



# Official Announcements

## Contents:

Examination  
regulations for the consecutive master's degree programs

“Computer Science” and “Cyber Security”

the Faculty of Mathematics and Natural Sciences  
the Rheinische Friedrich-Wilhelms-Universität Bonn

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**Note on the obligation to give notice of complaint:**

According to Section 12 Paragraph 5 of the Law on Universities of the State of North Rhine-Westphalia (Higher Education Act - HG) after one year has passed since the announcement of a regulation, the violation of procedural or formal requirements of the Higher Education Act or the regulatory or other autonomous law of the University of Bonn can no longer be claimed, unless

1. the regulations were not properly published,
2. the Rectorate has previously objected to the decision of the committee deciding on the regulations or
3. the formal or procedural defect has been reported to the university in advance, specifying the legal provision violated and the fact that gives rise to the defect.

**Examination  
regulations for the consecutive master's degree programs**

**“Computer Science” and “Cyber Security”**

**the Faculty of Mathematics and Natural Sciences  
the Rheinische Friedrich-Wilhelms-Universität Bonn**

**from July 18, 2023**

Due to Sections 2 Paragraph 4 and 64 Paragraph 1 of the Law on Universities of the State of North Rhine-Westphalia (Higher Education Act - HG) of September 16, 2014 (GV. NRW. P. 547), last amended by Article 1 of the law regarding Membership of the university hospitals in the state's employers' association from June 30, 2022 (GV. NRW. p. 780b), the Faculty of Mathematics and Natural Sciences of the Rheinische Friedrich-Wilhelms-Universität Bonn has issued the following examination regulations:

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Part 1

scope

**§ 1**

**scope**

(1) Students who begin studying in one of the consecutive master's programs "Computer Science" or "Cyber Security" at the University of Bonn after these examination regulations come into force study in accordance with these examination regulations.

(2) The examination regulations of the Faculty of Mathematics and Natural Sciences of the University of Bonn for the consecutive master's degree program "Computer Science" dated October 14, 2011 (Official Bek. of the University of Bonn, 41st year, No. 31 of October 19, 2011), hereinafter MPO CompSci 2011, last amended by the regulations amending the examination regulations for the consecutive master's degree program "Computer Science" dated July 17, 2014 (Official Bek. of the University of Bonn, 44th year, No. 15 of July 18, 2014 ), will expire on March 31, 2027. Exams according to MPO CompSci 2011 can be taken until March 31, 2026. The examination board can extend this deadline by six months upon a justified request.

(3) Students who completed their master's degree in "Computer Science" before this came into effect  
Examination regulations according to MPO CompSci 2011 and have not yet taken all exams

- a. continue their studies in accordance with the MPO CompSci 2011 in the currently valid version until the deadline in accordance with paragraph 2 or
- b. change to these examination regulations upon written, irrevocable request.

Students who continue their studies according to the MPO CompSci 2011 and have not completed it by March 31, 2026 will switch to these examination regulations ex officio at the end of March 31, 2026.

Services already provided must be taken into account. Paragraph 2 sentence 3 remains unaffected; The change to these examination regulations ex officio will then take place at the end of September 30, 2026.

Section 2

Study objective, degree and standard period of study

**§ 2**

**Aim of the study and purpose of the examination**

(1) The consecutive master's degree programs "Computer Science" and "Cyber Security" are offered by the Faculty of Mathematics and Natural Sciences at the University of Bonn and have a research-oriented profile.

(2) The course of study within the framework of these master's programs is intended to provide students with the necessary specialist skills and methods as well as job-relevant knowledge and key qualifications in such a way that they are able to do scientifically sound critically classify and apply scientific findings and methods in professional practice and to be responsible be empowered to act. The requirements and changes in the professional world and, if necessary, interdisciplinary relationships are taken into account. The study objectives focus primarily on

- specialist knowledge oriented towards current research questions based on in-depth basic knowledge;
- methodological and analytical skills that enable you to independently expand scientific knowledge, with research methods and strategies playing a central role.

(3) Students should learn to address complex problems and work on them using scientific methods, even beyond the current limits of knowledge.

(4) The master's examination forms the further professional qualification of an in-depth, research-related, scientific training in one of the subjects "Computer Science" or "Cyber Security".

### **§ 3**

#### **Academic degree**

If the master's examination in the "Computer Science" or "Cyber Security" degree program is passed, the Faculty of Mathematics and Natural Sciences at the University of Bonn awards the academic degree "Master of Science (M. Sc.)".

### **§ 4**

#### **Standard period of study, ECTS credit point system, scope of courses offered, course structure and language of instruction/examination**

(1) The standard period of study for full-time study, including the master's thesis, is four semesters (120 ECTS-LP). The standard period of study for the part-time study variant of this course of study, including the master's thesis, is six semesters (120 ECTS credits).

(2) The course content is selected and limited so that the master's examination can be completed within the standard period of study. They are taught in the form of modules, which usually consist of teaching units that are thematically, methodically or systematically related to one another.

(3) Each module is usually concluded with a module examination; For each successfully completed module, the student earns credit points (LP) according to the *European Credit Transfer and Accumulation System* (ECTS). One ECTS credit point corresponds to a calculated student workload of 30 hours in face-to-face and self-study.

(4) The course in the "Computer Science" degree program includes modules in the compulsory area amounting to 32 ECTS-LP (master's thesis amounting to 30 ECTS-LP and accompanying seminar amounting to 2 ECTS-LP) as well as modules from the subject-specific elective area amounting to 88 ECTS credits. Each student chooses one of four possible areas as the focus of their studies, from which a minimum of 31 and a maximum of 61 ECTS credits must be acquired. The remaining 27 to 57 ECTS credits are acquired from modules in the other areas, whereby at least two of the three other areas must be represented with 6 ECTS credits each; In total, a maximum of 10 ECTS credits may be earned from seminar modules in the compulsory elective area and a maximum of 18 ECTS credits from lab modules in the compulsory elective area. The details of the structure of the elective area, the modules, their entry requirements and the number of ECTS credit points per module are regulated in the module plan (Appendix 1). The choice of focus can be changed before the topic of the master's thesis is assigned upon a justified request to the examination board.

(5) Studying in the "Cyber Security" degree program includes modules in the compulsory area amounting to 51 ECTS-LP (including the master's thesis amounting to 30 ECTS-LP and the accompanying seminar amounting to 2 ECTS-LP) as well as compulsory elective modules amounting to 69 ECTS. Of these, at least 54 ECTS credits must be acquired in the subject-specific elective area. In the subject-specific compulsory elective area, at least 24 ECTS-LPs are allocated to modules in the subject-specific compulsory elective area of Cyber Security and at least 12 ECTS-LPs are allocated to modules in the subject-specific compulsory elective area of Computer Science; In total, a maximum of 4 ECTS credits may be achieved from seminar modules in the subject-related compulsory elective area and a maximum of 9 ECTS credits from lab modules in the subject-related compulsory elective area. The remaining maximum of 15 ECTS-LPs can be acquired in any area of the subject-related and non-subject-related compulsory elective areas. The details regarding the structure of the compulsory elective areas, the modules, their entry requirements and the number of ECTS credit points per module are regulated in the module plan (Appendix 2).

(6) To ensure that the course of study is structured appropriately, a study plan is drawn up as a recommendation for the students. An individual study plan can be created for each student based on his or her requirements.

(7) The language of instruction and examination in the "Computer Science" degree program is English. The examination board can provide for deviations for individual compulsory elective modules and will announce this before the start of the semester in accordance with Section 8 Paragraph 7.

(8) The teaching and examination languages in the "Cyber Security" degree program are German and English. The examination board can provide for deviations for individual compulsory elective modules and will announce this before the start of the semester in accordance with Section 8 Paragraph 7.

(9) Studies can be started in the summer and winter semesters. Starting in the winter semester is recommended.

### Section 3

#### Entrance requirements and credit recognition

### § 5

#### Admission requirements for studying

(1) The consecutive master's degree programs "Computer Science" and "Cyber Security" are aimed at applicants who, as an entry requirement, have a first professional university degree in the subjects of cyber security or computer science or a related subject.

(2) The university degree in accordance with paragraph 1 must provide evidence of the following qualifications in order to gain access to the "Computer Science" master's degree program:

1. Modules amounting to at least 18 ETCS-LP in mathematical foundations of computer science;
2. Modules amounting to at least 15 ETCS-LP in fundamentals of theoretical computer science;
3. Modules amounting to at least 18 ETCS-LP in the basics of programming software technology and information systems;
4. A scientific thesis worth at least 10 ECTS credits.

