taboos in Germany – traps and pitfalls in everyday life and behavior
- Germans like to speak English – but who understands their Germish or Denglish?

Part 3: Studying in Germany
- How to communicate with your professors and your co-students: learning the different levels of (in)formality in speaking and writing to different people
- How to study in Germany successfully – become familiar with German students' study strategies and comparisons and contrasts to students' study habits in different areas of the world

Company visits (such as):
- Continental AG (German automotive manufacturing company)
- MERCK (German chemical, pharmaceutical and life sciences company)

Course Goals and Objectives:
Recognition of cross-cultural similarities and differences between Germany and the home country of the students, and understanding the reasons for those similarities and differences based on academic analysis.

Course Structure: 4 units of in-class lectures and discussions, 5 field trips to corporations

Prerequisites: none

Learning Outcomes:
- Understanding of different European definitions of the term "culture"
- Understanding and critical reflection on the concepts of "cultural dimensions" and "cultural standards"
- Identifying, judging, and solving critical incidents in cross-cultural situations
- Getting acquainted with and understanding the German university system and its autonomous learning requirements

Grading:
The students' final grade is based on the participation in the seminar as well as a presentation that shows the obtained knowledge can be usefully applied in a real-world context.

The student's presentation will be evaluated on its clarity and organization, the demonstrated understanding of cross-cultural competence, and the ability to apply that understanding to a specific element of cross-culturality. The students are encouraged to select their own topics.

Teaching Material: Copies are distributed by the teacher.

<div style="background-color:#b5c878">

Lecture Series: Engineering Courses / 6 ECTS – 3 US/CAN Credits
</div>

Students are provided with basic material in advance to prepare them for the more advanced content of the courses. Knowledge of the basics is a prerequisite for a successful completion of these courses. Students are therefore strongly advised to acquire these basics by reading and completing homework assignments in advance.

Academic head: Prof. Dr.-Ing. Heinz-Peter Schiffer

<div style="background-color:#cbd9a0">

Mechanical Engineering Courses
</div>

I.) Automotive Engineering: Prof. Dr. rer. nat. Hermann Winner, Prof. Dr. techn. Christian Beidl

Course Description:
The course gives an introduction into automotive engineering by typical problems in this field. In the first block, lectures provide the basics of driving dynamics and Advanced Driver Assistance Systems. The problems are demonstrated by driving experiments and demonstrations. In the second block, lectures give a prospective view of future mobility using regenerative energy in order to fulfil future CO_2 targets in 2050. Different powertrain solutions will be introduced and analyzed by explaining the technologies and discussing the advantages and disadvantages.

Contents:
Block 1: Institute of Automotive Engineering (FZD)
- Driving Resistance (Theory and Experiments)
- Braking Dynamics (Theory and Experiments)
- Introduction to Advanced Driver Assistance Systems (ADAS) and Automated Driving Systems (ADS)
- Introduction to research projects at FZD

Block 2: Institute for Internal Combustion Engines and Powertrain Systems (VKM)
- Characterization of different energy storage systems and energy converters
- Analysis of efficiency chains and carbon footprints for Tank-to-Wheel (TTW) and Well-to-Wheel (WTW) approaches
- Introduction in powertrain concepts and combined powertrain systems (BEV, FCEV, HEV)
- Introduction in key powertrain components (Internal Combustion Engine & Fuel Cell)

Course Structure:
- Virtual phase (Self-study): Lecture recording of "Advanced Vehicle Propulsion Systems (AVPS) – Traffic & environment", Summary of physical and mathematical basics for tutorials

- <u>Virtual phase (Live sessions):</u> "Introduction to the Automotive Engineering Track", "Theory of Driving Resistance", "Theory of Braking Dynamics", "Q&A session – AVPS: Traffic & environment"
- <u>Attendance phase (Darmstadt):</u> "Theory of Lateral Dynamics", "Regenerative energy and alterations", "Energy carrier and respective powertrain systems", "Technologies of key powertrain components", "Combined powertrain systems", "Fuel cell"
- <u>Tutorials:</u> Introduction to Griesheim Airfield, experiments and driving demonstrations ADAS; Introduction of hybrid powertrains in RDE scenarios; Introduction to life cycle analysis of different powertrain solutions
- Analysis of tutorials, presentation of results and oral exam

Prerequisites:

Fundamentals in Engineering Mechanics (Equilibrium of Forces and Momentum)

Learning Outcomes

The students know the basics of driving resistances, braking dynamics, advanced driver assistance systems and automated driving. In addition, they have received an insight into the research projects of an automotive engineering institute. Furthermore, the students will know the basic functions of different energy storage concepts and the operating modes of various energy converters. In addition, they will be able to carry out an efficiency and CO_2 analysis for powertrain systems as well as for particular powertrain components. Based on the fundamentals and the analysis, the students will understand the advantages and disadvantages of individual and combined systems.

