TECHNISCHE UNIVERSITÄT DRESDEN

Directory of Modules for Visiting Students *Diplom* Programme in Electrical Engineering

Faculty of Electrical and Computer Engineering

Information Package for International Visiting and Exchange Students

August 2024

FAKULTÄT ELEKTROTECHNIK UND INFORMATIONSTECHNIK

Description

The Faculty of Electrical and Computer Engineering at the Technische Universität Dresden offers the Diplom degree **programme in Electrical Engineering**. This programme is an integrated five-year (single-tier) programme and thus **includes Bachelor as well as Master's level**.

Structure

The degree programme in Electrical Engineering is divided into **basic studies and main studies**. The **basic studies** include **semester 1-4** (= first and second year of the programme);
the **main studies** include **semester 5-10** (= third until fifth year of the programme).

The programme **comes in modules**. Each module **consists of 1, 2, 3 or 4 parts, i.e. courses**. Mostly the courses name is equivalent to the module name but sometimes it differs.

You must visit all parts/courses of one module!
Also, you have to choose minimum 70% of the modules offered by the Faculty of Electrical and Computer Engineering!

Language of instruction

The study programme is held in **German**, however, a very few modules are taught in English, too. Students who apply for this study programme should have **German language skills** of at least **B1**.

Specialization areas

Within the **main studies, there are 5 specialization areas**:

- Automation and Robotics / Automatisierungstechnik und Robotik
- Electrical Power Engineering / Elektroenergietechnik
- Electronic Systems and Technolgy and Biomedical Engineering / Geräte-, Mikro- und Medizintechnik
- Communications and Information Technology / Informationstechnik
- Microelectronics / Mikroelektronik

In order to avoid timetable conflicts you should choose from one spezialisation area!

Content of the following module catalogue

FAQ

The FAQ shall answer any questions about the module catalogue.

Why is it called modules but not courses?

Each module consists of 1,2,3 or 4 parts, i.e. courses. Mostly, if it is just one part, the course name is equivalent to the module name.

In which semester are the modules offered?

Please look in the columns “winter semester” / “summer semester”.
The academic year at the TU Dresden is divided into the winter semester (October–March) and summer semester (April–September). The semester dates for the following academic years can be found here.
Our module descriptions inform you in which semester, i.e. winter or summer semester, the respective module is offered. When setting up your learning agreement it is important to consider at first which semester you are coming to the TU Dresden (either the winter or summer semester) and then choose appropriate modules.

What level does the module have?

Please look in the columns “1st semester”, “2nd semester” etc. to find out the semester when it is held.
Basic studies are from 1st-4th semester; main studies from 5th-10th semester.

Why are the 7th and 10th semester not indicated?

During the 7th our students conduct a traineeship in companies. In the 10th they write their final thesis.
That is why you see the columns for the 5th, 6th, 8th, 9th semester only.
The **8th** is in **summer semester** and the **9th in winter semester**.
Some modules take two semesters and start in the 8th semester, i.e. summer semester.

Please make sure that you visit the whole module!

How long is an “hour per week”?

An hour per week (German: SWS =Semesterwochenstunde) is one lesson of 45 minutes per week during the teaching period.
At the TU Dresden, **lessons** usually last for **90 minutes**, i.e. one double lesson (German: Doppelstunde (DS).
1 double lesson (Doppelstunde) = 2 hours per week (Semesterwochenstunde)

What does L/E/P mean?

- L means lecture
- E means exercises
- P means practical lab course

What does 2/2/0 or 4/4/1 mean?

The **first number** stands for the hours per week for the **lecture**.
The **second number** stands for the hours per week for the **exercise**.
The **third number** stands for the hours per week for the **practical lab course**.

Examples:
2/2/0 = 2 hours per week lectures (90 minutes lecture every week), 2 hours per week exercises (90 minutes exercises every week), no practical lab course

4/1/1 = 4 hours per week lectures (180 minutes lecture every week), 1 hour (45 minutes) per week exercises but mostly conducted as 90 minutes every other week, 1 hour (45 minutes) per week practical lab course but conducted as 90 minutes every other week or as block course.

What does "PL" mean"?

It is German for Prüfungsleistung which means assessment.

I have chosen a module – what to do next?

After you have chosen a module you should know which parts are included in the module, in which semester the parts take place, and if a lecture, exercises and/or practical lab course is included. Furthermore you should search for it in the timetables.

Detailed information you can find on the websites Plan your Studies as well as
Create your timetable.

Note: The English version of our module descriptions is not legally binding.

Overview of the
Basic studies modules 1st-4th semester (Bachelor level)

Module number, with link to description	**Module name** English German	**1st semester winter semester** L/E/P	**2nd semester summer semester** L/E/P	**3rd semester winter semester** L/E/P	**4th semester summer semester** L/E/P	**Language of instruction**	**ECTS Credits**
EuI-ET-C-GET	Basics of Electrical Engineering Grundlagen der Elektrotechnik	2/2/0 PL				German	**5**
EuI-ET-C-Ma1	Introduction to Analysis and Algebra Algebraische und analytische Grundlagen	6/4/0 PL				German	**11**
EuI-ET-C-SwEgG	Software Engineering Basics Software Engineering Grundlagen	2/1/1 2 PL				German	**5**
EuI-ET-C-Wrkst	Materials Science Werkstoffe	2/1/0 PL				German	**3**
EuI-ET-C-Phy	Physics Physik	2/2/0	2/1/1 2 PL			German	**9 (4+5)**
EuI-ET-C-EMF	Electric and Magnetic Fields Elektrische und magnetische Felder		2/2/0 PL			German	**5**
EuI-ET-C-Ma2	Calculus for Functions with Several Variables Mehrdimensionale Differential- und Integralrechnung		4/4/0 PL			German	**9**
EuI-ET-C-SwEgV	Software Engineering Advanced Software Engineering Vertiefung		2/1/1 PL			German	**5**
EuI-ET-C-GE	Electronic Systems Design Geräteentwicklung		2/2/0 PL			German	**5**
ET-12 08 03	Dynamical Electrical Networks Dynamische Netzwerke			2/2/1 PL	0/0/2 PL	German	**8**
ET-01 04 03	Complex Function Theory Funktionentheorie			2/2/0 PL		German	**4**

ET-12 08 11	Microelectronic Technologies and Devices Technologien und Bauelemente der Mikro-elektronik			5/1/0 PL		German	**6**
ET-12 06 10	Project Electronics Technology Praxisprojekt Elektronik-Technologie			0/0/2 PL		German	**3**
ET-12 04 01	Electrical Power Engineering Elektroenergietechnik			3/1/0 PL	0/0/1 PL	German	**5**
ET-12 09 01	Systems Theory Systemtheorie			2/1/0	2/2/0 PL	German	**7**
ET-12 01 01	Microcomputer Technology Mikrorechentechnik			2/0/1	1/0/2 PL	German	**7**
ET-01 04 04	Partial Differential Equations and Probability Theory Partielle Differentialgleichungen und Wahr-scheinlichkeitstheorie				2/2/0 PL	German	**4**
ET- 12 08 31	Electronic Circuits Schaltungstechnik				4/2/0 PL	German	**7**
ET-12 10 24	Communications Nachrichtentechnik				2/1/0 PL	German	**3**
ET-12 01 02	Automation Engineering and Measurement Automatisierungs- und Messtechnik				3/2/0 PL	German	**5**

Overview of the
Main studies modules 5th-10th semester
(relevant for all specialization areas)

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 02 01	Electromagnetic Theory Theoretische Elektrotechnik	2/2/0 PL	2/2/0 PL	German	**10**
ET-12 02 02	Numerical Analysis Numerische Mathematik	2/1/0 PL		German	**4**
ET-12 08 32	Electronic Circuits – Experiments and Measurements Schaltungstechnik – Experimente und Messungen	0/0/2 PL		German	**3**
ET-12 08 06	Measurement and Sensor Techniques Mess- und Sensortechnik	2/1/1 2 PL		German	**4**

Overview of the
Main studies modules 5th-10th semester
In the specialization area: **Automation and Robotics**

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**8th semester summer semester** L/E/P	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 01 06	Advanced Seminar Automation, Measurement and Control Hauptseminar Automatisierungs-, Mess- und Regelungstechnik	0/2/0 PL				German	**4**
ET-12 01 03	Discrete event systems and control Ereignisdiskrete Systeme und Steuerungen	2/1/0 PL	2/0/1 2 PL			German	**6**
ET-12 01 05	Modelling and Simulation Modellbildung und Simulation	1/1/0 PL	2/1/1 2 PL			German	**8**
ET-12 13 01	Control of Continuous-Time Processes Regelungstechnik	3/1/1 PL	2/1/1 2 PL			German	**9**
ET-12 01 04	Process Control Prozessleittechnik		6/2/2 3 PL			German	**11**
ET-12 01 10	Industrial Automation Engineering 1 Industrielle Automatisierungstechnik – Basismodul			3/1/0 PL	0/0/2 PL	German	**7**
ET-12 01 21	Project Planning for Process Automation Systems Projektierung von Automatisierungssystemen			2/2/2 2 PL		German / English	**7**
ET-12 08 20	Laser Sensor Technology Lasersensorik			4/1/1 2 PL		German	**7**
ET-12 13 10	Nonlinear Systems und Process Identification Nichtlineare Systeme und Prozessidentifikation			4/2/0 2 PL		German	**7**
ET-12 01 11	Industrial Automation Engineering 2 Industrielle Automatisierungstechnik – Aufbaumodul			3/2/1 2 PL		German/ English	**7**
ET-12 01 12	Robotics Robotik			2/1/0 PL	2/1/1 2 PL	German	**7**
ET-12 01 13	Systems Design				4/2/0	German	**7**

	Systementwurf				2 PL		
ET-12 13 11	Nonlinear Control Systems, Advanced Nichtlineare Regelungssysteme – Vertiefung			2/0/0 PL	2/1/0 PL	German	**7**
ET-12 13 12	Optimal and Robust Multivariable Control Systems Optimale, robuste und Mehrgrößenregelung			2/0/0 PL	2/1/0 PL	German	**7**
ET-12 01 20	Human Machine System Technology Mensch-Maschine-Systemtechnik				2/2/2 2 PL	German	**7**
ET-12 01 22	Process Simulation and Operation Prozessführungssysteme			1/1/0 PL	2/2/0 2 PL	German	**7**
ET-12 08 21	Photonic Measurement System Technology Photonische Messsystemtechnik				3/1/1 or 4/0/1 2 PL	German/ English	**7**

Overview of the
Main studies modules 5th-10th semester
In the specialization area: **Electrical Power Engineering**

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**8th semester summer semester** L/E/P	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 02 04	Electrical Machines Elektrische Maschinen	3/1/1 2 PL				German	**5**
ET-12 04 02	High Voltage and High Current Engineering Hochspannungs- und Hochstromtechnik	2/1/1 2 PL				German	**5**
ET-12 04 03	Fundamentals of Electrical Power Systems Grundlagen elektrischer Energieversorgungs-systeme	3/2/0 2 PL				German	**5**
ET-12 02 03	Power Electronics Leistungselektronik	2/1/0	1/1/1 2 PL			German	**7**
ET-12 02 05	Electric Drives Elektrische Antriebe		3/1/1 2 PL			German	**6**
ET-12 02 06	Advanced Seminar Electrical Power Engineering Hauptseminar Elektrische Energietechnik		0/2/0 2 PL			German	**4**
ET-12 04 04	Operating of Electrical Power Systems Betrieb elektrischer Energieversorgungs-systeme		2/1/2 3 PL			German	**6**
ET-12 02 08	Numerical Methods for Electromagnetic Theory Numerische Verfahren der Theoretischen Elektrotechnik			3/1/2 2 PL		German	**7**
ET-12 02 10	Power Electronics, advanced Vertiefung Leistungselektronik			3/2/1 2 PL		German	**7**
ET-12 02 11	Microprocessor Control in Power Electronics Mikroprozessorsteuerung in der Leistungs-elektronik			2/1/2 2 PL		German	**7**

ET-12 04 05	Network Integration, System Performance and Quality of Supply Netzintegration, Systemverhalten und Versorgungsqualität			3/2/1 2 PL		German	**7**
ET-12 04 06	Planning of Electrical Power Systems Planung elektrischer Energieversorgungssysteme			4/3/0 3 PL		German	**7**
ET-12 04 07	High Voltage Engineering Vertiefung Hochspannungstechnik			5/0/1 2 PL		German	**7**
ET-12 02 07	Electromagnetic Compatibility Elektromagnetische Verträglichkeit			2/0/2	2/0/1 2 PL	German	**7**
ET-12 02 09	Selected Topics of Electromagnetic Theory Ausgewählte Kapitel der Theoretischen Elektrotechnik			2/1/0	2/1/0 PL	German	**7**
ET-12 02 12	Electromagnetic Energy Conversion Elektromagnetische Energiewandler			4/1/1 2 PL		German	**7**
ET-12 02 13	Electrical Drive Engineering Elektrische Antriebstechnik				4/1/1 2 PL	German	**7**
ET- 12 02 14	Selected Topics of Electrical Power Engineering Ausgewählte Kapitel der Elektrischen Energietechnik			2/1/0	2/1/0 PL	German	**7**
ET-12 02 15	Controlled Power Systems Geregelte Energiesysteme				4/1/1 2 PL	German	**7**
ET-12 02 16	Design of Power Electronic Systems Entwurf leistungselektronischer Systeme				4/2/0 2 PL	German	**7**
ET-12 02 17	Application of Electric Drives Anwendung elektrischer Antriebe			4/1/1 PL		German	**7**
ET-12 04 08	Protection and Control of Electrical Power Systems Schutz- und Leittechnik in elektrischen Energieversorgungssystemen				3/2/1 3 PL	German	**7**
ET-12 04 09	Stress of Electrical Equipment Beanspruchung elektrischer Betriebsmittel				3/1/2 3 PL	German	**7**
ET-12 04 10	Experimental High Voltage Engineering Experimentelle Hochspannungstechnik				4/0/2 2 PL	German	**7**

Overview of the
Main studies modules 5th-10th semester
In the specialization area: **Electronic Systems and Technology and Biomedical Engineering**

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**8th semester summer semester** L/E/P	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 05 02	Advanced Seminar Electronic Systems and Technology and Biomedical Engineering Hauptseminar Geräte-, Mikro und Medizin-technik	0/2/0 2 PL				German	**4**
ET-12 05 04	Design Methodologies Konstruktion	1/3/0 PL	1/1/0 PL			German	**6**
ET-12 06 01	Technologies for Electronic Packaging and As-sembly Technologien der Elektronik	2/0/1 PL	2/0/1 2 PL			German	**6**
ET-12 07 01	Biomedical Engineering Biomedizinische Technik	2/1/0	2/0/0 PL			German	**6**
ET-12 05 03	System Design Gerätetechnik		3/4/0 2 PL			German	**8**
ET-12 05 05	Physical Design and Physical Design Automation Rechnergestützter Entwurf		2/0/1 2 PL			German	**4**
ET-12 06 03	Quality Assurance Qualitätssicherung		2/1/0 PL			German	**4**
ET-12 05 06	Product and Precision Device Engineering Entwicklung feinwerktechnischer Produkte			2/0/4 2 PL		German	**7**
ET-12 05 07	Simulation Methodologies in System Design Simulation in der Gerätetechnik			2/4/0 PL		German	**7**

ET-12 06 05	Board Level Reliability of Electronic Products Funktionsmaterialien der Aufbau- und Verbindungstechnik der Elektronik			4/0/2 PL		German	**7**
ET-12 06 06	Computer-Aided Electronics Manufacturing Rechnergestützte Elektronikfertigung			4/2/0 PL		German	**7**
ET-12 07 02	Medical and Physiological Principles Medizinisch-physiologische Grundlagen			4/1/1 PL		German	**7**
ET-12 07 05	Signal processing in biomedical engineering Signalverarbeitung in der Biomedizinischen Technik				4/2/0 2 PL	German	**7**
ET-12 05 08	Electromechanical Design Gerätekonstruktion				2/0/4 2PL	German	**7**
ET-12 05 09	Electronic Design Automation Entwurfsautomatisierung				2/4/0 2 PL	German	**7**
ET-12 06 07	Hybrid Integration Hybridintegration				4/0/2 3d excursions 2 PL	German	**7**
ET-12 06 08	Nondestructive Testing Zerstörungsfreie Prüfung				4/0/2 2 PL	German	**7**
ET-12 07 03	Medical Devices Medizinische Gerätetechnik				3/2/1 2 PL	German	**7**
ET-12 07 04	Cooperative Systems in Biomedical Engineering Autonome und kooperative Systeme in der BMT				4/1/1 2 PL	German	**7**

Overview of the
Main studies modules 5th-10th semester
In the specialization area: **Communications and Information Technology**

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**8th semester summer semester** L/E/P	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 08 12	Integrated Analogue Circuits Integrierte Analogschaltungen	2/2/0 PL				German	**4**
ET-12 09 02	Signal Theory Signaltheorie	4/2/0 2 PL				German	**7**
ET-12 08 18	Integrated Circuit Design Schaltkreis- und Systementwurf	2/1/0	0/0/2 PL			German	**7**
ET-12 09 06	Acoustics Akustik		2/2/0 PL			German	**4**
ET-12 10 01	Information Theory Informationstheorie		2/2/0 PL			German	**4**
ET-12 10 02	Advanced Seminar Communication Systems Hauptseminar Kommunikationssysteme		0/2/0 2 PL			German	**4**
ET-12 10 03	RF Engineering Hoch- und Höchstfrequenztechnik		2/2/0 PL			German	**4**
ET-12 10 04	Communication Networks, Basic Module Kommunikationsnetze, Basismodul		2/2/0 PL			German	**4**
ET-12 08 16	Radio Frequency Integrated Circuits			3/1/2 PL		English	**7**
ET-12 08 20	Laser Sensor Technology Lasersensorik			4/1/1 2 PL		German	**7**
ET-12 09 13	Applied Intelligent Signal Processing Angewandte intelligente Signalverarbeitung			4/1/1 PL		German	**7**
ET-12 09 08	Room Acoustics / Virtual Reality Raumakustik / Virtuelle Realität			4/0/2 2 PL		German	**7**

ET-12 10 05	Communication Networks, Advanced I Kommunikationsnetze, Aufbaumodul			4/2/0 2 PL		German/ English	**7**
ET-12 10 09	Information Theory, Advanced I Aufbaumodul Informationstheorie				4/2/0 2 PL	German or English	**7**
ET-12 10 12	Antennas and Propagation Antennen und Wellenausbreitung			4/2/0 PL		German	**7**
ET-12 10 14	Optical Communications Optische Nachrichtentechnik				4/2/0 PL	German	**7**
ET-12 08 08	Circuit Simulation and System Identification Schaltungssimulation und Systemidentifikation			1/1/0 PL	2/1/0 PL	German	**7**
ET-12 09 05	Electro-Acoustics Elektroakustik			2/0/0 PL	2/0/2 2 PL	German	**7**
ET-12 10 21	Network Coding in Theory and Practice Netzwerkkodierung in Theorie und Praxis			4/2/0 2 PL		German/ English	**7**
ET-12 10 08	Statistics Statistik			2/1/0 PL	2/1/0 PL	German	**7**
ET-12 10 16	Digital Signal Processing and Hardware Implementation Digitale Signalverarbeitung und Hardware-Implementierung			2/1/2 2 PL		English	**7**
ET-12 08 17	Integrated Circuits for Broadband Optical Communications				3/1/2 PL	English	**7**
ET-12 08 19	VLSI Processor Design VLSI-Prozessorentwurf			2/2/2 2 PL		English	**7**
ET-12 08 21	Photonic Measurement System Technology Photonische Messsystemtechnik				3/1/1 or 4/0/1 2 PL	German/ English	**7**
ET-12 09 04	Speech Technology Sprachtechnologie				4/0/2 PL	German	**7**
ET-12 09 07	Technical Acoustics/ Vehicle Acoustics Technische Akustik/ Fahrzeugakustik				2/2/2 2 PL	German	**7**
ET-12 09 09	Psychoacoustics/ Sound Design Psychoakustik/ Sound Design				4/2/0 2 PL	German	**7**
ET-12 10 20	Communication Networks, Advanced II (Communication Networks 3) Kommunikationsnetze, Vertiefungsmodul				4/2/0 2 PL	English	**7**