(3) The university degree in accordance with paragraph 1 must provide evidence of the following qualifications in order to gain access to the "Cyber Security" master's degree program:

1. Modules amounting to at least 24 ECTS credits in the fundamentals of IT security;
2. Modules amounting to at least 18 ETCS-LP in mathematical foundations of computer science;
3. Modules amounting to at least 9 ETCS-LP in fundamentals of theoretical computer science;
4. Modules amounting to at least 18 ETCS-LP in the basics of programming software technology and information systems;
5. A scientific thesis worth at least 10 ECTS credits.

(4) In order to gain access to the Master's program in "Computer Science", applicants must have a command of the English language at least at level B2 of the Common European Framework of Reference for Languages (CEFR) according to a recognized language test (e.g. TOEFL, IELTS) or an equivalent qualification prove. Applicants do not have to prove any German language skills when enrolling.

(5) In order to gain access to the master's program in "Cyber Security", applicants must have a command of the English language at least at level B2 of the Common European Framework of Reference for Languages (CEFR) according to a recognized language test (e.g. TOEFL, IELTS) or an equivalent qualification prove. Applicants do not have to prove any German language skills when enrolling.



(6) Foreign applicants who are not equal to Germans either through or on the basis of international treaties and who do not have a German university entrance qualification can only be admitted to study in one of the master's programs in "Computer Science" or "Cyber Security", if you have successfully participated in the procedure for determining your course-related ability to study in accordance with Appendix 3 or Appendix 4.

(7) Capacity-related admission restrictions (numerus clausus) remain unaffected.

(8) Any selection of applicants required due to admission restrictions is based on the regulations for selection procedures in study programs with restricted admission at the Rheinische Friedrich-Wilhelm-Universität Bonn in force at the time of application in the currently valid version.

## **§ 6**

### **Recognition and crediting of study and examination achievements**

(1) Achievements achieved in courses at other state or state-recognized universities, at state or state-recognized vocational academies, in courses at foreign state or state-recognized universities or in another course of study at the University of Bonn will be recognized upon application, provided there is no significant difference in the skills acquired from the services being replaced; There is no check of equivalence. The examination board counts the recognized achievements towards modules of the curriculum. A final failed and no longer compensable examination performance from a course of study that is significantly similar in content to the chosen master's course constitutes an obstacle to enrollment.

(2) The standard of assessment for recognition is the materiality of differences. The standard for determining whether significant differences exist or do not exist is a comparison of the content, scope and requirements that were assumed for the service provided with those that apply to the service for which credit is to be given. There is no need to make a schematic comparison, but rather an overall view and overall assessment. A difference in the number of ECTS credit points to be acquired alone does not represent a significant difference. The above provisions apply accordingly to achievements achieved in further education. If there are no significant differences, the services provided will be fully recognized. If the examination according to the principles described above shows that a performance can only be partially credited, partial credit will be given within the corresponding module. The corresponding module is only passed when the missing achievements have been completed; Only then will ECTS credit points be awarded in accordance with these regulations. The examination committee decides on the scope and type of missing work to be provided. The equivalence agreements approved by the Conference of Education Ministers and the Conference of University Rectors as well as agreements within the framework of university partnerships must be observed.

(3) In accordance with Section 8 Paragraph 4 Sentence 2, the Examination Board is responsible for recognition and crediting procedures. It determines which courses are courses that are related to the chosen master's course or have a significant proximity to it in terms of content. When examining the materiality of differences, responsible specialist representatives must be heard. Furthermore, if there are doubts about the eligibility of achievements completed abroad, the Central Office for Foreign Education can be consulted. The student must be informed of the decision regarding recognition or its denial within 10 weeks and provided with information on legal remedies. If achievements cannot be credited or can only be partially credited, this must be justified by the examination board; In this respect, the burden of proof falls on him. If the examination board refuses to grant the desired credit, the student can request that the decision be reviewed by the Rectorate.

(4) If examination achievements are taken into account, the grades - as long as the grading systems are comparable - must be taken over and weighted with the ECTS credit points of the module to which the achievements are to be credited and included in the calculation of the overall grade. If study achievements are taken into account, they will be recorded without a grade and marked as "passed". If grading systems are not comparable, the note "passed" is included. The crediting will be identified as such in the certificate.

(5) If the requirements according to paragraph 1 are met, there is a legal right to credit.

The student must provide the information required for crediting about the achievements to be recognized. For each semester, the examination committee determines by which point in the semester an application for recognition for the respective semester can be submitted. Applications submitted after this point can only be considered for the following semester.

(6) Upon application, knowledge and qualifications acquired in ways other than through a course of study can be credited to the chosen course of study on the basis of submitted documents to the extent of up to 20% of the ECTS credit points to be earned in accordance with Section 4 Paragraph 1, if this knowledge and qualifications are equivalent in content and level to the examinations they are intended to replace.

## **§ 7**

### **Access to individual courses**

(1) If a limit on the number of participants is necessary for a course due to its nature or purpose or for other research and teaching reasons and the number of applicants exceeds the capacity, the examination board of the study program to which the corresponding module is assigned shall regulate this at the request of the lecturer is assigned, participation taking into account Section 59 HG. The criteria for the priorities are regulated in Appendix 5 to these examination regulations.

(2) The examination board determines the number of participants in courses whose number of participants is limited. The examination board announces this before the start of a semester.

## **Section 4**

### **Examination committee and examiners**

## **§ 8th**

### **Audit committee and office**

(1) To carry out the tasks assigned by these examination regulations, the Faculty Council of the Faculty of Mathematics and Natural Sciences forms a joint examination committee for the master's degree programs in "Computer Science" and "Cyber Security". The dean ensures that the examination board fulfills and can fulfill its tasks properly. The dean gives the necessary instructions and provides the necessary administrative support.

(2) The audit committee consists of seven members with voting rights, including:

- four members from the group of university lecturers of the faculty (including the chair and the deputy chair);
- a member of the group of academic staff of the faculty and
- two members from the group of students in the faculty.

The chair, the deputy chair and the other members are elected by the Faculty Council, separated by group. Those university lecturers who teach in one of the master's degree programs in accordance with paragraph 1 are eligible for election to the examination board. From the group of academic employees, those who teach in one of the two master's degree programs or who work in the organization of one of these degree programs can be selected. Those who are enrolled in one of the study programs in accordance with paragraph 1 can be selected from the group of students; it should come from everyone

A member of the two study programs can be elected. A deputy is elected for each of the seven members, who will represent the member in the event of their absence; these deputy members cannot take over the chairmanship of the examination committee. The term of office of the members from the group of university lecturers and the group of academic staff is three years, the term of office of the student members is one year. Re-election is permitted.

(3) The examination committee is an authority within the meaning of administrative procedure and administrative procedure law. The faculty will set up an office to provide administrative support to the examination board.

(4) The examination board ensures that the provisions of the examination regulations are adhered to and ensures that the examinations are carried out properly. He is in particular responsible for decisions in recognition and crediting procedures as well as for objections to decisions made in examination procedures. He reports regularly, at least once a year, to the Faculty Council on the development of examination and study times, including the duration of the master's theses, as well as on the distribution of overall grades. Once per semester, the examination committee informs the student secretariat which students have finally failed the master's examination in accordance with § 24 paragraph 6 or do not meet the admission requirements for the master's examination procedure in accordance with § 11 paragraph 1, based on a final decision from the examination committee. The examination board makes suggestions for reforming the examination regulations and the study plan. He can transfer the execution of specific tasks to be determined, in particular the appointment of examiners and assessors, to the chairperson by resolution. The transfer of the decision on objections according to sentence 2,

- - the review of decisions on deception and regulatory violations in accordance with Section 22 paragraph 1 sentences 1 and 2,
  - the assessment of the extent to which there has been a multiple or otherwise serious attempt at deception in accordance with Section 22 paragraph 3,
  - the decision on the invalidity of the master's examination and the revocation of the master's degree according to § 29 as well
  - the obligation to report to the Faculty Council in accordance with sentence 3
- is excluded.

(5) The meetings of the examination committee are not public. The members of the examination committee and their deputies are subject to official confidentiality. If they are not in public service, they must be sworn to secrecy by the chair of the examination board. A record of the results of the examination committee's deliberations and decisions is drawn up.

(6) The examination board has a quorum if, in addition to the chair or deputy chair, at least four other members or their representatives, including at least two university professors, are present. The examination committee decides with a simple majority. In the event of a tie, the vote of the chairperson or, in the event of his or her absence, the vote of the deputy chairperson decides. The members of the examination committee have the right to attend the examinations.

(7) Orders, appointments and other communications from the examination board that do not only affect individual people will be announced on a notice board or in electronic form with legally binding effect, taking data protection into account. Additional other notices are permitted but are not legally binding.