Grading

The student's knowledge with respect to the theory lessons and the tutorials is evaluated based on the submission of a written elaboration and an oral exam/presentation.

II.) Aeronautical Engineering, Prof. Dr.-Ing. Jeanette Hussong, Prof. Dr.-Ing. Uwe Klingauf

Course Description

The course deals with the design, function and operation of wind tunnels for Aerodynamic testing. This includes the use of essential measurement techniques in aerodynamics and flight mechanics. In practical sessions students will learn how to prepare and perform wind tunnel experiments based on an calibration example performed by the students. Measurement uncertainties will be discussed, and suitable measurement programs and data analysis methods will be applied using a commercial data processing program (LabVIEW).
In the second session, an overview of flight mechanics and flight testing will be given. Students will conduct practical experiments in the institute's research flight simulators to determine the performance of an airplane. The recorded data will be analyzed and discussed in a brief report.

Learning Outcomes

The students will be taught the basics of wind tunnel testing, data acquisition and the use of measurement technology for aerodynamics, flight mechanics and flight testing. The benefits and disadvantages of each

of these methods can be understood under consideration of physical interrelationships. In addition, an insight into the research work at the Institute of Fluid Mechanics and Aerodynamics as well as the Institute of Flight Systems and Automatic Control can be gained.

Content:
- Introduction of the Institutes and presentation of research work
- Theory of flight mechanics and flight testing
- Theory of pressure measurement methods in wind tunnels
- Practical exercises and wind tunnel tests
- Introduction to and practical experiments in flight simulators
- Data acquisition in the experiments
- Data interpretation and discussion

Course structure

Virtual session:
- Lecture videos on the theory of the course's contents; online question time if needed
- In preparation for this course, several files will be made available on the Moodle server under "Aeronautical Engineering"
- Learning material and exercises about "wind tunnel testing, flight mechanics and flight testing"

Session 1 – Wind Tunnel Testing:
- Introduction of the Institute of Fluid Mechanics and Aerodynamics
- Laboratory tour and presentation of research work at the institute
- Lecture about "Wind tunnel testing" and "Application of pressure measurements in wind tunnels"
- Practical exercise and wind tunnel test: "Preparation and use of the Prandtl tube to determine the wind tunnel velocity"; Introduction to wind-tunnel balance
- Measurements in the Aerodynamic Forces on an Airfoil
- Introduction to pressure calibration equipment and discussion of uncertainties
- Theoretical exercise: "Evaluation of measurement data"

Session 2 – Flight Testing:
- Introduction of the Institute of Flight Systems and Automatic Control
- Lecture about "flight mechanics and flight testing"
- Lecture about "automatic control"
- Lab tours
- Practical experiments in the research flight simulators (data acquisition)
- Data analysis and evaluation
- Preparation of a report about the results of the simulation experiments

Grading
At the end of the course, the acquired knowledge is assessed in a written examination. Students will also submit a brief report about their results from the second session (flight mechanics and flight testing).

III.) Mechatronic Engineering, Prof. Dr.-Ing. Stephan Rinderknecht

Course Description:
The course deals with the basics of mechatronic systems and the involved components. Main aspects are the functional description and modelling of mechanical elements, actuators and sensors. Based on the

properties of these components, we introduce analytical methods that characterize the static and dynamic behavior of the overall mechatronic system and design open or closed loop control for it. The course will be accompanying with some exercises within a small project to enhance the general understanding. In addition, real world applications and representative research projects in the IMS institute will be demonstrated through the course.

