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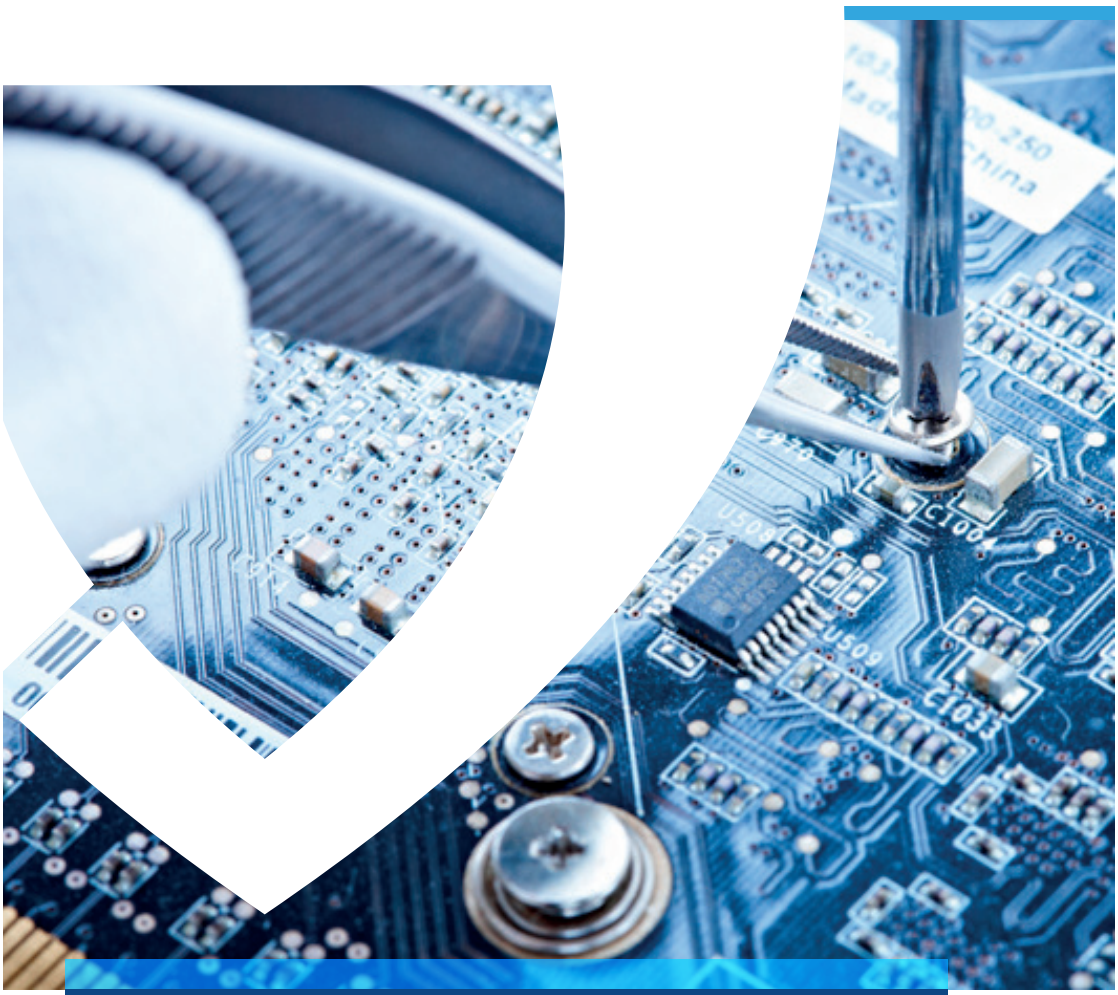


Study Program Handbook

Electrical and Computer Engineering

Bachelor of Science

Subject-specific Examination Regulations for Electrical and Computer Engineering (Fachspezifische Prüfungsordnung)

The subject-specific examination regulations for Electrical and Computer Engineering are defined by this program handbook and are valid only in combination with the General Examination Regulations forUndergraduate degree programs (General Examination Regulations = Rahmenprüfungsordnung). This handbook also contains the program-specific Mandatory Module and Examination Plans (Appendix 1a / 1b).

Upon graduation, students in this program will receive a Bachelor of Science (BSc) degree with a scope of 180 ECTS (for specifics see chapter 3 of this handbook).

Version	Valid as of	Decision	Details
Fall 2018 - V1	01.09.18	Academic Senate August 29, 2018	Master Version

Contents

1 The Electrical and Computer Engineering (ECE) Study Program

1.1 Concept

The extensive developments in microelectronics over recent decades have triggered a digital revolution where computers take center stage. While we still think of a computer as a desktop or a laptop, digital computing and digital signal processing have become vital for many of the products in our everyday life such as cars, mobile phones, tablets, cameras, household appliances, and more. The Electrical and Computer Engineering program focuses on the areas of communications and digital signal processing, including the enabling digital processing elements and their programming. Those enabling technologies are mostly subsumed under the headline of embedded systems.

1.2 Specific Advantages of the Electrical and Computer Engineering Program at Jacobs University

- Razor-sharp focus on signal processing, communications, and embedded systems: The ECE program at Jacobs University has just been redesigned to reflect the dynamic changes of electrical and computer engineering in Industry and Society. With a a sharp focus on signal processing, communications, and embedded systems, students will be ready to face the challenges of emerging areas such as Cyber-physical Systems, Internet of Things, Connected Vehicles and more.
- Early involvement in research: ECE at Jacobs University is strongly research-oriented. Each professor in the department has an independent research group including not only senior, but also junior students, even at the Bachelor studies level.
- Wide cooperation and open access to instructors: Jacobs University as a whole is a flat institution, where professors, research staff, and students engage in open dialog and cooperation without barriers.

1.3 Program-Specific Qualification Aims

By the end of this B.Sc. degree program, the student will be able to:

—— Theory ——

- describe and explain central concepts and tasks in general electrical engineering, analog and digital circuitry, deterministic and random signal processing, probability and information theory, and communications,
- differentiate between different types of signals, starting from DC and single sinusoids, general periodic and non-periodic functions to specific ones like ranging signals, audio, speech, or video, being able to treat them with the corresponding mathematical and algorithmic tools,
- describe properties of transmission media, be it wireless, wireline, or optical, and match suitable transmission methods and algorithms to them,
- convert signal processing and communications problems into a suitable mathematical treatment and algorithmic formulation to predict performances and determine limitations

via analytic calculation or simulation,
- identify implementation options based on signal processors or FPGAs to transfer theoretically described concepts and simulations into actual hard- and software realizations,
- discover over-arching relations between the central concepts, developing a holistic view, e.g., recognizing that all linear transforms are directly linked to each other, hence, show tightly related properties; algorithms in error-correction coding are similar to those in signal processing; a complex-baseband signal description for modulation shows links to the basic complex descriptions of sinusoidal signals introduced in the first study year,
- describe the structural differences and know the programming of digital signal processors and FPGAs (field programmable gate array) and circuit layout,