(8) The Examination Board can hold its meetings in physical presence as well as completely in electronic communication as an online video conference meeting (online meeting) or partially in electronic communication. At the request of a committee member, the chair of the committee may

agree to the participation of the applying member using a video conferencing tool, provided that the meeting room meets the necessary technical requirements for digital participation of individual members in the course of the meeting and in resolutions. For online meetings or meetings that are partly conducted electronically, only the video conferencing tools approved by the University of Bonn may be used.

(9) Resolutions in the examination board can be made electronically. If resolutions are made as part of an online meeting or a face-to-face meeting using a video conference tool, voting takes place either within the video conference tool or by using an online voting tool approved by the University of Bonn. Secret votes are taken during an online meeting exclusively using an online voting tool. The use of an online voting tool is also permitted in meetings that are held exclusively or partially in physical presence. Resolutions in the Audit Committee can also be passed by circular procedure, provided that no committee member objects to the circular procedure. With regard to the quorum, the same rules apply to resolutions in electronic communication and resolutions by circulation as to face-to-face meetings. In the case of circular resolutions, a deadline must be set for the response. If fewer responses from members are received within the deadline than are required for a quorum, the resolution is deemed not to have been passed. If a committee member objects to the resolution being passed in a circular manner within the deadline set for the response, the chair of the examination board must schedule a face-to-face meeting or an online meeting during which the resolution is passed. For circular resolutions, the chairperson will send the committee members a specific resolution template by post or email, which must be voted on. The committee members entitled to vote send their signed vote back to the chairperson of the examination committee by post, fax or scanned email. The voting results of the resolutions within the meaning of sentences 1 and 5 must be recorded. Sentence 11 does not apply if resolutions are passed by circulation using an online voting tool approved by the University of Bonn. In this case, a voting deadline must still be set and instructions on how to cast votes using the online voting tool will be provided when the template is sent.

(10) The chair of the examination board decides whether the examination board meeting takes place in person or as an online meeting. The chair also decides whether resolutions are made in person, in electronic communication or as circular resolutions. Paragraph 10 sentences 5 and 9 remain unaffected. At the request of one third of the members of the committee, an examination committee meeting must be held in person.

(11) The examination committee can involve employees of the office who are responsible for examination administration on a permanent basis or for individual meetings or agenda items. In this case, employees have the right to speak, but not the right to vote.

## **§ 9**

### **Examiners and assessors**

(1) The professors and junior professors of the Computer Science Department of the Faculty of Mathematics and Natural Sciences are examiners without the need to be expressly appointed by the examination board. This applies - provided that the persons concerned carry out teaching tasks in the master's program "Computer Science" or in the master's program "Cyber Security" in the respective semester - also for qualified members of the specialist group, lecturers, honorary professors, research assistants commissioned with independent teaching and teachers for special tasks. Each person according to sentences 1 and 2 can also take on the role of an assessor. Furthermore, the examination board can appoint additional examiners and assessors in accordance with Section 65 HG. Only those who have passed at least the relevant master's examination or an equivalent examination may be appointed as an assessor.

(2) Module examinations are usually held by the teachers teaching the module. This also applies to any second examiners within the meaning of Section 65 Paragraph 2 Sentence 1 HG. If the number of lecturers in the module falls below the number of examiners intended for an examination, the examination board will appoint the additional examiners. If a lecturer is prevented from holding module examinations on time due to illness or other important reasons, the examination board will ensure that another examiner is appointed to hold the module examination.

(3) The examiners are independent of instructions in their examination work.

(4) The candidate can suggest the examiners for the master's thesis. If possible, the suggestion should be taken into account; However, it does not constitute a claim.

(5) The examination board ensures that the names of the examiners are announced to the examinee in a timely manner, usually at least two weeks before the date of the respective examination.

## Section 5

Scope and implementation of tests,  
Examination modalities and forms of examination

### § 10

#### Scope of the master's examination

(1) The master's examination is intended to provide evidence of further professional, in-depth and research-related scientific qualifications.

(2) The master's examination consists of:

1. the module examinations accompanying the course, which focus on the content and qualification objectives of the course  
Obtain specified modules from the module plan (Appendix 1 or 2);
2. proof of the criteria for awarding ECTS credit points provided for in the module plan instead of a module examination;
3. the master's thesis.

All examinations should be completed within the standard period of study specified in Section 4 Paragraph 1.

(3) The examinations are taken during the course of study. Each module, even if it consists of several courses, is usually assigned a module examination, the results of which are included in the final certificate. The awarding of ECTS credit points requires the successful completion of the respective module. A module is considered to have been successfully completed if the associated module examination or all partial examinations associated with the module

- a. are graded as at least "sufficient" or if the criteria for awarding ECTS credit points provided for in the module plan instead of a module examination have been demonstrated.
- b.

(4) If a module consists of several courses that include partial module examinations, the ECTS credit points will be credited after passing the last partial module examination.

(5) The examinations are generally taken in the language of instruction. Examinations or parts of the examinations can also be taken in another language at the request of the students and after consultation with the respective examiner or examiners. However, there is no requirement to take parts of the exam in this language.

## **§ 11**

### **Admission to the master's examination procedure and module examinations**

(1) The student must apply for admission to the master's examination procedure. The application must be submitted in writing to the examination board before registering for the first module examination. The following must be enclosed with the application as proof that the admission requirements have been met:

1. proof of the general entry requirements specified in § 5;
2. a certificate of enrollment as proof of student enrollment in the chosen course of study at the University of Bonn; as
3. a statement as to whether the student has definitively failed an examination or the master's examination in the selected course of study or is currently undergoing another examination procedure at the time of registration for a module examination, the failure of which would constitute an obstacle to enrollment. This applies accordingly to examination procedures in a course of study that is significantly similar in terms of content.

(2) Only those who can be admitted to a module examination by the examination board: 1.

meets and provides evidence of the admission requirements in accordance

2. with paragraph 1; fulfills the requirements for the module and the module examination as specified in the module plan (Appendix 1 or 2).

Proof in accordance with sentence 1 number 1 is not required for admission to module examinations if proof of enrollment as a student in another course of study at the University of Bonn is provided, provided that this course of study imports the module in question in accordance with its own examination regulations, or if a Proof of current approval as a second listener in accordance with Section 52 Paragraph 1 HG is provided.

(3) If the student is unable to provide a document required under paragraph 1 sentence 3 in the prescribed manner, the examination board may allow the student to provide evidence in another way.

(4) The examination board decides on admission to the master's examination procedure or to the module examinations.

(5) The examination board may only refuse admission to the master's examination procedure if

- a. the documents in accordance with paragraph 1 are incomplete and/or are not submitted within a set deadline despite a request,
- b. the conditions specified in paragraph 1 are not met,
- c. the student has definitively failed a non-compensable examination or the master's examination in the chosen course of study or in a course of study that is significantly similar in content to this course of study, or
- d. the student is in an examination procedure at another university in accordance with § 6 paragraph 1 in the chosen course of study or in a course of study that has a significant similarity in content to this course of study, provided that the result of the examination procedure in the event of failure results in final failure the master's examination would lead.

(6) The examination board may only refuse admission to a module examination if the requirements specified in paragraph 2 are not met.

## **§ 12**

### **Examination modalities and compulsory attendance**

(1) The module examinations relate to the content and qualification objectives of the modules listed in the module plan (Appendix 1 or 2).

(2) During the module examinations, the examinee must be enrolled as a student in this course of study at the University of Bonn or in a course of study at the University of Bonn that imports modules from this course of study in accordance with its own examination regulations, or as a second student in accordance with Section 52 Paragraph 1 HG be permitted.

(3) The module examinations test the knowledge and skills acquired within the framework of the respective module as well as the ability to understand overarching connections.

Module examinations can be taken through graded partial examinations. The module examinations and partial module examinations take place in the form of

- exam papers,
- oral exams,
- project work,
- seminar lectures as well
- Presentations.

The respective form of examination and any subdivision into sub-examinations are specified in the module plan.

Deviations from the specifications in the module plan are possible in accordance with § 15 paragraph 4 and § 16 paragraph 4. The examination board then determines the specific form of examination in consultation with the examiners and announces it no later than the end of the third week of the lecture period of the semester in accordance with § 8 Paragraph 7 known.

(4) The module plan can determine that preliminary work (coursework) must be completed in order to take part in a module examination. If these are not provided, admission to the module examination cannot be granted. The examination board provides the specific requirements for the preliminary achievements (course achievements) at the request of the teacher before the start of the semester in accordance with Section 8 Paragraph 7 known.

(5) Two examination dates are scheduled for all module examinations that have to be taken in the form of written examinations or oral examinations. As a rule, the first examination date takes place after the lecture period of the semester in which the module or the associated courses are completed. As a rule, the second examination date takes place shortly before the start of the following semester. The examination dates of the exams, the periods within which the oral examinations are scheduled and the duration of the individual examinations will be announced by the examination board no later than the end of the third week of the lecture period of the semester in accordance with § 8 paragraph 7.