Contents:
- Introduction to mechatronic systems
- Modelling of mechatronic system components by equations and block diagrams
- Characterize the static and dynamic behavior of mechatronic systems
- Basic Control of mechatronic systems
- Mechatronic design methods and system integration

Course structure:
Part 1: Digital Sessions
Session 1:
- Introduction to mechatronics

Session 2:
- Mechanical components
- Basics to system modeling

Session 3:
- Actuators part 1
- Office hours

Session 4:
- Actuators part 2
- Sensors

Session 5:
- Basic system control
- Office hours

Part 2: Presence Sessions
Session 6:
- System Integration

Session 7:
- Mechatronic design methods

Session 8:
- Exercise series part 1: introduction to MATLAB/Simulink

Session 9:
- Exercise series part 2: System modeling in MATLAB/Simulink

Session 10:
- Exercise series part 3: Actuator modeling in MATLAB/Simulink

Session 11:

- Exercise series part 4: PID control in MATLAB/Simulink

Session 12:
- Get to know more about institute IMS Part 1

Session 13:
- Get to know more about institute IMS Part 2

Prerequisites:
None.

Learning Outcomes:
The students know the basics of mechatronic systems consisting of mechanical elements, sensors, actuators and open/closed loop control. They are able to characterize the static and dynamic behavior of the overall mechatronic system and control the system using controllers like PID. Moreover, the students understand mechatronic engineering design methods at different levels, i.e., component and system level of automotive drive trains.

Grading:
The grade will be based on the following examinations:
- Results of the exercises (30%)
- Written examinations (70%)

IV.) Production Engineering, Prof. Dr.-Ing. Dipl.-Wirtsch.-Ing. Peter Groche, Prof. Dr.-Ing. Matthias Weigold

Institute of Production Management, Technology and Machine Tools (PTW)

Institute for Production Engineering and Forming Machines (PtU)

Course Description

The aim of the course is to provide a deeper insight into production technology, production management, energy efficiency and the potentials and challenges of Industry 4.0 as it is developed and used at the institutes PTW and PtU. An overview of the stages of digitalization will be given which will be substantiated and explained in more detail on the basis of current research topics in the area of progressive die tools, especially shear cutting processes, laser applications and roll forming at the PtU.

The course focuses, on the one hand, on the special applications of lasers in manufacturing. This includes a lecture focusing on the physical basics of lasers and laser applications as well as an exercise, where welding and laser cutting processes will be studied. On the other hand, the use of new, innovative digital technologies in forming processes with regard to process monitoring, sensor integration and methods of data acquisition is demonstrated on the basis of the previously mentioned processes. The course starts with a self-study part to learn the basic mechanisms of the processes. Afterwards workshops in practise at the SFB Factory will give a first, hands-on insight into industrial standards paired with current research topics. In addition, an interactive exercise and learning session followed by a group exercise based on real process

data will provide an initial, practical insight into the learned theory. Furthermore, workshops in the Process Learning Factory CiP and in the ETA-Factory will give a first, hands-on insight into Lean Production and energy efficiency techniques.

Learning Outcome

The course will approach the physical fundamentals of laser-light, describing the processes of spontaneous and stimulated emission and pumping of active means. Following, the basic structure of a laser system and its components will be described. Moreover, the different laser sources will be presented and the relative characteristics analysed in relation to the possible applications in the manufacturing. The course will also approach the theoretical knowledge of the digitalization of forming processes and the integration of sensor technology in forming tools. As a basis for the application of data analysis and the prediction of process variables as well as component properties, the understanding of the acquisition and analysis of data from forming processes will be improved. Further, the integration of sensors into a standard forming tool as well as real-time data acquisition for process monitoring will be presented in a practical manner. In addition, students will gain deeper knowledge from the lecture in an interactive learning session. Aim is to visualize and sharpen the learned fundamentals in a practical group exercise using real recorded process data.

Additionally the students will learn how to draw value stream maps in realistic production systems with an hands-on application the process learning factory CiP. Based on this, potentials for the production system will be derived systematically. Different use cases of Industry 4.0 will be demonstrated on the shop floor. Additionally, the students will get in touch with the topic "Energy Value Stream Mapping", a suitable tool for detecting energy losses in industrial value streams.