————— Practical Work —————
- design circuitry, be it analog or digital, and program digital hardware components, be it signal processors or FPGAs,
- set up test circuits and simulate them,
- use dedicated high-end measurement equipment, like digital scopes, network and spectrum analyzers, operated either manually or under remote control,
- develop a suitable level of independence for industrial or academic environments,
- solve first basic theoretical or applied research projects guiding to research frontiers or illustrate the practical relevance of taught subjects,

————————- Transferable Skills ————————-
- analyze scientific and technical questions, put them into relationship to what is already known in the literature, suggest avenues to solve the questions at hand, and communicate these solutions effectively,
- present own results, and those of others, concisely and professionally in front of an audience,
- compare and judge results of analytic model-based treatment, simulation, and actual implementation,
- demonstrate a general set of scientific methods and skills used in electrical and computer engineering, many of which are applicable to other engineering and natural science disciplines,
- understand the value of reproducible results and ethical standards within science,
- recognize the value chain of research, development, and production

1.4 The Jacobs University Employability and Personal Development Concept

Jacobs University's educational concept aims at fostering employability which refers to skills, capacities, and competencies which transcend disciplinary knowledge and allow graduates to quickly adapt to professional contexts. Jacobs University defines employability as encompassing not just technical skills and understanding but also personal attributes, competencies and qualities enabling students to become responsible members of their professional and academic fields as well as of the societies they live in. Graduates of JU will be equipped with the ability to find employment and to pursue a successful professional career, which means that graduates

will be able to:

- acquire knowledge rapidly, gather, evaluate and interpret relevant information and evaluate new concepts critically to derive scientifically funded judgements;
- apply their knowledge, understanding and methodological competences to their activity or profession to solve problems;
- present themselves and their ideas effectively and to negotiate successfully;
- demonstrate understanding and knowledge of business principles and processes and to manage projects efficiently and independently;
- take responsibility for their and their team's learning and development.

Graduates of JU will also be equipped with a foundation to become globally responsible citizens, which includes the following attributes and qualities:

- graduates have gained intercultural competence; they are aware of intercultural differences and possess skills to deal with intercultural challenges; they are familiar with the concept of tolerance;
- graduates can apply problem-solving skills to negotiate and mediate between different points of view and to manage conflicts;
- graduates can rely on basic civic knowledge; they are able to analyse global issues of economic, political, scientific, social or technological nature; they are able to evaluate situations and take decisions based on ethical considerations;
- graduates are able and prepared to take on responsibility for their professional community and society.

1.5 Career Options

Higher demands for ECE engineers are to be expected. This is partly due to general economic trends, but especially related to unusually low student numbers in recent years. Especially, due to rapid developments, fundamental principles and cross-boundary knowledge becomes increasingly important. In addition, the required qualification profiles and personal attitudes differ for academic versus industrial careers. The ECE program at Jacobs University responds to all of these conditions for a successful career through the flexibility of the program and the transdisciplinary education. Jacobs University graduates start their careers in very diverse companies, successfully continue at old renown universities, or stay with Jacobs University for graduate education.

1.6 More Information and Contact

For more information please contact the study program chair:

Dr. Werner Henkel
Professor of Electrical Engineering
Email: w. henkel@jacobs-university.de
Telephone: +49 421 200-3157

or visit our program website: www.jacobs-university.de/ece-program

2 The Curricular Structure

2.1 General

The undergraduate education at Jacobs University equips students with the key qualifications necessary for a successful academic, as well as professional career. By combining disciplinary depth and transdisciplinary breadth, supplemented by skills education and extracurricular elements, students are prepared to be responsible and successful citizens within the societies they work and live in.

The curricular structure provides multiple elements enhancing employability, transdisciplinarity, and internationality. The unique Jacobs Track, offered across all study programs, provides a broad range of tailor-made courses designed to foster career competencies. These include courses which promote communication, technology, business, (German) language, and management skills. The World Track, included in the third year of study, provides extended company internships or study abroad options. Thus students gain training on the job and intercultural experiences. All undergraduate programs at Jacobs University are based on a coherently modularized structure, which provides students with a broad and flexible choice of study plans to meet their major as well as minor study interests.

The policies and procedures regulating undergraduate study programs at Jacobs University in general can be found on the website.

2.2 The Jacobs University 3C-Model

Jacobs University offers study programs according to the regulations of the European Higher Education Area. All study programs are structured along the European Credit Transfer System (ECTS), which facilitates credit transfer between academic institutions. The three-year undergraduate program involves six semesters of study with a total of 180 ECTS credits. The curricular structure follows an innovative and student-centered modularization scheme - the 3C-Model - which groups the disciplinary content of the three study years according to overarching themes:

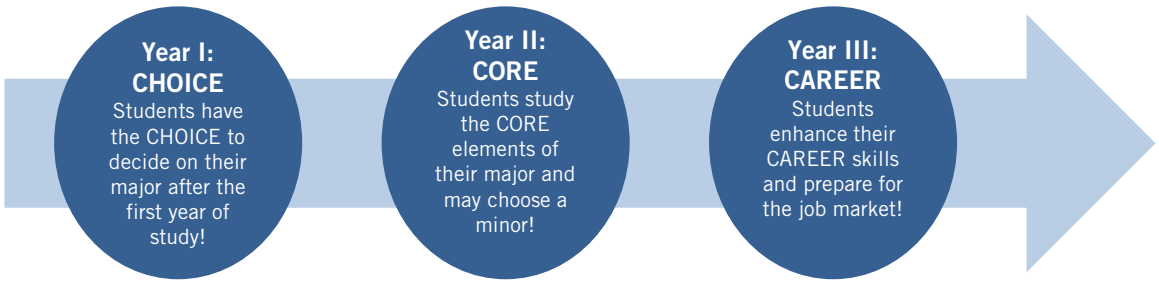


Figure 1: The Jacobs University 3C-Model

2.2.1 YEAR 1 - CHOICE

The first study year is characterized by a broad offer in disciplinary and interdisciplinary education. Students select three CHOICE modules from a variety of study programs. As a unique asset, our curricula allow students to select their study program freely from among the three selected CHOICE modules during their first year of study.

2.2.2 YEAR 2 - CORE

In the second year, students take three in-depth, discipline-specific CORE modules. One CORE module can also be taken from a second, complementary discipline, which allows students to incorporate a minor study track into their undergraduate education. Students will generally qualify for a minor if they have successfully taken at least one CHOICE module and one CORE module in a second field, and this extra qualification will be highlighted in the transcript.

2.2.3 YEAR 3 - CAREER

During their third year, students must decide on their career after graduation. In order to facilitate this decision, the fifth semester introduces two separate tracks. By default students are registered for the World Track.

