JACOBS UNIVERSITY

Study Program Handbook

Computer Science

Bachelor of Science

Subject-specific Examination Regulations for Computer Science (Fachspezifische Prüfungsordnung)

The subject-specific examination regulations for Computer Science are defined by this program handbook and are valid only in combination with the General Examination Regulations for Undergraduate 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 2016 - V1	01.09.16	AB August 2016	Master Version
Fall 2016 - V2	01.09.17	AB August 2017	2.2 revised, 2.5 added
Fall 2016 - V3	01.09.18	Academic Senate August 29, 2018	Figure 3 updated

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1 The Computer Science (CS) Study Program

1.1 Concept

Computer Science lies at the core of all modern industries, as computer systems and information technology underlie almost all of today's production processes. Computer technology changes constantly but there are a number of fundamental principles underlying these technologies. The Computer Science program at Jacobs University focuses on the understanding of these principles and their application in practice. In addition to courses dealing with core competencies (programming, software engineering, foundations of computer science), you will be covering mathematics (calculus, linear algebra and statistics) and take courses in engineering and sciences whilst also conducting guided research.

1.2 Specific Advantages of the Computer Science Program at Jacobs University

The Computer Science program at Jacobs University distinguishes itself from competitors by being rigorous on the foundations while at the same time being very contemporary.

- The faculty teaches students more than just facts. It motivates students to explore topics beyond the boundaries of standard textbooks. The student to faculty ratio enables a highly interactive style of education. In the 2009 an 2012 evaluations by the Centre for Higher Education Development (CHE), the overall study situation was ranked 1st and 3rd.

- Early involvement in research projects is an essential aspect of student education. Students obtain very early on a vivid experience of research, which often unfolds in interdisciplinary collaborations later on.

- The involvement of students and alumni in the program development process using a direct open dialogue ensures that the program is constantly fine tuned to the specific needs students face such as covering certain topics at a certain time that is relevant for the preparation of internship or job applications.

- The CS program has a successful student exchange program with Carnegie Mellon University (USA). Every year, some of the best CS students move to Pittsburgh in order to study a semester at CMU. In addition, CS students have exchanged with great success with Rice University (USA) and the University of Pennsylvania (USA).

- The CS students participate actively in international programming competitions. Jacobs University has hosted the Northwestern European Regional Contest (NWERC) of the ACM International Collegiate Programming Contest on campus in 2010 and 2011. In 2014, CS students organized the first JacobsHack! hackathon on campus, which was sponsored by Google, Microsoft, SAP, and ef.

1.3 Program-Specific Qualification Aims

The goal of the Computer Science program is to prepare students for excellent graduate schools and for successfully joining a highly dynamic and fast evolving job market.

In addition to general communication, presentation, and intercultural skills, students acquire strong programming and software-engineering skills. While students learn at least two imperative and object-oriented programming languages by heart, they are also exposed to other programming languages and paradigms so that they can easily learn new programming languages when needed.

Students develop a clear understanding of the foundations of computer science and basic methods and algorithms. This part of the education is a long-term investment in the understanding of basic principles that are strongholds in a very fast developing area of technology.

Finally, students obtain knowledge about systems and key system components (e.g., database systems, computer networks, web services, computer graphics) that are highly relevant for the development of many modern applications.

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 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.

1.5 Career Options

The job market for computer scientists has been very good in the last few years, and there is no indication that this will change soon. Because of the rapid changes in the field, it is important to focus one's education on fundamental principles and in subfields of promising future relevance. Cross-disciplinary breadth and flexibility, as well as social and work organization skills are increasingly important. The academic qualifications and personal profiles for academic and industrial careers differ. Jacobs University's Computer Science program responds to the needs in both areas and prepares students for successful careers through its program flexibility and emphasis on transdisciplinary education.