Content
- Introduction of the institutes
- Theory of Value Stream Mapping
- Practical exercises in the Process Learning Factory
- Demonstration of Industry 4.0
- ETA
- Digitization of forming processes
- Integration of sensor in forming tools
- Basics of laser Physics
- Lasers in manufacturing processes

Session 1: Introduction (PtU, PTW), Campus Lichtwiese

Location: Jovanka-Bontschits-Straße 10 (L1|07), 64287 Darmstadt

- Introduction of the institute
- Presentations from self-study of course participants
- Convey and deepen prior knowledge

Session 2: Lasers in manufacturing (PtU), Campus Lichtwiese
Location: Jovanka-Bontschits-Straße 10 (L1|07), 64287 Darmstadt

- Lecture and introduction: Laser systems in manufacturing
- Cutting and welding with the laser system
- Assessment of the manufactured parts

Session 3: Digitalization in forming technology (PtU), Campus Lichtwiese

Location: Jovanka-Bontschits-Straße 10 (L1|07), 64287 Darmstadt

- Introduction of the institute
- Demonstration of Industry 4.0
- Digitalization of forming processes
- Integration of sensor in forming tools
- Interactive learning session and group exercise

Session 4: Value Stream Mapping (PTW) Location: Prozesslernfabrik CiP, Campus Lichtwiese

Location: Prozesslernfabrik CiP, Jovanka-Bontschits-Straße 10 (L1|07), 64287 Darmstadt

- Introduction to lean production
- Hands-on application to identify waste in production
- Value Stream Analysis theory in classroom
- Hands-on application of the value stream analysis in the Learning Factory
- Demonstration of Industry 4.0 applications

Session 5: Energy Value Stream Mapping (PTW), Campus Lichtwiese, ETA-Factory

- Introduction to Energy Value Stream Mapping theory
- Hands-on application of learned theory in the ETA-Factory
- Introduction of energy waste
- Practical exercises to identify energy waste potentials
- Evaluation of results
- Written Exam

Session 6: Practical training and laboratory experiments (PtU)

- Laser cutting
- Laser welding
- Lab experiments an evaluation
- Industry 4.0 in roll forming
- Setup of a measurement chain
- Lab experiments and evaluation
- Written examination at PtU

Course structure:
- Lectures: 'Tour through the institute for production Engineering and Forming Machines', 'Lasers in manufacturing', 'Industry 4.0 and its use in shear cutting', 'Optimisation of the roll forming process through digitalisation'
- Interactive Exercise and learning Session
- Group exercise based on process data
- Exam

Prerequisites:

Self-study for prior knowledge. See section "Preparation and Written Documentation".

Grading

The grade will be based on the examination parts of the PtU and PTW. On the part of PtU the grade will be based on following examinations:

- Results of the group exercise (25%)
- Written examination (75%)

Schedule

tbd

Preparation and Written Documentation

In preparation for this course, lecture content on all relevant processes will be provided in advance for self-study. Course participants will be assigned to topics for preparing short presentations. These presentations need to be presented at the beginning of the course in the first sessions.

In preparation for this course several files have been made available on the Moodle server under 'Production Engineering'. These include the following:

- ISU 2021 Production Engineering – this file
- Value stream preperation
- ETA preparation
- PtU preparation
  - Slides in File: Production_Engineering_Lasers_in_Manufacturing
  - Slides in File: Production_Engineering_Digitization_in_Forming_Technology

Electrical Engineering Courses

I. Electromagnetic Field Simulation: Prof. Dr. rer. nat. Sebastian Schöps

Course Description:

The course gives an introduction into electromagnetic field simulation. The main course aspect is the finite integration technique (FIT) which is applied on Maxwell's equations to compute numerically electromagnetic phenomena. The aim of this course is to enable students to implement their own code in the GNU Octave/Matlab programming language for performing simple electromagnetic field simulations. To achieve this goal, the theoretical aspects are covered by lectures which are deepened and put into practice during group exercise sessions. In these sessions, the students develop simulation codes to simulate practical examples.

Contents:

Mathematical Foundations and Electromagnetic Field Theory

- Ordinary differential equations
- Differential operators: gradient, divergence and curl
- Maxwell's equations in integral and differential form

Numerical Methods

- Scientific computing in GNU Octave/Matlab
- Finite differences

- Solving systems of linear equations

Electrostatics

- Maxwell's equations in the static regime
- Discretization of gradient, divergence and permittivity
- Boundary conditions
- Example: Plate capacitor

Magnetostatics

- Scalar and vectorial magnetic potential
- Discretization of curl operators and permeability
- Example: Transformer

Quasistatics

- Maxwell's equations in the quasistatic regime
- Complex arithmetic and phasors
- Maxwell's equations in the frequency domain
- Skin Effect

Course Structure:

<u>Virtual part:</u> 06.06.2022 – 18.06.2021

Lecture videos on the theory of the course's contents; online question time if needed