(6) Courses in which the qualification goal cannot be achieved without the active participation of the students can be marked in the module plan as courses in which mandatory regular participation (compulsory attendance) is provided as a prerequisite for taking part in the examination. Including absences due to illness, absences of a maximum of 30% are permitted.

(7) The following applies to the assessment of examination achievements:

1. Written examinations must be assessed by an examiner. The assessment of written examinations must be communicated to the examinee after four weeks at the latest. Announcement will be made on a notice board or in electronic form by posting it in the examination organization system in accordance with data protection regulations; it should take place before the end of the standard period of study.
2. Oral examinations must be assessed by an examiner in the presence of an expert assessor. The essential items and the results of the individual tests must be recorded in a protocol. The result must be announced to the candidate following the oral examination.

Examinations in re-examinations for which there is no possibility of compensation if the examination is ultimately failed must always be assessed by two examiners. If two examiners are involved in the evaluation of an examination, the grade is made up of the arithmetic mean

individual reviews together; If the assessment of only one examiner results in an examination being deemed to have been failed, then in the case of a written examination, a third examiner must be involved. The grade is then derived from the arithmetic mean of the two better individual assessments. The assessment of the master's thesis is regulated in Section 20 Paragraph 4.

(8) The examination board can allow module examinations to be taken in electronic form or in electronic communication (online examinations). The examination board regulates further details on how these examinations are carried out.

### **§ 13**

#### **Module examinations - registration and deregistration**

(1) The student must register electronically with the examination board for each module examination on time. The possibility of registering in writing in justified cases remains reserved.

(2) For oral examinations, the examiners determine the specific examination dates and announce them at least two weeks before the respective examination date. The examination board announces the exam dates and the registration dates on notice boards or electronically; The reporting deadlines are exclusionary deadlines.

(3) The student can deregister from an exam or oral examination without giving reasons at least one week before the respective examination date. For project work, seminar lectures and presentations, cancellation must be made at least one week before the topic is published. Section 21 paragraph 3 remains unaffected. Deregistration can be done electronically or in writing.

The date of receipt by the examination board is decisive.

(4) Registration for the master's thesis is regulated separately in § 19 paragraph 2.

### **§ 14**

#### **Repeating exams**

(1) Any examination that is not passed may be repeated a maximum of twice. The repetition of the master's thesis is regulated in § 20 paragraph 7.

(2) Failure to pass the same compulsory module three times results in the loss of the right to take the examination and, once the decision of the examination board regarding the final failure of the master's examination becomes final, leads to exmatriculation by the student secretariat.

(3) Failure to pass the same compulsory elective module three times will result in the loss of the right to take an examination in this module. The examinee has the opportunity to complete a compulsory elective module in the relevant compulsory elective area that has not been passed or has not been passed at all

- another compulsory elective module in the associated compulsory elective area that has not been finally failed according to the module plan or

- If necessary, additional modules approved by the examination board

to compensate. If all compensation options have been exhausted without success, this will result in the loss of the right to take examinations in this compulsory elective area and will result in de-registration by the Student Secretariat once the examination committee's decision regarding the final failure of the Master's examination becomes final.

(4) A module examination graded at least "sufficient" cannot be repeated.

Deviating from sentence 1, students who have successfully attended the first date for the module examination in accordance with § 12 paragraph 5 within the first three semesters in a subject-related compulsory elective module that is completed with a written exam or an oral examination, must register for the



Purpose of improving grades on the second examination date for the module examination in accordance with Section 12 Paragraph 5 in can register in the same semester; in this case the better of the two grades applies. The opportunity to register for a second examination date in accordance with sentence 2 for the purpose of improving grades can be exercised a maximum of three times during the course of your studies.

(5) In modules that are completed with project work or seminar lectures, it is not possible to repeat the examination in the same semester. In such modules, the module examination can only be taken again as part of repeating the entire module.

## **§ 15**

### **Examination papers**

(1) In exams, students should prove that they can identify a problem from the subject area of the module using the methods common in this area and find ways to solve it in a limited amount of time and with limited resources. The examiners will announce the approved aids in good time.

(2) Examination work can be carried out as handwritten or computer-aided supervision work.

(3) Each exam lasts at least 90 minutes and a maximum of 180 minutes. Section 12 paragraph 7 applies accordingly.

(4) The examination board can, in agreement with the examiner, schedule an oral examination instead of a planned written examination, which covers the subject matter of the module; This will be announced no later than the end of the third week of the semester's lecture period in accordance with Section 8 Paragraph 7.

## **§ 16**

### **Oral exams**

(1) In oral examinations, the examinee should demonstrate that he or she has a broad knowledge of the subject being examined, is able to recognize its connections, classify specific questions into these connections, and identify possible solutions.

(2) Oral examinations are taken as an individual or group examination in front of an examiner in the presence of an expert assessor. The regulations in Section 12 Paragraph 7 remain unaffected. The examination time is a minimum of 15 and a maximum of 45 minutes per examinee and module examination. For group examinations, it must be ensured that all examinees within a group have the same examination time.

(3) Students who want to take the same oral examination at a later examination date will be admitted as listeners depending on the spatial conditions, provided no examinee objects. The decision is made by the examiner. Admission does not extend to advice and announcement of the examination results. Listeners are prohibited from making recordings during the exam.

(4) In agreement with the examiner, the examination board can schedule an examination paper that covers the subject area of the module instead of a planned oral examination. This will be announced no later than the end of the third week of the semester's lecture period in accordance with Section 8 Paragraph 7.

## **§ 17**

### **Project work, seminar lectures and presentations**

(1) Project work generally demonstrates the ability to work in a team and, in particular, the ability to develop, implement and present concepts. The examinee should show that they can define goals and develop interdisciplinary solutions and concepts within the framework of a larger task. In the case of project work carried out in the form of group work, the contribution of the individual examinee must be clearly recognizable and assessable and meet the requirements according to sentence 1. The examinee should give an oral presentation about the content and results of this project. The duration of the oral presentation should be at least 10 minutes and a maximum of 30 minutes for each candidate.

Project work must be completed by the end of the respective semester in which the event takes place (in a winter semester by March 31st and in a summer semester by March 30th).  
September).

(2) Seminar lectures are oral lectures with discussion and last at least 15 and a maximum of 60 minutes. The lectures are based on original scientific literature and our own research. As a rule, seminar lectures are completed in a written format of 5 to 10 DIN A4 formats.

Pages added. Through seminar lectures, the examinee documents the ability to present scientific results in a comprehensible manner and to explain them in the discussion. Seminar lectures must be held in the semester in which the associated course takes place.

(3) Presentations are oral lectures lasting at least 15 and a maximum of 60 minutes, through which the examinee documents the ability to comprehensibly present their own results obtained using scientific methods and to explain them in the discussion.

(4) Otherwise, the regulations for the assessment of written and oral examinations in accordance with Section 12 Paragraph 7 apply accordingly.

## **§ 18**

### **Compensation for disadvantages**

Students who are prevented from taking an examination as intended due to a disability or chronic illness or due to maternity protection regulations can submit an application for compensation for disadvantages to the examination board by submitting suitable evidence; The same applies to the provision of study achievements within the meaning of Section 12 Paragraph 4. Compensation for disadvantages is granted on a case-by-case basis. In particular, it can provide for deviations with regard to the completion of the examination, the duration of the examination and the use of aids or assistants. For students with disabilities or chronic illnesses, the entitlement to compensation for disadvantages extends to all examinations to be taken during the course of their studies, provided that no change in the illness or disability is to be expected; Sentence 2 remains unaffected. For courses requiring attendance and for compulsory internships or mandatory stays abroad that cannot be completed due to the impairment, even with support from the university, substitute services must be permitted provided that these provide equivalent skills and abilities.

## **Section 6**

### **master thesis**

## **§ 19**

### **Registration, topic and scope of the master's thesis**

(1) The master's thesis is a written examination paper that is intended to show that the examinee is able to solve a problem from the area of the chosen master's degree program within a specified period of time

to work independently using scientific methods, to find a solution and to present it appropriately.

(2) The student must register the master's thesis with the examination board in writing. The examination board announces the deadlines by which a master's thesis must be registered so that the master's degree can be completed within the standard period of study.

(3) When registering for the master's thesis, the student must indicate which examiners they would like to complete the thesis with.

(4) The topic of the master's thesis can be set by any examiner in accordance with Section 9 Paragraph 1. Whoever came up with the topic usually supervises this master's thesis.

