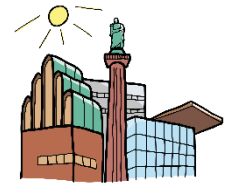


Syllabus

International Summer University

German Engineering and Language

May 18 – June 30, 2026



International Summer University
German Engineering & Language



1. Programme Goal

The International Summer University is an intensive interdisciplinary programme in which students will take academic courses in various fields of German engineering, while simultaneously attending intensive German Language classes. The programme is primarily designed to provide an insight into the broad field of cutting-edge engineering, help the participants build (foundational) 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; tailor-made modules will allow them to develop a deeper understanding of their chosen field of study by focusing specifically on these areas of engineering.

Alongside weekly Intensive German Language Classes and Cross-Cultural Competencies Training for Engineers, they also take intensive courses in either Mechanical or Electrical Engineering. In the **Mechanical Engineering** track, students receive a well-rounded knowledge of the fields of Automotive, Aeronautical, Mechatronics and Production Engineering. On the **Electrical Engineering** track, they participate in courses introducing Programming & Algorithms for Power Systems and Microfluidics + BioMEMS. In both Mechanical and Electrical Engineering programmes, students experience what it is like to study at TU Darmstadt, becoming familiar with the university's academic culture, learning environment, and study practices.

During the International Summer University Programme, students work alongside peers from around the world to enhance their communication, problem-solving, and teamwork skills as they tackle complex, real-world engineering challenges. The programme's various engineering courses provide opportunities to explore the latest research findings through a combination of lectures, interactive workshops, and group presentations. Students also gain practical insights through company visits to leading organisations such as the AMG Factory of Mercedes-Benz, as well as European Space Agency/European Space Organisation Centre (ESA/ESOC). These experiences not only allow participants to develop hands-on engineering skills but also strengthen their cross-cultural communication abilities and gain valuable perspectives on future career opportunities in German engineering.

2. Programme Prerequisites

The International Summer University: German Engineering and Language Programme has no formal pre-requisites, however, please note the following:

The participants must be enrolled and remain enrolled throughout the programme as students at their home university.

All Engineering courses as well as the Cross-Cultural Competencies Training for Engineers will be held in English, therefore students need to have sufficient knowledge of English.

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.

Note: If you already have some knowledge of German, you will be sent an e-mail by the ISU team after your application with a link to a language placement test. Based on the results of this test, we will assign you to a particular level (A2 / Beginners with prior Knowledge or B1 / Intermediate).

Cross-Cultural Competencies Training for Engineers

Cultural awareness is an asset but not required.

Lecture Series: Engineering Courses

This programme 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. Course-dependent prerequisites are described in the respective section.

3. Programme Structure and Course Descriptions

Outside of class for all courses (Engineering, German and Culture), students are expected to complete assigned reading, homework and prepare for workshops and final exams. Please read the detailed course structures (e.g. the format of the final exams) below or ask the teachers during the programme. Participation in the virtual live sessions and online tests and quizzes (if applicable) are mandatory.

Academic Credit/Contact Hours

Students will complete tasks/assignments, work in groups, give presentations and write final exams. At the end of the programme, they will receive a grade for each completed course and ECTS (credit points) for the successful completion of the programme.

Students can earn 12 ECTS (6 US/Canadian credit points) worth of academic credit for the entire programme. To make sure the credits will be accepted by your home institution we kindly advise you to get in touch with your home University faculty in advance.

- Engineering courses and workshops:
 - Mechanical Engineering: approx. 180 Hours; 6 ECTS (3 US/Canadian credit points)
 - or
 - Electrical Engineering: approx. 180 Hours; 6 ECTS (3 US/Canadian credit points)
- German and Culture (6 ECTS, 3 US/Canadian credit points):
 - Intensive German language course: approx. 120 Hours
 - Cross-Cultural Competencies Training for Engineers: approx. 60 Hours

1 ECTS (0.5 US/Canadian credit points) = approx. 25-30 hours of academic work

Course	total hours	self-study	online hours	contact hours
German Language	120	90	6	24
Cross-Cultural Competencies Training	60	54	0	6
<i>One of the following Engineering combinations:</i>				
Electrical Engineering Programming & Algorithms for Power Systems Microfluidics & BioMEMS	180	max. 115	depends on the course	59
<i>or</i>				
Mechanical Engineering Automotive + Mechatronic + Production + Aeronautical Engineering	180	max. 115	depends on the course	59
TOTAL	360			

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

Course Description:

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

German Language Course: A1 / Beginners

...is a German language course that assumes no prior knowledge of German. This course introduces students to the language and culture of the modern German-speaking world within an interdisciplinary academic context, covering topics such as personal identity and lifestyle, interpersonal relationships and communication, housing and living environments, daily study life and services, and social activities and cultural participation.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. This means that 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 an intensive preparation 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.