ET-12 10 22	Intelligent and cooperative Communications Intelligente und kooperative Kommunikation			4/2/0 2 PL		German/ English	**7**
ET-12 10 19	Optimization in modern Communication Sys-tems Optimierung in modernen Kommunikations-systemen				4/2/0 2 PL	German or English	**7**
ET-12 10 13	RF Systems Hochfrequenzsysteme			4/2/0 PL		German	**7**
ET-12 10 15	Basics Mobile Communications Systems Grundlagen mobiler Nachrichtensysteme			4/2/0 PL		German	**7**
ET-12 10 17	Upgrade Mobile Communication Systems Vertiefung Mobile Nachrichtensysteme				4/2/0 PL	German/ English	**7**
ET-12 10 18	Digital Signal Processing Systems Digitale Signalverarbeitungssysteme				3/1/2 2 PL	German	**7**
ET- 12 08 27	Neuromorphic VLSI Systems Neuromorphe VLSI Systeme			4/2/0 2 PL		German	**7**

Overview of the
Main studies modules 5th-10th semester
In the specialization area: **Microelectronics**

Module number, with link to description	**Module name** English German	**5th semester winter semester** L/E/P	**6th semester summer semester** L/E/P	**8th semester summer semester** L/E/P	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 08 12	Integrated Analogue Circuits Integrierte Analogschaltungen	2/2/0 PL				German	**4**
ET-12 06 02	Electronic Packaging Aufbau- und Verbindungstechnik der Elektronik	2/0/0 PL	0/0/2 PL			German	**4**
ET-12 08 13	Physics of selected devices Physik ausgewählter Bauelemente	2/1/0	2/0/1 2 PL			German	**6**
ET-12 08 23	Computer Aided Integrated Circuit Design Rechnergestützter Schaltkreisentwurf	2/1/0 PL	2/0/2 PL			German	**8**
ET-12 12 01	Microsystems and Semiconductor Technology Mikrosystem- und Halbleitertechnologie	2/0/0	6/1/3 2 PL			German	**12**
ET-12 08 15	Advanced Seminar: Micro- and Nanoelectronics Hauptseminar Mikro- und Nanoelektronik		0/2/0 2 PL			German	**4**
ET-12 05 07	Simulation Methodologies in System Design Simulation in der Gerätetechnik			2/4/0 PL		German	**7**
ET-12 08 16	Radio Frequency Integrated Circuits			3/1/2 PL		English	**7**
ET-12 11 01	Solid-State and Nano Electronics Festkörper- und Nanoelektronik				4/2/0 PL	German	**7**
ET-12 12 12	Design of Microelectromechanical Systems Entwurf Mikroelektromechanischer Systeme			4/2/1 2 PL		German	**7**
ET-12 12 04	Memory Technology			2/1/0	2/1/0 PL	English	**7**
ET-12 05 09	Electronic Design Automation Entwurfsautomatisierung				2/4/0 2 PL	German	**7**

ET-12 06 07	Hybrid Integration Hybridintegration				4/0/2 3 d excursion 2 PL	German	**7**
ET-12 08 17	Integrated Circuits for Broadband Optical Communications				3/1/2 PL	English	**7**
ET-12 08 19	VLSI Processor Design VLSI-Prozessorentwurf			2/2/2 2 PL		English	**7**
ET-12 11 04	Sensors and Sensor Systems Sensoren und Sensorsysteme				4/1/1 2 PL	German	**7**
ET- 12 11 05	Plasma Technology Plasmatechnik				4/2/0 PL	English	**7**
ET-12 12 09	New Actuators and Actuator Systems Neue Aktoren und Aktorsysteme				4/1/1 3 PL	German	**7**
ET- 12 08 27	Neuromorphic VLSI Systems Neuromorphe VLSI Systeme			4/2/0 2 PL		German	**7**
ET-12 12 07	Innovative Concepts for Active Nanoelectronic Devices				4/1/1 3 PL	English	**7**

Overview of the
Research oriented elective modules, 9th semester

Module number with link to description	**Module name** English German	**9th semester winter semester** L/E/P	**Language of instruction**	**ECTS Credits**
ET-12 01 23	Seminar for Graduate Students on Human-Machine-Interaction Oberseminar Mensch-Maschine-Interaktion	0/2/0 PL	German	**4**
ET-12 01 24	Seminar for Graduate Students on Automation Oberseminar Automatisierungstechnik	0/2/0 PL	German	**4**
ET-12 02 18	Seminar for Graduate Students on Electromagnetic Theory and Compatibility / Oberseminar Theoretische Elektrotechnik und Elektro-magnetische Verträglichkeit	0/2/0 PL	German	**4**
ET-12 02 19	Seminar for Graduate Students on Power Electronics Oberseminar Leistungselektronik	0/2/0 PL	German	**4**
ET-12 02 20	Seminar for Graduate Students on Machines and Drives Oberseminar Maschinen und Antriebe	0/2/0 PL	German	**4**
ET-12 04 11	Seminar for Graduate Students on Electrical Power Engineering Oberseminar Elektrische Energieversorgung	0/2/0 PL	German	**4**
ET-12 05 10	Seminar for Graduate Students on System Design Oberseminar Gerätetechnik	0/2/0 PL	German	**4**
ET-12 06 09	Seminar for Graduate Students on Electronic Packaging Oberseminar Aufbau- und Verbindungstechnik	0/2/0 PL	German	**4**
ET-12 07 06	Seminar for Graduate Students on Biomedical Engineering Oberseminar Biomedizinische Technik	0/2/0 PL	German	**4**
ET-12 08 22	Seminar for Graduate Students on Measurement System Technology Oberseminar Messsystemtechnik	0/2/0 PL	German	**4**
ET-12 08 25	Seminar for Graduate Students on Micro- and Nanoelectronics Oberseminar Mikro- und Nanoelektronik	0/2/0 PL	German	**4**
ET-12 10 23	Seminar for Graduate Students on Information Technology Oberseminar Informationstechnik	0/2/0 PL	German/ English	**4**
ET-12 12 08	Seminar for Graduate Students on Microelectronics Oberseminar Mikroelektronik	0/2/0 PL	German	**4**
ET-12 13 13	Seminar for Graduate Students on Control Theory Oberseminar Regelungs- und Steuerungstheorie	0/2/0 PL	German	**4**

Module descriptions
Basic studies modules 1st-4th semester

Module name	**Basics of Electrical Engineering**
Module number	EuI-ET-C-GET (EuI-BMT-C-GET, EuI-IST-C-GET, EuI-MT-C-GET, EuI-RES-C-GET)
Lecturer in charge	Prof. Dr. phil. nat. habil. Ronald Tetzlaff ronald.tetzlaff@tu-dresden.de
Objectives	After completing the module, students have basic knowledge of electrical engineering and electronics and have mastered methods for solving electrical engineering problems as a basis for further modules. The focus is on resistive circuits. They are able to describe linear and nonlinear two-pole circuits and take into account the temperature dependence of their parameters, systematically analyze electrical circuits with direct current and apply special simplified analysis methods such as two-pole theory and the superposition theorem. They can calculate the power conversion in circuits and analyze and measure thermal arrangements.
Contents	The content of the module is the calculation of electrical networks with direct current.
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises and self-study.
Prerequisites	Knowledge of mathematics and physics at basic A-level is required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Information Systems Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 150 minutes.
Credit points and grades	5 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every winter semester.
Workload	The total effort is 150 hours.
Duration	The module takes one semester.

Module name	**Introduction to Analysis and Algebra**
Module number	EuI-ET-C-Ma1 (EuI-BMT-C-Ma1, EuI-IST-C-Ma1, EuI-MT-C-Ma1, EuI-RES-C-Ma1)
Lecturer in charge	Prof. PD Dr. Sebastian Franz sebastian.franz@tu-dresden.de
Objectives	After completing the module, students have basic mathematical knowledge and knowledge of algebra. They are able to calculate with real and complex numbers and apply functions, sequences, series, vectors, vector spaces, determinants and matrices.
Contents	The contents of the module are set theory, real and complex numbers, number sequences, series, analysis of real functions of one variable, linear spaces and mappings, matrices, determinants, linear sliding systems, eigenvalues and eigenvectors.
Modes of teaching and learning	6 hours per week lectures, 4 hours per week exercises and self-study.
Prerequisites	Knowledge of mathematics at basic A-level is required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Information Systems Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 180 minutes.
Credit points and grades	11 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every winter semester.
Workload	The total effort is 330 hours.
Duration	The module takes one semester.

Module name	**Software Engineering Basics**
Module number	EuI-ET-C-SwEgG (EuI-BMT-C-SwEgG, EuI-MT-C-SwEgG, EuI-RES-C-SwEgG)
Lecturer in charge	Prof. Dr.-Ing. Dr. h. c. Frank H.P. Fitzek frank.fitzek@tu-dresden.de
Objectives	After completing the module, students have competencies and practical skills in dealing with various programming languages and programming environments.
Contents	The module focuses on the structure and programming of computers with Python and assembler. This includes information representation, basic Boolean circuits, computer architecture, algorithms and their complexity analysis, i.e. Big O notation.
Modes of teaching and learning	2 hours per week lectures, 1 hour per week exercises, 1 hour per week practical lab course and self-study.
Prerequisites	Knowledge of mathematics at basic A-level is required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes and a complex assignment of 60 hours.
Credit points and grades	5 credit points can be earned by the module. The module grade is the weighted mean of the grades of the assessments. The written exam is weighted by 1/3 and the complex assignment 2/3.
Frequency	The module is offered every winter semester.
Workload	The total effort is 150 hours.
Duration	The module takes one semester.

Module name	**Materials Science**
Module number	EuI-ET-C-Wrkst (EuI-BMT-C-Wrkst, EuI-MT-C-Wrkst, EuI-RES-C-Wrkst)
Lecturer in charge	Dr.-Ing. Stefan Enghardt stefan.enghardt@tu-dresden.de
Objectives	After completing the module, students will be able to establish a connection between the microscopic structure, the macroscopic properties and the practical application aspects of the materials. They know the theoretical basics of atomic structure, types of bonding, crystal structure, real structure and microstructure and have knowledge of materials testing.
Contents	The module covers the following areas: Overview of materials and practical examples, fundamentals of materials science, state diagrams and alloys, conductor, semiconductor, dielectric and magnetic materials as well as materials testing and diagnostics.
Modes of teaching and learning	2 hours per week lectures, 1 hour per week exercises and self-study.
Prerequisites	Knowledge of mathematics and physics at basic A-level is required. The following literature, for example, can also be used for preparation: - Elemente der Mathematik SII, Westermann Verlag, - Lambacher Schweizer Mathematik Oberstufe, Klett Verlag, - Bigalke/Köhler Mathematik, Cornelsen Verlag, - Lehrbuch Physik Gymnasiale Oberstufe, Duden Verlag, - Metzler Physik SII, Westermann Verlag, - Dorn/Bader Physik SII, Westermann Verlag.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 90 minutes.
Credit points and grades	3 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every winter semester.
Workload	The total effort is 90 hours.
Duration	The module takes one semester.

Module name	**Physics**
Module number	EuI-ET-C-Phy
Lecturer in charge	PD Dr. Eduard Lavrov eduard.lavrov@tu-dresden.de
Objectives	After completing the module, students will have knowledge of areas of physics as a prerequisite for understanding physical phenomena and their application in electrical engineering. With the thinking and working methods of physics, they are able to find solutions to physical problems independently.
Contents	The module covers the fields of mechanics, thermodynamics, vibrations and waves, optics and the structure of matter.
Modes of teaching and learning	4 hours per week lectures, 3 hours per week exercises, 1 hour per week practical lab courses and self-study.
Prerequisites	Knowledge of physics at basic A-level is required.
Usability	The module is a compulsory module in the basic studies of the degree programme Electrical Engineering. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 180 minutes and an ungraded portfolio of 20 hours. A bonus to the written exam is the completion of 15 hours of exercises.
Credit points and grades	9 credit points can be earned by the module. The module grade is the unweighted mean of the grades of the assessments with the following regulation: An individual examination is only graded as "passed" or "failed" (ungraded examination). The ungraded examination graded "pass" is not included in the further grading; the ungraded examination graded "fail" is included in the further grading with the grade "insufficient" (5.0).
Frequency	The module is offered every academic year beginning in the winter semester.
Workload	The total effort is 270 hours.
Duration	The module takes two semesters.

Module name	**Electric and Magnetic Fields**
Module number	EuI-ET-C-EMF (EuI-BMT-C-EMF, EuI-IST-C-EMF, EuI-MT-C-EMF, EuI-RES-C-EMF)
Lecturer in charge	Prof. Dr. phil. nat. habil. Ronald Tetzlaff ronald.tetzlaff@tu-dresden.de
Objectives	After completing the module, students know the basic concepts, quantities and methods for calculating simple electric fields and magnetic fields. They are able to calculate the energy stored in the field, the force effects caused by the fields and the induction effects in the magnetic field. Students are familiar with the basic principles of the electronic components resistor, capacitor, coil and transformer and their descriptive equations.
Contents	The module covers the calculation of simple electric fields and magnetic fields.
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises and self-study.
Prerequisites	The skills to be acquired in the modules **Introduction to Analysis and Algebra** and **Basics of Electrical Engineering** are required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Information Systems Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 150 minutes.
Credit points and grades	5 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every summer semester.
Workload	The total effort is 150 hours.
Duration	The module takes one semester.

Module name	**Calculus for Functions with Several Variables**
Module number	EuI-ET-C-Ma2 (EuI-BMT-C-Ma2, EuI-IST-C-Ma2, EuI-MT-C-Ma2, EuI-RES-C-Ma2)
Lecturer in charge	Prof. PD Dr. Sebastian Franz sebastian.franz@tu-dresden.de
Objectives	After completing the module, students have knowledge of differentiation and integration of functions with one and several variables, analytical solutions of differential equations and systems of differential equations as well as vector analysis.
Contents	The contents of the module are analysis of real functions of several variables, vector analysis, function series, differential equations and Taylor series.
Modes of teaching and learning	4 hours per week lectures, 4 hours per week exercises and self-study.
Prerequisites	The skills to be acquired in the modules **Introduction to Analysis and Algebra** are required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Information Systems Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 150 minutes.
Credit points and grades	9 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every summer semester.
Workload	The total effort is 270 hours.
Duration	The module takes one semester.

Module name	**Software Engineering Advanced**
Module number	EuI-ET-C-SwEgV (EuI-BMT-C-SwEgV, EuI-MT-C-SwEgV)
Lecturer in charge	Prof. Dr.-Ing. Dr. h. c. Frank H.P. Fitzek frank.fitzek@tu-dresden.de
Objectives	After completing the module, students will be able to apply their programming skills to an embedded system and select different programming environments based on their complexity and level of application.
Contents	The contents of the module are embedded systems such as Raspberry Pi Pico and the efficient and portable programming of data structures and algorithms in a typed procedural language such as C as well as the comparison with other languages such as Assembler or MicroPython. The module also includes object-oriented programming languages.
Modes of teaching and learning	2 hours per week lectures, 1 hour per week exercises, 1 hour per week practical lab courses and self-study.
Prerequisites	The skills to be acquired in the modules **Software Engineering Basics** are required.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Mechatronics. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a complex assignment of 60 hours.
Credit points and grades	5 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every summer semester.
Workload	The total effort is 150 hours.
Duration	The module takes one semester.

Module name	**Electronic Systems Design**
Module number	EuI-ET-C-GE (EuI-BMT-C-GE, EuI-MT-C-GE, EuI-RES-C-GE)
Lecturer in charge	Prof. Dr.-Ing. habil. Jens Lienig jens.lienig@tu-dresden.de
Objectives	After completing the module, students will have acquired basic knowledge of the design and development of electronic assemblies and devices. They will have an understanding of engineering tasks and the various requirements to be taken into account. As a result, students are able to take an engineering approach to the development and design of these products, taking into account all relevant aspects.
Contents	The module covers design fundamentals such as technical representation, circuit diagram creation and CAD, as well as focusing on device design and device requirements, reliability of electronic devices, thermal dimensioning and electromagnetic compatibility (EMC).
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises and self-study.
Prerequisites	There are no special prerequisites.
Usability	The module is a compulsory module in the basic studies of the degree programmes Electrical Engineering, Biomedical Engineering, Mechatronics and Renewable Energy Systems. It creates the prerequisites for the modules that list that module in the "Prerequisites" field.
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.
Credit points and grades	5 credit points can be obtained by the module. The module grade is the grade of the examination.
Frequency	The module is offered every summer semester.
Workload	The total effort is 150 hours.
Duration	The module takes one semester.

Module number	Module name	Lecturer in charge
ET-12 01 01	Microcomputer Technology	Prof. Dr.-Ing Frank Fitzek
Contents and objectives	Contents of the module are computer architecture and instruction set architecture, coupling with technical processes; instruction set oriented programming (assembler); efficient and portable programming of data structures and algorithms in a typical based procedural language (eg C) as well as object-oriented analysis, design and generic implementation of data structures and algorithms using examples of electrical engineering and information technology (eg C ++).	
Modes of teaching and learning	3 hours per week lectures, 3 hours per week practical lab courses, and self-study.	
Prerequisites	Competencies acquired in modules such as Computer Science.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a practical lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the module assessment.	
Frequency	Annually, beginning in the winter semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-01 04 03	Complex Function Theory	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	Content of the module is the function theory with the main focus on differentiation, integration, series development and conformal transformation. Outcomes: The students have knowledge of functions with complex variables.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study.	
Prerequisites	Competencies acquired in modules such as **Introduction to Analysis and Algebra** and **Calculus for Functions with Several Variables**.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-01 04 04	Partial Differential Equations and Probability Theory	Prof. Dr. rer. nat. habil. Z. Sasvári
Contents and objectives	The content of the module focuses on partial differential equations and probability theory. Outcomes: After completion of the module, the students have knowledge of special analytical solution methods of partial differential equations and probability theory.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study.	
Prerequisites	Competencies acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Complex Function Theory**.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 03	Dynamical Electrical Networks	Prof. Dr. phil. nat. habil. Ronald Tetzlaff
Contents and objectives	The module contents: the analysis of linear dynamic networks. Outcomes: After completing this module, students are able to apply methods for analyzing linear dynamic circuits excited by periodic signals and to determine the transient behavior between stationary states. They are able to describe, to model and to analyze linear two-ports. They can determine transfer functions, analyze and graphically represent the network behavior for different frequencies, and determine basic filter structures. Phasor representations and Nyquist plots are mastered.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, 3 hours per week practical lab course, and self-study.	
Prerequisites	Knowledge acquired in modules such as **Basics of Electrical Engineering**, or equivalent. The prerequisites for participation in the lab course is to pass the module exam of the module **Basics of Electrical Engineering**.	
Requirements for the award of ECTS credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a lab course. Both assessments must be passed.	
ECTS credit points and grades	8 ECTS credit points can be earned. The module grade is determined by the weighted average of the grades of both elements of assessment. The module grade consists to 2/3 of the grade of the written exam and to 1/3 of the lab course grade.	
Frequency	annually, starting in the winter semester	
Workload	240 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 08 31	Electronic Circuits	Prof. Dr. sc. techn. habil. F. Ellinger
Contents and objectives	This module gives an introduction to electronic circuits, such as basic analogue circuits, differential amplifiers, power amplifiers, operational amplifiers and its applications, power supply, basic digital circuits, combinational und sequential logic. Students learn fundamental principles and practical realisations of analogue and digital circuits. They understand the properties of these circuits using different structures and the properties of the electronic devices. They can handle the methods of circuit analysis and they can dimension the circuits for specific applications.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Basics of Electrical Engineering,** **Microelectronic Technologies and Devices**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 180 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 01	Systems Theory	Prof. Dr.-Ing. Rafael F. Schaefer rafael.schaefer@tu-dresden.de
Contents and objectives	Content: The module deals with the fundamentals of systems theory with focus on digital systems, analogue time-continuous systems, analogue time-discrete systems and selected applications. Objectives: Having successfully completed the module, the students are familiar with the regulative significance of the system concept in engineering. They master the application of signal transformations for the effective description of the system behaviour in the area of image. In particular, they are able to apply the approach of system theory to important areas of their own discipline, e.g. to the calculation of electrical networks in the case of non-sinusoidal or stochastic excitation and to the realization of systems with desired transfer behaviour in time-discrete form (digital filter).	
Modes of teaching and learning	4 hours per week lectures and 3 hours per week exercises and self-study	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Basics of Electrical Engineering**, or equivalent.	
Requirements for the award of ECTS credit points	The ECTS credit points are awarded when the module assessment is passed. The module assessment is a written exam of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, beginning in the winter semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 02	Automation Engineering and Measurement	Prof. Dr. techn. K. Janschek
Contents and objectives	Content: 1. Fundamentals of automation engineering wit the focus on behavioural description, control design in the frequency domain, digital control loops, industrial standard controllers, discrete-event control systems, elementary control concepts and automation technologies 2. Fundamentals of measuring with the focus on measurement principles, SI units, analogue measurement technology (fundamentals, measurement bridges, lock-in measurement technique, quadrature demodulation technique, measurement of transit times and distances) and statistical measurement data evaluation (calculation of standard deviation and confidence intervals, propagation of the measurement uncertainty, setup of uncertainty budget for measurement) Objectives: Having successfully completed the modules, the students 1. understand fundamental behaviour description forms for technical systems. Further, they master the basic theoretical and computer-aided handling of linear, time-invariant and discrete-event behaviour models for the control of technical systems. They are able to design control algorithms for simple tasks. 2. are familiar with the principles of analogue measuring procedures and are able to evaluate measurement results by using statistical methods. They are able to calculate and interpret random and systematic measuring uncertainties.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, and self-study	
Prerequisites	Competences acquired in basic modules on Physics.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written test of 210 minutes.	
ECTS credit points and grades	5 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the summer semester	
Workload	150 working hours	

Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 04 01	Electrical Power Engineering	Dr. Schlegel
Contents and objectives	Contents: - Generation, transformation, transport, distribution and usage of electrical energy - Structure of electrical energy supply - Fundamentals of three-phase power and their mathematical description - Electrical safety and coordination of stress and strength - Fundamentals of power electronics - Electromechanic energy converters Objectives: Having successfully completed this module, the students are able to undertake basic calculations and measurements for simple three-phase systems. They are familiar with principles of safety measures in electrical networks. They are able to calculate simple insulation configurations. The students are familiar with the fundamental mode of operation of power electronic circuits, electrical machines and three-phase transformers.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	None	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 min. (PL1) and a lab course (PL2). Both elements of assessment have to be passed.	
ECTS credit points and grades	5 ECTS credit points The module M grade is calculated as follows: M = (2PL1 + PL2)/3	
Frequency	annually, in the winter semester	
Workload	150 working hours	
Duration	2 semester	

Module number	Module name	Lecturer in charge
ET-12 08 11	Microelectronic Technologies and Devices	Prof. Dr.-Ing. habil. M. Schröter
Contents and objectives	The module includes – the physical fundamentals of electronic devices – the physical-technical fundamentals for their production by means of microtechnologies Objectives: The students are capable of: – understanding the fundamental functioning and electrical features of the most important semiconductor electronic devices on basis of a simplified description of the physical potential ratio and transport mechanisms in semiconductors – discussing the most important characteristic lines – constructing physical modell descriptions (including equivalent circuit diagrams) of semiconductor electronic devices for their application – working with fundamental principles for the production and miniaturisation of devices and circuits – understanding the modes of functioning of the individual technologies as well as their coaction resulting in simple process flows	
Modes of teaching and learning	5 hours per week lectures, 1 hour per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Basics of Electrical Engineering,** **Physics**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. This assessment is a written exam of 210 minutes.	
ECTS credit points and grades	6 ECTS credits The module grade is the grade of the exam.	
Frequency	annually, in the winter semester	
Workload	180 hours	
Duration	1 Semester	

Module number	Module name	Lecturer in charge
ET-12 10 24	Communications	Prof. Dr.-Ing. Dr. h. c. G. Fettweis
Course contents and intended learning outcomes	The module includes: Signal theory (sine waves, Dirac function, convolution, Fourier transform), linear time-invariant systems (transfer function, impulse response), bandpass signals (real and complex up and down mixing of signals, equivalent lowpass signal), analogue modulation (modulation, demodulation, properties of AM, PM, FM), analogue-digital conversion (sampling, signal reconstruction, quantization, sub- and oversampling), digital modulation schemes (modulation methods, matched-filter receiver, bit error probability). Outcomes: After completing this module, the students master the basic principles and the practical application of communications engineering. The students will be able to understand the basic signal processing in communications systems and to describe them mathematically. They are familiar with the transmission in base-band and band-pass area and know the basic analogue and digital modulation methods. They understand the impact of noise on the transmission quality for simple analogue and digital transmission scenarios.	
Teaching methods	2 hours per week lectures, 1 hour per week tutorial, and self-study.	
Required previous knowledge	Competences provided in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Complex Function Theory,** **Systems Theory** (1st semester of module), or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	3 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the summer semester	
Workload	90 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 06 10	Project Electronics Technology	Prof. Dr.-Ing. habil. T. Zerna
Contents and objectives	The content of the module is - computer aided design of printed circuit boards - manufacturing of printed circuit boards - parameter optimization for technological processes - technologies of assembling electronic modules - testing and initial operation of electronic modules - simulation of the quality behaviour of manufacturing processes - Qualification purposes The students acquire basic knowledge, competences and practical skills about designing substrates, about assembling and testing electronic modules as well as about parallel processes of quality management. In addition they will gain social, rhetorical and presentation competences as a result of the team oriented and self-organized lab work based on the division of labour.	
Modes of teaching and learning	4 hours per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as **Fundamentals of Electrical Engineering,** **Materials Science,** **Physics**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an assignment and its presentation (90 min.) by the team.	
ECTS credit points and grades	3 ECTS credit points The grade is the arithmetic mean of the assignments and its presentation.	
Frequency	Annually, in the winter semester	
Workload	90 working hours	
Duration	1 semester	

Module descriptions
Main studies modules 5th-10th semester

Module number	Module name	Lecturer in charge
ET-12 08 06	Measurement and Sensor Techniques	Prof. Dr.-Ing. habil. J. Czarske
Contents and objectives	Contents: – Principles of digital measuring methods and of electric sensors for determining non-electric quantities – Application of analogue and digital measuring methods with respect to sensors Intended learning outcomes: Students will acquire skills to use analogue and digital measurement methods for the detection of e.g. position, velocity, force and temperature. They will be able to handle calculation methods for determining measurement uncertainties in consideration of noise processes.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as **Systems Theory**, or equivalent.	
Requirements for the award of ECTS credit points	Credit points are earned if the module assessment is passed. The assessment consists of a written exam (120 min) and a lab course. Both assessments must be passed.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 4/5 of the exam grade and to 1/5 of the lab course grade.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 32	Electronic Circuits – Experiments and Measurements	Prof. Dr. sc. techn. habil. F. Ellinger
Contents and objectives	Content of the module are the assembling and metrological characterization of electronic circuits such as amplifier ground circuits, feedback circuits, power levels, operational amplifiers, power supply, power supply circuits, basic digital circuits, and combinational und sequential circuits. Students learn practical realisations of analogue and digital circuits. They can determine the parameters of the circuits metrologically and compare and evaluate them in theoretical dimensions.	
Modes of teaching and learning	2 hours per week tutorial, and self-study	
Prerequisites	Competences acquired in modules such as **Electronic Circuits**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment is a practical lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the winter and summer semester	
Workload	90 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 03	Discrete event systems and control	Prof. Dr. techn. Klaus Janschek
Contents and objectives	Content: **1. Discrete event behavioral description forms** Signal based, finite automata, petri-nets, statecharts **2. Discrete event control design** Bottom-up / top-down with automata and petri-nets **3. Practical use of industrial control engineering** Language for specific purposes Objectives: The students 1. understand basic behavioral description forms for discrete event systems. They have a command of theoretical and computational handling of event-discrete behavioral models for the control of technical systems. 2. are able to design discrete event control algorithms independently for manageable tasks. 3. know the basic structure of industrial control technology and are able to implement own control designs on industrial control platforms.	
Teaching methods	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Required previous knowledge	Competences aquired in modules such as **Automation and Measurement**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1), of a written exam of 90 minutes (PL2), and a practical lab course (PL3).	
ECTS credit points and grades	6 ECTS credit points The module grade is determined by the weighted average of PL1, PL2 and PL3: M = (3PL1 + 2PL2 + PL3) / 6	
Frequency	Annually, starting in the winter semester.	
Workload	180 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 04	Process Control	Prof. Dr.-Ing. habil. L. Urbas
Contents and objectives	Content: The basic principles and practical implementation for the - recording of process data - processing of process data with the aim of conducting the process safely and economcally - influencing the process. Objectives: The students 1. are able to realize cycles in industrial processes, including the functioning, construction and engineering methods for planning and implementing networked process control facilities. The students are able to present their knowledge about causal relationships in fault models. 2. know different measuring systems for the recording of processes, e.g. in the flow and production technology. They are also capable of presenting and evaluating the physical principle and the technical design of the measuring system techniques under real conditions. 3. know the functioning and the methods for the design of facilities for drive technology and actuators to influence a process.	
Modes of teaching and learning	6 SWS lecture, 2 hours per week tutorial, 2 hours per week practical lab course, and self-study	
Prerequisites	Competences acquired in basic modules on physics and modules such as ET-12 09 01Systems Theory, ET-12 01 02 Automation Engineering and Measurement, ET-12 04 01 Electrical Power Engineering.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1), of a written exam of 180 minutes (PL2), and a lab course (PL3).	
ECTS credit points and grades	11 ECTS credit points The module grade is determined by the weighted average of PL1, PL2 and PL3. PL1 contributes by 40%, PL2 by 50%, and PL3 by 10%.	
Frequency	annually, in the summer semester	
Workload	330 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 05	Modelling and Simulation	Prof. Dr. techn. Klaus Janschek
Content and objectives	Content: **1. Engineering Mechanics – Dynamics** Kinematics of the rigid body, kinematics of the point, kinetics of the rigid body, vibration of single degree of freedom systems **2. Elements of physical modelling** Energy-based modelling paradigms (Euler-Lagrange), tor based modelling paradigms (generalized Kirchhoff networks), signal-based modelling paradigms, differential algebraic equation systems **3. Elements of simulation technology** Numerical integration of ordinary differential equation systems, differential algebraic equation systems (DAE) and hybrid (event discrete continuous) equation systems, modular simulation (signal / object-oriented) Objectives: The students 1. are able to cope with the area of dynamics 2. are qualified in physical modelling paradigms and are capable of creating mathematical models, such as DAE-systems, independently. 3. know the basic structure of numerical integration algorithms and special features in their application for technical, physical systems.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week practical lab course, self-study	
Prerequisites	Competences acquired in modules such as ET-12 01 02 Automation Engineering and Measurement.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written exam of 60 minutes (PL1), of a written exam of 120 minutes (PL2), and a lab course (PL3).	
ECTS credit points and grades	8 ECTS credit points The module grade is the weighted average of the grades for the elements of assessment: PL1 contributes by ¼, PL2 by ½ and PL3 by ¼.	
Frequency	Annually. The module starts in the winter semester.	
Workload	240 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 06	Advanced Seminar Automation, Measurement and Control	Head of specialization area Automation, Measurement and Control
Contents and objectives	The module deals with topics and questions of Automation, Measurement and Control as well as the methodology of scientific and project-orientated work. Objectives: After completing this module, students will be able to apply their skills autonomously, individually or within a team to specific tasks. They are able to document the single steps of the procedures comprehensibly. The students are expected to present and discuss their results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences aquired in modules such as ET-12 01 02 Automation Engineering and Measurement.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a project of 12 weeks and a colloquium.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of the grade of the project and the grade of the colloquium. The grade of the project is weighted with 2/3 and the grade of the colloquium with 1/3 for the module grade.	
Frequency	annually, during the winter semester	
Workload	120 hours	
Duration of module	1 Semester	

Module number	Module name	Lecturer in charge
ET-12 01 10	Industrial Automation 1	PD Dr.-Ing. Annerose Braune
Contents and objectives	Content: Automation technology solutions for locally distributed automation systems using current information technologies such as the Internet, XML and model-driven technologies in automation technology Objectives: The students 1. are capable of working with basic concepts, protocols and services of the Internet technologies 2. have basic experience and skills in dealing with current technologies that are relevant for automation 3. are capable of evaluating basic risks and opportunities of the application of modern information technologies 4. are capable of solving a managebale application with the learned methods as a small project.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 2 hours per week project, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 01 02 Automation Engineering and Measurement.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1) and a project of 15 weeks (PL2).	
ECTS credit points and grades	7 ECTS credit points The module grade (M) is determined by the weighted average of PL1 and PL2: M = (4PL1 + 3PL2)/7.	
Frequency	annually, beginning in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 11	Industrial Automation Engineering 2	Prof. Dr. techn. Klaus Janschek
Content and objectives	Content: Automation technolgy concepts and solutions for selected applications, such as position control for space vehicles, embedded systems, or industrial automation means. Objectives: The students 1. are able to design basic concepts, model descriptions and approaches of the respective application domain 2. master fundamental solution methods 3. are capable of dealing with examples of automation devices.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week project, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 01 02 Automation Engineering and Measurement.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 120 minutes (PL1) and a project of 15 hours (PL2).	
ECTS credit points and grades	7 ECTS credit points The module grade M is determined by the weighted average: M = (3 PL1 + 2 PL2) / 5	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 12	Robotics	Prof. Dr. techn. Klaus Janschek
Content and objectives	Content: **1. Control of serial manipulators** – Kinematic fundamentals – Trajectories – Robot dynamics – Position control – Force control **2. Control of mobile robots** – Kinematic fundamentals – Navigation (localization) – Path planning Objectives: The students are capable of 1. applying controlled industrial robot systems. They master the theoretical and computational handling of behavior models and algorithms for the controlling of industrial robot systems (manipulators, serial kinematics). 2. working with behavioral models for the navigation (position, orientation) and path planning of autonomous mobile robot platforms. They master the basic methodological and algorithmic approaches 3. solving a manageable design task with the learned methods as a small project.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, 1 hour per week project, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 13 01 Control of Continuous-Time Processes and ET-12 01 05 Modelling and Simulation.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of two written exams of 120 minutes each and a project of 20 hours.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted mean of the grades for the elements of assessment: The grades for the written exams contribute by 3/7 each and the grade for the project by 1/7.	
Frequency	Annually, beginning in the summer semester.	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 13	Systems Design	Prof. Dr. techn. Klaus Janschek
Content and objectives	Content: **1. System design of mechatronic systems** - Multi-body dynamics - Mechatronic converter principles - Stochastic behavior analysis - System budgets **2. System design of complex automation systems** - Definition of requirements - Function-oriented behavior modeling - Object-oriented behavioral modeling - Fundamentals of project management Objectives: The students are capable of 1. applying methods and tools of physically based behavior modeling and analysis (mechatronic systems). They are able to conduct a sound quantitative evaluation of design and optimization. 2. working with concepts, methods and tools of abstract behavior modeling and analysis (complex automation systems). They are able to conduct a sound quantitative evaluation of design and optimization.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 13 01 Control of Continuous-Time Processes and ET-12 01 05 Modelling and Simulation.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of two written exams of 120 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of both elements of assessment.	
Frequency	Annually, in the winter semester.	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 20	Human Machine Systems Technology	Prof. Dr.-Ing. habil. Leon Urbas
Content and objectives	Content: Principles and methods of the human-machine-system to take into account the human factor in the analysis, evaluation and design of complex, interactive technical systems Objectives: The students 1. master fundamental methods of the human-machine systems technology for the description, analysis, evaluation and design of dynamic interactive systems. 2. are capable of working systematically on domain-specific issues of human-machine interaction.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, 2 hours per week practical lab course and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory, ET-12 01 02 Automation Engineering and Measurement, and ET-12 01 04 Process Control.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 120 minutes and a project of 30 hours.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of assessment.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 21	Project Planning for Process Automation Systems	Prof. Dr.-Ing. habil. Leon Urbas
Content and objectives	Content: Methods for Computer Assisted Engineering in Process Automation (CEA-PA) with the following focus: 1. computer-aided integrated and life-cycle-wide project planning of process automation systems with e.g. requirements analysis, basic, detail and order engineering, implementation and commissioning, information modeling for integrated engineering systems 2. implementation in automation projects Objectives: The students 1. know the methods and means for computer-aided project planning of complex automation systems from process requirements and 2. can implement these in specific domains and application areas or deepen these by means of further computer-based methods.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week tutorial, 2 hours per week project, and self-study. The language of instruction is at least partly English.	
Prerequisites	Competences in the field of automation.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 120 minutes in English language and a project of 30 hours. The written exam can be answered in English or German, depending on the student's choice.	
ECTS credit points and grades	7 ECTS credit points can be earned. The module grade is determined by the arithmetic mean of both elements of assessment: M = (PL1 + PL2) / 2	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration of the module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 22	Process Simulation and Operation	Prof. Dr.-Ing. habil. Leon Urbas
Content and objectives	The module contains knowledge-based methods and algorithms for automated process evaluation, process diagnosis and process control. Qualification goals: The students will be able to plan, design, implement and operate complex knowledge-based close-to-process (partially) automated information processing systems. They will be able to combine and use such methods in systems theory and automation terms in order to create complex automation systems.	
Modes of teaching and learning	3 hours per week lectures, 3 hours per week tutorial, and self-study The language of instruction is partly English.	
Prerequisites	Competences acquired in modules such as ET-12 01 04 Process Control.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of a written exam of 90 minutes each, an oral exam of 30 minutes, and a project of 30 hours.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the module assessments.	
Frequency	annually, beginning in the summer semester	
Workload	210 hours	
Duration of the module	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 01 23	Seminar for Graduate Students on Human-Machine-Interaction	Prof. Dr.-Ing. habil. Leon Urbas
Content and objectives	Content: - Specific aspects of the design and empirical evaluation of human-machine interaction - Methods of scientific and project-based engineering Objectives: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work and the methods used, and are capable of presenting and discussing the results.	
Modes of teaching and learning	2 hours per week seminar, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 01 05 Modelling and Simulation.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is calculated from the weighted mean of the grades for the different means of assessment: the grade for the assignment contributes by 2/3 and the presentation by 1/3.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration of the module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 01 24	Seminar for Graduate Students on Automation	Prof. Dr. techn. K. Janschek
Content and objectives	Content: - Current topics, trends and issues of automation for different applications - Methods of scientific and project-based working as well as the presentation of results Qualifikationsziele: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work and the methods used, and are capable of presenting and discussing the results. They are able to master the basic methods of modelling, design and analysis of automatic systems. They are further capable of presenting and discussing the results.	
Modes of teaching and learning	2 hours per week seminar, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 01 05 Modelling and Simulation, ET-12 01 02 Automation Engineering and Measurement.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is calculated from the weighted mean of the grades for the different means of assessment: the grade for the assignment contributes by 2/3 and the presentation by 1/3.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration of the module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 01	Electromagnetic Theory	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	With regard to contents, the module comprises the basics of the classical electromagnetic field theory. After completion of the module, the students have the ability to assess the causes and connections between most electromagnetic phenomena and are capable solving field problems with fundamental analytical methods. The students can establish relationships between the different disciplines in electrical engineering, the motivation and the scientific limits.	
Modes of teaching and learning	4 hours per week lectures, 4 hours per week exercises and self-study	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Complex Function Theory,** **Electric and Magnetic Fields**, or equivalent	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of two written examinations. Each examination takes 120 minutes.	
ECTS credit points and grades	10 ECTS credit points The module grade is the arithmetic mean of grades of the two examinations.	
Frequency	annually, first part in winter semester, second part in summer semester	
Workload	300 hours	
Duration of module	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 02 02	Numerical Analysis	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	With regard to contents, the module comprises the basics of numerical analysis with a view to their application in electrical engineering. After completion of the module, the students possess the ability to apply basic numerical methods to engineering problems and are capable to assess the error of the approximation.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial and self-study	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Complex Function Theory,** **Basics of Electrical Engineering,** **Electric and Magnetic Fields,** **Dynamical Electrical Networks**, or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment is a written examination. The examination takes 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the examination.	
Frequency	annually in winter semester	
Workload	120 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 03	Power Electronics	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module deals with - the working principle of power electronical actuators, - the design and function of power diodes and power semiconductor switches which can be turned on actively, - analyses of the function of line-commutated and load-commutated converters, - the simplification of the topologies for simulations, - the design of the main components of power electronic systems, - common modulation methods for the generation of the control signals, - common feed-forward and feed-back control algorithms. Objectives: The module qualifies for the selection and design of usable topologies and the selection and dimensioning of the power semiconductor switches for typical applications. The students are capable of verifying the basic function of the power electronic system by the use of simulation tools.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week practical lab course and self-study including a project	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering and Physics**, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessement consists of a written exam of 120 minutes and a project of 22 weeks.	
ECTS credit points and grades	7 credit points The module grade consists to 80% of the grade of the written exam and to 20% of the project grade.	
Frequency	annually, starting in the winter semester	
Workload	210 hours	
Duration	2 semester	