(5) The topic of the master's thesis can only be issued if the student meets the requirements for the master's thesis listed in the module plan (Appendix 1 or Appendix 2). The topic of the master's thesis is determined by the examination board. The topic of the work and the time of issue must be recorded. Before registering for the master's thesis, the student must be given the opportunity to make suggestions for the area from which the topic of the master's thesis is chosen; However, there is no entitlement to a topic from a specific area. At the student's request, the examination board will ensure that the student receives a topic for the master's thesis in a timely manner within the meaning of paragraph 9.

(6) The topic of the master's thesis can only be returned by the candidate once and only within the first two months after it was issued. Returning the topic does not count as a failed attempt. The newly issued topic must differ significantly in content from the originally issued topic.

(7) The master's thesis can also be admitted in the form of a group work. Then the contribution of the individual examinee to be assessed as an examination performance must be clearly distinguishable and assessable based on the specification of sections, page numbers or other objective criteria that enable a clear demarcation. In addition, the requirements under paragraph 1 must be met.

(8) The text part of the master's thesis should consist of at least 25 and a maximum of 100 DIN A4 pages. In group work, each examinee's text section should consist of at least 25 and a maximum of 100 DIN A4 pages.

(9) 30 ECTS credits are awarded for the master's thesis, which corresponds to 900 hours of student work. The processing period is a maximum of six months, in the part-time version a maximum of nine months. The examination board sets the latest submission deadline for the master's thesis and informs the student of it. The topic, task and scope of the master's thesis must be limited so that the master's thesis can be completed within the specified deadline under reasonable requirements. Upon a justified request, the examination board can grant a grace period of up to six weeks in agreement with the supervisor. The topic of the master's thesis is usually assigned after the end of the lecture period of the third semester; In the part-time version, usually after the end of the lecture period of the fourth semester.

## **§ 20**

### **Submission, evaluation and repetition of the master's thesis**

(1) The master's thesis must be submitted to the examination board on time in a digital version suitable for electronic comparison; The date of submission must be documented. The examination board will provide details on the form of electronic submission in accordance with Section 8 Paragraph 7. The candidate cannot withdraw a submitted master's thesis. If the master's thesis is not submitted on time, it will be graded as "insufficient".

(2) When submitting the master's thesis, the examinee must confirm in writing that he or she has written the work - in the case of group work, the appropriately marked portion of the work - independently, has not used any sources or aids other than those specified, and has identified quotations. The original written declaration must be submitted to the examination board no later than seven days after the master's thesis has been transmitted electronically.

(3) The master's thesis must be assessed and evaluated by two examiners. One of the examiners is the one who set the topic of the master's thesis; the second examiner The second examiner is determined by the examination board from among the examiners in accordance with Section 9 Paragraph 1. It must be ensured that at least one of the examiners is a member of the group of university lecturers or a qualified member of the university Bonn is. The examinee has the right to make suggestions, but there is no right to be assigned a specific examiner.

(4) The individual assessment must be carried out in accordance with Section 24 Paragraph 1 and justified in writing. The grade for the master's thesis is calculated from the arithmetic mean of the individual assessments, provided the difference is less than 2.0. If the difference is 2.0 or more, the examination board will appoint a third examiner to evaluate the master's thesis. In this case, the grade is the arithmetic mean of the two better individual assessments. When forming the mean value, the procedure is in accordance with Section 24 Paragraph 2. However, the master's thesis can only be graded as "sufficient" or better if at least two grades are "sufficient" or better. If the master's thesis was carried out as group work by several students, the independent contribution of each individual student within the overall work must be assessed.

(5) The assessment of the master's thesis will be communicated to the examinee no later than eight weeks after the submission deadline.

(6) For the master's thesis graded "sufficient" or better, the examinee earns 30 ECTS credits.

(7) If the master's thesis is graded "insufficient," the candidate can repeat it once. The topic of the second master's thesis may be selected from the same area from which the first master's thesis comes, but the content must differ significantly from the topic of the first master's thesis. Returning the topic of the master's thesis in a repeat attempt in the manner specified in § 19 paragraph 6 is only permitted if the student did not make use of this option when writing his or her first master's thesis. If the second master's thesis is also graded as "unsatisfactory", the master's examination is definitively failed; This results in the loss of the right to take examinations and, once the relevant decision of the examination committee becomes final, leads to de-registration by the student secretariat.

## Section 7

### Procedural irregularities and safeguards

#### § 21

#### **Cancellation, default, withdrawal and reprimand**

(1) The examinee can deregister electronically from module examinations with the examination board within the deadlines specified in § 13 paragraph 3 without giving reasons; If this is not possible, deregistration can also be made in writing. The date of receipt by the examination board is decisive.

(2) An examination performance will be graded as "insufficient" if the examinee withdraws from the examination after the deregistration deadline has expired without good reasons. The same applies if he fails to take part in the examination or to complete an examination within the specified processing time (failure).

(3) After the end of the deregistration period, a candidate who is registered for an examination can withdraw for valid reasons, in particular due to illness-related inability to take the examination. The withdrawal must be reported to the examination board immediately in writing. The reasons given for withdrawal or failure must be immediately substantiated in writing. To prove the inability to take the exam due to illness, a medical certificate confirming the inability to take the exam must be presented. If you withdraw from an exam for health reasons after the exam has started and the assignment has been given, you must consult a doctor on the same day to determine your inability to take the exam. In individual cases, the examination board can request the presentation of a certificate from a medical officer at the university if there is sufficient factual evidence that assumes ability to take the examination is likely or that evidence other than that in accordance with sentence 4 appears to be appropriate. Withdrawal after the examination has begun is generally not possible, especially if the examinee has already seen the result of the examination or has become aware of it in another way. If the examination board accepts the evidence of withdrawal due to illness or other valid reasons, the examination attempt is deemed not to have been made.

(4) Defects in an examination must be reported by the examinee immediately to the respective examiner or to the supervisor. The complaint must be recorded and submitted to the examination board. If the examination board accepts the complaint, the examination attempt is deemed not to have been made.

## **§ 22**

### **Deception and violation of the rules**

(1) If the examinee attempts to influence the result of the examination through deception or the use of unauthorized aids, the examination in question will be graded as "insufficient"; The determination is made by the respective examiner or supervisor, recorded and forwarded to the examination board. An examinee who disrupts the orderly course of the examination can be excluded from continuing the examination by the respective examiner or by the supervisor after warning; In this case, the examination performance in question will be graded as "insufficient". The reasons for the exclusion must be put on record.

(2) The examinee can request that decisions according to paragraph 1 sentences 1 and 2 be reviewed by the examination board within a period of two weeks.

(3) The examination committee assesses the extent to which there has been a multiple or otherwise serious attempt at deception. In the event of this, the examination board can, after hearing the candidate beforehand, decide that the candidate loses the right to take examinations in this course of study. Once the decision of the examination board regarding the loss of the right to take examinations becomes final, de-registration will be carried out by the student secretariat.

(4) Anyone who intentionally violates a provision of these examination regulations relating to cheating about examination results is acting in an unlawful manner. The administrative offense can be punished with a fine of up to 50,000 euros. The responsible administrative authority for the prosecution and punishment of administrative offenses according to sentence 1 is the Chancellor of the University of Bonn.

## **§ 23**

### **Protective regulations**

(1) Maternity protection regulations, as set out in the applicable Maternity Protection Act (MuSchG), must be taken into account accordingly; The required evidence must be submitted by the student. The maternity leave period interrupts any period according to these examination regulations; the duration of the

Maternity leave is not included in the deadline. Once the required evidence has been submitted, the examination board will inform the students of the newly set examination deadlines.

(2) The periods of parental leave must be taken into account upon application in accordance with the applicable law on parental allowance and parental leave (BEEG). The candidate must notify the examination board in writing of the period or periods for which they wish to take parental leave no later than four weeks before the date from which they wish to take parental leave, enclosing the necessary evidence. The examination committee checks whether the legal requirements are met that would give an employee a right to parental leave under the BEEG and immediately informs the candidate of the result and, if applicable, the newly set examination deadlines.

Processing deadlines for examinations cannot be interrupted by parental leave. The exam topics set are considered not assigned. After the parental leave has expired, the examinee receives a new topic. Section 21 paragraph 3 sentence 1 remains unaffected.

(3) Upon request, downtime due to the care or care of spouses, registered life partners, direct relatives, second-degree collateral relatives or first-degree in-laws should be taken into account if they are in need of care or care. The examination committee checks whether the requirements of sentence 1 are met. The application must be submitted immediately after the conditions have been met. The application must be accompanied by meaningful evidence. The examination board immediately informs the candidate of the result and, if necessary, of the newly set examination deadlines. Processing deadlines for examinations cannot be extended due to such downtime. The exam topics set are considered not assigned. After the downtime has expired, the examinee receives a new topic. Section 21 paragraph 3 sentence 1 remains unaffected.