1.6 More Information and Contact

For more information please contact the study program coordinator:

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Telephone: +49 421 200-3587

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

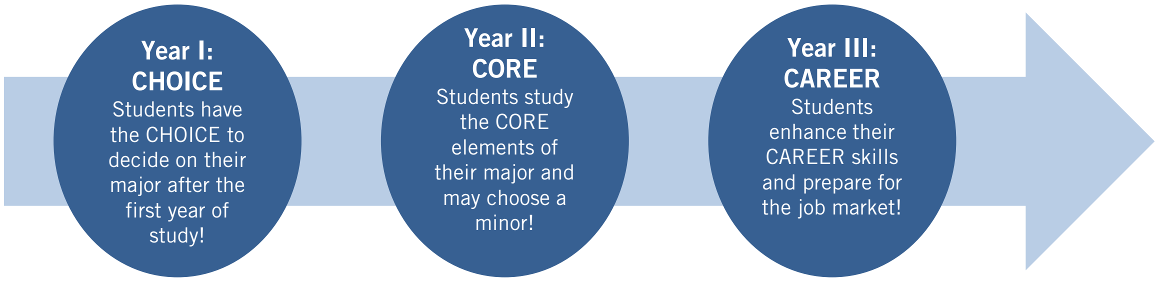


Figure 1: The Jacobs University 3C-Model

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.

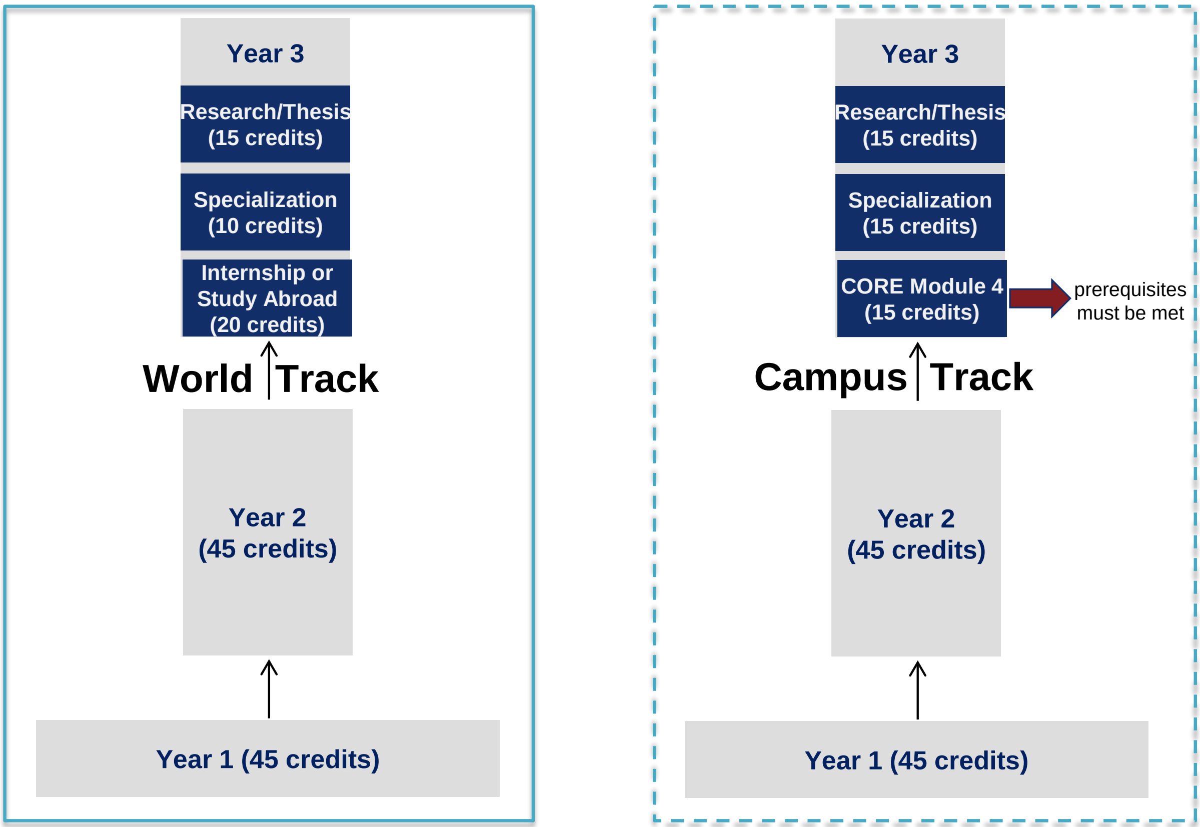


Figure 2: World Track versus Campus Track

Career Skills

Throughout their studies all students attend a mandatory set of career skills courses and events.