By the end of this course, students will be able to introduce themselves and others and 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: 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 within an interdisciplinary academic context, covering topics such finding accommodation, the education system, internships, orientation at university, financing your studies, mobility and leisure activities for students.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. This means that 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 an intensive preparation 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.

By the end of this course, 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: 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 within an interdisciplinary academic context, covering topics such semesters abroad, the work world, artificial intelligence, the environment and sustainability, and media usage.

To develop the ability to communicate effectively in German, this course is structured as a blended online learning course. This means that 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 an intensive preparation 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.

By the end of this course, students will be able to deal with most situations that are likely to arise in everyday routines and as well, in 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 with a headset for virtual course period as well as assignments.
2. Course book:

Level A1:

Kurs DaF A1 – Deutsch für Studium und Beruf (licence codes for learning platform, provided by course administration)

Level A2:

Kurs DaF A2 – Deutsch für Studium und Beruf (license codes for learning platform, provided by course administration)

Level B1:

Kurs DaF B1 – Deutsch für Studium und Beruf (license codes for learning platform, provided by course administration)

Assessment

10 % active course participation

10 % oral skills (presentations, dialogues)

20 % homework (exercises in the workbook and on Moodle after each class)

60 % final exam (listening, reading, grammar, writing) – 90 minutes

Participation and Attendance

Students are expected to attend 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 only be excused if you have documentation for medical or family emergencies, exams and important official appointments. Note: After two 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, this is key to your language development.** Remember that you will spend most of this class (5-6hrs/week) working on your own. It is therefore highly recommended that you develop a weekly routine.

MAKE MISTAKES/ MACHT FEHLER!

Errors and mistakes are what drive innovation, learning and development. They are proof that we gradually build a system of the new language and apply the rules we have 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) for homework / assignments 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.

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

Course Description:

In an increasingly interconnected world, engineers must be knowledgeable and skilled in an interpersonal, intercultural and international work environment. This course will introduce engineering students to a global future. Participants will understand the dimensions of culture, the levels of communication and the complexity of international teamwork.

In synchronous and asynchronous learning activities, the course provides direct and practical experience of cross-cultural work in global teams and a sustained reflection on the interdependencies of technology, culture and engineering practices as well as identities.

Furthermore, students will reflect on intercultural negotiation processes and analyze them to develop strategies for situations in a professional engineering context. The goal of this training is to make people aware of the opportunities and potentials of intercultural interaction in everyday private and professional life.

Part 1: Intercultural Communication, e.g.

- History of a Discipline
- Communication in all its dimensions

Part 2: Case Studies, e.g.

- The Cult(ure) of Objects: Cars around the world
- The Culture of Disciplines: Engineers vs. Managers vs. Politicians

Part 3: Intercultural Communication and Social Justice, e.g.

- The Culture of Gender
- The Culture of Race

Part 4: Studying in Germany

- The Academic Culture (in Germany)
- How to successfully study (in Germany) (tbc)

Course Goals and Objectives: Awareness of intercultural similarities and differences and understanding the reasons for those similarities and differences based on academic analysis.

Course Structure: 8 units of in-class lectures and discussions

Prerequisites: none

Learning Outcomes:

- Understanding the term “culture”
- Understanding and critical reflection standards”
- Identifying opportunities in intercultural situations

Grading: The students' final grade is based on active participation in the seminar as well as interactive participation on the Moodle platform.

Students must submit five reflective assignments that demonstrate their knowledge of concepts and their application in the real world.

Teaching Material: Material provided by the teacher.

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

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 the 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. Jeanette Hussong

Mechanical Engineering Courses

In the field of Mechanical Engineering, students get an intensive overview in Automotive Engineering, Aeronautical Engineering, Mechatronic Engineering and Production Engineering. Students will gain 2 ECTS for each of the following Mechanical Engineering courses; in total 6 ECTS.