## Section 8

### Assessment and final documents

#### § 24

#### **Evaluation of examination performance, formation of grades and passing the master's examination**

(1) The grades for the individual examinations are determined by the respective examiners. Section 12 paragraph 7 remains unaffected. The following grades should be used for the evaluation:

1	very good an excellent performance
2	a performance that is significantly above the average good requirements
3	Fair Poor a performance that meets average requirements
4	a service that, despite its shortcomings, still meets the requirements
5	not sufficient a service that no longer meets the requirements due to significant defects.

For a differentiated assessment of the examination performance, individual grades can be raised or lowered by 0.3 to intermediate values; grades 0.7 and 4.3 as well as 4.7 and 5.3 are excluded. An examination is passed if it is graded at least "sufficient"; otherwise it is not passed.

(2) When calculating the module grades and the overall grade, only the first decimal place after the decimal point is taken into account; all other positions are deleted without rounding.

(3) The examination in a module is passed if the module grade is at least "sufficient". If the module grade is made up of several partial examinations, it is calculated based on the weighting of the individual examinations specified in the module plan. Section 10 paragraph 3 sentence 4 remains unaffected. The module grade is:

with an average of up to and including 1.5 with	= very good
an average of 1.6 up to and including 2.5	= good

with an average of 2.6 up to and including 3.5 with an average	= satisfactory =
of 3.6 up to and including 4.0 with an average of 4.1 or more	sufficient
	= not sufficient.

(4) The master's examination is passed when all modules required in accordance with § 4 paragraph 4 or § 4 paragraph 5 as well as the master's thesis have been passed and 120 ECTS credits have been acquired.

(5) The graded modules are used to calculate the overall grade. Each individual module grade is weighted by multiplying it by the number of ECTS credit points in the corresponding module. The sum of all module grades weighted in this way is divided by the total number of ECTS credit points of all graded modules (weighted arithmetic mean). Paragraph 3 Sentence 4 applies accordingly. Deviating from this, the overall grade is "excellent" if the calculated overall grade is not worse than very good (1.3) and the master's thesis was graded "very good" (1.0). Modules that were recognized as "passed" due to a lack of comparability of the grading systems are not included in the calculation of the overall grade.

(6) The master's examination is definitively failed if:

- the examinee has not successfully completed a module examination in the compulsory area in accordance with Section 10 Paragraph 3 Sentence 4 Letter a or Section 14 Paragraph 2 three times; or
- the compensation options in the compulsory elective area in accordance with Section 14 paragraph 3 have been exhausted; or
- the repeated master's thesis was graded "insufficient".

## § 25

### Transcript

(1) A provisional certificate will be issued to the examinee about the results of the master's examination passed immediately after all grades have been received. A certificate in German will then be issued immediately. An English translation of the certificate can also be issued at the candidate's request. The certificate contains

all modules from which ECTS credit points were acquired;

- the semester in which the ECTS credit points are acquired;
- the module grades achieved;
- the topic and grade of the master's thesis;
- the date of the last examination performance and
- the overall grade of the master's examination.

At the candidate's request, the results of additional examinations in accordance with Section 30 will also be included in the certificate; these are not included in the calculation of the overall grade.

(2) The certificate bears the date of issue. It is stamped with the seal of the examination board and signed by the chair of the examination board.

(3) If the master's examination is ultimately not passed, the examination board will issue the candidate with a written notice of this with instructions on legal remedies.

(4) If a student leaves the university without completing their studies, upon request after de-registration they will be issued with a certificate of achievement for the overall study and examination achievements. This certificate of achievement is limited to the successfully completed parts of the course of study. In addition, at the student's request, a certificate can be issued which also shows which examinations have not been passed or are still missing in order to pass the master's examination.

## **§ 26**

### **Master certificate**

At the same time as the certificate for the master's examination, the examinee will be given a master's certificate in German and English with the date of the certificate confirming the award of the academic degree in accordance with § 3. The certificate is signed by the dean of the Faculty of Mathematics and Natural Sciences and the chairman of the examination board and bears the seal of the Faculty of Mathematics and Natural Sciences.

## **§ 27**

### **Diploma supplement**

The master's certificate is supplemented by a *diploma supplement* (supplementary document). The *Diploma Supplement* is a standardized English and German language document that contains the following information:

- the main course content underlying the degree;
- the course of studies;
- the skills acquired with the degree;
- Information on the accreditation of the course of study and
- Information about the awarding university.

The relative classification of the overall grade of the master's examination in the ECTS grading scale is shown on the *diploma supplement*.

## **§ 28**

### **Inspection of the examination files**

(1) Upon request, the examinee must be granted access to their examination papers, the relevant reports from the examiners and examination protocols for oral examinations; the application must be submitted no later than three months after the announcement of the examination results. Section 29 of the Administrative Procedure Act remains unaffected by this.

(2) Upon written request, the examinee will be granted access to their examination files within a period of three months after the examination board has issued the certificate in accordance with Section 25. Section 29 of the Administrative Procedure Act remains unaffected by this.

(3) The examination board determines the place and time of the inspection and informs the examinee of this in good time. The examination board regulates the possibility of making copies or other true-to-original reproductions and announces this in accordance with Section 8 Paragraph 7. Copies and other reproductions of the examination files or parts thereof serve exclusively to pursue the examinee's own rights resulting from the examination legal relationship and can therefore only be used by the examinee or made accessible to a person commissioned by the examinee to represent his or her legal interests. Any duplication or distribution of copies or other reproductions beyond this is prohibited.

## **§ 29**

### **Invalidity of the master's examination, revocation of the master's degree**

(1) If an examinee has cheated in an examination and this fact only becomes known after the certificate has been handed out, the examination board can subsequently correct the grades for those examinations in which the cheating occurred, as well as the overall grade, and declare the examination to be canceled in whole or in part declare passed.

(2) If the requirements for admission to an examination were not met without the examinee intending to deceive, and this fact only becomes known after the certificate has been issued, so



This deficiency is remedied by passing the examination. If an examinee intentionally obtained admission wrongly, the examination board will decide on the legal consequences in compliance with the Administrative Procedure Act.

(3) Those affected must be given the opportunity to comment before a decision is made.

(4) The incorrect examination certificate must be confiscated and, if necessary, a new examination certificate must be issued. If one or more of the examinations have been declared failed due to cheating, the master's certificate and all other documents documenting the completion of the course must be confiscated along with the incorrect examination certificate. A decision according to paragraph 1 and paragraph 2 sentence 2 is excluded after a period of five years after the examination certificate was issued.

(5) If the Master's examination is declared to have been failed overall, the Master's degree must be revoked and the Master's certificate, the Master's certificate and all other documents documenting the degree completion must be confiscated.

### **§ 30**

#### **Additional examinations**

By the end of the semester in which they complete the master's examination in accordance with Section 10 Paragraph 2, students can, upon request, complete examination achievements beyond their standard course of study to the extent of up to 15 ECTS credits in additional modules. These can be modules from the respective master's degree program as well as modules that cannot be credited but are offered in another degree program at the University of Bonn and can be selected as an additional module in the respective master's degree program. At the student's request, the result of these examinations will be included in the certificate in accordance with Section 25, but will not be taken into account when determining the overall grade.

#### **Section 9**

Come into effect

### **§ 31**

#### **Entry into force and publication**

These examination regulations come into force on the day after their publication in the official announcements of the Rheinische Friedrich-Wilhelms-Universität Bonn - Announcement Gazette.

W. Witke

The Dean

the Faculty of Mathematics and Natural Sciences  
the Rheinische Friedrich-Wilhelms-Universität Bonn  
University professor Dr. Walter Witke

Issued on the basis of the resolution of the Faculty Council of the Faculty of Mathematics and Natural Sciences of June 28, 2023, the emergency decision of the Dean of the Faculty of Mathematics and Natural Sciences of June 30, 2023 and the resolution of the Rectorate of July 11, 2023.

Bonn, July 18, 2023

For the principal

K. Sandman

The Prorector for Studies, Teaching and University Development at the  
Rheinische Friedrich-Wilhelms-Universität Bonn

University professor Dr. Klaus Sandman

**Appendix 1: Module plan for the consecutive master's degree program "Computer Science"****Explanations of the module plan:**

- Abbreviations of the event types: P = internship, S = seminar, Ü = scientific exercise, V = lecture.
- Marked with an asterisk (\*): courses in which, in accordance with Section 12 Paragraph 6, mandatory regular participation (compulsory attendance) is required as a prerequisite for taking exams. The obligation to participate is in addition to any other listed coursework.
- The course type(s) in the module are listed in the "Course Type" column.
- The "Duration/Subject Semester" column lists the duration (D) of the module (in semesters) and its placement in a subject semester (FS).
- In the "Academic achievements" column, only academic achievements are listed as a prerequisite for taking part in the examination. S.d. § 12 paragraph 4 or criteria for awarding ECTS credit points for modules without an examination are listed.