1. **The World Track**
   In this track there are two mandatory elective options:

   - **Internship**
     The internship program is a core element of Jacobs Universitys employability approach. It includes a mandatory semester-long internship off-campus (minimum 16 weeks in full-time) which provides insight into the labor market as well as practical work experience related to the respective area of study. Successful internships may initiate career opportunities for students.
     As an alternative to the regular internship, a limited number of students have the opportunity to prepare in a structured manner the formation of their own start-up in the 5th semester, and can attain 20 ECTS for this study-related achievement. Jacobs University cooperates with the City Accelerator Bremen (CAB) to which students can be admitted. There are several requirements which must be fulfilled before the 5th semester in order to be admitted to the CAB, i.e. attendance of specific seminars and workshops and the successful presentation of the business idea within the framework of a competition (pitch). The module is successfully completed, when the student / team of students have submitted the business plan to CAB.

     For further information, please contact the Career Services Center (http://www.jacobs-university.de/career-services/contact).

   - **Study Abroad**
     Students can take the opportunity to study abroad at one of our partner universities.

Courses recognized as study abroad credits need to be pre-approved according to the Jacobs University study abroad procedures and carry minimum of 20 ECTS credits in total. Several exchange programs allow you to be directly enrolled at prestigious partner institutions worldwide. Jacobs University's participation in Erasmus+, the European Unions exchange program, provides an exchange semester at a number of European universities including Erasmus study abroad funding.

For more information, please contact the International Office (http://intoffice.user.jacobs-university.de/outgoing/).

2. **The Campus Track**
   Alternatively, students may also opt to follow the Campus Track by continuing their undergraduate education at Jacobs, namely by selecting an additional CORE module during their third year and redistributing the remaining courses and modules across the third year. This opportunity can be used by students to more intensively focus on their major or to fulfill the minor requirements for a second field of interest.

In the sixth semester, all students select from a range of specialization courses within their study program and concentrate on their Bachelor thesis in the context of a Project/Thesis Module.

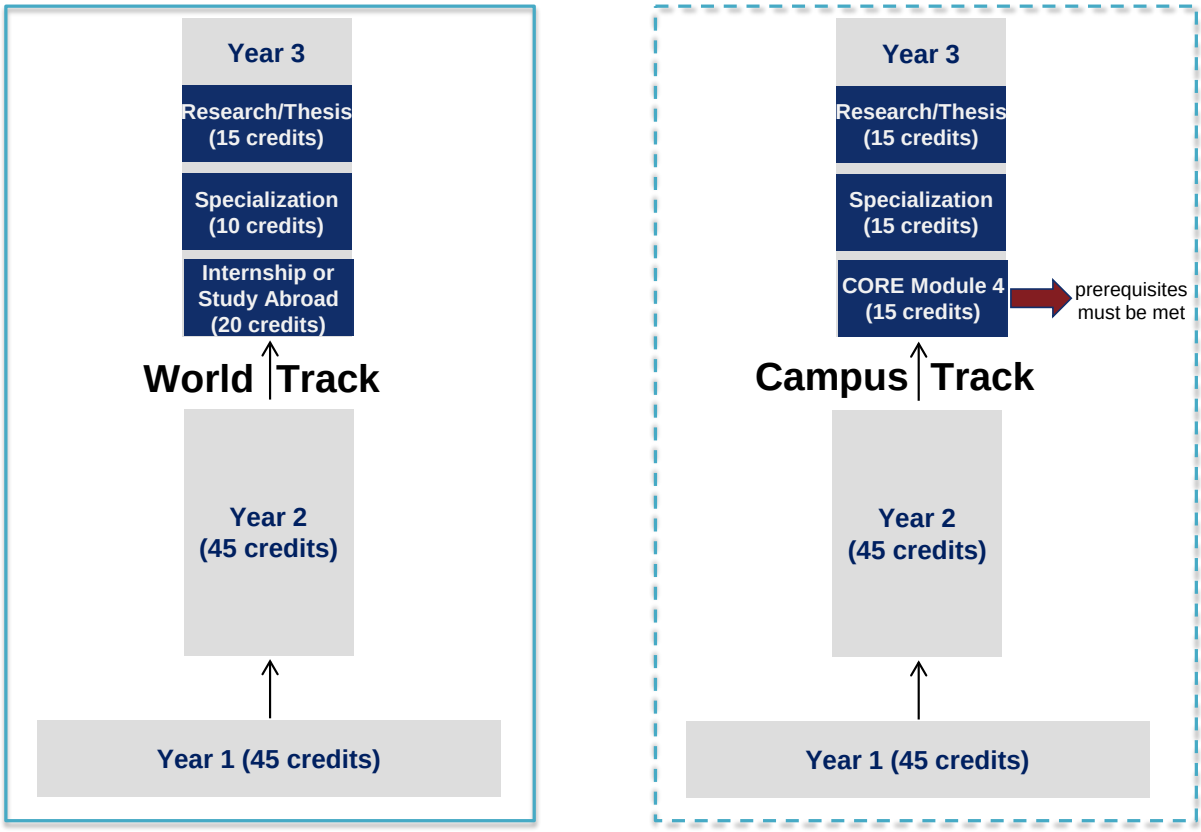


Figure 2: World Track versus Campus Track

Career Advising

Is a mandatory component of the Jacobs University's Advising and Counseling Scheme. Further components are "Academic Advising" and "Psychological Counseling and Intercultural Services". Throughout their studies all students attend a mandatory set of career skills events. The mandatory "Career Skills Advising" prepares all undergraduate students at Jacobs University for the transition from student life to working life as well as for their future career. Skills, knowledge and information which are fundamental for participation in an internship or a semester abroad will be conveyed concurrently. Essential components include information sessions, compulsory workshops on various career-relevant topics as well as participation in the annual Jacobs Career Fair.

All undergraduate students will be automatically registered for "Career Skills Advising". However, every student has to keep track of his/her individual fulfillment of requirements and has to register on CampusNet for all workshops and sessions during the official registration period at the beginning of each semester. An overview of the sequence in which events should be attended is shown in the table below.

CAREER ADVISING For Undergraduate Students matriculated Fall 2018

SEMESTER	1	2	3	4	5	6
MANDATORY BASICS	CSC-INFO Session: "CSC Services" CA01-990000		CSC-INFO Session: "World Track" CA01-990026			
MANDATORY SEMINARS	Both seminars have to be attended in your first or second semester: CSC-APPLICATION TRAINING CA01-990001 CSC-SUCCESS IN STUDIES, CAREER AND LIFE CA01-990031					
MANDATORY ELECTIVE SEMINARS (seminar program subject to availability)			Attend 2 out of several career skills seminars and workshops in your third or forth semester, i.e. ▪ Research & Contacting Employers ▪ Business Etiquette ▪ Presentation Skills ▪ Communication Skills ▪ Grad School Application Training ▪ Self-Management ▪ Time-Management ▪ Decision Making ▪ Preparing for an Interview ▪ Introduction to Project Management ▪ Career Orientation ▪ Working in Germany ▪ Stress Management			
OTHER MANDATORY COMPONENTS				CSC-JACOBS CAREER FAIR in February, on campus CA01-990003		
CAREER RELATED STUDY PROGRAM COMPONENTS					INTERNSHIP (World Track) or STUDY ABROAD (World Track) or CAMPUS TRACK (exceptional)	INTERNSHIP & STUDY ABROAD EVENT

Figure 3: Career Advising

2.3 The Jacobs Track

The Jacobs Track, another stand-alone feature of Jacobs University, runs parallel to the disciplinary CHOICE, CORE, and CAREER modules across all study years and is an integral part of all study programs. It reflects our commitment to an in-depth methodological education, it fosters our transdisciplinary approach, it enhances employability, and equips students with extra skills desirable in your general field of study. Additionally, it integrates essential language courses.