Module number	Module name	Lecturer in charge
ET-12 02 04	Electrical Machines	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: **Fundamentals of electrical machines** in structure, function, performance, agitator speed or power setting and efficiency - Fundamentals of electromagnetic energy conversion - Transformers - DC maschines - Synchronous machines - Induction machines - Small machines - Linear motors - Testing of electrical machines Objectives: Having successfully completed the module, the students can follow the steady-state operating performance of electrical machines and evaluate their properties by means of suitable calculations, measurements and tests.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering**, or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of an oral examination of 40 minutes and a lab course.	
ECTS credit points and grades	5 ECTS credit points The module grade is the weighted average of both elements of assessment. The grade of the oral exam contributes by 70% and the grade of the lab course by 30%.	
Frequency	Annually, in the winter semester	
Workload	150 hours	
Duration of module	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 02 05	Electric Drives	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: *Electric Drives* - Basics of electromechanical drives - Agitator speed and torque control of DC and AC drives with power electronic actuators - Control of electrical drives Objectives: Having successfully completed the module, the students can follow the performance of electrical drives on the basis of equivalent circuits and evaluate their control properties by means of suitable calculations, measurements and tests.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical ab course, and self-study	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering and Physics**, or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a written examination (180 minutes) and a lab course.	
ECTS credit points and grades	6 ECTS credit points The module grade is the weighted average of both elements of assessment. The grade of the written exam contributes by 70% and the grade of the lab course by 30%.	
Frequency	Annually, in the summer semester.	
Workload	180 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 06	Advanced Seminar Electrical Power Engineering	Head of specialization area Electrical Engineering
Contents and objectives	The module comprises topics and questions of Electrical Power Engineering, as well as the methodology of scientific and project-orientated work. After completion of the module, the students have the ability to independently apply their skills and abilities in a team or individually to solve problems. The workflow will be documented and the results presented and discussed. They can work in teams and develop concepts, which they implement and defend.	
Modes of teaching and learning	2 hours per week project work and self-study	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering,** **Electric and Magnetic Fields,** **ET-12 08 03 Dynamical Electrical Networks,** **Physics** **ET-12 01 01 Microcomputer Technology,** **ET-12 04 01 Electrical Power Engineering** or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of a project of 12 weeks and a colloquium.	
Credit points and grades	4 ECTS credit points The module grade is the weighted mean of both elements of the assessment: M = (2 PL1 + PL2) / 3.	
Frequency	Annually, in summer semester	
Workload	120 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 07	Electromagnetic Compatibility	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	The module contains topics and questions of the electromagnetic compatibility in electrical systems. After completion of the module, the students have the ability to theoretically and practically assess electromagnetic compatibility problems. They know the legal framework within the EU and relevant norms. They recognise parasitc coupling phenomena and take appropriate countermeasures.	
Modes of teaching and learning	4 hours per week lectures, 3 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Power Systems,** **ET-12 02 01 Electromagnetic Theory,** or equivalent.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. With up to 20 registered students, the module assessment consists of an oral examination of 30 minutes and laboratory work. With more than 20 registered students, the oral exam can be replaced by a written exam of 120 min.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted mean of grades of the laboratory work and the oral examination. The grade of the oral examination counts 2/3 and the grade for the laboratory work 1/3.	
Frequency	annually, beginning in the summer semester	
Workload	210 hours	
Duration of module	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 02 08	Numerical Methods for Electromagnetic Theory	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	With regard to contents, the module comprises numerical and semi-analytical methods for the computation of electromagnetic field problems and electromagnetic compatibility problems. After completion of the module, the students are able to attend a number of electromagnetic field problems with numerical procedures. Afterwards they will be able to distinguish between appropriate and less appropriate procedures for a specific problem, to review results in the context of intrinsic uncertainties, and to optimise the underlying models.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week exercises, 2 hours per week practical lab course and self-study	
Prerequisites	Competences acquired in modules such as **Introduction to Analysis and Algebra,** **Calculus for Functions with Several Variables,** **Complex Function Theory,** **ET-12 02 02 Numerical Analysis,** **ET-12 02 01 Electromagnetic Theory** or equivalent.	
Requirements for the award of credit points	The credit points are awarded if the module assessment is passed. If 20 students or less take part in the module, the module assessment consists of an oral examination of 30 minutes and laboratory work. If more than 20 students take part in the module, the oral exam can be replaced by a written exam of 120 min.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted mean of grades of the laboratory work and the oral examination. The grade of the oral examination counts 2/3 and the grade for the laboratory work 1/3.	
Frequency	Annually, in summer semester	
Workload	210 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 09	Selected Topics of Electromagnetic Theory	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	With regard to contents, the module comprises selected topics and questions of electromagnetic field theory. After completion of the module, the students are able to assess currently relevant research topics in electromagnetics. They learn to apply and review the basic concepts of electromagnetic theory.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as **ET-12 02 01 Electromagnetic Theory.**	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. With up to 20 registered students, the module assessment consists of an oral examination of 30 minutes. With more than 20 registered students, the oral exam can be replaced by a written exam of 120 min.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral examination.	
Frequency	Annually, beginning in summer semester	
Workload	210 hours	
Duration of module	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 02 10	Power Electronics, Advanced	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module deals with - design and function of power semiconductor switches which can be turned on and off actively, - analyses of the function of self-commutated converters, - simplification of the topologies for simulations, - design of the main components of power electronic systems, - common modulation methods for the generation of the control signals, - common feed-forward and feed-back control algorithms. Objectives: The module qualifies for the selection and design of usable topologies and the selection and dimensioning of the power semiconductor switches for a wide range of applications. The students are capable of verifying the function of the power electronic system and its control by the use of simulation tools.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week practical lab course and self-study including a project	
Prerequisites	Competences acquired in modules such as ET-12 02 03 Power Electronics.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessement consists of a written exam of 120 minutes and a project of 14 weeks.	
ECTS credit points and grades	7 ECTS credit points The module grade consists to 2/3 of the written exam grade and to 1/3 of the project grade.	
Frequency	annually, starting in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 11	Microprocessor Control in Power Electronics	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module deals with - the design and function of common power electronic topologies for energy and drive applications, - analyses of the characteristics and simplification of the topologies for the modelling in order to design the control, - common modulation methods for the generation of the control signals and possible implementations on digital control platforms, - common feed-forward and feed-back control algorithms and issues of the implementation on digital control platforms, - programming of the control of a voltage source converter in order to operate an induction motor. Objectives: The students are capable of implementing controllers on a digital control platform by using a high-level programming language. They are capable of understanding the structure and function of a digital control platform, and of rating the main characteristics of a digital control platform in relation to the application, and of evaluating the pros and cons of different solutions.	
Modes of teaching and learning	2 hours per week lectures, 1 hours per week tutorial, 2 hours per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 03 Power Electronics.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 20 minutes as group exam with up to 3 students and of 20 minutes per student, and a project of 3 weeks.	
ECTS credit points and grades	7 ECTS credit points The module grade consists to ¾ of the project grade and to ¼ of the oral exam grade.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 12	Electromagnetic Energy Conversion	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Design and calculation of electrical machines: parameters for optimum use of energy and general dimensions, windings and winding concepts, magnetic materials and magnetic circuit design, contacts: slip rings, brushes, commutator; determination and calculation of the machine parameters, loss calculation and efficiency, heating and cooling, concept development and optimization as well as laws of growth. 2. Transformers: power transformers; laws of growth; TK-number; core: structure, design, stationary mode and non-stationary mode; windings: structure and design of windings; insulation: terminology, insulation systems, insulation materials for transformers; design: core design, winding design, insulation design; clamping structures: terminology, principles, materials, design of core pressing elements, boiler design; sensors and control devices: oil monitoring, monitoring, EMC problems. Objectives: Having successfully completed this modules, the students have knowledge of the most important construction principles of electromagnetic power transformers and they are capable of designing, of calculating, of simulating with FEM and of rudimentally optimizing electrical machines and transformers.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, 20 hours project, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes (PL1) as individual exam and a lab course (PL2).	
ECTS credit points and grades	7 ECTS credit points The module grade (M) is derived from the weighted average of the grades of the elements of assessment: M=(7PL1+3PL2)/10	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 13	Electrical Drive Engineering	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Automatic drives: Elements of the drive system; information technology and signal processing, control algorithms; automatic three-phase drives: converter supply, pulse control, interaction betweem power converter and motor, control methods, dynamic behaviour and field-oriented control, energy-efficient control, sensorless control; system integration of automated drives: systems solutions, regulation of drive systems with complex mechanical units, functionally integrated drives, combination drives. and 2. Design of drive systems: basics and components, mechanical transmission system, selection and dimensioning, actuating drives and stepping drives, system pertubations, motion control and technology functions, data processing in converters, fieldbuses for electrical drives, hardware and software structure of digital controller modules, modelling and numerical algorithms, methods of system simulation, computer-aided design (Rapid Prototyping), possibilities of electrical power engineering, design and simulation of a belt drive of a conveyor belt system. or 3. Electrical machine dynamics: methods and types, dynamic behaviour of orthogonal windings – externally excited direct current machine, dynamic behaviour successive windings – transformers, torque determined from energy efficieny or field sizes, types of space vectors, transmission behaviour and dynamic operating status of induction machines, upper shafts analysis, harmonics analysis, zero sequence networks, wave processes and stress analysis. Objectives: The students will learn the operating system of electrical drives in automatic and mechatronic systems. They can describe, draft and design a drive system, and they will understand the dynamic processes in electrical machines. They can design and optimize regulated plants.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines and ET-12 02 05 Electric Drives.	

Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes (PL1) as individual exam and a lab course (PL2).
ECTS credit points and grades	7 ECTS credit points The module grade (M) is derived from the weighted average of the grades of the elements of assessment: M=(7PL1+3PL2)/10
Frequency	Annually, in the winter semester.
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 02 14	Selected Topics of Electrical Power Engineering	Head of specialization area Electrical Power Engineering
Contents and objectives	Contents of the module are current topics and questions of the electrical power engineering. Outcomes: After successful completion of the module, the students can deal with current and relevant and research-active areas of electrical power engineering. They can question and crosslink the knowledge acquired using new methodological approaches and contents.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 04 01 Electrical Power Engineering or ET-12 02 06 Advanced Seminar Electrical Power Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes as individual exam.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral examination.	
Frequency	Annually, beginning in the summer semester.	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 02 15	Controlled Power Systems	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Controlled energy systems: Definition of energy and performance, general control structures; synchronous generator: energy converters, modelling, regulation; network and isolated operation; asychronous generators: single andf double fed energy converters, modelling, regulation; network and isolated operation; exemplary regulations: steam power plant, hydropowerplant, wind power plant, pump storage plant; flywheel accumulators: flywheel, motor/generator, converter, magnetic bearings, construction, regulation; grid control: primary, secondary and tertiary regulation; power flow regualtors: contact based, line commulated, self commutated FACTS, regulating transformers, active filters; high voltage direct current transmission and 2. Electrical machine dynamics: Methods and types, dynamic behaviour of orthogonal windings – externally excited direct current machine, dynamic behaviour successive windings – transformers, torque determined from energy efficieny or field sizes, types of space vectors, transmission behaviour and dynamic operating status of induction machines, upper shafts analysis, harmonics analysis, zero sequence networks, wave processes and stress analysis. Objectives: The students will have knowledge of the dsign and the operating behaviour of electric energy transformers in power plants. They will understand the dynamic processes in electrical machines and networks, and they can design and optimize regulated plants.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, 1 project (20 hours), and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines, ET-12 02 05 Electric Drives ET-12 13 01 Control of Continuous-Time Processes.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes (PL1) as individual exam and a lab course (PL2).	
ECTS credit points and grades	7 ECTS credit points The module grade (M) is derived from the weighted average of the grades of the elements of assessment: M= (7PL1+3PL2)/10	