<u>Live sessions:</u> 20.06.2022 – 01.07.2022

- Group exercises (3 per week)
    ◦ Theoretical exercises: mathematical basics, finite differences, fundamentals of FIT
    ◦ Practical exercises: programming of a field simulation code using GNU Octave/Matlab for computing a plate capacitor and a transformer
- Attestation of the programming code

Prerequisites:

Basic knowledge of or interest in mathematics (calculus, linear algebra, numerical analysis) and programming

Learning Outcomes:

The students successfully attending this course understand and are able to simulate simple electrical engineering problems using space-discretization. They can interpret and manipulate Maxwell's equations for the special cases of static and quasistatic fields in frequency domain. Moreover, they are able to set up a simple field simulation code using the GNU Octave/Matlab programming language.

Grading:

At the end of the course, the students' acquired knowledge is assessed in an oral attestation of the programming code they developed during the group exercises. In this process, the students present and explain their code.

II. Microfluidics and bioMEMS: Prof. Ph.D. Thomas P. Burg

Course Description

This course gives an introduction to the field of microfluidic and microelectromechanical systems (MEMS) for a variety of applications in the biomedical sciences. Starting with the physics and technology of miniaturized fluidic systems, we will explore devices for measuring bioelectrical signals and biomarkers concentrations with miniaturized sensors. Then the focus will shift to several exciting developments in the analytical sciences using microfluidics, such as droplet-based methods for single cell and single molecule analysis, integrated optical sensing, and advanced microscopic imaging techniques. Different applications will be illustrated using examples from recent literature.

Content

- Technology of microfluidic systems
- The solid-liquid-interface
- Transport processes
- Wearable devices
- Affinity biosensors
- Single cell and single molecule methods
- Optofluidics and advanced microscopy techniques

Course Structure

<u>Virtual part:</u> 06.06.2022 – 18.06.2021
<u>Live sessions:</u> 20.06.2022 – 01.07.2022

Self-study materials (videos, reading assignments)

Prerequisites

1st year undergraduate physics

Learning Outcomes

Students will learn to evaluate and compare conventional and microfluidic bioanalytical methods for laboratory medicine and Point-of-Care applications. They become familiar with the underlying physical principles and scaling laws and learn to analyze the impact of miniaturization quantitatively. The skills acquired in this course will enable the participants to select appropriate techniques, to advance knowledge, and to address technological gaps in the biomedical sciences with the help of microfluidic systems.

Grading

25% participation

75% Written essay

4. Scheduled Program Plan 2022

Please go to our website (www.tu-darmstadt.de/isu) to find the most current version of the program schedule for our ISU 2022 or write us an email.

5. Grading and Credit Points

The grades are calculated as follows:

Credit Points: International Summer University 2022 at TU Darmstadt					
Sessions	**Amount of sessions** approx.	**Workload in hours** approx.	**ECTS** 1 ECTS = 25 - 30h	**US Credit Point** 1 ECTS = 0.5 US CP	**% Grade**
Engineering Credit Points			6	3	50
Lecture Serie: Engineering Courses					
> Automotive Engineering incl. homework and preperation	7	50	3	1,5	25
> Aeronautical Engineering incl. homework and preperation	7	50	3	1,5	25
> Mechatronic Engineering incl. homework and preperation	7	50	3	1,5	25
> Production Engineering incl. homework and preperation	7	50	3	1,5	25
> Electromagnetic Field Simulation incl. homework and preparation	7	50	3	1,5	25
> Microfluidics and BioMEMS incl. homework and preparation	7	50	3	1,5	25
Total: Lecture Serie: Engineering courses	14	100	6	3	50
Intercultural Credit Points			2	1	15
Cross-Cultural Competencies Training for Engineers					
> Intercultural Training	2	25	1	0,5	
> Project work and presentation	1	6,25	0,25	0,125	
> Homework and preparation	1	6,25	0,25	0,125	
Intercultural Experience					
> Company visits, Excursion, Social Events	4	12,5	0,5	0,25	
Total: Cross-Cultural Competencies Training for Engineers		50	2	1	16
German Language Credit Points			4	2	35
German Intensive Language Course					
> Class hours	12	75	3	1,5	
> Homework, preparation and exam	12	75	3	1,5	
Total: German Intensive Language Course	14	150	6	3	50
Total		300	12	6	100