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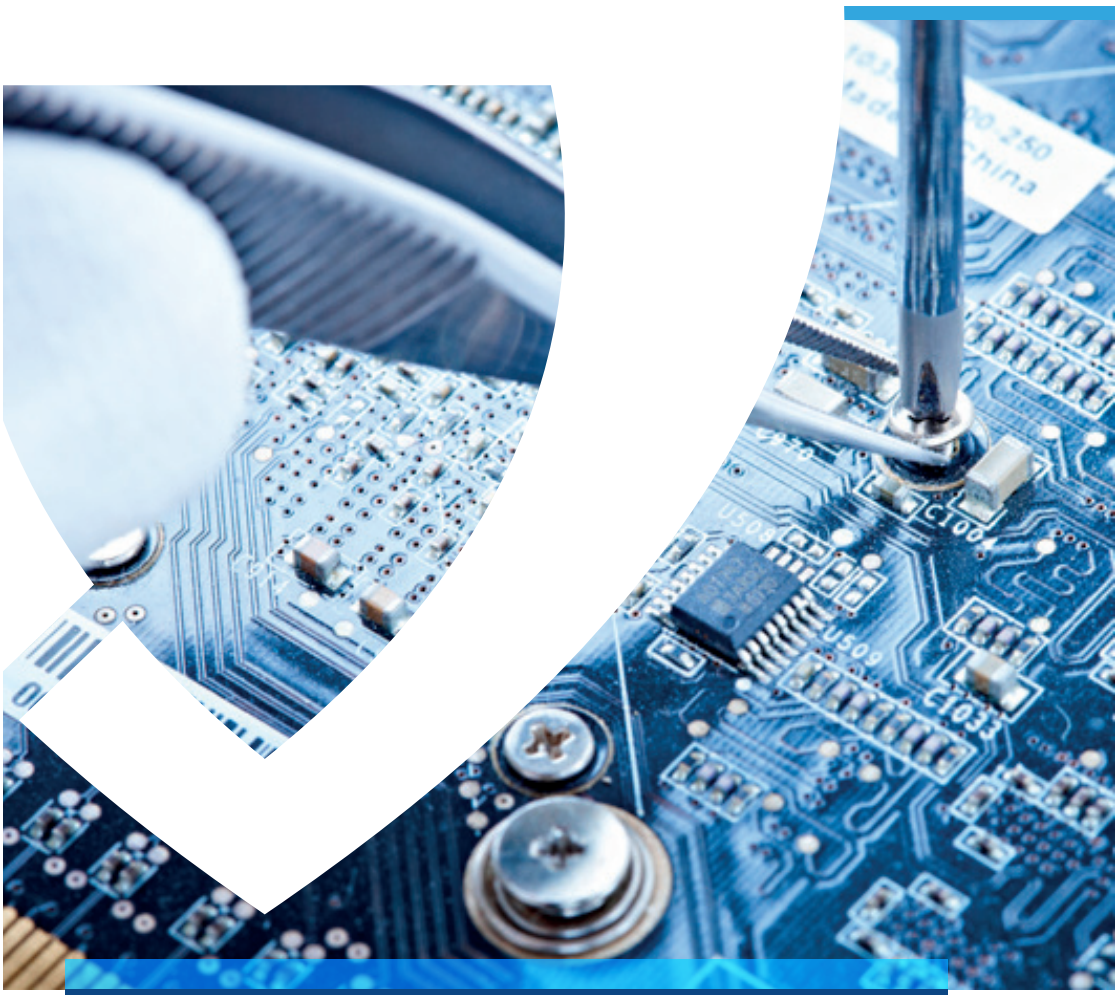

Study Program Handbook

Electrical and Computer Engineering

Bachelor of Science

Contents

1 The Electrical and Computer Engineering (ECE) Study Program **1**
1.1 Concept . . . 1
1.2 Specific Advantages of the Electrical and Computer Engineering Program at Jacobs University . . . 1
1.3 The Jacobs University Employability and Personal Development Concept . . . 1
1.4 Career Options . . . 2
1.5 More Information and Contact . . . 2