Mathematics, statistics, and other methods courses are offered to all students within a comprehensive Methods Module. This module provides students with general foundations and transferable techniques which are invaluable to follow the study content not only in the study program itself but also in related fields.

The Skills Module equips students with general academic skills which are indispensable for their chosen area of study. These could be, for example, programming, data handling, presentation skills, and academic writing, scientific and experimental skills.

The transdisciplinary Triangle Module offers courses with a focus on at least one of the areas of business, technology and innovation, and societal context. The offerings comprise essential knowledge of these fields for students from other majors as well as problem-based courses that tackle global challenges from different disciplinary backgrounds. Working together with students from different disciplines and cultural backgrounds in these courses broadens the students horizon by crossing the boundaries of traditional disciplines.

Foreign languages are integrated within the Language Module. Communicative skills and foreign language competence foster students intercultural awareness and enhance their employability in a globalized and interconnected world. Jacobs University supports its students in acquiring and improving these skills by offering a variety of language courses at all proficiency levels. Emphasis is put on fostering German language skills, as they are an important prerequisite for students to learn about, explore, and eventually integrate into their host country. Hence, acquiring 10 ECTS credits in German is a requirement for all students. Students who meet the requirements of the German proficiency level (e.g. native speakers) are required to select courses in any other language program offered.

2.4 Modularization of the Electrical and Computer Engineering Program

Year 1
Take the mandatory module listed below and select two further CHOICE modules from a different study area.

Introduction to Electrical Engineering (CH10-GenEE)
The module comprises the classical introduction to Electrical Engineering (EE) in general. Starting from the basics of the electric phenomenon, its fundamental elements (charge, current, potential, energy, etc.), its interaction with materials (conductivity, capacitance, inductance etc.) and its manipulation by man-made structures (electronic components and circuits), the course then develops into a wide set of general principles, laws and analytical tools to understand electric circuits and electric systems in general. The module also offers a solid foundation on which specialization areas in EE (e.g. Communications, Control, etc.) are built.

Year 2
Take all three modules or replace one with a CORE module from a different study program.

Communications (CO25-Communic)
The module comprises the essential contents of digital communications. Starting from first steps to understand modulation and demodulation procedures with and without noise, students will learn the basics for modern wireless communications starting from wireless channel properties to wireless transmission and system aspects. Additionally, the information theoretic foundation is provided that determines the possibilities and methods for error analysis, data compression, communications, and encryption.

Electronics and Noise (CO26-ElectroNoise)
The module offers a solid background in electromagnetic theory, circuit analysis & design and the theory of noise. To this end, the concepts of electric and magnetic fields are introduced, followed by Maxwells equations in vacuum and matter, and a discussion of how these lead to lumped element models on the one hand and field-based descriptions on the other. The design course (lecture+ lab) treats a variety of combinations of linear and non-linear circuit elements (resistors, capacitors, inductors, diodes, transistors, operational amplifiers, logic gates, and flip-flops) from a modular design perspective (supplies, amplifiers, switches, triggers, registers, counters and timers). Noise as a ubiquitous challenge, in particular to mobile technology, is presented based on a focused introduction to probabilities, random variables, their distribution functions leading to a discussion of random voltages and rules for their treatment in electrical circuits.

Signal Processing (CO27-SigProcess)
The Signal Processing module covers Signals & Systems and Digital Signal Processing together with their corresponding labs, which summarizes knowledge standard for all EE / ECE programs worldwide plus some additional introduction into digital communications as a possible DSP application. The module comprises in depth treatment of all linear transforms, such as Fourier series, Fourier transform, Laplace and z-transforms (one- and two-sided), Discrete Fourier Transform (DFT) and its fast counterpart FFT. Furthermore, digital filters are discussed

in detail and methods that are essential for speech, audio, and video processing, such as sub-band coding, linear prediction, Discrete Cosine Transform to name just a few. In the digital communications part, the description and components of baseband, single-carrier, and multicarrier transmission are described, including matched filter, whitening filter, and equalizer structures. Labs will provide practical aspects starting from simple signal processing tasks, up to programming a signal processor, including computer architectural aspects.

Some CORE Modules require students to have taken a specific CHOICE Module. Please see the Module Handbook for details regarding pre-requisites.

Year 3
In the 3rd year students follow the World Track by default:

1. **World Track**
   5th Semester
   - Internship / study abroad

   6th Semester
   - ECE Project / Thesis Module
   - Program-specific Specialization Module Exemplary course offering:
     - Coding Theory
     - Wireless Communications II
     - Advanced Digital Design

2. **Campus Track**
   Students who do not enter the World Track follow the Campus Track.
   5th and 6th Semester
   - Program-specific Project / Thesis Module
   - Program-specific Specialization Module
     (please see World Track for exemplary course offering)
   - Additional CORE Module

2.5 The Bachelor Thesis / Project

This module is a mandatory graduation requirement for all undergraduate students. It consists of two components in the major study program guided by a Jacobs Faculty member:

1. **A Research Project** (5 ECTS)
   and
2. **The Bachelor Thesis** (10 ECTS)

The workload for the project component is about 125 hours and for the thesis component about 250 hours.The title of the thesis will be shown on the transcript.

2.5.1 Aims

Within this module, students apply knowledge they have acquired about their major discipline, skills, and methods to become acquainted with actual research topics, ranging from the identification of suitable (short-term) research projects, preparatory literature searches, the realization of discipline-specific research, and the documentation, discussion, and interpretation of the results. Research results obtained from the Research Project can be embedded in the Bachelor Thesis.

2.5.2 Intended Learning Outcomes

1. Research Project
   This module component consists of a guided research project in the major study program. The well-defined research task must be completed and documented according to the scientific standards in the respective discipline. It involves a high degree of independence, supported by individualized instructor feedback and guidance.
2. Bachelor Thesis
   With their Bachelor Thesis students should demonstrate mastery of the contents and methods of the major specific research field. Furthermore, students should show the ability to analyze and solve a well-defined problem with scientific approaches, a critical reflection of the status quo in scientific literature, and an original development of their own ideas.