Frequency	annually, in the winter semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 02 16	Design of Power Electronic Systems	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module deals with - the function of basic topologies (DC/DC converter, voltage source converter) in order to derive a mathematical model, - modelling of common power semiconductor switches, - calculation of the system variables at a stationary operating regime, - design of the passive components of power electronic systems, - design of common feed-forward and feed-back control algorithms, - verification of the function with simulation tools. Objectives: The students are capable of using basic methods to simplify a power electronic system and its components in order to derive a mathematical model. The students are capable of calculating the system variables with the mathematical model, and of designing the components and the control including observers.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, 40 hours project, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 02 03 Power Electronics and ET-12 02 10 Power Electronics, advanced.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam of 40 minutes as individual exam and a project of 10 weeks.	
ECTS credit points and grades	7 ECTS credit points The module grade is the average of the oral exam grade and the project grade.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 17	Application of Electric Drives	Prof. Dr.-Ing. W. Hofmann
Contents and objectives	Content: 1. Electric vehicle and traction drives: - traction drives: basics, mechanics of the train haulage, drive motors, converter technology, regulation of the mains current converter, regulation of the motor converter, railway control circuits; - vehicle drives: introduction, hybrid and electric drive structures, requirements and development goals, drive motors, power electronics, power supply, regulation 2. Direct drives and magnetic bearings techniques: - direct drives: introduction, torque motors, high-speed drives, linear drives, regulation; - magnetic bearings techniques: introduction, active and passive magnetic bearings, correcting elements, drafting and design, regulation of a radial bearing, rotor dynamics, imbalances, gyroscope effect, sensor technology. Objectives: The students are able to professionally select, design and optimize powertrains for mobile application as well as direct drive systems and magnetic bearings.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines and ET-12 02 05 Electric Drives.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an oral exam as individual exam of 40 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 18	Seminar for Graduate Students on Electromagnetic Theory and Compatibility	Prof. Dr. rer. nat. habil. H. G. Krauthäuser
Contents and objectives	The module comprises selected topics and questions of electromagnetic field theory and electromagnetic compatibility, as well as the methodology of scientific and project-orientated work. The students have the ability to independently apply their skills and abilities in a team or individually to solve problems. The workflow will be documented and the results presented and discussed. Their knowledge, skills and abilities will be expanded through this.	
Modes of teaching and learning	2 hours per week lectures and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 01 Electromagnetic Theory, ET-12 02 07 Electromagnetic Compatibility.	
Requirements for the award of credit points	The credit points are awarded when the module assessment is passed. The module assessment consists of an assignment and an oral presentation of 30 minutes.	
ECTS credit points and grades	4 credit points The module grade is the weighted mean of grades of the assignment and the oral presentation. The grade of the assignment counts 2/3 and the grade for the presentation 1/3.	
Frequency	Annually, in the winter semester	
Workload	120 hours	
Duration of module	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 19	Seminar for Graduate Students in Power Electronics	Prof. Dr.-Ing. St. Bernet
Contents and objectives	The module deals with - recent topics, trends and problems in the field of power electronics, - methods of scientific and project-based working and the presentation of the results. Objectives: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work and the methods used, and are capable of presenting and discussing the results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 03 Power Electronics and ET-12 02 10 Power Electronics, advanced.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade for the assignment and to 1/3 of the grade for the presentation.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 02 20	Seminar for Graduate Students on Machines and Drives	PD Dr.-Ing. habil. V. Müller
Contents and objectives	Content: - Current issues and questions of control, regulation and modelling - Experimental studies of electrical machines and electrical drives Objectives: After completing this module, the students are capabale of preparing a summarizing presentation on a specific topic on the basis of their scientific research. They are capable of presenting these results and defending these in a discussion. They are further capable of presenting their results on a poster clearly and graphically.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 04 Electrical Machines, ET-12 02 05 Electric Drives, ET-12 02 12 Electrical Machines, Advanced and ET-12 02 13 Electrical Drive Engineering	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade for the assignment and to 1/3 of the grade for the presentation.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 02	High Voltage and High Current Engineering	Prof. Dr.-Ing. S. Großmann
Contents and objectives	The module contains basics and principles of – High voltage engineering – High current engineering Qualification: After successful completion of the module, the students will be able to comprehend the operating behaviour of components in an electrical power supply network. Furthermore the students will be able to evaluate the stress of a component by electrical and mechanical loads by means of proper measurements and tests.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial/seminar, 1 hour per week practical lab course and self-study	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering**.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of a lab course and an oral exam of 30 min. If more than 20 students take part in the module, the oral exam can be replaced by a written exam of 90 min.	
ECTS credit points and grades	5 ECTS credit points The module consists to 70% of the oral exam grade/the written exam grade and to 30% of the lab course grade.	
Frequency	annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 03	Fundamentals of Electrical Power Systems	Dr. Schlegel
Contents and objectives	Contents: - Function, parameter estimation and modeling of all important equipment in electrical distribution networks - Simplified methods for the calculation of voltage and current distribution as well as the basic aspects of design and dimensioning of electrical systems Intended learning outcome: Upon successful completion of the module, students are able to create and apply models for equipment in the electrical power system. They have the skills to determine the parameters for the most important equipment from geometrical data, manufacturer's specification or with the help of measurements. The students are familiar with the basics of dimensioning of electrical equipment.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, and self-study.	
Prerequisites	Competences acquired in modules such as **Basics of Electrical Engineering**.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two written exams of 120 minutes and 90 minutes.	
ECTS credit points and grades	5 ECTS credit points The module grade consists to 2/3 of the grade for the exam of 120 min. and to 1/3 of the grade for the exam of 90 min.	
Frequency	annually, in the winter semester	
Workload	150 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 04	Operating of Electrical Power Systems	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - Calculation of symmetric and unsymmetric normal and failure processes in electrical power systems - Assessing the stress of electrical equipment Intended learning outcome: Upon successful completion of the module, students are able to assess various operating modes and fault conditions in electrical power systems and calculate with simplified methods. They are able to comprehend these processes by measurements and to assess the stability of individual equipment regarding the resulting stress.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 04 01 Electrical Power Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam of 120 minutes and two lab courses.	
ECTS credit points and grades	6 ECTS credit points The grade is determined by the weighted average of the grades of the written test and the lab courses. The weights are 50% for the written exam and 25% for each lab course.	
Frequency	annually, in summer semester	
Workload	180 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 05	Network Integration, System Performance and Quality of Supply	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - all areas of quality of supply, i.e. service reliability, power quality and service quality in electrical power supply as well as - the stress from transient operation processes. Intended learning outcome: The students are able to assess the connection of consumer and generator installations regarding their effect on power quality. They know the methods to assess the service reliability of electrical energy supply and evaluate the calculation results. They are familiar with transient operation processes and their effects.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as Basics of Electrical Power Systems, ET-12 04 04 Operating of Electrical Power Systems, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 150 minutes as well as of a lab course. If less than 20 students take part in the module, the written exam might be replaced by an oral exam of 45 miutes as individual exam.	
ECTS credit points and grades	7 ECTS credit points The grade is determined by the weighted average of the grades of the elements of assessment: M = (3 PL1 + 2 PL2) / 5	
Frequency	Annually, in summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 06	Planning of Electrical Power Systems	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - mathematical methods for calculating the stress of individual equipment within electrical power systems and - the principles of planning electro technical installations and distribution networks. Intended learning outcome: The students are able to calculate and assess holistically, steady and transient stress. They have mastered all important procedures and methods to dimension respectively select the equipment with regard to their voltage and current stresses and other criteria. The students know the basic standards for the planning.	
Modes of teaching and learning	4 hours per week lectures, 3 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 04 03 Fundamentals of Electrical Power Systems.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam of 120 minutes and two written exams of 90 minutes. With up to 5 registered students the written exams can be replaced by an oral exams of 45 minutes and two oral exams of 30 minutes.	
ECTS credit points and grades	7 ECTS credit points The grade is determined by the arithmetic mean of the grades of the exams: M= (4 PL1 + 3 PL2 + 3 PL3) / 10.	
Frequency	annually, in summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 07	High Voltage Engineering	Prof. Dr.-Ing. S. Großmann
Contents and objectives	The module contains selected topics from – High voltage engineering – Insulation technology – Lightning protection Qualification: After successful completion of the module, the students will be able to evaluate the function, design and rating of electrical equipment. Furthermore the students will learn simplified methods to dimension and test electrical equipment.	
Modes of teaching and learning	5 hours per week lectures, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 04 02 High Voltage and High Current Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a lab course and an oral exam of 30 minutes.	
ECTS credit points and grades	7 ECTS credit points The grade for this module consists to 70% of the grade of the oral exam and to 30% of the lab course grade.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 08	Protection and Control of Electrical Power Systems	Dr. Schlegel
Contents and objectives	Contents: - the construction and operation of the protection and control systems in electrical power systems and - the essential criteria of the selective protection technology and related algorithms. Intended learning outcome: After completing this module, the students will be able to evaluate the interfaces the process and the subsystems of the secondary equipment. They can evaluate criteria for detection of errors in electrical energy supply systems with respect to their suitability and accuracy. They can understand the basic principles of numerical protection devices and can comprehend and critically evaluate the methods and algorithms of the selective protection technology. Students are able to independently design protection systems and determine the necessary parameter settings.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week exercises, 1 hour per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 04 05 System Performance and Quality of Supply of Electrical Power Systems, ET-12 04 03 Fundamentals of Electrical Power Systems.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams (of 120 minutes and of 90 minutes) and a lab course. With up to 5 registered students the written exams can be replaced by two oral exams as individual exams of 45 and 30 minutes.	
ECTS credit points and grades	7 ECTS credit points The grade is determined by the weighted average of the grades of the three elements of assessment. M = (4 PL1 + 2 PL2 + 4 PL3) / 10	
Frequency	annually, in winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 09	Stress of Electrical Equipment	Prof. Dr.-Ing. S. Großmann
Contents and objectives	The module contains – Basics of the design and operational mode of electrical equipment with high current load in electrical power engineering Qualification: By completing the module successfully, the students will be able to rate, evaluate and test components of systems with high current load. They will be enabled to do scientific research on the subject.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week practical lab, 1 project, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 04 02 High voltage and high current engineering and ET-12 04 07 High voltage engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an oral exam as individual exam of 30 minutes (PL1), one project (PL2), and a practical lab course (PL3).	
ECTS credit points and grades	7 ECTS credit points The grade for this module (M) is determined by the weighted average of the 3 assessments: M=(2PL1+PL2+PL3)/4	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 10	Experimental High Voltage Engineering	Prof. Dr.-Ing. S. Großmann
Contents and objectives	The module contains – High voltage test technique – Measurement technique – Scientific methods for planning experiments and their statistical evaluation. Qualification: After successful completion of the module, the students will be able to plan and perform scientific experiments as well as to evaluate them statistically. The students will gain HV-related and methodical knowledge for scientific research on the subject.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 04 02 High voltage and high current engineering and ET-12 04 07 High voltage engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a lab course and an individual oral as individual exam of 30 minutes.	
ECTS credit points and grades	7 credit points The grade for this module is determined by the weighted average of the lab course and the oral exam. The oral exam is weighted as 70% of the module grade and the lab course as 30%.	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 04 11	Seminar for Graduate Students Electrical Power Engineering	Prof. Dr.-Ing. P. Schegner
Contents and objectives	Contents: - special issues and questions of the electrical energy supply, high voltage and high current engineering and - methods of scientific and project-based working. Intended learning outcome: The students are able to apply skills independently, individually and in teams to solve a task. They will document the steps, present and discuss the results. This will help them expand knowledge and skills.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences that are provided by modules such as Electrical Power Engineering, ET-12 04 03 Fundamentals of Electrical Power Systems, ET-12 04 04 Operating of Electrical Power Systems and ET-12 04 06 Planning of Electrical Power Systems	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an assignement and the corresponding presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade of the assignement and to 1/3 of the grade of the presentation.	
Frequency	annually in winter semester	
Workload	120 working hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 02	Advanced Seminar Electronic Systems and Technology and Biomedical Engineering	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers the steps of an engineering process based on annually announced assignments by participating institutes. - Passing early engineering phases of a product, a technology or a fabrication process - Detailed specification of assignment task - Team assignments - Documentation of engineering process - Research of current-state applications - Individual research of theoretical fundamentals for solution finding - Creation of conceptual solution variants including their documentation - Presentation of the solution concept Intended learning outcomes: Students completing this module are qualified to apply techniques, methods and principles for early engineering phases of a product, a technology or a fabrication process. This is accomplished by project- and team-oriented solving of complex tasks in recent research.	
Modes of teaching and learning	2 hours per week project and self-study	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, Physics, ET-12 01 01 Microcomputer Technology, Electronic Systems Design and ET-12 06 10 Project Electronics Technolgy.	
Requirements for the award of ECTS credit points	The credit points are obtained by passing the module assessment. This assessment comprises a project of 12 weeks and a colloquium.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of the grades for the project (contributes by 1/3) and the colloquium (contributes by 2/3).	
Frequency	Annually, during winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 03	System Design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers **1 Design process and concepts *(Entwicklungsprozess ausgehend vom Lösungskonzept)*** - Design analysis and optimization with proof of functional correctness - Design reports and documentation - Presentation of design solution **2 Introduction on Sensors *(Einführung in die Sensorik)*** - Sensor and measuring technology - Sensors for thermal, mechanical, magnetical and optical applications **3 Optical Systems *(Technische Optik)*** - Wave optics and geometrical optic - Materials and elements - Fibre-optic guides, electro-optical and electro-micro-optical-mechanical elements and systems - Light engineering, digital and analog light processing, adaptive optics, optical devices Intended learning outcomes: Students completing this module are qualified to apply techniques and methods of system engineering in a creative manner, in particular for sensor and optical devices.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week exercises, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 05 02 Advanced Seminar Electronic Systems and Technology.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. This assessment consists of a written exam of 180 minutes and a project of 12 weeks. Both examinations must be passed.	
ECTS credit points and grades	8 ECTS credit points The module grade is determined by the weighted average of both elements of the module assessment, for which the written exam contributes by 2/3 and the project by 1/3.	
Frequency	annually, in the summer semester	
Workload	240 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 04	Design Methodologies	PD Dr.-Ing. T. Nagel
Contents and objectives	This module covers **1 Fundamentals of Design *(Grundlagen der Konstruktion)*** - Basics of system engineering - Standards for measures, tolerances, fittings, material load capacities - Mechanical connecting components - Mechanical functional components - Mechanical devices **2 Computer-Aided Design *(CAD-Konstruktion)*** – Method of constructing CAD models – Modelling assembly constraints – Parametric and adaptive construction – Construction of variants – Deformation and load simulation Intended learning outcomes: Students completing this module are qualified to design components and devices, dimension components and assemble them properly. They are capable to provide documentation of the design process conforming to standards while using modern CAD tools.	
Modes of teaching and learning	2 hours per week lectures, 4 hours per week tutorial, and self-study	
Prerequisites	Comptences acquired in modules such as Electronic Systems Design.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. This assessment comprises a written examination (120 minutes) on fundamentals of design and the tutorial assignments. Both elements of assessment must be passed.	
ECTS credit points and grades	6 ECTS credit points The module grade is determined by the arithmetic mean of both elements of assessment, i.e. the written examination and the tutorial assignments.	
Frequency	Annually, starting in the winter semester	
Workload	180 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 05 05	Physical Design and Physical Design Automation	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers - Terms and concepts of physical design and physical design automation - Related design phases - The library concept - Layout interfaces - Goals and constraints for physical design - Commercial physical design tools Intended learning outcomes: Students completing this module are qualified in the methodology of physical design and physical design automation. They are furthermore capable of handling a layout process using commercial design tools.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week practical lab course, and self-study	
Prerequisites	Comptences acquired in modules such as Electronic Systems Design and ET-12 05 02 Advanced Seminar Electronic Systems and Technology and Biomedical Engineering	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. This assessment comprises an assignment and an oral team examination of 30 minutes for each team member. Both elements of assessment must be passed.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of both elements of assessment, for which the assignment contributes by 40% and the oral examination by 60%.	
Frequency	annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 06	Product and Precision Device Engineering	PD Dr.-Ing. T. Nagel
Contents and objectives	This module covers **1 Fundamentals of Product Engineering *(Grundlagen der Produktentwicklung)*** - Systematic solving of production tasks - Methods of product engineering - Structural engineering process - Creativity techniques for finding solutions - Fault avoidance during product development - Scope of duties for product engineers **2 Design of Precision Devices *(Baugruppenentwicklung)*** - Planning, construction and fabrication of a precision-mechancis drive mechanism - Finding of solution variants - Dimension and devise of an optimal solution - Creation of the set of drawings - Fabrication of parts and assembly of the device group - Initiation of the device group and verification of functionality Intended learning outcomes: Students completing this module are qualified to design innovative solutions of precision devices. They are capable of applying the concepts of product engineering and provide sets of drawings.	
Modes of teaching and learning	2 hours per week lectures, 4 hours per week practical lab courses, and self-study	
Prerequisites	Comptences acquired in modules such as Electronic Systems Design and ET-12 05 04 Design Methodologies.	
Requirements for the award of ECTS credit points	The credit points are obtained by passing the module assessment. This assessment consists of a written examination of 90 minutes and an assigment. With up to 5 registered students, the written exam can be replaced by an oral individual exam of 30 min. Both elements of assessment must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the arithmetic mean of both elements of assessment, i.e. the examination and the assignment.	
Frequency	annually, during the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 07	Simulation Methodologies in System Design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	Content: Finite Element Method (FEM): 1. Fundamentals of modelling for the different physical domains of device technology using the example of structural mechanics, heat and electromagnetic fields, 2. generalized process steps for the creation of theoretically sound FEM models Thermal design: 1. Fundamentals of heat transport, 2. Thermal calculations and models Optimization: - Method of model creation and simulation, considering the holistic system-simulation approach for system design - Model experiments for the construction process (analysis, nominal value optimization, probabilistic optimization, multicriteria optimization) Objectives: Students completing this module will obtain qualified fundamentals for systematic application of FEM tools. They understand the key concept of holistic system simulation for the design process. They are capable of finding robust and cost-effective solutions in system-design processes by applying system simulations while accounting for ubiquitous parameter variations and functional behaviour.	
Modes of teaching and learning	2 hours per week lectures, 4 hours per week exercises, and self-study	
Prerequisites	Comptences acquired in modules such as Electronic Systems Design.	
Requirements for the award of ECTS credit points	The credit points are earned when the module assessment is passed. The module assessment consists of individual tutorial assignments.	
ECTS credit points and grades	7 ECTS credit point The module grade is determined by the grade obtained for the tutorial assignments.	
Frequency	annually, during the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 08	Electromechanical Design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	Content: 1. the *development methods for the device technology*, with a focus on: a) Development methodology b) Construction rules and principles from technology and nature c) Constructive design guidelines for the device technology d) Basics for precision drives e) Accuracy parameters for drive systems 2. the *assembly development* with the main focus: a) Transfer of a task into a requirements list b) Conception of solution variants c) Objective decision-making towards a principled solution d) Constructing, dimensioning and designing the basic solution e) Creation of product documentation f) Manufacture, assembly, commissioning and proof of function of the assembly. Objectives: 1. The students have the skills and abilities to draft and design precision engineering devices, taking into account generally applicable design principles and design rules. In addition, you will gain knowledge about the accuracy parameters for drive systems and constructive options to correspond to them. 2. By applying the theoretically learned skills and abilities, the students gain practical experience in the design process and are able to independently and systematically develop a concept from a task assigned to them, to convert this into an overall design and to present the results in product documentation	
Modes of teaching and learning	2 hours per week lectures, 4 hours per week practical lab course, and self-study	
Prerequisites	Comptences acquired in modules such as Electronic Systems Design and ET-12 05 04 Design Methodologies.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. This assessment consists of a written exam of 90 minutes (PL1) and an assignment (PL2). Both elements of assessments must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade M is the unweighted mean of the two assessments.	
Frequency	annually, during the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 09 ET-12 05 09	Electronic Design Automation	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers - Relevance of electronic design automation (EDA) - Design styles, design steps, layout design, geometrical fundamentals, etc. - Floorplanning - Partitioning and placement algorithms - Routing algorithms - Methods for compaction and verification - Trends in EDA Intended learning outcomes: Students completing this module have obtained knowledge of algorithms which are used in modern design tools for physical design automation (going from netlist to the final layout). They are thus capable of writing design modules on their own or adapting commercial design tools for specific tasks.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, 2 hours per week seminars, and self-study	
Prerequisites	Students should have knowledge of the basics of electrical engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral examination of 30 minutes and tutorial assignments. Both elements of assessment must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of assessment: M = (3PL1 + 2PL2) / 5	
Frequency	annually, during winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 10	Seminar for Graduate Students System design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers - specific topics and trends in system design and - methods of scientific and project-based engineering Intended learning outcomes: Students completing this module are qualified to apply skills and techniques self-employed and in teams to complete specific tasks. They can create the documentation of process steps and can present and discuss the results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Some specific expertise is required, which can for example be aquired by completing the modules ET-12 05 04 Design Methodologies, ET-12 05 03 System Design, and ET-12 05 05 Physical Design and Physical Design Automation.	
Requirements for the award of ECTS credit points	The credit points are obtained by passing the module assessment. This assessment consists of an assignment and a related presentation of 30 minutes, which is graded as a separate examination.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment, for which the assignment contributes by 2/3 and the presentation by 1/3.	
Frequency	Annually, during winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 05 07	Simulation Methodologies in System Design	Prof. Dr.-Ing. habil. J. Lienig
Contents and objectives	This module covers **1 Finite Element Method (FEM) *(Finite Elemente Methode)*** - Fundamental theory of FEM for application in varying physical domains - Basic process steps for the creation of theoretical substantiated FEM models - Parametrization of FEM models based on script languages **2 Probabilist Simulation of Systems *(Probabilistische Systemsimulation mit FEM)*** - Method of model creation and probabilistic simulation, considering a holistic system-simulation approach - Model experiments for the construction process (analysis of variants, probabilistic simulation, probabilistic optimization) - Solution finding as robust multi-objective optimization - Trends for system simulations Intended learning outcomes: Students completing this module will obtain qualified fundamentals for systematic application of FEM tools. They understand the key concept of holistic system simulation for the design process and have the required skills and knowledge to find robust solutions by applying system simulations while accounting for ubiquitous parameter variations and functional behaviour.	
Modes of teaching and learning	2 hours per week lectures, 4 hours per week exercises, and self-study.	
Prerequisites	Competences acquired in modules such as Electronic Systems Design or equivalent.	
Requirements for the award of ECTS credit points	The credit points are obtained by passing the module assessment. This assessment consists of individual tutorial assignments.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the grade obtained for the tutorial assignments.	
Frequency	Annually, during the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 06 01	Technologies for Electronic Packaging and Assembly	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	This module covers **1 Electronic Packaging (*Aufbau- und Verbindungstechnik der Elektronik*)** – trends in electronic packaging – packaging of semiconductor devices – assembly technologies for semiconductor devices – thin-film technologies for electronic circuits – thick-film technologies for electronic circuits – printed circuit board technologies – surface finish technologies for electronic components – packaging for optoelectronics **2 Assembly Technologies (*Montagetechnologien der Elektronik*)** – packaging of electronic components – package types for SMD and THT – fine-pitch-assembly – theory on assembly precision – special technologies for component assembly – technologies for system integration Intended learning outcomes: Students completing this module gain knowledge as well as practical experience for the assembly of electronic components and the manufacturing process of printed circuit boards. The students are qualified to apply the fundamentals on joining technologies like bonding, soldering and adhesive bonding as well as structuring technologies for circuit boards including packaging and assembly of electronic components. They are familiar with the technological steps and the necessary equipment.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as Electronic Systems Design, ET-12 06 10 Project Electronics Technology or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams (90 min. each) and a practical lab course. All elements of assessment must be passed.	
ECTS credit points and grades	6 ECTS credit points The grade of the module is the arithmetic mean of all elements of assessment.	
Frequency	annually, starting in the winter semester	

Workload	180 hours
Duration	2 semesters

Module number	Module name	Lecturer in charge
ET-12 06 02	Electronic Packaging	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	This module covers Electronic Packaging: – trends in electronic packaging – packaging of semiconductor devices – assembly technologies for semiconductor devices – thin-film technologies for electronic circuits – thick-film technologies for electronic circuits – printed circuit board technologies – surface finish technologies for electronic components – packaging for optoelectronics Intended learning outcomes: Students completing this module gain knowledge as well as practical experience for the assembly of electronic components and the manufacturing process of printed circuit boards. The students are qualified to apply the fundamentals on joining technologies like bonding, soldering and adhesive bonding as well as structuring technologies for circuit boards including packaging and assembly of electronic components. They are familiar with the technological steps and the necessary equipment.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 06 10 Project Electronics Technology, Electronic Systems Design or equivalent.	
Requirements for the award of ECTS credit points	The credit points are acquired if the module assessment is passed. The module assessment consists of a written exam of 90 minutes and a lab course.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment, for which the written exam contributes by 2/3 and the lab course by 1/3.	
Frequency	annually, starting in the winter semester	
Workload	120 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 06 03	Quality Assurance	Dr.-Ing. habil. H. Wohlrabe
Contents and objectives	The modul includes methods for the application of quality assurance especially in electronics production - Description of quality characteristics and their distribution and parameters - Quality standards - Statistical tests of quality data - Construction and usage of quality control charts - Machine and process capability analysis - Analysis of reliability data - Regression analysis Outcomes: Through knowledge of modern methods of quality assurance, especially the methods of statistical process control (SPC), students are able to secure the product quality during construction, design and production of assemblies and devices. They can examine, select and properly apply methods for quality assurance.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week turorials, and self-study	
Prerequisites	Skills in mathematics, particularly in linear algebra, analysis, ordinary differential equations, theory of probability and mathematical statistics, are necessary.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade for the written exam.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 06 05	Board Level Reliability of Electronic products	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	**1. Package constructions, materials, modules, assembly demands** Students that design and learn to specify electronic products as a way to meet their performance and reliability objectives despite pressure to deliver quickly technology solutions. The collected product design faces new challenges in: the need for further miniaturization; the use of higher speed signals; the introduction of new materials and device technologies; the information in globalization of the supply chain; and the exposure to harsher lifecycle environments associated with the penetration of electronics into a growing range of applications, many of which demand portability and in the future power electronics. The lectures are available to ensure that a product will meet its reliability goals, and to achieve this efficiently and economically aspects. **2. Materials and reliability** Design for reliability, demands on materials, interconnect materials /glues, solders, substrates, packages; Assembly parameters, design for manufacturing, design for reliability, stress consumption, stress free assemblies, goals for lifetime requirements.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences in terms of materials and basics in electronic assemblies as well as knowledge of industrial requirements for save processes and products, life cycle requirements.	
Requirements for the award of ECTS credit points	The credit points are earned when the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The grade is the grade for the written exam.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 06 06	Computer-Aided Electronics Manufacturing	Dr.-Ing. habil. H. Wohlrabe
Contents and objectives	This module includes two parts (2 hours per week lectures and 1 hour per week tutorial each) 1. **Production control and planning (*Fertigungsplanung und -steuerung*)** 2. **Statistical methods (*Statistische Verfahren*)** The module gives a scientific introduction to the methods of analysis and optimization of production processes, particularly in electronic industry. Mathematical methods are applied for optimal design of manufacturing processes as well as product quality assurance. The most important areas are: - Models for description of manufacturing systems and of quality characteristics of products - Performance evaluation and scheduling of manufacturing and test processes - Fundamentals of Discrete Event Simulation (DES) - Application of various statistical analysis and optimization methods; e.g. Design of Experiments (DoE)	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Skills in mathematics are recommended, particularly in linear algebra, analysis, ordinary differential equations, theory of probability and mathematical statistics.	
Requirements for the award of ECTS credit points	The credit points are earned when the module assessment is passed. The module assessment consists of a written exam of 180 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade for the written exam.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 06 07 **ET-12 06 07**	Hybrid Integration	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	This module includes two parts **1. Hybrid technique** (***Hybridtechnik***) - Technologies for the Hybrid technique, - thin film- and thick film technologies, - substrates and pastes, - thermal processes, - single layer and multilayer techniques, - design rules, hybridisation, components, housing - printing, sintering, laser application and trimming - packaging techniques, - functional test, and **2. Micro und nano integration** (***Mikro- und Nano-Integration***) - Micro and nano integration of electronic components, - nano scaling und nano materials, - processes and tools for the nano structuring, - photonic und nano systems, 3D integration The module provides skills in the fields of thin film and thick film technologies, hybrid integration and packaging of such components. The knowledge of micro and nano integration qualifies the students for the solving of innovative tasks in the electronic packaging technology. The students become able to estimate and choose such technologies.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, up to 3 one-day excursions, and self-study	
Prerequisites	Competences in the field of electronic packaging technologies as acquired in the module ET-12 08 11 Microelectronic Technologies and Devices.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a practical lab course. Both assessments have to be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted average for the written exam (2/3) and the lab course (1/3).	
Frequency	annually, in the winter semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 06 08	Nondestructive Testing	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	This module covers **1 Non-destructive testing of electronic devices (*Zerstörungsfreie Prüfung elektronischer Baugruppen*)** including: • imaging techniques • storage of digital images • image pre-processing, image segmentation • attribute extraction, data classification and **2 Micro and ano non-destructive testing methods (*Zerstörungsfreie Prüfung elektronischer Baugruppen*)** including: • acoustic methods • imaging scanning probe methods • X-ray techniques • magnetic techniques • thermography and thermal wave microscopy. Intended learning outcomes: Students completing this module acquire knowledge and competences about function, design and use of non-destructive testing methods, particularly to characterise electronic components and devices.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 08 06 Measurement and Sensor Techniques and ET-12 06 01 Technologies for Electronic Packaging and Assembly.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam of 180 minutes and of a practical lab course. Both elements of assessment have to be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment, for which the written exam contributes by 2/3 and the lab course by 1/3.	
Frequency	Annually, in the winter semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 06 09	Seminar for Graduate Students in Electronic Packaging	Prof. Dr.-Ing. habil. Dr. h.c. Karlheinz Bock
Contents and objectives	This module covers – trends and special issues in electronic packaging – methodology for scientific and project based engineering Intended learning outcomes: Students completing this module gain the skill and capability to solve specific problems autonomously, alone or in a team. They master the documentation of the workflow and have the ability to present and discuss their results.	
Modes of teaching and learning	2 hours per week seminar, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 06 10 Project Electronics Technology, ET-12 06 01 Technologies for Electronic Packaging and Assembly, and ET-12 06 07 Hybrid integration is recommended.	
Requirements for the award of ECTS credit points	The credit points are acquired if the module assessment is passed. The module assessment consists of an oral presentation of 30 min.	
ECTS credit points and grades	4 ECTS credit points The grade of the module is the grade of the oral presentation.	
Frequency	Annually, during the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 07 01	Biomedical Engineering	Prof. Dr.-Ing. habil. H. Malberg
Contents and objectives	The module contains the basics of biomedical engineering for diagnosis and therapy, particularly - the relevant physical, physiological and biochemical phenomena - the basic principles and the design of biomedical devices, - the diagnostic biosignal recording and processing - the automatic processing of diagnostic signals and information, - the therapeutic basic principles in clinical applications - the principles of organ assist systems, - biomaterials and biocompatibility, and - bionics Outcome: The students gain general knowledge about biomedical engineering and the complex interactions between the organism and engineering. They acquire the necessary qualifications to design devices for measuring physiological quantities. Furthermore, they are able to project automatic devices for diagnostic and organ assist systems and know the most import and therapeutic procedures in clinical practice. They can transfer biological/physiological basics to technical components and work flows.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, and self-study	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering and Electronic Systems Design.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	6 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, starting in the winter semester	
Workload	180 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 07 02	Medical and physiological principles	Prof. Dr.-Ing. habil. H. Malberg
Contents and objectives	The module contains the **1. Basics in Medicine and Physiology (*Grundlagen der Physiologie und Medizin*)** - the structure and function of cells, organs and organ systems, - the electro- and neurophysiologic basics, - the cardiovascular system, - the auto regulation and regulatory circuits of the organism, - the main pathophysiological phenomena, and - the clinical workflow **2. Measuring of Physiological *Signals* (*Messung physiologischer Signale*)** - detection of electrical and nonelectrical physiological values, - medical sensoring, and - artifacts and noise processing **3. Biomedical Engineering in Clinical Practice (*Biomedizinische Technik in Kliniken*)** - Application of biomedical devices in clinics of the medical faculty “Carl Gustav Carus” at the TU Dresden - special technical effects in the clinical environment **4. Medical Terminology *(Medizinische Terminologie)*** - basics of the interdisciplinary medical language in anatomy, physiology and biomedical engineering Intended learning outcomes: The students know the technical relevant processes of life, the basic physiological processes and pathomechanisms, and the main principles in diagnosis and therapy by biomedical engineering. Moreover, they know the features of the interface between organism and engineering. They know medical and biomedical terminology and are qualified for the interdisciplinary cooperation between physicians and engineers.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as Physics, ET-12 07 01 Biomedical Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 90 minutes PL1 and exercise tasks PL2.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted mean of the examinations: M = (4 PL1 + 1 PL2)/ 5	
Frequency	annually, summer semester	

Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 07 03	Medical Devices	Prof. Dr.-Ing. habil. H. Malberg
Contents and objectives	The module contains *1. Medical equipment* Based on medical questions and problems, technical solutions in the form of medical devices are considered. Selected organ systems such as cardiovascular system, urinary system, respiratory system and nervous and muscular system are discussed. *2. Regulatory Affairs* Basic legal (Medical Device Regulation) and normative requirements for medical devices and their manufacturers. Intended learning outcomes: After completing the module, the students are able to classify medical technology processes and systems in a clinical environment. Furthermore, they have basic knowledge of regulatory requirements along the life cycle of medical devices. You independently solve tasks in the application and development of diagnostic and therapeutic technology in the training process.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week exercises, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as Physics, ET-12 07 01 Biomedical Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 90 minutes and a lab course. Both assessments have to be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is generated by the weighted average of both elements of assessment: M=(2 PL1 + PL2) / 3.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 07 04	Autonomous and cooperative Systems in Biomedical Engineering	Prof. Dr.-Ing. habil. Hagen Malberg
Contents and objectives	The module focuses on 1. *Connected and intelligent implants*, in particular • Introduction to implant technology • Functional implants, getting to know integrated sensors and clinical applications • Generalization of measurement, automation and analysis tasks • Structure and design of intelligent and networked implants, including energy supply, biocompatible structure and connection technology, interfaces 2. *Cardiac assistance systems*, in particular • Therapy concept, functionality, pacemaker codes • Design and application of cardiac pacemakers and defibrillators • rate-adaptive systems, telemonitoring, security 3. *Biomechanical systems in rehabilitation*, in particular • Introduction of posture and movement analysis • Biomechanical measurement methods • Instrumental gait analysis • Therapy concepts (prostheses, orthoses, exoskeletons). Intended learning outcomes: After completing the module, the students have knowledge, skills and abilities in dealing with autonomous and cooperative systems in medicine. They know the functional principles as well as the methodical tools for the development of such systems.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week exercise, 1 hour per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as Physics, ET-12 07 01 Biomedical Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam 90 minutes and a lab course. Both elements of assessment have to be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment: M = (2 PL1 + PL2) / 3.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 07 05	Signal processing in biomedical engineering	Prof. Dr.-Ing. habil. Hagen Malberg
Contents and objectives	This module covers 1. *Basics of signal processing*, in particular • Digital filtering • Signal analysis in the frequency domain (e.g. time-frequency analysis, transformations, linear prediction) • Measurement of transfer functions 2. *special biosignal processing*, in particular • the medical signal processing chain • Artifact handling and principal component analysis • Biosignal analysis in the time domain • Biosignal analysis with non-linear and knowledge-based methods • Medical statistics and study planning. Intended learning outcomes: After completing the module, the students have knowledge, skills and abilities for the IT-supported analysis of physiological signals. They know the functional principles as well as the methodical tools for the development of such systems.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week seminar, and self-study	
Prerequisites	Competences acquired in modules such as Physics, ET-12 07 01 Biomedical Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a written exam (90 minutes) and a “Beleg”. Both must be passed.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the unweighted average of both elements of module assessment.	
Frequency	annually, during the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 07 06	Seminar for Graduate Students in Biomedical Engineering	Prof. Dr.-Ing. habil. H. Malberg
Contents and objectives	The module contains 1. special topics and trends in diagnostic and therapeutic device technologies, and 2. the scientific and management methods of engineering Intended learning outcomes: The students are able to solve interdisciplinary tasks in biomedical engineering independently or in a working team. They know the main procedures of engineering and are able to present and to discuss their results.	
Modes of teaching and learning	2 hours per week seminar, 1 presentation, and self-study	
Prerequisites	Some specific expertise is required, which can for example be aquired by completing the modules Physics, ET-12 07 01 Biomedical Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The assessment consists of an assignment and a presentation of 30 minutes as an individual exam.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade of the assignment and to 1/3 of the grade of the presentation.	
Frequency	annually, during winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 08	Circuit Simulation and System Identification	Prof. Dr. phil. nat. habil. R. Tetzlaff
Contents and objectives	The module contents: the mathematical basics of system identification and its practical application, basic system properties, important modeling approaches, methods for parameter identification and essential aspects of signal selection and data conditioning as well as adaptation of model parameters with appropriate algorithms. Outcomes: The students can select suitable model approaches based on theoretical considerations (linear/nonlinear, time/frequency domain). They are aware of simplifications made and consider specific boundary conditions for the applied methods. Students are able to define and analyze the set of data available for the identification and to evaluate it in terms of suitability. The students master the application of common methods for system identification and are able to evaluate the result.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, ET-12 08 31 Electronic Circuits, ET-12 09 01 Systems Theory, Introduction to Analysis and Algebra, Calculus for Functions with Several Variables.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The assessment consists of two written exams of 120 minutes.	
ECTS credit points and grades	7 credit points The module grade is the arithmetic mean of the two exams.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET- 12 08 12	Integrated Analogue Circuits	Prof. Dr.-Ing. habil. U. Jörges
Contents and objectives	Integrated analogue circuits, such as reference sources, translinear circuits, transconductance amplifiers, mixers, analogue switchs, switched capacitor circuits, current conveyors and others. Students learn the fundamental properties of devices and circuits, such as temperature dependency, nonlinearities, noise and matching. They learn important functionally blocks of integrated analogue systems. Students can analyse symbolically, dimension and design analogue circuits.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, ET-12 08 31 Electronic Circuits (1st module semester), ET-12 08 03 Dynamical Electrical Networks or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the exam.	
Frequency	annually, during the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 13	Physics of Selected Devices	Prof. Dr.-Ing. habil. M. Schröter
Contents and objectives	The module contains the courses: - ***Numerical simulation of devices*** (winter semester) and - ***Modeling for circuit design*** (summer semester). The module includes: - Design, operation and electrical properties of micro- and nanoelectronic devices for integrated circuits. Outcomes: The students are capable of - describing the behavior of components on the basis of important physical models, - implementing numerical solution methods for physical models, - applying Computer-aided tools for the numerical simulation of micro- and nanoelectronic devices, - constructing equivalent circuits, - developing compact models based on realistic devices and fit model parameter from measurements.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 08 11 Microelectronic Technologies and Devices or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and an assignment.	
ECTS credit points and grades	6 ECTS credit points The grade is determined by the weighted average of the grades of both elements of assessment: M = (7 PL1 + 3 PL2) / 10.	
Frequency	annually, starting in the winter semester	
Workload	180 hours	
Duration	2 semester	

Module number	Module name	Lecturer in charge
ET-12 08 15	Advanced Seminar: Micro- and Nanoelectronics	Prof. Dr.-Ing. habil. M. Schröter
Contents and objectives	The module includes: - Topics of micro- and nanoelectronics and the methodology of scientific and project-based work organization. Outcomes: The students are capable of - solving tasks in teams or independently (conception and documentation) in the field of micro- and nanoelectronics, - presenting and defending their own work, - acquiring new topics from literature.	
Modes of teaching and learning	2 hours per week project, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 08 11 Microelectronic Technologies and Devices, ET-12 08 12 Integrated Analogue Circuits or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a project of 12 weeks and a colloquium.	
ECTS credit points and grades	4 ECTS credit points The module grade is determined by the weighted average of the grade of the project and the grade of the colloquium (oral exam). The grade of the project is weighted with 2/3 and the grade of the colloquium with 1/3 for the module grade.	
Frequency	Annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET- 12 08 16 ET- 12 08 16	Radio Frequency Integrated Circuits	Prof. Dr. sc. techn. habil. F. Ellinger
Contents and objectives	The content of the module focuses on: – high frequency integrated circuits for high speed wireless communications such as low noise amplifiers, power amplifiers, mixers, oscillators on basis of active and passive devices, as well as complete radio frontends and architectures – advantages and challenges of aggressively scaled CMOS and BiCMOS, Moore than Moore (e.g. FinFET, SOI, strained silicon) and Beyond more Moore (silicon nano wire, CNT and organic) technologies are discussed from circuit design perspective. After completion of the module, the students obtain competences regarding – methods for the design of analog high frequency integrated circuits. They know the basic circuits and architectures of the systems. – analysis and optimisation of these circuits, – complete design cycle for high frequency integrated circuits using the Cadance CAD system and are therefore prepared in this field for the requirements in industry and academia, – technical English	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab courses, and self-study. The lecture is given in English.	
Prerequisites	Students should have basic knowledge of circuit design on Bachelor level.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, during the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET- 12 08 17 ET- 12 08 17	Integrated Circuits for Broadband Optical Communications	Prof. Dr. sc. techn. habil. F. Ellinger
Contents and objectives	Integrated circuits for optical broadband communications, such as transimpedance amplifiers, detector circuits, laser drivers, multiplexers, frequency dividers, oscillators, phase locked loops, synthesizesr and data recovery circuits. Students learn the methods of the design of fast integrated circuits and systems for optical broadband communications. They are able to analyse and optimise these circuits. The students know the complete design cycle using the program CADENCE.	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab courses, and self-study. The language of instruction is English.	
Prerequisites	Competences acquired in modules such as ET-12 08 31 Electronic Circuits (on Bachelor level).	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 18	Integrated Circuit Design	Prof. Dr.-Ing. habil. C. Mayr
Contents and objectives	The content of the module includes the basics and methods for development of application-specific digital integrated circuits (ASICs). This involves the transformation of a numeric algorithm into a data-dependency graph, the useage of scheduling and allocation procedures, optimizing regarding the consumption of resources (area, duration) as well as the implementation and functional verification (simulation) of the ASIC. After completing the module, the students are enabled to develop the data path (register transfer description) and the control unit (FSM) of a slected numerial algorithm using a data dependency graph. They know the implementation flow, which includes both the automated synthesis of complex blocks based on a hardware description language (eg. Verilog), as well as manually optimized digital data path elements.	
Modes of teaching and learning	2 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-01 04 04 Partial Differential Equations and Probability Theory, Basics of Electrical Engineering ET-12 08 11 Microelectronic Technologies and Devices ET-12 08 31 Electronic Cicuits.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a project report of 40 hours.	
Credit points and grades	7 ECTS credit points The module grade is the grade of the project report.	
Frequency	annually, beginning in the winter semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 08 19 ET-12 08 19	VLSI Processor Design	Prof. Dr.-Ing. habil. C. Mayr
Contents and objectives	Content of the module: - Basics, concepts and methods for designing complex digital VLSI-systems - Architectures for highly integrated digital processing systems, with emphasis on user-specific signal processing systems - Methods for the efficient transfer of architectural concepts in the highly integrated implementation of a digital system. - Specification and abstract modelling of the system, conversion into a Register-Transfer-Level (RTL) description, automated circuit synthesis and physical implementation (place & route, layout synthesis), delivering the data for the manufacture of the chip. - Verification of the design on all levels of abstraction (behaviour, implementation) via simulation (functional verification) - Proof of the equivalence of transformation steps via formal verification, i.e. by checking compliance with design rules (signoff-verification) - Training in working together as a design team (division of tasks, definition of interfaces, schedule planning and time management) Objectives: After completion of this module, the students will be able to carry out a complete implementation and verification of a VLSI-System (e.g. a processor with a complexity comparable to an 8051) using industrial design software (Synopsys, Cadence).	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, 2 hours per week practical lab courses, and self-study The language of instruction is at least partly English.	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, ET-01 04 03 Complex Function Theory, ET-01 04 04 Partial Differential Equations and Probability Theory, ET-12 08 31 Electronic Circuits, ET-12 09 01 Systems Theory, or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a project report of 30 hours and an oral presentation of 20 minutes.	

Credit points and grades	7 ECTS credit points The module grade is the weighted average of the grade of the project report and the grade of the oral presentation: M = (2 PL1 + PL2) / 3.
Frequency	annually, in summer semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 08 20 **ET-12 08 20**	Laser Sensor Technology	Prof. Dr.-Ing. habil. J. Czarske
Contents and objectives	The module deals with the basic principles and the realisation of laser sensors in practice. – Laser measurement technology (laser technology, biophotonics, fiber optic measurement systems, optical information technology) – Mechatronic laser sensors – Experimental investigation and application of laser sensors Intended learning outcomes: Students will acquire skills to describe the physical principle and the technical design of laser sensors and to assess them. They will be able to handle the basic approaches and methods for the system design of modern laser sensors.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory, ET-12 02 01 Electromagnetic Theory, and ET-12 08 06 Measurement and Sensor Techniques.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an individual oral exam of 40 min duration and a lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment, for which the oral exam contributes by 6/7 and the lab course by 1/7.	
Frequency	annually, during the summer semester	
Workload	210 hours	
Duration	1 Semester	

Module number	Module name	Lecturer in charge
ET-12 08 21 ET-12 08 21	Photonic Measurement System Technology	Prof. Dr.-Ing. habil. J. Czarske
Contents and objectives	The content of the module includes the basic principles, the theoretical treatment and the practical realization of photonic measurement systems. This includes experimental investigations of photonic systems as well as other key topics to choose from, such as digital holography and image processing, laser measurement systems for fluid technology or biomedical systems technology and optogenetics. Intended learning outcomes: The students are able to implement laser-optical measuring systems and to measure physical quantities by applying these.	
Modes of teaching and learning	4 SWS lectures and exercises, 1 SWS project and self-study. The courses are to be selected from a catalog of courses, which is announced at the beginning of the semester as is customary in the faculty. The language of instruction is at least partly English.	
Prerequisites	Competences acquired in modules such ET-12 08 06 Measurement and Sensor Techniques.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of an individual oral exam of 40 min and a project of 12 weeks.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the weighted average of both elements of module assessment, for which the oral exam contributes by 6/7 and the project by 1/7.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 Semester	