The mandatory Career Skills module 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 of the module include information sessions, compulsory seminars on various career-relevant topics as well as participation in the annual Jacobs Career Fair.

The successful completion of the Career Skills Module and the encompassed single seminars are graded with Pass/Fail for all students. ECTS credits are not awarded. All undergraduate students will be automatically registered for the Career Skills Module. However, every student has to keep track of his/her individual fulfillment of requirements and has to register on Campusnet for all seminars and sessions during the official registration period at the beginning of each semester. An overview of the sequence in which components should be completed is shown in the table below:

CAREER SKILLS MODULE For Undergraduate Students matriculated Fall 2015 and Fall 2016

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-RESEARCHING & CONTACTING EMPLOYERS CA01-990004					
MANDATORY ELECTIVE SEMINARS (seminar program subject to availability)			Attend 2 out of several career skills seminars and workshops. i.e. ▪ Business Etiquette ▪ Presentation Skills ▪ Communication Skills ▪ Grad School Application Training ▪ Self-Management ▪ Time-Management ▪ Decision Making ▪ Preparing for an Interview ▪ Introduction to Project Management			
OTHER MANDATORY COMPONENTS				CSC-JACOBS CAREER FAIR in February, on campus CA01-990003	INTERNSHIP or STUDY ABROAD or CAMPUS TRACK	INTERNSHIP & STUDY ABROAD EVENT Online CSC-CAREER SURVEY CA01-990002

Figure 3: The Career Skills Module

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 Computer Science Program

2.4.1 Content

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

General Computer Science (CH08-GenCS)
The introductory module General Computer Science covers abstract and concrete notions of computing machines, information, and algorithms. You will develop an understanding of the

mathematical foundations of computer science. Core concepts such as algorithms, computations, and complexity will be introduced. The module also introduces you to basic data structures and elementary sort and search algorithms. You will learn how to represent graphs and how basic graph algorithms work. By studying elementary algorithms in depth, you will learn how to prove properties of algorithms such as their complexity. The module finally introduces you to different programming paradigms and how to approach and solve programming problems in a systematic way. The object-oriented programming paradigm and object-oriented design patterns will be studied in some depths.

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

Applied Computer Science (CO19-ApplCS)
The Applied Computer Science module familiarizes you with core components used by many modern computer applications such as relational databases and associated query languages. You will learn how to use web application frameworks and you will learn the foundations of computer graphics, such as rendering, shading, lighting, or textures. The module also introduces you to tools and techniques that can be used to develop software in a structured way in order to control development efforts and costs while improving the overall software quality

Technical Computer Science (CO20-TechCS)
The Technical Computer Science module introduces you to systems-oriented aspects of computer science. You will learn how an operating system kernel organizes a collection of hardware components into useful programming abstractions. Concurrent programming will be introduced and the various techniques to prevent race conditions and to coordinate concurrent activities. You will learn how computer programs can communicate. You will understand the purpose of the different layers of computer networks and how the Internet works. Basic distributed algorithms will be introduced that allow you to build robust and scalable distributed applications.

Theoretical Computer Science (CO21-TheoCS)
Theoretical Computer Science module covers the formal foundations of computer science. You will learn about different classes of formal languages and how they relate to discrete automata. You will learn what it means for a function to be computable and that there are functions that are impossible to compute. You will learn how to classify computable problems according to their inherent difficulty. Finally, you will learn how to use first-order logic to reason about programs and how to write programs using programming languages that are based on first-order logic.

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
   - Computer Science Project / Thesis Module
   - Program-specific Specialization Module
     Exemplary course offering:
     - Programming in Java
     - Distributed Algorithms
     - Data Technologies

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 coordinators 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.