2 The Curricular Structure **3**
2.1 General . . . 3
2.2 The Jacobs University 3C-Model . . . 3
2.2.1 YEAR 1 - CHOICE . . . 4
2.2.2 YEAR 2 - CORE . . . 4
2.2.3 YEAR 3 - CAREER . . . 4
2.3 The Jacobs Track . . . 5
2.4 Modularization of the Electrical and Computer Engineering Program . . . 6
2.4.1 Content . . . 6
2.4.2 Structure . . . 8

3 Appendix 1a/1b: Mandatory Course Plans for World Track and Campus Track **9**

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, digital signal processing, and control, including the enabling digital processing elements and their programming.

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

- Razor-sharp focus on 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 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 a 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 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 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 possess the ability to acquire knowledge rapidly, to assess information and to evaluate new concepts critically;

- graduates have communicative competences which allow them to present themselves and their ideas and to negotiate successfully;

- graduates are familiar with business-related processes and management skills and are able to manage projects efficiently and independently.

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 in negotiating and mediating between different points of view;

- graduates can rely on basic civic knowledge and have an understanding for ethical reasoning; students are familiar with the requirements for taking on responsibility.

1.4 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.
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1.5 More Information and Contact

For more information please contact the study program coordinator:

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:

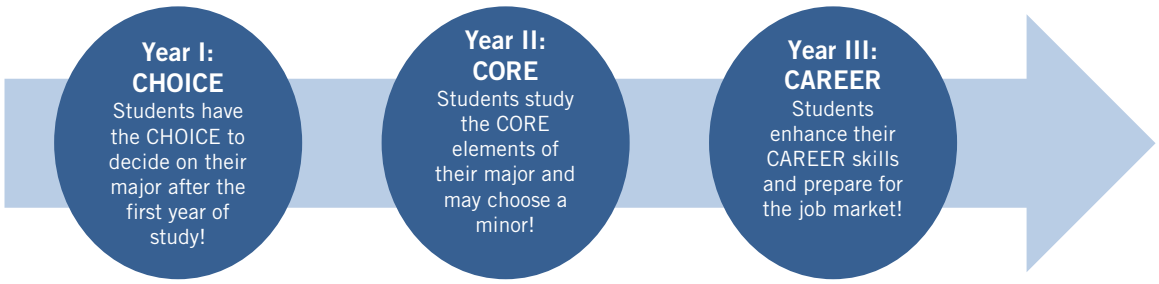


Figure 1: The Jacobs University 3C-Model

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. For more 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. All students attend a mandatory set of career skills courses and events throughout their studies. These equip them with necessary skills for their 5th semester and their future career.

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

2.4.1 Content

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.