Both, the Research Project and the Bachelor Thesis, can also have an inter- or transdisciplinary nature - with the explicit permission of the supervisor.

2.5.3 Supervision

Both module components can be performed with the same Jacobs faculty member, or different ones, the latter in order to allow a broader research experience. Students are required to choose a supervisor, at the latest, by the end of the drop-add period of the semester in which the module component is taken. **The selected supervisor(s) must approve the Project topic and Bachelor Thesis topic before the student starts to work towards the module component.** The respective study program chairs will assist in the search for prospective supervisor(s).

2.5.4 Registration

World Track students register for both components, at the earliest, in their 6th semester.
Campus Track students register for the Project component in the 5th and for the Bachelor Thesis component, at the earliest, in their 6th semester.

The registrations must be made before the end of the respective drop/add periods.

Later enrolment is possible for those students pursuing a second major or those who graduate late for other reasons. These students perform their (second) thesis earliest in the 7th semester of their studies. They have to contact the Student Records Office for individual registration.

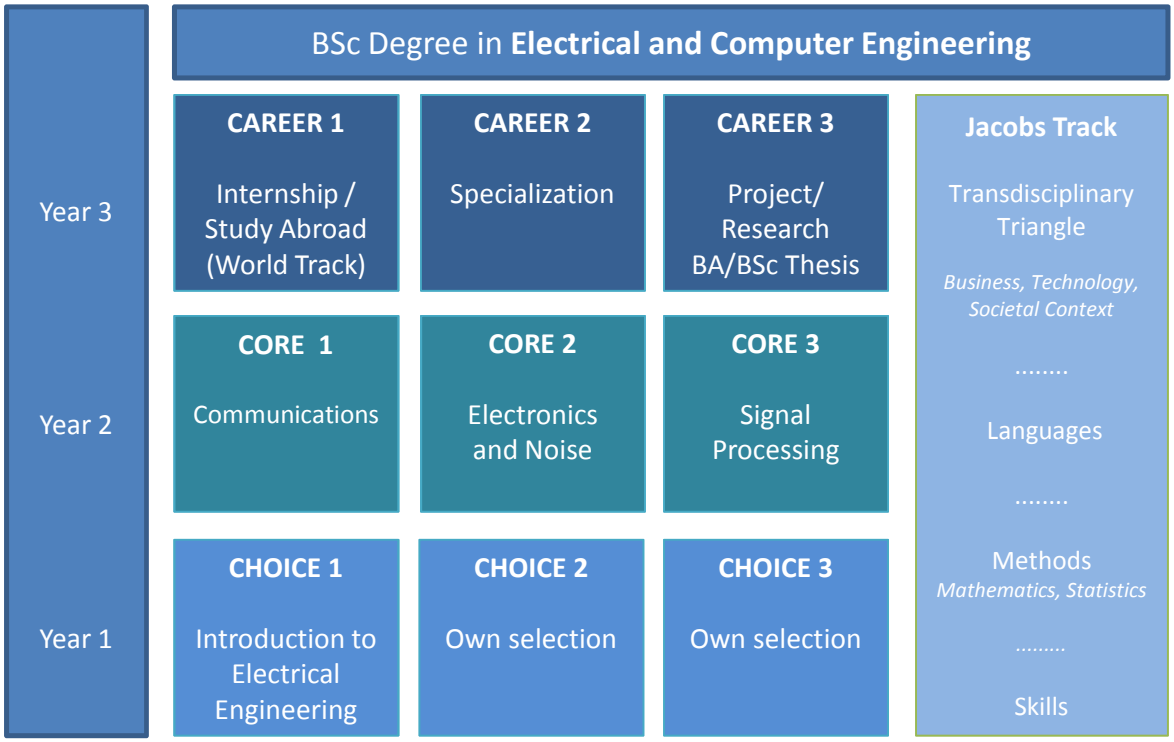
Students are allowed to extend their thesis related work into the intersession or summer break upon approval of the thesis supervisor and Student Records. Students are not allowed to register for different Bachelor Thesis courses in the same semester.

2.5.5 Formal Regulations for the Bachelor Thesis

- Timing
  The Thesis work has to be generated within the semester of registration. The semester period has 14 weeks.
- Extent
  The document must be between 15-25 pages in length, including references, but excluding appendices or supporting information. Deviations in length and format can be determined within individual study programs and should be communicated to all registered students by the study program chair.
- Cover page
  The cover page must show the title of the Bachelor Thesis, the university's name, the month and year of submission, the name of the student and the name of the supervisor.
- Statutory Declaration
  Each Bachelor Thesis must include a statutory declaration signed by the student confirming it is their own independent work and that it has not been submitted elsewhere. The respective form can be found on the Student Records Office website.
- Submission
  The Bachelor Thesis must be submitted as a hard copy (pdf-file) to the supervisor and additionally to the Student Records Office via online form on the Student Records Office website.

  Deadline for submission of the Bachelor Thesis is May 15 (unless specified otherwise by the Student Records Office).

2.6 Structure



YEAR 1 *Take three CHOICE modules, two free selection*
YEAR 2 *Take three CORE modules, one CORE module can be substituted by a CORE module from a second study program to pursue a minor*
YEAR 3 *Alternatively Campus Track with a 4th CORE module instead of internship/study abroad module*

Figure 4: Electrical and Computer Engineering Module Structure

3 Appendix 1a/1b: Mandatory Module and Examination Plans for World Track and Campus Track

Jacobs University Bremen reserves the right to substitute courses by replacements and/or reduce the number of mandatory/mandatory elective courses offered.

4 Appendix 2: Course Data for Program-Specific CHOICE and CORE Courses

All course data stated in the appendix is based on the previous study year and subject to change.