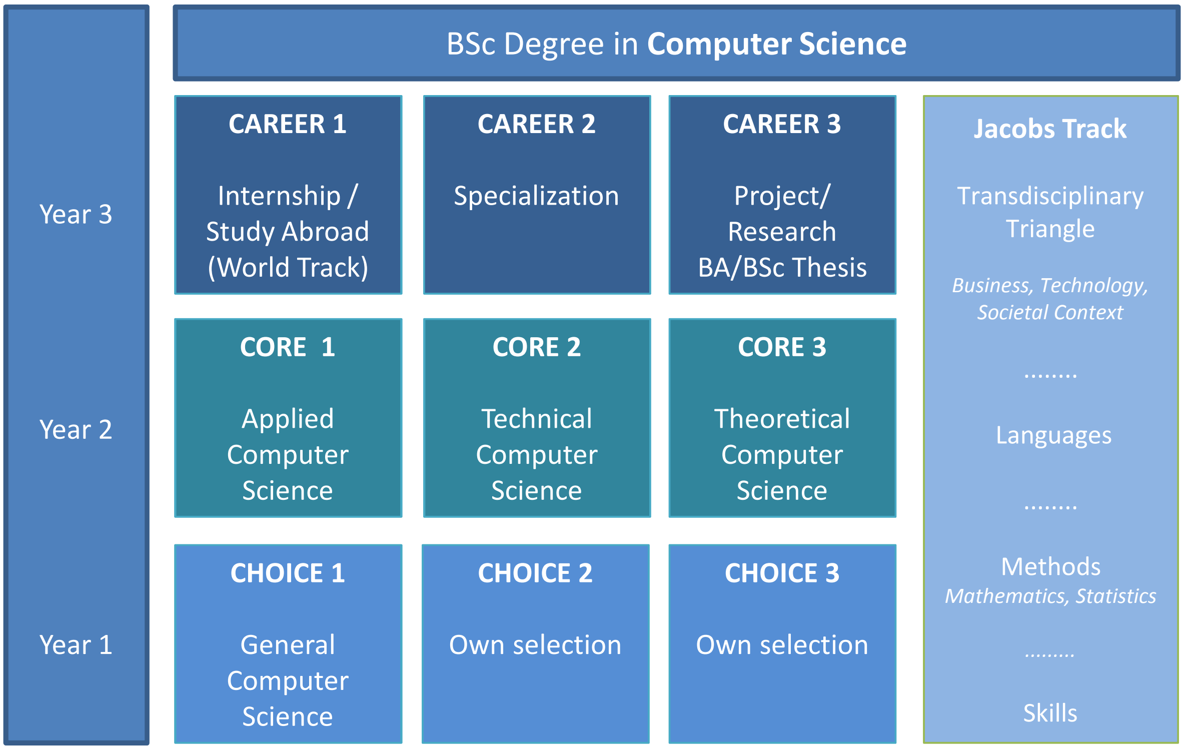
2.5.5 Formal Regulations for the Bachelor Thesis

- 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 coordinator.

- 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).

2.5.6 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: Computer Science 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

Computer Science – World Track

Matriculation Fall 2016

Year 1 - CHOICE

Take the mandatory CHOICE module listed below, this is a requirement for the CS program.

Program-Specific Modules		Type	Status[1]	Semester	Credits
Year 1 - CHOICE					**45**
CH08-GenCS	**Module: General Computer Science**		**m**		**15**
CH08-320101	General Computer Science	Lecture	m	1	5
CH08-320142	Object-Oriented Programming I	Lab	m	1	2,5
CH08-320201	Algorithms and Data Structures	Lecture	m	2	5
CH08-320143	Object-Oriented Programming II	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]

Jacobs Track Modules (General Education)		Type	Status[1]	Semester	Credits
Year 1					**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** [4]		**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

Take all three modules <u>or</u> replace one with a CORE module from a different study program. [2]

Program-Specific Modules		Type	Status[1]	Semester	Credits
Year 2 - CORE					**45**
CO19-ApplCS	**Module: Applied Computer Science**		**me**		**15**
CO19-320302	Databases and Web Services	Lecture	m	3	5
CO19-320322	Computer Graphics	Lecture	m	3	5
CO19-320212	Software Engineering	Lecture	m	4	5
CO20-TechCS	**Module: Technical Computer Science**		**me**		**15**
CO20-320202	Operating Systems	Lecture	m	3	5
CO20-320241	Computer Architecture and Programming Languages	Lecture	m	3	5
CO20-320301	Computer Networks	Lecture	m	4	5
CO21-TheoCS	**Module: Theoretical Computer Science**		**me**		**15**
CO21-320211	Formal Languages and Logic	Lecture	m	3	5
CO21-320203	Secure and Dependable Systems	Lecture	m	4	5
CO21-320352	Computability and Complexity	Lecture	m	4	5