- 2 ECTS, Automotive and Mechatronics Engineering
- 2 ECTS, Aeronautical Engineering
- 2 ECTS, Production Engineering

I.) 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 potential 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 based on 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 about 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 practice 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.

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 manufacturing. The course will also approach 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 fundamentals learned in a practical group exercise using real recorded process data.

Content

- Introduction of the institutes
- Demonstration of Industry 4.0
- Digitization of forming processes
- Integration of sensor in forming tools
- Basics of laser Physics
- Lasers in manufacturing processes

Session 1: Introduction (PtU), 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: 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. The grade will be based on following examinations:

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

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
- PtU preparation
 - Slides in File: Production_Engineering_Lasers_in_Manufacturing
 - Slides in File: Production_Engineering_Digitization_in_Forming_Technology

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

Institute for Fluid Mechanics and Aerodynamics (SLA)

Institute of Flight Systems and Automatic Control (FSR)

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 programme (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: force equilibriums & controls"
- Lecture about "flight mechanics: performance & measurement"
- 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.) Automotive and Mechatronics Engineering: Prof. Dr.-Ing. Steven Peters, Prof. Dr. techn. Christian Beidl, Prof. Dr.-Ing. Stephan Rinderknecht, Prof. Dr. rer. Nat. Debora Clever

Internal combustion engines and vehicle drives (VKM)

Institute of Automotive Engineering (FZD)

Institute for Mechatronic Systems (IMS)

Course Description:

The course gives an introduction into automotive engineering and mechatronics by typical problems in this field. In the first block, lectures give a prospective view of future mobility using regenerative energy in order to fulfil future CO₂ targets in 2050. Different powertrain solutions will be introduced and analysed by explaining the technologies and discussing the advantages and disadvantages. In the second block, lectures provide the basics of programming with MATLAB. The third block offers a comprehensive introduction to the fundamentals of robotics, with a focus on industrial applications. Students will learn core concepts of robotic systems, including kinematics, dynamics, and control, relevant to modern automated production environments.

Contents:

Block 1: 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)

Block 2: Institute of Automotive Engineering (FZD)

- Introduction to the topic of digitalisation in the context of mechanical engineering
- Introduction to MATLAB
- Introduction to programming paradigms, data structures and algorithms
- Introduction to research projects at FZD

Block 3: Institute for Mechatronic Systems (IMS)

- Introductory Crash Course in Matrix Algebra (Multiplication & Transformations) (Virtual)
- Fundamentals of robotics and coordinate systems used in industrial robots
- Kinematic modelling (forward/inverse) and Denavit-Hartenberg convention for robotic arms
- Robot control, motion planning, and singularities in production systems
- Applications of robots in industrial automation and smart manufacturing

Course Structure:

- Virtual phase (Self-study): Lecture recording of “Advanced Vehicle Propulsion Systems (AVPS) – Traffic & environment”, Doing the “Matlab fundamentals online course”
- Attendance phase (Darmstadt): “Introduction to programming paradigms”, Technologies of key powertrain components“ and „Hybrid powertrains“
- Tutorials: Introduction to RobotCarRoll; Introduction of hybrid powertrains in RDE scenarios;

Prerequisites:

Fundamentals in Engineering Mechanics (Equilibrium of Forces and Momentum), Laptop which is capable of running MATLAB

Learning Outcomes

The students know the basics of writing code in MATLAB on their own. 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 CO₂ 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.

By the end of the course, students will understand the principles and mathematical foundations of industrial robotic systems. They will be able to analyse, model, and control robot manipulators used in automated manufacturing settings.

Grading

The student's knowledge with respect to the theory lessons and the tutorials is evaluated based on the submission of code snippets (FZD), a written elaboration (FZD and VKM), an oral exam/presentation (FZD) and a written exam (VKM, IMS).

Electrical Engineering Courses

In the field of Electrical Engineering students will participate in courses introducing **Programming & Algorithms for Power Systems** and Microfluidics + BioMEMS. Students will gain 3 ECTS for each of the following Electrical Engineering courses; in total 6 ECTS.

- 3 ECTS, Programming & Algorithms for Power Systems
- 3 ECTS, Microfluidics and BioMEMS

I. Programming & Algorithms for Power Systems: Prof. Dr. rer. nat. Florian Steinke**Course Description:**

The lab course trains practical programming skills on applications from the power systems domain. It also teaches basic concepts of algorithms and data structures. The programming work is conducted in groups to practice teamwork in programming. The course is intended as an enabler for independent research projects later in the curriculum.