Appendix 1a - Mandatory Module and Examination Plan for World Track

Electrical and Computer Engineering – World Track

Matriculation Fall 2018

	Program-Specific Modules	Type	Status[1]	Semester	Credits		Jacobs Track Modules (General Education)	Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**45**						**20**
Take the mandatory CHOICE module listed below, this is a requirement for the ECE program.											
CH10-IntroEE	**Module: Introduction to Electrical Engineering**		**m**		**15**		**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CH10-300101	General Electrical Engineering I	Lecture	m	1	5		JT-ME-120103	Calculus I	Lecture	m	1	2,5
CH10-300111	Electrical Engineering I Lab	Lab	m	1	2,5		JT-ME-120104	Calculus II	Lecture	m	1	2,5
CH10-300102	General Electrical Engineering II	Lecture	m	2	5		JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
CH10-300112	Electrical Engineering II Lab	Lab	m	2	2,5		**JT-SK-Skills**	**Module: Skills**		**m**		**5**
	Module: CHOICE (own selection)		**e**	**1/2**	**30**		JT-SK-320111	Programming in C I	Lecture	m	1	2,5
Students take two further CHOICE modules from those offered for all other study programs. [2]							JT-SK-320112	Programming in C II	Lecture	m	2	2,5
							JT-TA-TriArea	**Module: Triangle Area**		**m**		**2,5**
								Take one course from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	1/2	2,5
							JT-LA-Language	**Module: Language**		**m**		**5**
								Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	1/2	5
							CA01-CarAdv	**Career Advising**[4]		**m**		
Year 2 - CORE					**45**							**20**
Take all three modules or replace one with a CORE module from a different study program. [2]												
CO25-Communic	**Module: Communications**		**me**		**15**		**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CO25-300202	Communications Basics	Lecture	m	3	2,5		JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	3	2,5
CO25-300203	Communications Lab	Lab	m	3	2,5		JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO25-300341	Information Theory	Lecture	m	4	5		CO16-100242	Numerical Methods II	Lecture	m	4	2,5
CO25-300311	Wireless Communications	Lecture	m	4	5							
CO26-ElectroNoise	**Module: Electronics and Noise**		**me**		**15**		**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**7,5**
CO26-300321	Probability and Random Signal Processing	Lecture	m	3	5			Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	3/4	7,5
CO26-300211	Electromagnetics	Lecture	m	3	5							
CO26-300212	Introduction to Electronics	Lecture	m	4	2,5							
CO26-300222	Electronics Lab	Lab	m	4	2,5							
CO27-SigProcess	**Module: Signal Processing**		**me**		**15**		**JT-LA-Language**	**Module: Language**		**m**		**5**
CO27-300201	Signals and Systems	Lecture	m	3	5			Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	3/4	5
CO27-300221	Signals and Systems Lab	Lab	m	3	2,5							
CO27-300302	Digital Signal Processing	Lecture	m	4	5		**CA01-CarAdv**	**Career Advising**[4]		**m**		
CO27-300231	Digital Signal Processing and Communications Lab	Lab	m	4	2,5							
Year 3 - CAREER					**45**							**5**
CA02 / CA03	**Module: Internship / Study Abroad**		**m**	**5**	**20**		**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**5**
								Take two courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	6	5
CA11-ECE	**Module: Project / Thesis ECE**		**m**		**15**		**CA01-CarAdv**	**Career Advising**[4]		**m**		
CA11-300303	Project ECE		m	6	5							
CA11-300304	Thesis ECE		m	6	10							
CA-S-ECE	**Module: Specialization Area ECE**		**m**		**10**							
	Take 10 ECTS of specialization courses [2]		me	5/6	10							
Total ECTS												**180**

[1] Status (m = mandatory, e = elective, me = mandatory elective)

[2] For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

[3] You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).

[4] Mandatory component of the Jacobs University's Counseling and Advising Scheme.

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
General Electrical Engineering I	CH10-300101	5
Module Affiliation CH10-IntroEE Introduction to Electrical Engineering	***Workload (hrs / sem)*** Contact Time: 35,00 Private Study: 90,00	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims

This course is the first part of a two-part course, spanning the first two semester of electrical engineering. The emphasis of the first semester is the analysis of circuits in DC steady state and transient modes. We start by familiarizing the student with some general concepts of Electrical Engineering, such as charge and capacitance (electrostatics) and inductance (electrodynamics), resistance, (semi)conductivity and dopped materials, Ohm's Laws, Kirchhoff's Laws, etc.. As the courses progresses, increasingly powerful circuit analysis tools are covered, including various circuit transformation tools such as Deltay-Wye, Source Transformation, Duality, Thevenin and Norton's equivalents and Tellegen's Theorem. The course then naturally moves to the analysis of the transient response of circuits with capactitor and inductors (RL, RLC, RLC and higher-order), including the Laplace Transform and various concepts that follows from the latter such as Impedance, Transfer Function (especially in relation to the study of OpAmp circuits), and Two-Port Networks. Theory is introduced through an alternation of expositive and exercise lectures, and the theoretical concepts are deepened by "hands on experience" in the accompanying Electrical Engineering I Lab, which is mandatory.

Methods of Assessment

Name	Weighting
Exercise Assignment	10%
Final Exam	35%
Midterm Exam	35%
Quizz(es)	10%
Timely presence and active participation	10%

Course Name	***Course No***	***ECTS***
General Electrical Engineering II	CH10-300102	5
Module Affiliation CH10-IntroEE Introduction to Electrical Engineering	***Workload (hrs / sem)*** Contact Time: 35,00 Private Study: 90,00	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims

The course is the continuation of General Electrical Engineering I (CH10-300101), which is a mandatory pre-requisite, and focuses on AC circuit analysis. We start with the concepts of impedance and phasors, which allow for a convenient representation of circuit elements and their responses in terms of linear systems. Subsequently, we introduce tools for the analysis of AC signals, specifically, the Fourier Series and the Fourier Transform. Using these tools are a basis, we revise various elementary circuits, first studied in CH10-300101 under the Laplace framework, now emphasizing the notions of frequency (oscillation) and phase (rotation), thus establishing the fundamental concepts required to understand Communication Systems (module CO-25) and Signal Processing (module CO27), to be pursued in the second year. Similarly to General Electrical Engineering I, theory is introduced via an alternation of expositive and exercise lecturers, and reinforced via practical experiments conducted under the lab course in Electrical Engineering (CH10- 300112), which is a mandatory companion

Methods of Assessment

Name	Weighting
Exercise Assignment	10%
Final Exam	35%
Midterm Exam	35%
Quizz(es)	10%
Timely presence and active participation	10%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Electrical Engineering I Lab	CH10-300111	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CH10-IntroEE Introduction to Electrical Engineering	Contact Time: 25,50 Private Study: 37,00	Bachelor 1st Year CHOICE

Course Description / Content / Aims

The objective of the lab course is to give the student "hands on experience" in the basic concepts of Electrical Engineering, as worked out in the lecture General Electrical Engineering I (mandatory for the lab course). Moreover, the students will be familiarized with the standard measurement tools of the electrical engineer, multimeters and the oscilloscope.

Methods of Assessment

Name	Weighting
Final Exam	40%
Report	60%

Course Name	***Course No***	***ECTS***
Electrical Engineering II Lab	CH10-300112	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CH10-IntroEE Introduction to Electrical Engineering	Contact Time: 25,50 Private Study: 37,00	Bachelor 1st Year CHOICE

Course Description / Content / Aims

The lab course accompanies the General Electrical Engineering II lecture (CH10-300102). The key concepts treated in the lecture will be highlighted by experiments (such as Fourier analysis, amplitude and frequency modulation, signal processing,...).

Methods of Assessment

Name	Weighting
Final Exam	40%
Report	60%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Communications Basics	CO25-300202	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO25-Communic Communications	Contact Time: 17,50 Private Study: 45,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

In this course, we will apply techniques from signals and systems combined with random processes to study modulation and demodulation procedures with and without noise. Based on these fundamentals of communications, we will address several aspects of binary data transmission including the matched filter problem.