Jacobs Track Modules (General Education)		Type	Status[1]	Semester	Credits
Year 2					**20**
JT-ME-MethodsMath	**Module: Methods / Mathematics**		**m**		**7,5**
JT-ME-120201	Elements of Probability	Lecture	m	3	2,5
JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5
JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
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

Program-Specific Modules		Type	Status[1]	Semester	Credits
Year 3 - CAREER					**45**
CA02 / CA03	**Module: Internship / Study Abroad**		**m**	**5**	**20**
CA01-CarSkills	**Module: Career Skills**		**m**		
CA10-CS	**Module: Project/Thesis CS**		**m**		**15**
CA10-320305	Project CS		m	6	5
CA10-320306	Thesis CS		m	6	10
CAS-WT-CS	**Module: Specialization Area CS**		**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 3					**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).

[4] CS students may also take the *Programming in Python* skills courses, but the received credits will not count towards the 180 ECTS credits required by the major nor do they count for the GPA.

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

Computer Science – Campus Track

Matriculation Fall 2016

	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 CS program.											
CH08-GenCS	**Module: General Computer Science**		**m**		**15**	**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CH08-320101	Introduction to Computer Science	Lecture	m	1	5	JT-ME-120103	Calculus I	Lecture	m	1	2,5
CH08-320142	Object-Oriented Programming I	Lab	m	1	2,5	JT-ME-120104	Calculus II	Lecture	m	1	2,5
CH08-320201	Algorithms and Data Structures	Lecture	m	2	5	JT-ME-120122	Foundations of Linear Algebra I	Lecture	m	2	2,5
CH08-320143	Object-Oriented Programming II	Lab	m	2	2,5	**JT-SK-Skills**	**Module: Skills** [4]		**m**		**5**
	Module: CHOICE (own selection)		**e**	**1/2**	**30**	JT-SK-320111	Programming in C I	Lecture	m	1	2,5
						JT-SK-320112	Programming in C II	Lecture	m	2	2,5
Students take two further CHOICE modules from those offered for all other study programs. [2]						**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					**45**						**20**
Take all three modules or replace one with a CORE module from a different study program. [2]											
CO19-ApplCS	**Module: Applied Computer Science**		**me**		**15**	**JT-ME-MethodsMath**	**Module: Methods / Mathematics**		**m**		**7,5**
CO19-320302	Databases and Web Services	Lecture	m	3	5	JT-ME-120201	Elements of Probability	Lecture	m	3	2,5
CO19-320322	Computer Graphics	Lecture	m	3	5	JT-ME-120113	Foundations of Linear Algebra II	Lecture	m	4	2,5
CO19-320212	Software Engineering	Lecture	m	4	5	JT-ME-120202	Numerical Methods I	Lecture	m	4	2,5
CO20-TechCS	**Module: Technical Computer Science**		**me**		**15**	**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**7,5**
CO20-320202	Operating Systems	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
CO20-320241	Computer Architecture and Programming Languages	Lecture	m	3	5						
CO20-320301	Computer Networks	Lecture	m	4	5						
CO21-TheoCS	**Module: Theoretical Computer Science**		**me**		**15**	**JT-LA-Language**	**Module: Language**		**m**		**5**
CO21-320211	Formal Languages and Logic	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
CO21-320203	Secure and Dependable Systems	Lecture	m	4	5						
CO21-320352	Computability and Complexity	Lecture	m	4	5						
Year 3 - CAREER					**45**						**5**
COXX	**Module: Additional (4th) CORE module**		**m**	**5/6**	**15**	**JT-TA-TriArea**	**Module: Triangle Area**		**m**		**5**
CA01-CarSkills	**Module: Career Skills**		**m**				Take two courses from the triangle (BUSINESS, TECHNOLOGY & INNOVATION, SOCIETAL CONTEXT) area. Each counts 2,5 ECTS [3]		me	5	5
CA10-CS	**Module: Project/Thesis CS**		**m**		**15**						
CA10-320305	Project CS		m	5	5						
CA10-320306	Thesis CS		m	6	10						
CAS-CT-CS	**Module: Specialization Area CS**		**m**		**15**						
	Take **six** specialization courses (2.5 ECTS each) [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] CS students may also take the *Programming in Python* skills courses, but the received credits will not count towards the 180 ECTS credits required by the major nor do they count for the GPA.