Module number	Module name	Lecturer in charge
ET-12 08 22	Seminar for Graduate Students on Measurement System Technology	Prof. Dr.-Ing. habil. J. Czarske
Contents and objectives	Content: - Current trends and issues of measurement system technology - Methods of scientific and project-based working as well the presentation of results Objectives: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work and the methods used, and are capable of presenting and discussing the results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Required are competences that can be acquired in modules such as ET-12 08 06 Measurement and Sensor Techniques. Further, competences are recommended that can be acquired in modules on Sensor Technology, Photonic Measurement System Techniques and Signal Processing	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade for the assignment and to 1/3 of the grade for the presentation.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 23	Computer Aided Integrated Circuit Design	Prof. Dr.-Ing. habil. C. Mayr
Contents and objectives	Content of the module: 1. Integrated Circuit Design Basics and methods necessary for an Application-Specific Integrated Circuit (ASIC) design project. Each step of the design process from algorithmic specification to synthesis strategies (CDFG-Control Data Flow Graph, Scheduling, Allocation) will be explained. For one data path the according Register-Transfer- Level-Sequences (RTL) as well as the Random-, Microprogram- and Data Path control units will be described and verified through simulation. 2. Physical Design Designmethodology for layout generation of Integrated Circuits, MCMs and PCBs. Detailed step-by-step description of the computer assisted layout generation from a netlist description to the final layout. After completion of this module, the students will have knowledge about the basics of the C-like hardware description language VERILOG used to design and to simulate the circuit at system-, behavioral-, RT- and logic level verification of a VLSI-System. Furthermore, the students will be able to use modern design tools for the physical layout implementation.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, Electric and Magnetic Fields Electronic Systems Design or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a design project of 50 hours and an oral presentation of 20 minutes per person. Both elements of assessment must be passed.	
Credit points and grades	8 ECTS credit points The module grade is the weighted average of the grade of the project report (66%) and the grade of the oral presentation (33%).	
Frequency	Annually, starting in the winter semester	
Workload	240 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 08 25	Seminar for Graduate Students: Micro- and Nanoelectronics	Prof. Dr.-Ing. habil. M. Schröter
Contents and objectives	The module includes: – Special issues and trends in the field of modeling of micro- and nanoelectronic components – Methods of scientific and engineering project-based activities Outcomes: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work methods, can present and discuss the results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences acquired in modules such as ET-12 08 13 Physics of selected devices.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of a graded assignment and a graded presentation of 30 minutes duration as a single test.	
ECTS credit points and grades	4 ECTS credit points The module grade is derived from the grades of the assignment and of the presentation; the assignment contributes by 2/3 and the presentation by 1/3.	
Frequency	annually in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 02	Signal Theory	Prof. Dr.-Ing. P. Birkholz
Contents and objectives	The module content includes: Analysis of continuous time and discrete time signals in the time and frequency domain. A second focus is the description of stochastic signals as realisations of stochastic processes and its processing by static and dynamic systems. Learning outcomes: The students master the fundamental principles and the practical application of methods of signal processing in the time domain and in the frequency domain. They are familiar with the relationship between the processing of continuous time and discrete time signals. They know the different forms of spectral analysis and are able to decide which forms are applicable under which conditions. In particular, they understand how short time spectral analysis works and the specifics concerning its application. The students are able to describe stochastic signals as realisations of stochastic processes. They are capable of calculating the behaviour of deterministic and stochastic systems that are processing stochastic processes.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory, ET-01 04 03 Complex Function Theory, ET-01 04 04 Partial Differential Equations and Probability Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of 2 written exams of 120 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades of the 2 written exams.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 13	Applied Intelligent Signal Processing	Prof. Dr.-Ing. P. Birkholz
Contents and objectives	The content of the module includes: - methods for recording and analyzing audio signals, image signals and biosignals - methods of classification and regression in the field of machine learning - the implementation of selected processes from 1) and 2) on an embedded system	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 09 02 Signal Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment is a written exam of 150 minutes and an ungraded lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is the unweighted mean of the parts of the assessment.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 04	Speech Technology	Prof. Dr.-Ing. P. Birkholz
Contents and objectives	The module content includes: The algorithms and methods required for the lingual human-machine interaction (speech recognition and speech synthesis). Learning outcomes: Successful students master the latest technologies being used in speech recognition and speech synthesis. They know the basic concepts of linguistics and the hierarchical semiotic system and the structures of natural language. They are able to define it by means of formal languages and grammars and employ this knowledge in the development of speech recognition systems. Furthermore, they know the structure of speech synthesis systems and the algorithms used in linguistic-phonetic and acoustic-phonetic implementations. They know how to adapt these systems to meet specific demands such as multilingual or multimodal interaction.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 02 Signal Theory, ET-12 09 03 Intelligent Audio Signal Processing, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the module assessment consists of a written exam worth 150 minutes and an ungraded lab course. With up to 15 registered students the module assessment consists of an oral exam as individual exam worth 30 minutes and an ungraded lab course. The nature of the specific exam is announced at the end of the registration period as usually known from the faculty.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 05	Electro-Acoustics	Prof. Dr.-Ing. habil. E. Altinsoy
Contents and objectives	The module content includes: in-depth knowledge of electro-acoustics with an emphasis on the evaluation of audio systems as well as the active control of sound and vibration. Learning outcomes: The students are able to integratively apply their knowledge in the various disciplines of electrical engineering/mechanics/acoustics to complex structures (nonlinear, time dependent, with distributed parameters). A typical example is the rating of sound systems using objective measurements. The students are proficient in the development of new measurement methods, which employ test signals as well as music for the rating of the electro-acoustic system. They understand the relationship between measured physical symptoms and physical causes and their impact on the perceived sound quality. They have learned advanced methods for modeling and analysis of electrical, mechanical and acoustic systems and the systematic design of measurement and control instrumentation, which are implemented using digital signal processors.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 09 02 Signal Theory, ET-12 09 06 Acoustics , or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of 2 written exams of 90 minutes each and a lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is the weighted mean of the grades of the 3 elements of assessment, for which the 2 written exams contribute by 2/5 each and the grade for the lab course by 1/5.	
Frequency	annually, beginning in the summer semester	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 09 06	Acoustics	Prof. Dr.-Ing. habil. E. Altinsoy
Contents and objectives	The module focuses on physical acoustics, hearing acoustics, electroacoustics and room acoustics. This includes physical and psychoacoustic basic parameters of the acoustics, the description and measurement of acoustic events, electroacoustic transducers and basic principles of listening perception.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Basic knowledge in physics, mathematics and electrical engineering	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 180 minutes.	
ECTS credit points and grades	4 ECTS-credit points The module grade is the grade of the written exam.	
Frequency	annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 07	Technical Acoustics / Vehicle Acoustics	Prof. Dr.-Ing. habil. E. Altinsoy
Contents and objectives	The design and quality of vehicle interior sound becomes increassingly important in the development process of new vehicles. The physical behaviour of vibration and sound generation (also transmission) ranked first in the design process. This module provides the theoretical and practical foundation for technical acoustics with focus on vehicle acoustics and includes a lab course on the sound and vibration measurement technique. Generation, transmission and damping of air- and structure-borne sound, transfer path analysis and synthesis, manipulation of the vehicle interior and exterior sound will be introduced. The lab course includes examples in the following areas: - technical acoustics - electromechanic and electroacoustic systems.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 08 06 Measurement and Sensor Techniques, ET-12 09 06 Acoustics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral exam as individual exam of 30 minutes and a lab course.	
ECTS credit points and grades	7 ECTS-credit points The module grade is the weighted mean of both assessments: M = (2 PL1 + PL2) / 3.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 08	Room Acoustics/ Virtual Reality	Prof. Dr.-Ing. habil. E. Altinsoy
Contents and objectives	This module provides the theoretical and practical foundation for room acoustics (first part) and interface design for virtual reality applications (second part). 1)The first part of the module (room acoustics) includes the theory of sound fields in enclosed spaces, geometrical acoustics, sound absorbers, electroacoustic systems in rooms and design of lecture halls, concert halls, opera houses, etc. 2) The aim of the second part of the module is to present the advanced concepts for generation of real-time interactive auditory, haptic, and visual virtual environments. Nowadays, such kinds of systems play a pronounced role in scientific and industrial research & development and, thus, become more and more important as tools for automotive industry (e.g. driving simulators, prototyping of engineering designs, restyling, ergonomics, etc.), telecommunication industry, architecture, and entertainment industry. Students learn audio recording and reproduction technologies (binaural techn., stereophony, surround sound, VBAP, ambisonics, wave field synthesis), implementation of room acoustical models, sound synthesis techniques, haptic and visual reproduction technologies. Furthermore, students will be exposed to the process of creating virtual environments, by developing some small VR applications (auditory/haptic/visual) as members of a small team.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory, ET-12 09 02 Signal Theory and ET-12 09 06 Acoustics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists an oral exam of 55 minutes as individual exam and a project work of 30 hours.	
ECTS credit points and grades	7 ECTS credits points The module grade is the arithmetic mean of the oral exam and the project work: M = (PL1 + PL2) / 2.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 09 09	Psychoacoustics / Sound Design	Prof. Dr.-Ing. habil. E. Altinsoy
Contents and objectives	This module gives an introduction to: 1.Psychoacoustics: Psychoacoustics is concerned with the relationships between the physical characteristics of sounds and their perceptual attributes. The aim of this module is to give students an understanding on the theory and practice of psychophysics, including the various aspects of psycho-acoustics, such as sensitivity, masking, loudness, sharpness, pitch, timbre and roughness. In this module various binaural models and the aspects of the binaural hearing will be introduced. 2. Sound design Each perceived sound in product use is a carrier of information. Each sound has a meaning to its listener, and as such each sound is perceived as a sign. The humming sound inside a car is mostly associated with, e.g., sportiness. This module outlines basic principles of sign theory and gives guidelines to how human perception of a product is affected by product sounds. Intended learning outcomes: Students learn to construct signals, which evoke – if they are heard – specific physical, affective or psychomotor reactions. They are qualified for the product development, e.g., in the automotive, hearing aid, household appliance or telecommunication industry and in medical engineering companies.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 08 06 Measurement and Sensor Techniques, ET-12 09 06 Acoustics, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 90 minutes and a project of 30 working hours.	
ECTS credit points and grades	7 ECTS credits The module grade results from the arithmetic mean of both elements of assessment.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 01	Information Theory	Prof. Dr.-Ing. Rafael F. Schaefer rafael.schaefer@tu-dresden.de
Contents and objectives	Content of this module: – basic information theoretic measures – source coding – channel coding – coding theorem – rate-distortion theory Intended learning outcomes: Students are able to master the basic principles of Information Theory. They are familiar with the calculation and the meaning of entropy as well as the mutual information for discrete and statistical random variables. Furthermore, students know the source coding and channel coding theorems and are able to apply the results from these coding theorems for a practical system design. They are able to construct source codes as well as channel codes and are further able to indicate procedures for decoding. Various performance metrics for the evaluation of the performance of information systems e.g. the ergodic capacity or the outage capacity are used and interpreted confidently.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Basic knowledge which can be acquired in modules such as Introduction to Analysis and Algebra, ET-12 10 24 Communications.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessmen consists of a written exam of 120 min.	
ECTS credit points and grades	4 ECTS credit points The grade of the written exam is the grade for the module.	
Frequency	annually, during the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 02	Advanced Seminar Communication Systems	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	This module encompasses new topics and issues regarding communications and network engineering combined with the methodology of scientific and project based operations. Intended learning outcome: After completing this module, students will be able to apply their skills autonomously, individually or within a team to specific tasks. In doing so, single steps of the procedures should be documented comprehensibly. Students are expected to present and discuss their results. Moreover, students can work in teams to develop their concepts, which they will then realize and defend.	
Modes of teaching and learning	2 hours per week project and self-study	
Prerequisites	Basic knowledge that can be acquired in modules such as ET-12 10 24 Communications ET-12 08 06 Measurement and Sensor Techniques ET-12 09 02 Signal Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module exam is passed successfully. The module exam consists of a project work of 12 weeks and a colloquium.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the project work and to 1/3 of the colloquium.	
Frequency	annually, during the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 03	RF Engineering	Prof. Dr.-Ing. D. Plettemeier
Contents and objectives	The modules content comprises: the physical basics of devices and circuits as well as RF systems and radio transmission systems. This includes theory and praxis of RF wave guides (micro strip lines, hollow wave guides and optical fibers), their associated circuit components and circuits as well as their characterization through scattering parameters. Qualification objectives: Students will have the ability to evaluate RF connections and design wave guides. They are trained in handling RF equivalent circuits and description of n-ports by scattering parameters. Students can certainly apply the basics of wave radiation, propagation and reflection and have basic knowledge of signal transmission over various wave guides.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 02 01 Electromagnetic Theory (1st semester of the module), ET-12 10 24 Communications and ET-12 09 01 Systems Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment is a written exam of 180 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 04	Communication Networks, Basic Module	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	Content: The principles of message routing in communication networks, the architecture of communication networks in wire-bound, wireless and optical technology and the communication protocols of the OSI model. Media access methods, multiplexing techniques and the transmission technology ATM are introduced. Objectives: The students master circuit switching and packet switching methods, layered protocols and they can evaluate static and statistical multiplexing methods. The students are acquainted with TCP/IP and CSMA/CD exemplary. They know fundamental methods for network design.	
Modes of teaching and learning	2 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 04 Partial Differential Equations and Probability Theory, ET-12 10 24 Communications ET-12 09 01 Systems Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment is a written exam of 150 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the summer semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 05	Communication Networks, Advanced I	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	Content: • The planning process for communication networks with transport, service and cost modelling and principles for the dimensioning and routing in communication networks, including their implementation in algorithmic or heuristic optimization approaches • Integrated packet networks with selected basics of networking technologies and protocols for LAN, MAN and WAN Objectives: Having succeessfully completed this module, the students have a sound knowledge of planning, dimensioning and optimization of integrated communication networks. They understand the procedures and protocol structures that are used for efficient, flexible and reliable operation of these networks and have an overview of currently used technologies and their trends. The students are familiar with the basic technologies for integrated communication networks. They understand the system structures and processes and are able to evaluate and apply these. They master the most important networking technologies, their operating principles and protocols and are able to apply these to new problems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 10 24 Communications and ET-12 10 04 Communication Networks, Basic Module or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the assessment consists of two written exams of 120 minutes each. With up to 15 registered students, the assessment consists of an oral exam as individual exam of 30 minutes and a written exam of 120 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 19	Optimization in modern Communication Systems	Prof. Dr.-Ing. Rafael F. Schaefer rafael.schaefer@tu-dresden.de
Contents and objectives	Content: The foundations of optimization in communication systems and modern methods of signal processing for communication in radio systems Objectives: The students are familiar with optimization problems that occur in communication technology as well as with modern approaches and methods of information theory and signal processing. The students have the mathematical knowledge necessary for classifying these problems and master both analytical methods as well as numerical methods for the solution thereof. They are able to apply these to different scenarios and are thus able to develop optimal and efficient strategies for current problems in modern communication systems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study. The language of instruction can be either German or English. At the beginning of the teaching period, the lecturer announces the language the module will be taught in.	
Prerequisites	Competences acquired in modules such as ET-12 10 01 Information Theory, ET-12 09 01 Systems Theory or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 120 minutes each each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 20	Communication Networks, Advanced II	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	Content: • Tools for analyzing the performance of communication systems, in particular the analytical and simulative approach, and the exemplary realization by implementation • Future communication systems, their planning, analysis and structure • Approaches to project-based work, incl. work-structuring and presentation of the results (in writing and oral) in front of an expert public Objectives: Having successfully completed this module, the students have a thorough understanding of the modelling and performance analysis of communication networks and their protocols. They are able to chose and apply appropriate methods of investigation for various problems. The students have learned to look at their tasks in a professional manner, to structure their project in terms of work and time, and to present their results in a public-oriented manner.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study. The language of instruction is English.	
Prerequisites	Competences acquired in modules such as ET-12 10 24 Communications, ET-12 10 04 Communication Networks, Basic Module, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the assessment consists of a written exam o 120 minutes and a project of 30 hours. With up to 15 registered students, the assessment consists of an oral exam as individual exam of 30 minutes and a project work of 30 hours.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 08	Statistics	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	Content: • Theoretical and practical fundamentals and methods of descriptive statistics (moments and calculation rules; important specific probability distributions, limit theorems) • Estimation and testing of the assessing statistics (point and interval estimates, hypothesis tests, analysis of statistical correlations) Objectives: The students are able to carry out scientific investigations of mass phenomena based on combinatorics and probability theory. By doing so, they obtain information on the basic population of the considered objects or processes from concrete samples, taking probabilistic models into account. They are able to find the necessary statistical models and lead them to an analytical treatment. The students are able to determine sample function, to estimate statistical parameters, confidence and prediction intervals, to test hypotheses on distribution parameters or laws using statistical methods and to identify stochastic correlations between several parameters.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-12 09 01 Systems Theory or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 135 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.	
Frequency	Annually The module starts in the summer semester.	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 10 09	Information Theory, Advanced I	Prof. Dr.-Ing. Rafael F. Schaefer rafael.schaefer@tu-dresden.de
Contents and objectives	This module comprises: Elements of the multi-user information theory, meaning capacity regions and attainable rate regions of multiple access channels, broadcast channels, relay channels, interference channels with coding theorems and converse Intended learning outcome: After completing this module, students are familiar with the elements of the network information theory and the basic results regarding capacity regions und attainable rate regions. Students further obtain information theoretical and mathematical tools to prove coding theorems. Amongst these coding theorems are superposition coding, Gelfand-Pinkser coding, dirty-paper coding, successive-interference-cancellation, Han-Kobayashi-coding, backward-decoding and many more. Furthermore, students will know the current status of technology – e.g. the capacity region of the multi-antenna broadcast channel – as well as unsolved issues regarding network information theory and its difficulties. They further apply their gained knowledge and the functional interpretation of system designs of future mobile communication systems, for cellular systems (multiple access and broadcast channel), relay and multi-hop systems as well as ad hoc networks to specific tasks. Moreover, they confidently deploy various performance metrics, are familiar with the stochastic description of wireless networks, and can evaluate average and outage-performances.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study. The language of instruction can be German or English, and is announced at the beginning of the semester by the lecturer.	
Prerequisites	Competences provided by modules such as ET-12 10 01 Information Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 120 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the two written exams.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 12	Antennas and Propagation	Prof. Dr.-Ing. D. Plettemeier
Contents and objectives	The content of this module is: Basic concepts of antenna theory and electromagnetic wave propagation. Objectives: The students are familiar with the calculation of linear- and aperture radiators and know the basic principles and methods for the calculation of wave fields. The students know the application of Green's theorems and approach. They are familiar with equivalent circuits of the input impedance and the design of matching networks. The students are capable of approximating radiation characteristics of phased antenna array as well as designing reflector antennas and compact high gain antennas (e.g. Cassegrain and Gregory systems). They will be able to evaluate characterize and measure antenna performance.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 10 03 RF Engineering.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral exam of 45 minutes as individual exam.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 13	RF Systems	Prof. Dr.-Ing. D. Plettemeier
Contents and objectives	The module content: The operation and the physical basics of modern RF and wireless systems. Objectives: The students are familiar with ground- and satellite-based radio navigation and positioning systems. Communication satellite links can be described at system level. Basic understanding of satellite technology, antenna systems and phenomena of wave propagation (free space propagation, atmospheric absorption, plasma frequency, reflection and scattering, Doppler effect, etc.) are taught. The students are familiar with the different radar techniques (e.g. pulse-radar, pulse Doppler radar, FMCW radar and secondary radar, MTI principle, chirp) and with the system description and signal processing. They have obtained knowledge regarding the functionality and methods of the signal processing of radar imaging techniques (e.g. SAR principles).	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 10 03 RF Engineering, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment is an individual oral exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral exam.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 14	Optical Communications	Prof. Dr.-Ing. D. Plettemeier
Contents and objectives	The module comprises: the design and the development of optical transmission systems. Intended learning outcomes: The students are proficient with the physical basics of different types of optical waveguides (planar wave guides, single mode and multi mode fiber) and the transmission properties in linear and nonlinear regime. Further important points are optical connection and measurement methods, passive optical components (couplers, isolators, interferometers) as well as optical transmission systems from the system theoretical point of view. Here, recent and future synchronous and asynchronous optical networks operating in time and wavelength division multiplex are focused. The students know the different system approaches (e.g. optical packet switching, dynamically switched optical networks) and the network technologies needed for that (modulation formats, signal regeneration, compensation of transmission impairments).	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 10 03 RF Engineering, ET-12 10 24 Communications and ET-12 09 01 Systems Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of an oral exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the oral exam.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 15	Basics Mobile Communications Systems	Prof. Dr.-Ing. Dr. h.c. G. Fettweis
Contents and objectives	Having completed the module, the students know and understand the basic structure of cellular mobile communications systems (system and protocol architectures, radio network planning and optimization, capacity calculation). They are able to analyze und to solve problems of radio network planning. They know the phenomena of the mobile radio channel (Doppler effect, multipath propagation), master the basic principles of digital signal transmission over frequency-selective and time-variant transmission channels and are able to analyze, to describe mathematically and to work out solutions for real-word data transmission problems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study.	
Prerequisites	Competences acquired in modules such as ET-12 10 24 Communications, ET-12 09 01 Systems Theory or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the assessment consists of a written exam of 150 minutes. With up to 15 registered students, the writtem exam will be replaced by an oral exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 16	Digital Signal Processing and Hardware Implementation	Prof. Dr.-Ing. Dr. h.c. G. Fettweis
Contents and objectives	Having completed the module, the students master processes for software implementation of digital signal processing algorithms on different hardware platforms and can evaluate them with respect to various criteria. The students know methods for hardware and software realization of communications engineering problems as well as design and optimization methods for digital signal processing systems. They are able to design and optimize signal processing systems in the field of communications by taking into account the mutual influence of the hardware and software (HW / SW co-design).	
Modes of teaching and learning	2 hours per week lectures, 1 hours per week tutorial, 2 hours per week practical lab courses, and self-study. The language of instruction is at least partially in English.	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-12 10 24 Communications, ET-12 09 01 Systems Theory.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of two exams. Exam 1 is a written exam of 120 minutes if the number of participants exceeds 16. With up to 16 participants, the written exam will be replaced by an oral exam as an individual exam of 20 minutes. The type of exam will be announced at the end of the registration period at the faculty. Exam 2 is a lab report.	
ECTS credit points and grades	7 ECTS credit points The module grade results from the arithmetic mean of the grades of both elements of assessment.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 17	Upgrade Mobile Communications Systems	Prof. Dr.-Ing. Dr. h.c. G. Fettweis
Contents and objectives	Contents of the module are special and/or current topics in the field of mobile communications. The student has the option to choose two lectures from a catalogue of several lectures. Examples of contents to choose from: 1. Fundamentals of Estimation and Detection 2. Machine Learning in signal processing 3. Algorithms for multi-antenna systems Objectives: Having completed this module, the students are able to understand the concepts of modern mobile systems and to contribute creatively to solve radio transmission problems under mobile communications conditions. The students have a deeper understanding of the problems in mobile communications (signal transmission via disturbed frequency-variant and time-variant communication channels), have the knowledge and skills to analyze these problems theoretically, to develop and implement practical solutions. The students are able to express themselves in English technical terminology.	
Modes of teaching and learning	The module includes lectures and exercises in the amount of 6 hours per week, and self-study. The language of instruction is at least partly in English.	
Prerequisites	Competences acquired in modules such as ET-12 10 24 Communications, ET-12 09 01 Systems Theory or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the module assessment is a written exam of 150 minutes. With up to 15 registered students, the written exam will be replaced by an oral exam as an individual exam of 45 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the exam.	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 18	Digital Signal Processing Systems	Prof. Dr.-Ing. Dr. h.c. G. Fettweis
Contents and objectives	Having completed the module, the students have the mathematical knowledge necessary for describing and analyzing discrete-time systems (e.g., fundamentals of time-discrete systems and spectral analysis of time, signal sampling and reconstruction, digital filtering, quantization, multirate systems, adaptive filtering), and can use this knowledge in the design and implementation of digital signal processing systems. The students are able to simulate signal processing modules and to implement them with the help of digital signal processors (DSPs).	
Modes of teaching and learning	3 hours per week lectures, 1 hour per week exercises, 2 hours per week practical lab courses, and self-study.	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-12 09 01 Systems Theory, or equivalent.	
Requirements for the award of credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 120 minutes and a lab report.	
ECTS credit points and grades	7 ECTS credit point The module grade results from the weighted grades of the elements of assessment; the written exam contributes by 2/3 and the lab report by 1/3.	
Frequency	Annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 21	Network Coding in Theory and Practice	Prof. Dr.-Ing. Frank Fitzek
Contents and objectives	Content: • Theoretical fundamentals of network coding (NC) • Evaluation of NC's performance in present and future communications systems Objectives: 1. The students are able to cope with the joint treatment of coding and routing in networks. They understand the basics of graph theory for modelling and analysing networks as well as the central statements of the network coding theory. They can create network codes for various scenarios. They know both the classic NC in wire-bound and the extension to the wireless case. They are familiar with current research topics in the fields coding in networks 2. They know the performance of NC systems and master the simulation as well as the implementation of NC on simple communication systems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study The language of instruction can either be German or English. At the beginning of the teaching period, the lecturer announces whether the module will be taught in English or German.	
Prerequisites	Competences acquired in modules such as ET-12 10 01 Information Theory, ET-12 09 01 Systems Theory, ET-12 10 04 Communication Networks, Basic Module, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the assessment consists of two written exams of 120 minutes each. With up to 15 registered students, the written exams can be replaced by two oral exams as individual exams of 30 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.	
Frequency	Annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 10 22	Intelligent and cooperative Communications	Prof. Dr.-Ing. Rafael F. Schaefer rafael.schaefer@tu-dresden.de
Contents and objectives	The content of the module includes an introduction to basic concepts and algorithms of machine learning as well as modern methods of resource allocation in radio systems and their application to cooperative communication systems. Objectives: 1. The students know and understand the basic structures, concepts and algorithms of machine learning and deep learning including application-related design, classification and training methods. They know typical and current problems and areas of application of machine learning and are able to evaluate them critically. They can design, train and validate problem-specific artificial neural networks with up-to-date software. 2. The students have an overview of cooperation techniques and their applications in modern communication networks. They know the approaches and methods of game theory and can use them to analyze conflict situations, such as those that occur when resources are allocated in communication systems. They are familiar with sample systems and the associated analytical and simulative considerations as well as exemplary implementation using implementation on practical systems.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study. The language of instruction can be either German or English. At the beginning of the teaching period, the lecturer announces in which language the module will be taught.	
Prerequisites	Competences acquired in modules such as Information Theory, Systems Theory, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module examination consists of a document PL1 for qualification objective 1 and a written exam PL2 of 120 minutes duration for qualification objective 2. With up to 15 registered students, the examinations can be replaced by an oral examination as an individual examination of 30 minutes each. If applicable, this will be announced to the registered students at the end of the registration period, as is customary for the faculty.	