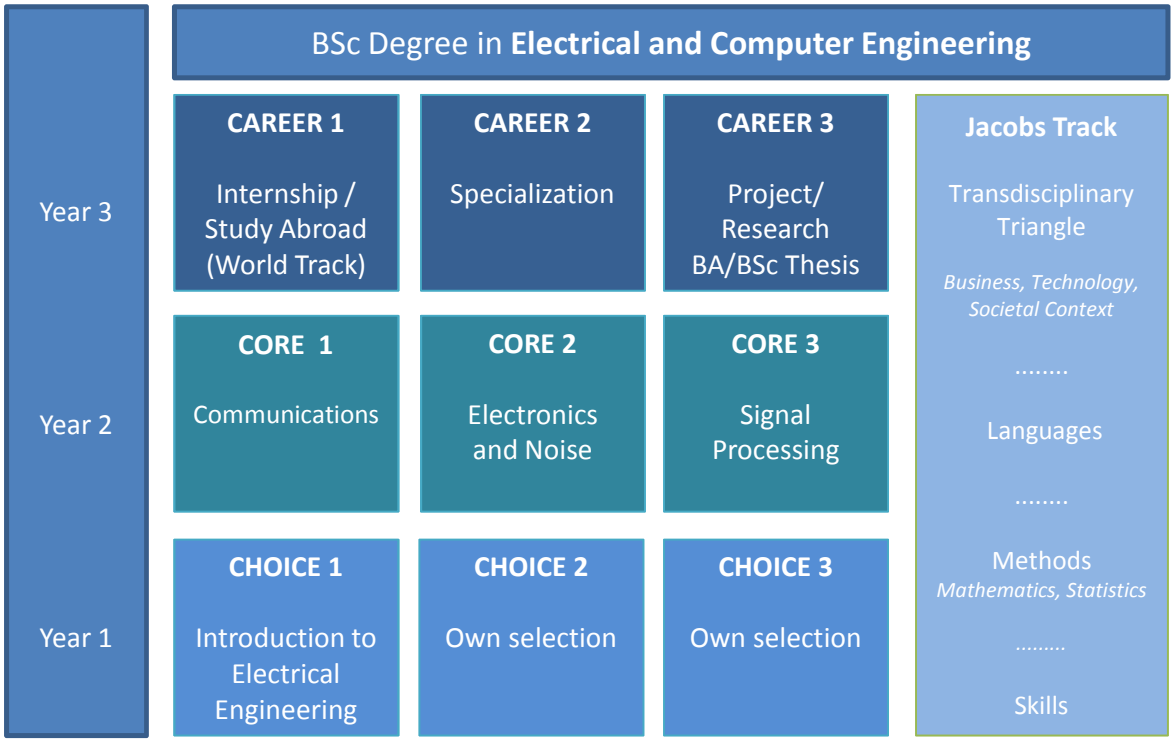
Some CORE Modules require students to have taken a specific CHOICE Module. Please see the Module Handbook for details regarding pre-requisites.

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:
     - Advanced Random Processes
     - Multi-user Wireless Communications
     - Digital Communications with a Focus on Wireline
     - Channel Coding
     - Speech Signal Processing
     - Detection and Estimation
     - Model Order Reduction
     - Embedded Systems Design Lab
     - 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

2.4.2 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 2: Electrical and Computer Engineering Module Structure

3 Appendix 1a/1b: Mandatory Course 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

Appendix 1a - Mandatory Course Plan for World Track

Electrical and Computer Engineering – World Track

Matriculation Fall 2015

Program-Specific Modules		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**45**
Take the mandatory CHOICE module listed below, this is a requirement for the ECE program.					
CH10-IntroEE	**Module: Introduction to Electrical Engineering**		**m**		**15**
CH10-300101	General Electrical Engineering I	Lecture	m	1	5
CH10-300111	Electrical Engineering I Lab	Lab	m	1	2,5
CH10-300102	General Electrical Engineering II	Lecture	m	2	5
CH10-300112	Electrical Engineering II Lab	Lab	m	2	2,5
	Module: CHOICE (own selection)		**e**	**1/2**	**30**
Students take two further CHOICE modules from those offered for all other study programs. [2]					
Year 2 - CORE					**45**
Take all three modules or replace one with a CORE module from a different study program. [2]					
CO25-Communic	**Module: Communications**		**me**		**15**
CO25-300202	Communications Basics	Lecture	m	3	2,5
CO25-300203	Communications Lab	Lab	m	3	2,5
CO25-300341	Information Theory	Lecture	m	3	5
CO25-300311	Wireless Communications	Lecture	m	4	5
CO26-ElectroNoise	**Module: Electronics and Noise**		**me**		**15**
CO26-300321	Probability and Random Signal Processing	Lecture	m	3	5
CO26-300211	Electromagnetics	Lecture	m	4	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**
CO27-300201	Signals and Systems	Lecture	m	3	5
CO27-300221	Signals and Systems Lab	Lab	m	3	2,5
CO27-300302	Digital Signal Processing	Lecture	m	4	5
CO27-300231	Digital Signal Processing and Communications Lab	Lab	m	4	2,5
Year 3 - CAREER					**45**
CA02 / CA03	**Module: Internship / Study Abroad**		**m**	**5**	**20**
CA01-CarSkills	**Module: Career Skills**		**m**		
CA11-ECE	**Module: Project / Thesis ECE**		**m**		**15**
CA11-300303	Project ECE		m	6	5
CA11-300304	Thesis ECE		m	6	10
CA-S-ECE	**Module: Specialization Area ECE**		**m**		**10**
	Take four specialization courses (2.5 ECTS each) [2]		me	5/6	10