Appendix 2 - Course Data

Course Name General Computer Science	***Course No*** CH08-320101	***ECTS*** 5
Module Affiliation CH08-GenCS General Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims

The course covers the fundamental concepts and techniques of computer science in a bottom-up manner. Based on clear mathematical foundations (which are developed as needed) the course discusses abstract and concrete notions of computing machines, information, and algorithms, focusing on the question of representation vs. meaning in Computer Science.

To have a theoretical notion of computation, we introduce inductively defined structures, term representations, abstract interpretation via equational substitution. This is contrasted with a first concrete model of computation: Standard ML, which will also act as the primary programming language for the course. We cover a basic subset of ML that includes types, recursion, termination, lists, strings, higher-order programming, effects, and exceptions. Back on the theoretical side, we cover string codes, formal languages, Boolean expressions (syntax) and Boolean Algebras (semantics). The course introduces elementary complexity theory (big-O), applying it to analyzing the gate-complexity of Boolean Expressions (prime implicants and Quine McCluskey's algorithm).

Methods of Assessment

Name	Weighting
Final Exam	30%
Home Work	20%
Midterm Exam	20%
Quizz(es)	30%

Course Name Object-oriented Programming I	***Course No*** CH08-320142	***ECTS*** 2,5
Module Affiliation CH08-GenCS General Computer Science	***Workload (hrs / sem)*** 62,5	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims

This course offers an introduction into the basic concepts of object-oriented programming using the programming language C++. The unit covers the object-oriented programming constructs in C++ in a hands-on manner. In the first part, topics like introduction to objects and information hiding, making and using objects, data abstraction, inline functions, function and operator overloading, constructors, copy constructors, destructors, dynamic object creation are addressed. In the second part of the course the concepts of inheritance, polymorphism, virtual functions, and templates are introduced. The learned concepts have to be applied by solving programming problems.

Methods of Assessment

Name	Weighting
Course Assignments	35%
Final Exam	65%

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Object-oriented Programming II	CH08-320143	2,5
Module Affiliation CH08-GenCS General Computer Science	***Workload (hrs / sem)*** 62,5	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims
This course is the continuation of the first semester course unit and offers a more advanced view of the object-oriented programming skills learned during the first course unit. It covers advanced topics of C++ programming like exception handling (throwing, catching, cleaning up), defensive programming (unit testing and debugging techniques), templates in more detail, generic algorithms (working with common STL algorithms), generic containers (working with common STL containers like vectors, lists, deques, stacks, sets), features of C++11, multiple inheritance, and design patterns. The learned concepts have to be applied by solving programming problems.

Course Name	***Course No***	***ECTS***
Algorithms and Data Structures	CH08-320201	5
Module Affiliation CH08-GenCS General Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 1st Year CHOICE

Course Description / Content / Aims
Algorithms and data structures are in the core of computer science. An algorithm is an effective description for calculations using a finite list of instructions that can be executed by a computer. A data structure is a concept for organizing data in a computer such that they can be used efficiently. This is an introductory course to learn about fundamental algorithms for solving problems efficiently, basic algorithmic concepts, fundamental data structures for efficiently storing, accessing, and modifying data, and the analysis of algorithms and data structures with respect to their computational and memory complexity. The presented concepts and techniques form the basis of almost all computer programs.

Appendix 2 - Course Data

Course Name	***Course No***	***ECTS***
Databases and Web Services	CO19-320302	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO19-ApplCS Applied Computer Science	125	Bachelor 2nd Year CORE

Course Description / Content / Aims

This course offers a combined introduction to database and Web services. The database part introduces Entity Relationship (ER) models and designs using the Unified Modeling Language (UML). This part also introduces relational databases and the Structured Query Language (SQL), relational design theory, indexing, query processing, transaction management, and NoSQL / Big Data databases. In the Web services part, topics addressed include markup languages, 3-tier application architectures, and web services. Security aspects are addressed from both perspectives.