ECTS credit points and grades	7 ECTS credit points The module grade is the arithmetic mean of the grades for both elements of assessment.
Frequency	Annually, in the summer semester
Workload	210 hours
Duration	1 semester

Module number	Module name	Lecturer in charge
ET-12 10 23	Seminar for Graduate Students on Information Technology	
Contents and objectives	Content: - Current trends and issues of Information Technology in various applications - Methods of scientic and project-based working as well as the presentation of results Objectives: The students are capable of solving a given task independently, individually, and in teams. They master the documentation of the work and the methods used, and are capable of presenting and discussing the results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 02 Signal Theory, ET-12 10 01 Information Theory, ET-12 08 18 Integrated Circuit Design and ET-12 09 06 Acoustics	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade for the assignment and to 1/3 of the grade for the presentation.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 11 01	Solid-State and Nano Electronics	Prof. Dr. rer. nat. et Ing. habil. Thomas Härtling
Contents and objectives	The module comprises: – **Solid-state electronics** with electronic functions based on di-, piezo-, pyro- and ferroelectricity, magnetic effects, electronic effects of plasmons and electron emission, – **Nanotechnology and nanoelectronics** of nanoelectronic devices (effects in nanodots and nanowires as well as effects taking place at very small numbers of charge carriers). Intended learning outcome: After successfully passing the module, students are able – to bring physically caused material effects to bear, – to apply probability-based theoretical basics of these effects, – to evaluate these effects, and – to use electronic and ionic effects for up-to-date electron devices.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, self-study.	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-01 04 04 Partial Differential Equations and Probability Theory, Materials Science, ET-12 12 01 Microsystems and Semiconductor Technology or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 8, the module assessment consists of a written exam of 90 minutes. With up to 8 registered students, the module assessment consists of an oral exam as individual exam of 30 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the exam.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 08 27	Neuromorphic VLSI Systems	Prof. Dr.-Ing. habil. Ch. G. Mayr
Contents and objectives	The content of the module includes: - Design Methods for Integrated Analog CMOS circuits and their circuit sizing, - neuromorphic VLSI systems and their neurobiological basics, common abstraction models, as well as the use in research and technology, eg. in brain-machine-interfaces and for signal processing, - foundations, concepts and methods for the preparation and analysis of analog and neuromorphic CMOS circuits with the design software Cadence DF2. Outcomes: After completing the module, students will be familiar with the areaof neuronal networks from neurobiological foundations up to to the application circuit. They are able to work with design tools (Cadence DF2, Specter), to design and dimension CMOS circuits, and to verify the parameters by simulation and to create associated circuit layouts.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study.	
Prerequisites	Competences acquired in modules such as Basics of Electrical Engineering, ET-12 08 31 Electronic Circuits, ET-12 09 01 Systems Theory, ET-12 02 02 Numerical Analysis, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment consists of an assignment and a report.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade is the weighted mean of the parts of the assessment: M = (2 PL1 + PL2 / 3..	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 11 04	Sensors and Sensor Systems	Prof. Dr.-Ing. habil. G. Gerlach
Contents and objectives	The module comprises: – Physical effects connecting diverse measurands of sensors with electronic sensor quantities – Properties of sensors (material properties, transducer mechanisms, fabrication technology, construction of sensors, application requirements), – Design, application and operation of sensors Intended learning outcome: After successfully passing the module students are able – to apply physical basics of sensors, – to connect coupling effects and interferences caused by material properties, fabrication and application, – to estimate the impact of effects upon the sensor behaviour and to compare it with other influences, and – to use sensors for diverse applications.	
Modes of teaching and learning	Lectures, exercises, and lab work with at least 6 hours per week (typically 4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course), and self-study.	
Prerequisites	Competences acquired in modules such as Introduction to Analysis and Algebra, Calculus for Functions with Several Variables, ET-01 04 03 Complex Function Theory, ET-01 04 04 Partial Differential Equations and Probability Theory, ET-12 12 01 Microsystems and Semiconductor Technology or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 150 minutes and a lab course.	
ECTS credit points and grades	7 ECTS credit points The module grade is calculated from the weighted mean of both the grade of the written exam (2/3) and the grade of the lab course (1/3).	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 11 05	Plasma Technology	Prof. Dr. E. v. Hauff
Objectives	Students have a fundamental understanding of the physics of plasmas used in industrial processes and tools. Furthermore, they are able to choose suitable technical plasma sources and plasma process tools for specific applications. In addition they can name typical examples for layers and layer stacks used in major application fields for coatings.	
Contents	The module contents include: 1. The fundamentals of plasma physics, industrial plasma processes, and process tool design 2. Basics of thin film growth, hard coatings and barriers, glass and optical coatings, electronic and functional coatings, and treatment technologies	
Modes of teaching and learning	4 hours per week lectures, 2 hour per week exercises, and self-study. The language of construction is English.	
Prerequisites	Competences acquired in modules such as Physics.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment consists of a written exam of 90 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is the grade of the written exam.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 12 01	Microsystems and Semiconductor Technology	Prof. Dr.-Ing. A. Richter
Contents and objectives	The module includes: - Fundamentals of microsystems technology - Micro-structuring technologies (manufacturing of complex, miniaturized systems) - Materials for semiconductor and micro technology - Sensory applications (basic material, semiconductor technologies, micro technology) Outcomes: On completion of the module, the students have the ability to specifically select the materials of the semiconductor and micro technology for micro sensor and micro actuator applications, to determine their functional parameters and to use the associated semiconductor technologies for structuring and system configuration.	
Modes of teaching and learning	8 hours per week lectures, 1 hour per week tutorial, 3 hours per week practical lab courses, and self-study.	
Prerequisites	Basic knowledge acquired in modules such as Basics of Electrical Engineering, Materials Science, ET-12 08 11 Microelectronic Technologies and Devices or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. With up to 15 registered students, the module assessment consists of two individual oral exams of 35 minutes. If the number of registered students exceeds 15, the module assessment consists of 2 written exams of 90 minutes and a lab course.	
ECTS credit points and grades	12 ECTS credit points The grade of the module is determined by the arithmetic mean of the grades of the exams: M = (2 PL1 + 2 PL2 + PL3) /5.	
Frequency	annually, starting in winter semester	
Workload	360 working hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 12 12	Design of Microelectro-mechanical Systems	Prof. Dr.-Ing. habil. U. Marschner
Contents and objectives	The module includes: - Design of microsystems with modeling and simulation of techniques and processes (electrical devices, sensors and actuators as well as complete systems) - Electromechanical networks with mechanical, magnetic, fluidic (acoustic) and coupled systems (circuit-oriented representation, interaction) - Combination of network modelling with the method of finite element modeling (complete systems consisting of electrical and non electrical components) Outcomes: The students have competences: - to describe the basic model of technological processes - in effective design and descriptive analysis of the dynamic behavior of electro-mechanical, magnetic and fluidic systems - about the function and modeling electromechanical transducers - in operation and applications of FEM and FDM methods - in complete system description using HDL languages	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, 1 hour per week assignment, and self-study.	
Prerequisites	Competencies acquired in modules such as Materials Science, Physics, or equivalent	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The module assessment is a written exam of 150 minutes PL1 and an assignment PL2.	
ECTS credit points and grades	7 ECTS credit points The grade of the module is weighted mean of the assessments: M = (3 PL1 + PL2) / 4.	
Frequency	annually, in the summer semester	
Workload	210 working hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 12 04	Memory Technology	Prof. Dr.-Ing. T. Mikolajick
Contents and objectives	This module covers memory concepts in the market and in research respectively development stage: - Magnetic memories - Optival memories - Semiconductor memories (SRAM, DRAM, nonvolatile Memories (EPROM, EEPROM, Flash)) - Innovative semiconductor memories (e.g. ferroelectric, magnetoresistive, resisitive, organic, and single molecule memories) Objectives: After completion of the module the students have the competences to optimize and develop new generations of existing memory concepts. Based on the physical effects they will also be able to develop new memory concepts. Furthermore, the students are able to evaluate the areas of application for the memory concept and are aware of their limitation.	
Modes of teaching and learning	3 hours per week lectures, 2 hours per week seminars, and self-study. The module is taught in English.	
Prerequisites	Competencies acquired in modules such as ET-12 08 11 Microelectronic Technologies and Devices, or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 20, the module assessment consists of a written exam of 90 minutes. With up to 20 registered students, the written exam will be replaced by an oral exam as individual exam of 15 minutes.	
ECTS credit points and grades	7 ECTS credit points The grade of the module is the grade of the exam.	
Frequency	Annually, beginning in the summer semester	
Workload	210 working hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 12 09	New Actuators and Actuator Systems	Prof. Dr.-Ing. A. Richter
Contents and objectives	Content: - Unconventional actuators (Systematics of actuatoric effects, the physical basis of these effects, operating principles, design and dimensioning guidelines, application examples and relevant application fields) - microfluidics (Fluid properties, fluid dynamics, phenomena of fluid manipulation, basic elements and basic operations, platform technologies, analytical methods) Objectives: The students are able to select appropriate actuator principles for specific tasks, to define the necessary interfaces for the system implementation and to dimension the actuator elements appropriately. They are able to recognize the unique physical characteristics of the fluid motion in microstructures and are able to apply technologies and analysis methods for microfluidic systems.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, 1 hour per week practical lab course, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 12 01 Microsystems and Semiconductor Technology or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 15, the module assessment consists of a written exam of 90 minutes, a presentation and a lab course. With up to 15 registered students, the module assessment consists of an oral individual exam of 30 minutes, a presentation and a lab course.	
ECTS credit points and grades	7 ECTS credit points The grade of the module is the weigthed mean of the grades for the different elements of assessment: the grade for the oral exam contributes by 50%, the grade for the presentation and for the lab course contribute by 25% each.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 12 07	Innovative Concepts for Active Nanoelectronic Devices	Prof. Dr.-Ing. T. Mikolajick
Contents and objectives	The module includes innovative semiconductor components and nanoelectronic materials. Objectives: The students will have the ability, to recognize material science boundary conditions with the help of knowing the design, properties, production and structure formation of materials and the effects and the basic types of small structures of component concepts, applications and future trends as well as the bottom up and top down nanoelectronic concepts. Furthermore, they will be able to design innovative concepts for active components and systems of nanoelectronics and to understand physical effects and transport mechanisms, as well as to recognize concrete embodiments for components currently in use but also in the research or development stage and the respective technological and electrical boundary conditions.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study. The module is taught in English.	
Prerequisites	Competences acquired in modules such as ET-12 08 13 Physics of Selected Devices or equivalent.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. If the number of registered students exceeds 20, the module assessment consists of 2 written exams of 90 minutes each and a collection of practical lab course tests. With up to 20 regsitered students the assessment consists of 2 individual oral exams of 20 minutes each.	
ECTS credit points and grades	7 ECTS credit points The grade of the module is the weighted mean of the different elements of assessment: M = (4PL1+ 4PL2 + 2PL3)/10.	
Frequency	annually, in the winter semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 12 08	Advanced Seminar Microelectronics	Prof. Dr. rer. nat. J. W. Bartha
Contents and objectives	The module consists of: - Specific topics and trends in microelectronics and - Methods of scientific and project based engineering work. Objectives for qualification: The students are capable of applying their skills and expertise to solve specific problems individually or within a team. They master the documentation of their workflow and cope with the presentation of their results.	
Modes of teaching and learning	2 hours per week seminar and self-study	
Prerequisites	Competences acquired in modules such as Materials Science, Physics.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed successfully. The assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade is derived from the grade for the assignment (2/3) as well as the grade for the presentation (1/3).	
Frequency	annually, each winter semester	
Workload	120 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 13 01	Control of Continuous-Time Processes	Prof. Dr.-Ing. habil. K. Röbenack
Contents and objectives	Content: Basic principles of control of linear systems with focus on frequency domain methods, state-space methods and sampled-data control. Objectives: The students • understand the basic structure of rules and control systems. They are able to mathematically describe linear continuous-time systems (mainly in the frequency range) and to analyse these with regard to their stability. Further, they are able to systematically design single-loop linear controllers. • understand the solutions of state-space models in time and frequency domains, are familiar with the concepts of controllability and observability and are able to check these properties for given systems. They are also capable of designing state controller and state observer and understand the basics of sampled-data control.	
Modes of teaching and learning	5 hours per week lectures, 2 hours per week exercises, 2 hours per week practical lab courses, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 120 minutes each (P1 and P2) as well as a lab course (P3).	
ECTS credit points and grades	9 ECTS credit points The module grade is calculated from the weighted average of the grades of the written exams and the grade of the lab course. PL1 and PL2 contribute by 2/5 each, P3 by 1/5.	
Frequency	Annually The module starts in the winter semester.	
Workload	270 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 13 10	Nonlinear Systems und Process Identification	Prof. Dr.-Ing. habil. K. Röbenack
Contents and objectives	Content: The module includes • Design and analysis of nonlinear control systems, such as sliding mode control, backstepping and • Identification of parameters from measurement data, for example, by using classes of static, discrete-time and continuous-time models Objectives: The students are able to work with nonlinear control systems, mathematically analyze such systems and dimension simple controller for nonlinear systems. They are able to identify the parameters from measurement data for particular classes of static, discrete-time and continuous-time models.	
Modes of teaching and learning	4 hours per week lectures, 2 hours per week exercises, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 120 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the arithmetic mean of both exams.	
Frequency	annually, in the summer semester	
Workload	210 hours	
Duration	1 semester	

Module number	Module name	Lecturer in charge
ET-12 13 11	Nonlinear Control Systems, Advanced	Prof. Dr.-Ing. habil. Klaus Röbenack
Contents and objectives	Content: • Mathematical tools of nonlinear systems (e.g. differential geometry) • System theoretical elements of complex control systems (e. g. spatially distributed systems) Objectives: The students are capable of analyzing complex control systems and dimension nonlinear control systems. They are able to model, identify, analyze, control and regulate complex control systems (e.g. spatially distributed systems) by means of mathematical and system theoretical correlations.	
Modes of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 09 01 Systems Theory and ET-12 13 01 Control of Continuous-Time Processes.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 90 minutes each.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the arithmetic mean of both exams.	
Frequency	Annually The module starts in the summer semester.	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 13 12	Optimal and Robust Multi-variable Control Systems	Prof. Dr.-Ing. habil. K. Röbenack
Contents and objectives	Content: 1. Analysis and design of optimal and / or robust control 2. Design of control concepts for multivariable systems or systems with model uncertainties Objectives: The students create optimal or robust controls and regulations (controller design). They are able to develop control concepts for multivariable systems or systems with model uncertainties, e.g. for the simultaneous influencing or decoupling of several sizes.	
Methods of teaching and learning	4 hours per week lectures, 1 hour per week tutorial, and self-study	
Prerequisites	Competences acquired in modules such as ET-12 13 01 Control of Continuous-Time Processes.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessment is passed. The assessment consists of two written exams of 90 minutes.	
ECTS credit points and grades	7 ECTS credit points The module grade is determined by the arithmetic mean of both exams.	
Frequency	Annually The module starts in the summer semester.	
Workload	210 hours	
Duration	2 semesters	

Module number	Module name	Lecturer in charge
ET-12 13 13	Seminar for Graduate Students on Control Theory	Prof. Dr.-Ing. habil. K. Röbenack
Contents and objectives	The content of the module includes: - Classical and modern concepts of control theory Objectives: After completing this module, students are capable of familiarising themselves with papers on Control Theory as well as Systems Theory, of presenting their hereby acquired knowledge as well as testing their knowledge in examples of use.	
Modes of teaching and learning	2 hours per week seminars and self-study	
Prerequisites	Competences acquired in modules such as ET-12 13 01 Control of Continuous-Time Processes, ET-12 13 10 Nonlinear Systems und Process Identification.	
Requirements for the award of ECTS credit points	The credit points are earned if the module assessement is passed. The module assessment consists of an assignment and a presentation of 30 minutes.	
ECTS credit points and grades	4 ECTS credit points The module grade consists to 2/3 of the grade for the assignment and to 1/3 of the grade for the presentation.	
Frequency	annually, in the winter semester	
Workload	120 hours	
Duration	1 semester	