Contents:

- Repetition of programming basics in Java
- Introduction to abstract algorithms and data structures with the following examples:
 - Sorting
 - Depth-first and breadth-first search
 - Arrays and linked lists
- Introduction to complexity analysis for algorithms, specifically big-O notation
- Formulating and solving real-world power system problems: energy trading, distribution grid optimization

Course Structure:

- Virtual part: 18.05.2026 – 31.05.2026 (2 sessions of 1.5h)
- Live sessions: 01.06.2026 – 30.06.2026 (8 hands-on sessions of 3.5h)
- The programming is performed in groups of 2-3.
- The final code is reviewed orally.

Prerequisites:

- Being able to understand standard mathematical notation
- Some basic prior programming experience is helpful.

Learning Outcomes:

The students successfully attending this course can program simple tasks in Java or other programming languages. They have experienced the value of good algorithms and can evaluate their benefits. They have practiced teamwork and have experienced how to transfer real problems, here from the power systems domain, into the abstract language that renders them solvable by standard algorithms.

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 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

Virtual part: 18.05.2026 – 31.05.2026

Live sessions: 01.06.2026 – 30.06.2026

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 Programme Plan

Please go to our website (www.tu-darmstadt.de/isu) to find the most current version of the programme schedule for our ISU, find it in the moodle course (if you are already enrolled) or write us an email.

5. Grading and Credit Points

Credit Points: International Summer University 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
Lecture Serie: Engineering Courses					
Mechanical Engineering					
> Automotive and Mechatronics Engineering incl. homework and preparation	9	60	2	1	16,67
> Aeronautical Engineering incl. homework and preparation	5	60	2	1	16,67
> Production Engineering incl. homework and preparation	4	60	2	1	16,67
Electrical Engineering					
> Programming & Algorithms for Power Systems incl. homework and preparation	9	90	3	1,5	25
> Microfluidics and BioMEMS incl. homework and preparation	9	90	3	1,5	25
Total: Lecture Serie: Engineering courses	18	180	6	3	50
German Intensive Language Course					
> Class hours (online and in-person)	12	90	3	1,5	
> Homework, preparation and exam	12	30	1	0,5	
Total: German Intensive Language Course	14	120	4	2	34
Cross-Cultural Competencies Training for Engineers					
> Intercultural Training	2	30	1,0	0,5	8
> Project work and presentation	1	10	0,3	0,2	
> Homework and preparation	1	10	0,3	0,2	
Intercultural Experience					
> Company visits, Excursion, Social Events	4	10	0,3	0,2	
Total: Cross-Cultural Competencies Training for Engineers	8	60	2	1	16
Total	40	360	12	6	100
Lecture Series: Engineering Courses					
					100% \pm 50%
German Intensive Language Course					100% \pm 34%
Cross-Cultural Competencies Training for Engineers					100% \pm 16%

Grading and Grade Conversion

Äquivalenztabelle (nach §25 APB)

	From	To	Grade German	verbal Grade German	Verbale Grade English	Grade English
1,0 bis 1,199 = 1,0 (sehr gut)	1,0	1,199	1,0	sehr gut	Excellent	A
1,2 bis 1,599 = 1,3 (sehr gut)	1,2	1,599	1,3	sehr gut	Excellent	A
1,6 bis 1,899 = 1,7 (gut)	1,6	1,899	1,7	gut	Very good	B
1,9 bis 2,199 = 2,0 (gut)	1,9	2,199	2,0	gut	Very good	B
2,2 bis 2,599 = 2,3 (gut)	2,2	2,599	2,3	gut	Good	C
2,6 bis 2,899 = 2,7 (befriedigend)	2,6	2,899	2,7	befriedigend	Good	C
2,9 bis 3,199 = 3,0 (befriedigend)	2,9	3,199	3,0	befriedigend	Satisfactory	D
3,2 bis 3,599 = 3,3 (befriedigend)	3,2	3,599	3,3	befriedigend	Satisfactory	D
3,6 bis 3,899 = 3,7 (ausreichend)	3,6	3,899	3,7	ausreichend	Sufficient	E
3,9 bis 4,099 = 4,0 (ausreichend)	3,9	4,099	4,0	ausreichend	Sufficient	E
ab 4,1	ab 4,1		5	nicht bestanden/nicht ausreichend	Fail	FX/F