A hands-on group project complements theory: on a self-chosen topic, students implement the core of a Web-accessible information system running on MySQL and Linux.

Working knowledge is required in basic data structures like trees, object-oriented concepts, as well as - for the project work - HTML and Linux. Basic algebra knowledge is useful.

Methods of Assessment

Name	Weighting
Final Exam	35%
Home Work	30%
Midterm Exam	35%

Course Name	***Course No***	***ECTS***
Computer Graphics	CO19-320322	5
Module Affiliation	***Workload (hrs / sem)***	***Level***
CO19-ApplCS Applied Computer Science	125	Bachelor 2nd Year CORE

Course Description / Content / Aims

Computer graphics deals with the digital synthesis and manipulation of visual content, typically embedded in a three-dimensional scene. Prominent tasks in computer graphics are geometry processing, rendering, and animation. Geometry processing is concerned with object representations such as surfaces and their modeling, rendering is concerned with simulating light transport to get physically-based photorealistic images of 3D scenes or applying a certain style to create non-photorealistic images, and animation is concerned with descriptions for objects that move or deform over time. This is an introductory course into the concepts and techniques of 3D (interactive) computer graphics. It includes mathematical foundations, basic algorithms and principles, and advanced methods and concepts.

Methods of Assessment

Name	Weighting
Final Exam	35%
Home Work	45%
Midterm Exam	20%

Appendix 2 - Course Data

Course Name Software Engineering	***Course No*** CO19-320212	***ECTS*** 5
Module Affiliation CO19-ApplCS Applied Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 2nd Year CORE

Course Description / Content / Aims

This course is an introduction to software engineering and object-oriented software design. At the core of the lecture is the notion of software quality and the methods to achieve and maintain it in environments of "multi-person construction of multi-version software".

Based on their pre-existing knowledge of an object-oriented programming language, students are familiarized with software architectures, design patterns and frameworks, software components and middleware, UML-based modelling, and validation by testing. Further, the course addresses the more organisational topics of project management and version control. Practical work underpins this by looking at suitable tools.

The course is recommended to all students on whose software skills people will depend one day.

Course Name Operating Systems	***Course No*** CO20-320202	***ECTS*** 5
Module Affiliation CO20-TechCS Technical Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 2nd Year CORE

Course Description / Content / Aims

This course introduces the concepts and principles used by operating systems to provide programming abstractions that enabling an efficient development and execution of application programs. Students will gain an understanding how an operating system kernel manages hardware components and how it provides abstractions such as processes, threads, virtual memory, file systems, and inter-process communication facilities.

Students are introduced to event-driven and concurrent programming and the mechanisms that are necessary to solve synchronization and coordination problems, thereby avoiding race conditions, deadlocks, and resource starvation. The Linux kernel will be used throughout the course to illustrate how key ideas and concepts have been implemented and how they can be used by application programs.

Methods of Assessment

Name	Weighting
Final Exam	40%
Homework	30%
Quizz(es)	30%

Appendix 2 - Course Data

Course Name Computer Architecture and Programming Languages	***Course No*** CO20-320241	***ECTS*** 5
Module Affiliation CO20-TechCS Technical Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 2nd Year CORE

Course Description / Content / Aims

The course gives an introduction to fundamental concepts of computer architectures and programming languages. After numerical representations of data, logic and digital circuits are introduced. Then conversions from different number systems to other number systems are presented together with the BCD code, the Gray code and 2's complement. Later basic logic circuit components like logic gates, latches and flip-flops are introduced. A full parallel adder is built to illustrate the usage of previously presented concepts. The second part of the course addresses instruction set architectures, operations and operands of the computer hardware. Then measuring the performance and comparing different instruction architectures is illustrated. The third part of the course discusses how a datapath can be built along with single-cycle, multi-cycle datapath versions, and pipelined datapaths with data and control hazards. The last part of the course concerns the components and characteristics of programming languages, their processing (e.g., compilation, interpretation, translation, etc.) as well the corresponding phases, structure and functionality. We conclude the course by building a simple compiler.