Jacobs Track Modules (General Education)		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**20**
JT-ME-MethodsMath	**Module: Methods / Mathematics**		**m**		**7,5**
JT-ME-120103	Calculus I	Lecture	m	1	2,5
JT-ME-120104	Calculus II	Lecture	m	1	2,5
JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
JT-SK-Skills	**Module: Skills**		**m**		**5**
JT-SK-320111	Programming in C I	Lecture	m	1	2,5
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
Year 2 - CORE					**20**
JT-ME-MethodsMath	**Module: Methods / Mathematics**		**m**		**7,5**
JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5
JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO16-100242	Numerical Methods II	Lecture	m	4	2,5
JT-TA-TriArea	**Module: Triangle Area**		**m**		**7,5**
	Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	3/4	7,5
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	3/4	5
Year 3 - CAREER					**5**
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

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).

Appendix 1b - Mandatory Course Plan for Campus Track

Electrical and Computer Engineering – Campus Track

Matriculation Fall 2015

Program-Specific Modules		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**45**
Take the mandatory CHOICE module listed below, this is a requirement for the ECE program.					
CH10-IntroEE	**Module: Introduction to Electrical Engineering**		**m**		**15**
CH10-300101	General Electrical Engineering I	Lecture	m	1	5
CH10-300111	Electrical Engineering I Lab	Lab	m	1	2,5
CH10-300102	General Electrical Engineering II	Lecture	m	2	5
CH10-300112	Electrical Engineering II Lab	Lab	m	2	2,5
	Module: CHOICE (own selection)		**e**	**1/2**	**30**
Students take two further CHOICE modules from those offered for all other study programs. [2]					
Year 2 - CORE					**45**
Take all three modules or replace one with a CORE module from a different study program. [2]					
CO25-Communic	**Module: Communications**		**me**		**15**
CO25-300202	Communications Basics	Lecture	m	3	2,5
CO25-300203	Communications Lab	Lab	m	3	2,5
CO25-300341	Information Theory	Lecture	m	3	5
CO25-300311	Wireless Communications	Lecture	m	4	5
CO26-ElectroNoise	**Module: Electronics and Noise**		**me**		**15**
CO26-300321	Probability and Random Signal Processing	Lecture	m	3	5
CO26-300211	Electromagnetics	Lecture	m	4	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**
CO27-300201	Signals and Systems	Lecture	m	3	5
CO27-300221	Signals and Systems Lab	Lab	m	3	2,5
CO27-300302	Digital Signal Processing	Lecture	m	4	5
CO27-300231	Digital Signal Processing and Communications Lab	Lab	m	4	2,5
Year 3 - CAREER					**45**
COXX	**Module: Additional (4th) CORE module**		**m**	**5/6**	**15**
CA01-CarSkills	**Module: Career Skills**		**m**		
CA11-ECE	**Module: Project / Thesis ECE**		**m**		**15**
CA11-300303	Project ECE		m	5	5
CA11-300304	Thesis ECE		m	6	10
CA-S-ECE	**Module: Specialization Area ECE**		**m**		**15**
	Take six specialization courses (2.5 ECTS each) [2]		me	5/6	15

Jacobs Track Modules (General Education)		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**20**
JT-ME-MethodsMath	**Module: Methods / Mathematics**		**m**		**7,5**
JT-ME-120103	Calculus I	Lecture	m	1	2,5
JT-ME-120104	Calculus II	Lecture	m	1	2,5
JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
JT-SK-Skills	**Module: Skills**		**m**		**5**
JT-SK-320111	Programming in C I	Lecture	m	1	2,5
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
Year 2 - CORE					**20**
JT-ME-MethodsMath	**Module: Methods / Mathematics**		**m**		**7,5**
JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5
JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO16-100242	Numerical Methods II	Lecture	m	4	2,5
JT-TA-TriArea	**Module: Triangle Area**		**m**		**7,5**
	Take three courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	3/4	7,5
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	3/4	5
Year 3 - CAREER					**5**
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	5	5

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).