Methods of Assessment

Name	Weighting
Final Exam	60%
Home Work	40%

Course Name	***Course No***	***ECTS***
Communications Lab	CO25-300203	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO25-Communic Communications	Contact Time: 25,50 Private Study: 37,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

This course compliments the lecture course on communications by providing hands-on experience in practical development of a communications system using Matlab Simulink and Matlab simulations. In this lab, you will learn how to design and program the building blocks needed to implement a digital transmitter and receiver chain including BPSK, QPSK, pulse shape, up-conversion, matched filter, PLL, carrier recovery, symbol timing recovery, and demodulation

Methods of Assessment

Name	Weighting
Final Exam	60%
Lab Performance	20%
Lab Report	20%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Wireless Communications	CO25-300311	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO25-Communic Communications	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

Wireless Communications is a dynamic area in electrical engineering, which evolves rapidly with the fast advancements of wireless technologies, ranging from cellular systems to sensor networks to near field communications. This course serves therefore the purpose of establishing the fundamental background to enable students to posteriorly follow the progress in the area on his/her own. The focus is single-user (point-to-point) systems, leaving the multiuser case to be studied under the follow up course Wireless Communications II (CAS-300441). We start with the mathematization of the wireless channels, gradually recasting the physical phenomenon of wave propagation onto statistical models. Using the latter as a basis, and after briefly reviewing digital modulation (which is covered in more detail in the accompanying course CO25-300202), we introduce various tools to analyze the performance of wireless systems, establishing both the challenges and mechanisms to circumvent them. The discussion then naturally evolves to covering the notions of diversity, degrees of freedom and capacity, the introduction of which motivates the study of Information Theory, also part of this module (course CO25-300341).

Methods of Assessment

Name	Weighting
2 Quizz(es)	10%
Active Participation	10%
Exams	70%
Exercise Assignments	10%

Course Name	***Course No***	***ECTS***
Information Theory	CO25-300341	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO25-Communic Communications	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

Information theory serves as the most important foundation for communication systems. The course provides an analytical framework for modeling and evaluating point-to-point and multi-point communication. After a short rehearsal of probability and random variables and some excursion to random number generation, the key concept of information content of a signal source and information capacity of a transmission medium are precisely defined, and their relationships to data compression algorithms and error control codes are examined in detail. The course aims to install an appreciation for the fundamental capabilities and limitations of information transmission schemes and to provide the mathematical tools for applying these ideas to a broad class of communications systems. Aside from source and channel aspects, an introduction to security is given, including publickey cryptography. Information theory is standard in every communications-oriented Bachelor's program.

Methods of Assessment

Name	Weighting
Final Exam	40%
Home Work	20%
Midterm Exam	40%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Electromagnetics	CO26-300211	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO26-ElectroNoise Electronics and Noise	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

Unlike other engineering disciplines, the complete theory of electrical engineering can be summarized in four fundamental equations known as Maxwell's equations. This course gives an introduction to electric and magnetic field theory, leading to Maxwell's equations. In addition, the theory is applied to wave propagation problems and guided waves on transmission lines. This knowledge enables us to understand the physics behind electrical signals travelling through lines and electronic devices. Contents Electric Field: Electric charge, charge distributions, Coulomb's law, electric field, dipoles, electric flux, Gauss' law, potential, capacitance, Currents: current density, conductance, superconductors, semiconductors, Magnetic Fields: magnetic force, magnetic flux, Ampere's law, inductance, Faraday's law, Lenz' law, displacement current, boundary conditions, Electromagnetic Waves: Maxwell's equations, electromagnetic waves, radiation. Guided Waves: waves on transmission lines, wave reflection, standing waves, line parameters, Smith chart, cascaded two-port networks.

Methods of Assessment

Name	Weighting
Final Exam	50%
Home Work	20%
Midterm Exam	30%

Course Name	***Course No***	***ECTS***
Introduction to Electronics	CO26-300212	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO26-ElectroNoise Electronics and Noise	Contact Time: 17,50 Private Study: 45,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

The course gives an introduction to electronics and electronic circuits. After a review on semiconductor properties, the operation principle and the application of diodes, bipolar junction transistors (BJTs), and field-effect transistors (FETs) will be discussed. Different electronic circuits will be analyzed and designed including rectifiers, voltage doublers, single- and multi-stage amplifiers, and operational amplifiers (OpAmps).

Methods of Assessment

Name	Weighting
Final Exam	60%
Tests/Reports	40%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Electronics Lab	CO26-300222	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO26-ElectroNoise Electronics and Noise	Contact Time: 25,50 Private Study: 37,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

The goal of the lab course is to establish a basic understanding of electrical circuits and electronic components. The knowledge and understanding of Kirchhoff's laws, mesh and nodal analysis, and basic circuit theorems taught throughout the courses on general electrical engineering I and II is assumed. The goal will be accomplished by a combined approach of experimental and simulation experiments. The experiments will provide the students with practical experience and allow the students to relate the experiments to device and circuit models. LTSpice will be used for the simulation of the basic components and circuits.
Topics: RLC circuits, filters and resonators, diodes, pn-junctions and their application, bipolar junction transistors (BJT) and elementary transistor circuits including amplifiers, differential amplifiers and the basics of operational amplifiers, application of operational amplifiers. MOS field effect transistors and their application in amplifiers and inverter circuits.

Methods of Assessment

Name	Weighting
Final Exam	45%
Prelab	25%
Tests/Reports	30%

Course Name	***Course No***	***ECTS***
Probability and Random Signal Processing	CO26-300321	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO26-ElectroNoise Electronics and Noise	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

This course provides a foundation in the theory and applications of probability and random signals and an understanding of the mathematical techniques relating to random processes in the areas of signal processing, detection, estimation, and communication. Topics include the axioms of probability, random variables, and distribution functions, functions of random variables, and random vectors.

Methods of Assessment

Name	Weighting
Final Exam	60%
Home Work	40%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Signals and Systems	CO27-300201	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO27-SigProcess Signal Processing	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

This course offers a comprehensive exploration of signals and systems which is the key knowledge for almost all electrical engineering tasks. Continuous-time and discrete-time concepts/methods are developed in parallel, highlighting their similarities and differences. Introductory treatments of the applications of these basic methods in such areas as filtering, communication, sampling, discrete-time processing of continuous-time signals, and feedback, will be discussed.

Methods of Assessment

Name	Weighting
Final Exam	40%
Home Work	20%
Midterm Exam	40%

Course Name	***Course No***	***ECTS***
Signals and Systems Lab	CO27-300221	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO27-SigProcess Signal Processing	Contact Time: 25,50 Private Study: 37,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

The concepts of signal and systems will be applied throughout the lab course by experimental and simulation means. The lab course is offered in conjunction with the course on Signals and Systems (CO27-300201). The concepts of signals and systems are generic and applications can be found in several areas like communications, speech and image processing, or process control. The goal of the lab is to apply these concepts by a combined approach of experiments and simulations. The experiments will provide the students with practical experience and allow the students to relate the experiments to signals and systems theory. Topics: Step response of RLC circuits, filters (RLC circuits), Fourier transform and Fourier series, sampling, digital filters, modulation, control experiment.