Methods of Assessment

Name	Weighting
Final Exam	40%
Home Work	30%
Midterm Exam	30%

Course Name Computer Networks	***Course No*** CO20-320301	***ECTS*** 5
Module Affiliation CO20-TechCS Technical Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 2nd Year CORE

Course Description / Content / Aims

Computer networks and in particular the Internet play a critical role in today's world. The course discusses the underlying network protocols in some depth in order to enable students to understand the core issues involved in network protocol design. Fundamental algorithms and principles are explained in the context of existing protocols as they are used in today's Internet.

The course covers topics such as local area networks (based on the IEEE 802 family of standards), Internet protocols, routing algorithms and protocols, flow and congestion control mechanisms, network data representation and encodings, application layer protocols, remote procedure calls, and the basics of network security.

Appendix 2 - Course Data

Course Name Formal Languages and Logic	**_Course No_** CO21-320211	**_ECTS_** 5
Module Affiliation CO21-TheoCS Theoretical Computer Science	**_Workload (hrs / sem)_** 125	**_Level_** Bachelor 2nd Year CORE

Course Description / Content / Aims

A programming language is a richly and rigorously structured language. When a computer processes a program, it has to check it for syntactical correctness, filter out from the program text the underlying modular structure, compile it from a high-level programming language like C++ into a lower-level language (like assembler). All of these operations and transformations ground in the mathematical theory of formal languages, whose basic concepts and techniques (automata models and grammars in particular) are presented in the first half of this lecture. The second half of the lecture is devoted to an introduction to first-order logic (FOL). FOL is the prime formalism when it comes to represent real-world scenarios in a machine-processable format. FOL is the central starting point to venture into such important fields of computer science as Artificial Intelligence ("knowledge representation"), program verification systems, or semantic web technology. The lecture covers syntax and semantics of FOL, including a proof calculus and the completeness theorem.

Methods of Assessment

Name	Weighting
Active Participation(Classroom presence)	10%
Active Participation(Homeworks)	15%
Examination(Final exam)	30%
Tests/Reports(Miniquizzes)	45%

Course Name Secure and Dependable Systems	**_Course No_** CO21-320203	**_ECTS_** 5
Module Affiliation CO21-TheoCS Theoretical Computer Science	**_Workload (hrs / sem)_** 125	**_Level_** Bachelor 2nd Year CORE

Course Description / Content / Aims

This course introduces formal methods for analyzing and assuring safety and security of software systems. The course starts off with a clarification of concepts such as dependability, quality, safety, and security of software systems, and how to achieve them in the software development process. We introduce the foundations of cryptography as a basis for security mechanisms. The main part of the course introduces different paradigms of safety/security analysis such as formal testing (code coverage), static program analysis (control/data flow analysis and abstract interpretation), model checking (computational tree logic), and program verification (Hoare calculus, dynamic logic). The formal techniques will be used for analyzing both safety and security properties of programs. Where possible, students will be given hands-on micro-projects in state-of-the-art tools (e.g., Isabelle for program verification).

Appendix 2 - Course Data

JACOBS UNIVERSITY

Course Name	***Course No***	***ECTS***
Computability and Complexity	CO21-320352	5
Module Affiliation CO21-TheoCS Theoretical Computer Science	***Workload (hrs / sem)*** 125	***Level*** Bachelor 2nd Year CORE

Course Description / Content / Aims

This course fully answers the question "What problems can a computer possibly solve?" (by characterizing those solvable problems, equivalently, through Turing machines, random access machines, recursive functions and lambda calculus). A full answer to the related question, "how much computational resources are needed for solving a given problem" is not known today. However, the basic outlines of today's theory of computational complexity will be presented up to the most famous open problem in computer science, namely the "P = NP" question: if a computer could guess the right answer to a computational problem (and only needs to check its correctness), would that computer be faster than another one that can't guess the right solution? This may seem a ridiculously obvious case of a clear YES answer, but in fact it is considered by many to be the deepest open question in contemporary mathematics (and computer science, of course).