Methods of Assessment

Name	Weighting
Final Exam	45%
Prelab	25%
Tes/ Report	30%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Digital Signal Processing and Communications Lab	CO27-300231	2,5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO27-SigProcess Signal Processing	Contact Time: 25,50 Private Study: 37,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

In today's world, digital signal processors (DSPs) are finding ever increasing use in diverse areas of electrical engineering, such as automotive monitoring and control, hi-fi audio components, telephony, wireless, DSL, radar, remote sensing, etc. This course compliments the lecture courses on DSP and communications by providing hands-on experience in practical development of a communications system using DSPs. Note that although the focus is DSP in this course, many of the concepts learned also applied to embedded development, which is also becoming increasingly important in our electronic world!

Methods of Assessment

Name	Weighting
Active Participation	20%
Final Exam	60%
Tests/Reports	20%

Course Name	***Course No***	***ECTS***
Digital Signal Processing	CO27-300302	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO27-SigProcess Signal Processing	Contact Time: 35,00 Private Study: 90,00	Bachelor 2nd Year CORE

Course Description / Content / Aims

The course is actually a combination of standard DSP contents and applications in digital communications. The standard DSP contents are linear transforms, Sampling theorem, quantization, networks with delay elements difference equations, filter structures (implementations in C/Matlab), z-transform, frequency-domain characterization (Parseval), DFT, window functions, frequency response of frequency-selective filters, fast convolution (overlap save, overlap add), power spectral density, periodogram, design of poles and zeros, least squares identification and prediction (LPC, Toeplitz algorithms), design of digital filters (short introduction to wave digital filters), sampling rate conversion, subband coding, FFT algorithms, quadrature mirror filters, filter banks, two-dimensional transforms, discrete cosine transform, (wavelets) and an introduction to video coding. The communications part is essentially an introduction to digital communications with channel properties, passband and complex baseband description, PAM, QAM, matched filter, whitened matched filter, equalizer structures and its adaptation with LMS and ZF. An introduction to multicarrier transmission (OFDM, DMT) and the relation to filter banks will be given, too. OFDM and DMT are the transmission methods used in every current wireless and wireline system (LTE, DSL, DVB-t,...). Overall, the course provides a complete coverage of digital signal processing and the essential basics of digital communications. The course is hence mandatory for ECE and a must for other students with a focus towards signal processing, video and audio, and communications.

Methods of Assessment

Name	Weighting
Final Exam	40%
Home Work	20%
Midterm Exam	40%

Appendix 1b - Mandatory Module and Examination Plan for Campus Track

Electrical and Computer Engineering – Campus Track

Matriculation Fall 2018

Program-Specific Modules		Type	Status[1]	Semester	Credits	Jacobs Track Modules (General Education)		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**45**						**20**
Take the mandatory CHOICE module listed below, this is a requirement for the ECE program.											
CH10-IntroEE	**Module: Introduction to Electrical Engineering**		**m**		**15**	**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CH10-300101	General Electrical Engineering I	Lecture	m	1	5	JT-ME-120103	Calculus I	Lecture	m	1	2,5
CH10-300111	Electrical Engineering I Lab	Lab	m	1	2,5	JT-ME-120104	Calculus II	Lecture	m	1	2,5
CH10-300102	General Electrical Engineering II	Lecture	m	2	5	JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
CH10-300112	Electrical Engineering II Lab	Lab	m	2	2,5	**JT-SK-Skills**	**Module: Skills**		**m**		**5**
	Module: CHOICE (own selection)		**e**	**1/2**	**30**	JT-SK-320111	Programming in C I	Lecture	m	1	2,5
Students take two further CHOICE modules from those offered for all other study programs. [2]						JT-SK-320112	Programming in C II	Lecture	m	2	2,5
						JT-TA-TriArea	**Module: Triangle Area**		**m**		**2,5**
							Take one course from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	1/2	2,5
						JT-LA-Language	**Module: Language**		**m**		**5**
							Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	1/2	5
						CA01-CarAdv	**Career Advising**[4]		**m**		
Year 2 - CORE					**45**						**20**
Take all three modules or replace one with a CORE module from a different study program. [2]											
CO25-Communic	**Module: Communications**		**me**		**15**	**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CO25-300202	Communications Basics	Lecture	m	3	2,5	JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	3	2,5
CO25-300203	Communications Lab	Lab	m	3	2,5	JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO25-300341	Information Theory	Lecture	m	4	5	CO16-100242	Numerical Methods II	Lecture	m	4	2,5
CO25-300311	Wireless Communications	Lecture	m	4	5						
CO26-ElectroNoise	**Module: Electronics and Noise**		**me**		**15**	**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**7,5**
CO26-300321	Probability and Random Signal Processing	Lecture	m	3	5		Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	3/4	7,5
CO26-300211	Electromagnetics	Lecture	m	3	5						
CO26-300212	Introduction to Electronics	Lecture	m	4	2,5						
CO26-300222	Electronics Lab	Lab	m	4	2,5						
CO27-SigProcess	**Module: Signal Processing**		**me**		**15**	**JT-LA-Language**	**Module: Language**		**m**		**5**
CO27-300201	Signals and Systems	Lecture	m	3	5		Take two German courses (2,5 ECTS each). Native German speakers take courses in another offered language	Seminar	me	3/4	5
CO27-300221	Signals and Systems Lab	Lab	m	3	2,5						
CO27-300302	Digital Signal Processing	Lecture	m	4	5	**CA01-CarAdv**	**Career Advising**[4]		**m**		
CO27-300231	Digital Signal Processing and Communications Lab	Lab	m	4	2,5						
Year 3 - CAREER					**45**						**5**
COXX	**Module: Additional (4th) CORE module**		**m**	**5/6**	**15**	**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**5**
							Take two courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	6	5
CA11-ECE	**Module: Project / Thesis ECE**		**m**		**15**	**CA01-CarAdv**	**Career Advising**[4]		**m**		
CA11-300303	Project ECE		m	5	5						
CA11-300304	Thesis ECE		m	6	10						
CA-S-ECE	**Module: Specialization Area ECE**		**m**		**15**						
	Take 15 ECTS of specialization courses [2]		me	5/6	15						
Total ECTS											**180**

[1] Status (m = mandatory, e = elective, me = mandatory elective)

[2] For a full listing of all CHOICE / CORE / CAREER / Jacobs Track modules please consult the **CampusNet online catalogue** and / or the module handbook (on our website).

[3] You are required to take six Triangle Area courses in total. Select two from each of the three triangle areas (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT).

[4] Mandatory component of the Jacobs University's Counseling and Advising Scheme.