Further details about the modules, in particular about the courses offered for a module and the courses to be attended in the module, will be announced by the examination board before the start of the respective semester in accordance with § 8 paragraph 7 in the form of the module handbook.

**Mandatory area**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 0401	Master Thesis		At least 60 ECTS credits	D: 1 semester FS: 4th semester	Ability to write a scientific paper with your own new results.	no	master thesis	30
MA-INF 0402	Master Seminar	S*	The registration must be done together with the registration for the master's thesis take place	D: 1 semester FS: 4th semester	Ability to present self-developed results, ability to critically discuss one's own and others' results, also in a broader specialist context.	no	presentation	2

**Subject-specific elective area**

In the subject-specific elective area, modules amounting to 88 ECTS credits must be completed. The following applies:

- At least 31 ECTS credits and a maximum of 61 ECTS credits must be acquired in the focus area selected in accordance with Section 4 Paragraph 4. At least one must be Seminar module and a lab module must be completed.
- The remaining 27 ECTS-CP to 57 ECTS-CP must be acquired from the remaining focus areas. Two of the remaining ones must be Focus areas must be represented with 6 ECTS credits each.
- In total, a maximum of 10 ECTS-LPs may be achieved from seminar modules and 18 ECTS-LPs from lab modules in the subject-specific elective area.

The examination board can approve additional compulsory elective modules and will announce these before the start of the semester in accordance with Section 8 Paragraph 7.

**Elective modules – focus on algorithms**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1102	Combinatorial Optimization	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Advanced knowledge of combinatorial optimization. Modeling and development of solution strategies for combinatorial optimization problems	Successful participation in the exercise	Oral exam	9
MA-INF 1103	Cryptography	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Basic private-key and public-key cryptosystems: AES, RSA, group-based. Security reductions. Key exchange, cryptographic hash functions, signatures, identification; factoring integers and discrete logarithms; lower bounds in structured models.	Successful participation in the exercise	Exam	9
MA-INF 1105	Algorithms for Data Analysis	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Advanced algorithmic techniques and data structures relevant to analysis tasks for Big Data. Qualification goals: In-depth insights into selected methods and techniques of modern algorithms with respect to Big Data and/or analysis tasks (technical) as well as presentation of solutions and methods, critical discussion of applied methods and techniques (soft skills).	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1106	High Performance Computing: Modern Architectures and Trends	V	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding principles of computer architecture in modern HPC systems at component and system level, as well as the implication for application (parallel) programming.	no	Oral exam	4
MA-INF 1201	approximation Algorithms	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Introduction to design and analysis of approximation algorithms for NP-hard problems, and techniques for proving lower and upper bounds, probabilistic methods and applications.	Successful participation in the exercise	Oral exam	9
MA-INF 1202	chip design	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Knowledge of the central problems and algorithms in chip design. Competence to develop and apply algorithms for solving real-world problems, also with respect to technical constraints. Techniques to develop and implement efficient algorithms for very large instances.	Successful participation in the exercise	Oral exam	9
MA-INF 1203	Discrete and Computational Geometry	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Knowledge of fundamental theorems and concepts in the area of discrete and computational geometry; design and analysis of geometric algorithms; combinatorial analysis of the complexity of geometric configurations; Competence to apply this knowledge autonomously in solving new problems.	Successful participation in the exercise	Oral exam	9
MA-INF 1205	Graduate Seminar Discrete optimization	S*	no	D: 1 semester FS: 2nd semester	Competence to understand new research results based on original literature, to put such results in a broader context and present such results and relationships.	no	Seminar lecture	6
MA-INF 1206	Seminar Randomized and approximation Algorithms	S*	no	D: 1 semester FS: 2nd semester	Goal of the seminar is the discussion of current research in algorithms. Each participant presents a paper or a group of related papers within a talk and a written report.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1207	Lab Combinatorial Algorithms	P*	no	D: 1 semester FS: 2nd semester	Current topics in computational analytics from the current research literature.  Qualification goals: Ability to design, analyze, and implement efficient algorithms for computational analytical problems. Further, the ability to work constructively with others in small teams	no	Project work	9
MA-INF 1209	Seminar Advanced Topics in Cryptography	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding research publications, often written tersely. Distilling this into a presentation. Determination of relevant vs. irrelevant material. Developing a presentation that fascinates fellow students.	no	Seminar lecture	4
MA-INF 1213	Randomized Algorithms etc Probabilistic Analysis	V, O	no	D: 1 semester FS: 2nd semester	Understanding the use of randomization in computing, both in the context of randomized algorithms and probabilistic analysis.	Successful participation in the exercise	Oral exam	9
MA-INF 1217	Seminar Theoretical Foundations of Data Science	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Goal of the seminar is the discussion of current research related to the theoretical foundations of data science. Each participant presents a paper or a group of related papers within a talk and a written report.	no	Seminar lecture	4
MA-INF 1218	Algorithms and Uncertainty	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding approaches for modeling uncertainty in algorithmic theory. Designing and analyzing algorithms with performance guarantees in the context of uncertainty.	Successful participation in the exercise	Oral exam	9
MA-INF 1219	Seminar Algorithmic Game Theory	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Participants present advanced topics in Algorithmic Game Theory and Algorithmic Mechanism Design based on current conference and journal papers.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1220	Seminar Algorithms for Computational Analytics	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Current topics in computational analytics from the current research literature. Qualification goals: Ability for individual literature research, critical reading, comprehension and clear didactic preparation and presentation. Further, the ability to present and critically discuss the presented results.	no	Seminar lecture	4
MA-INF 1221	Lab Computational Analytics	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Design and implementation of efficient exact and approximate algorithms and data structures for computational analytics problems. Qualification goals: Ability to design, analyze, and implement efficient algorithms for computational analytical problems. Further, the ability to work constructively with others in small teams.	no	Project work	9
MA-INF 1222	Lab High performance Optimization	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical study of optimization problems and their solution using state-of-the-art methods and modern computing devices. Qualification goals: Ability to design, analyze, and implement efficient algorithms for computational analytical problems and the use of high performance computing systems. Further, the ability to work constructively with others in small teams.	no	Project work	9
MA-INF 1223	Privacy Enhancing Technologies	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Fully homomorphic encryption (FHE). Zero-Knowledge techniques, in particular: Non-interactive zero-knowledge proof (NIZKs). Secure multi-party computations (MPC). Anonymization, TOR. Pseudonymization. Blinding. Weaker privacy notions, like differential privacy.	Successful participation in the exercise	Exam	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1301	Algorithmic Game theory	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Fundamental results in (algorithmic) game theory and (algorithmic) mechanism design. Techniques and methods related to mathematical modeling of strategic agents. Analyzing and designing systems of strategic agents, with a focus on computational efficiency and performance guarantees.	Successful participation in the exercise	Exam	9
MA-INF 1304	Seminar Computational Geometry	S*	no	D: 1 semester FS: 2nd-3rd Sem.	Presentation and discussion of advanced topics in computational geometry. Independent reading of scientific papers in this area.	no	Seminar lecture	4
MA-INF 1305	Graduate Seminar on Applied Combinatorial Optimization	S*	no	D: 1 semester FS: 3rd semester	Competence to understand new theoretical results and practical solutions in VLSI design and related applications, as well as presentation of such results	no	Seminar lecture	6
MA-INF 1307	Seminar Advanced Algorithms	S*	no	D: 1 semester FS: 3rd semester	Presentation of selected advanced topics in algorithm design and various applications	no	Seminar lecture	4
MA-INF 1308	Lab Algorithms for Chip design	P*	no	D: 1 semester FS: 3rd semester	Competence to implement algorithms for VLSI design, efficient handling of very large instances, testing, documentation. Advanced software techniques.	no	Project work	9
MA-INF 1309	Lab Efficient Algorithms: Design, Analysis and Implementation	P*	no	D: 1 semester FS: 3rd semester	Within the lab, current algorithms are implemented and evaluated. At the end of the lab, each project is presented and a written report is submitted.	no	Project work	9
MA-INF 1314	Online Motion Planning	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Algorithmic and analytic aspects of motion planning tasks. Design and analysis of online strategies for searching, exploration and escape under incomplete information.	Successful participation in the exercise	Oral exam	9
MA-INF 1315	Lab Computational Geometry	P*	no	D: 1 semester FS: 2nd semester	Design, implementation, analysis and documentation of efficient algorithms for selected problems in computational geometry.	no	Project work	9



Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1316	Lab Cryptography	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to properly present and defend design decisions, to prepare readable documentation of software; skills in constructively collaborating with others in small teams over a longer period of time; ability to classify one's own results into the state-of-the-art of the resp. area.	no	Project work	9
MA-INF 1320	Lab Advanced Algorithms	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Implementation of algorithms from advanced algorithmic theory, evaluating these algorithm on suitably chosen instances, and discussing how theoretical results transfer to practice.	no	Project work	9
MA-INF 1321	Binary Linear and Quadratic Optimization	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding computational methods to solve (potentially large-scale) mixed-integer programs in practice. Application-specific modeling and reformulation of combinatorial optimization problems, handling quadratic objective functions.	Successful participation in the exercise	Oral exam	6
MA-INF 1332	Seminar Focus Topics in High Performance Computing	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Goal of the seminar is the discussion of current research related to High Performance Computing (HPC). Each participant selects a topic from the list and prepares a written report and a talk.	no	Seminar lecture	4

**Elective modules – focus on graphics, vision, audio**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2113	Foundations of Audio Signal Processing	V, O	no	D: 1 semester FS: 1st semester	Understanding basic concepts of signal processing, introduction to digital signal processing, processing of audio signals and related algorithmic concepts.	Successful participation in the exercise	Exam	6
MA-INF 2201	Computer Vision	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding linear filters, Hough transform, image segmentation, graph cuts, mean shift, active contours, level sets, MRFs, expectation maximization, background subtraction, temporal filtering, active appearance models, shape models, optical flow, 2D tracking, camera models, 2D /3D features, stereo, 3D reconstruction, 3D pose estimation, deformable meshes, RGBD vision.	Successful participation in the exercise	Exam	9
MA-INF 2203	Selected Topics in Signal Processing	V, O	no	D: 1 semester FS: 2nd semester	Learning advanced as well as state of the art topics and techniques in digital signal processing. Study examples from the field of digital audio signal processing with a focus on music audio. Develop skills for analyzing audio signals and designing audio features for selected application scenarios. Mathematical modeling of signal processing problems in practical applications. Design and implementation of corresponding algorithms and data structures solving those problems. Efficiency issues.	Successful participation in the exercise	Exam	9
MA-INF 2206	Seminar Vision	S*	MA-INF 2201 – Computer Vision	D: 1 semester FS: 2nd or 3rd Sem.	Within the seminar, current approaches in the field of computer vision are discussed. Each participant presents a paper as part of a talk. Each talk is accompanied by a written report.	no	Seminar lecture	4
MA-INF 2207	Seminar Graphics	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Within the seminar, current approaches in the field of computer graphics are discussed. Each participant presents a paper as part of a talk. Each talk is accompanied by a written report.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2208	Seminar Audio	S*	no	D: 1 semester FS: 2nd semester	Within the seminar, current approaches in the field of audio signal processing are discussed. Each participant presents a paper as part of a talk. Each talk is accompanied by a written report.	no	Seminar lecture	4
MA-INF 2209	Advanced Topics in Computer Graphics I	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Analytical formulation of problems related to geometry processing and rendering. Knowledge of techniques and algorithms to optimize, process, analyze and store geometry and reflectance data as well as knowledge of the major algorithms for the simulation of light distributions in 3D scenes and volume data sets. Self-dependent implementation of the basic algorithms.	Successful participation in the exercise	Project work	9
MA-INF 2212	Pattern Matching and Machine learning for Audio signal Processing	V, O	no	D: 1 semester FS: 2nd semester	Understanding basic concepts and methods from pattern matching and machine learning in the context of audio signal processing.	Successful participation in the exercise	Exam	6
MA-INF 2213	Advanced Computers vision	V, O	MA-INF 2201 – Computer Vision	D: 1 semester FS: 2nd or 3rd Sem.	Understanding linear methods for classification and regression, random forests, neural networks, SVMs, prototype methods, nearest neighbors, Gaussian processes, metric learning, structured learning, and their applications to image classification, object detection, action recognition, pose estimation, face analysis, tracking.	Successful participation in the exercise	Oral exam	6
MA-INF 2214	Computational Photography	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding the principles of optical image formation and digital light sensing. Foundations, methods and applications of computational imaging: plenoptic function, light transport, signal processing, inverse problems, regularization and sparse recovery, computational display. Experimental recreation of essential techniques: light fields, reflectance fields, direct-global separation.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2215	Seminar Computational Photography / Digital Material Appearance	S*	no	D: 1 semester FS: 2nd semester	Goal of the seminar is the discussion of current works related to computational photography and digital material appearance. Each participant presents a paper or a group of related papers within a talk and a written report.	no	Seminar lecture	4
MA-INF 2216	Lab Visual Computing P*		no	D: 1 semester FS: 1st-3rd Sem.	Within the lab, a practical task in the context of visual computing is added (eg from a research paper), including testing and evaluation.	no	Project work	9
MA-INF 2217	Advanced Deep Learning for Graphics	V, O	no	D: 1 semester FS: 1st-3rd Sem.	This course discusses autoencoders, generative models and the extension of these methods to graph- and manifold-structured data. Applications discussed will include inverse problems in computer graphics and the synthesis of models including data completion and super-resolution.	Successful participation in the exercise	Exam	6
MA-INF 2218	Video Analytics	V, O	MA-INF 2201 – Computer Vision	D: 1 semester FS: 2nd-3rd Sem.	Understanding approaches for video clip classification, temporal video segmentation, spatio-temporal action detection, anticipation, and weakly supervised learning.	Successful participation in the exercise	Oral exam	6
MA-INF 2219	Seminar Visualization and Medical Image Analysis	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within Visualization and Medical Image Analysis. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4
MA-INF 2220	Lab Visualization and Medical image Analysis	P*	no	D: 1 semester FS: 2nd semester	Carrying out a practical task in the context of visualization or medical image analysis. Making, implementing, and defending design choices, documentation, testing and evaluation, presenting results.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2222	Visual Data Analysis	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Understanding, implementing, and applying systems for visual data analysis. In particular, perceptual and conceptual foundations and algorithms for the visualization of multi- and high-dimensional data, graphs, geospatial data, scalar, vector and tensor fields, artificial neural networks.	Successful participation in the exercise	Exam	9
MA-INF 2307	Lab Vision	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Within the lab, a computer vision approach is implemented. This can be a demo application, an improvement of an existing source code, or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented and a <u>written report is submitted</u> .	no	Project work	9
MA-INF 2308	Lab Graphics	P*	no	D: 1 semester FS: 3rd semester	Within the lab, a computer graphics approach is implemented. This can be a demo application, an improvement of an existing source code, or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented and a <u>written report is submitted</u> .	no	Project work	9
MA-INF 2309	Lab Audio	P*	no	D: 1 semester FS: 3rd semester	Understanding, implementing and evaluating methods and algorithms from audio signal processing in the context of a small research project. Documenting and presenting the obtained results and implementation.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2310	Advanced Topics in Computer Graphics II	V, O	no	D: 1 semester FS: 3rd semester	This class focuses on advanced topics in the field of geometry and digital appearance processing. Students will become familiar with recent developments in the area of shape analysis, shape retrieval, material acquisition and modeling techniques.	Successful participation in the exercise	Oral exam	9
MA-INF 2312	Image Acquisition and Analysis in Neuroscience	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Understanding the whole computational pipeline that is involved in the acquisition and analysis of MR-based neuroimaging. In particular, image reconstruction, artifact removal, image registration and segmentation, statistical modeling, relevant applications of machine learning.	Successful participation in the exercise	Oral exam	6
MA-INF 2313	Deep Learning for Visual recognition	V, O	no	D: 1 semester FS: 1st-3rd Sem.	This course discusses the state-of-the-art convolutional and recurrent neural networks as well as their use in applications for visual recognition. Participants learn to build their own network for visual recognition tasks such as object recognition, image segmentation and caption generation.	Successful participation in the exercise	Oral exam	6
MA-INF 2314	Image Processing, Search and Analysis I	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	This lecture introduces fundamental signal processing techniques (Fourier transforms, digital filters) and transformations of range and domain of images for artistic effects (warping, morphing).	Successful participation in the exercise	Exam	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2316 Lab	Computational Photography / Digital Material Appearance	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Within the lab, a computational imaging and/ or digital material appearance technique is implemented. This can be a newly developed approach, an improvement of an existing technique, or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented within a seminar and a written report.	Successful ones Exercise participation	Exam	9
MA-INF 2317 Num	merical Algorithms for Visual Computing and Machine Learning	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding numerical methods that frequently occur in visual computing and machine learning, as well as modeling aspects relevant for practical problems in these fields.	no	Exam	6

**Elective modules – focus on security, information and communication management**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3108	Secure Software Engineering	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The lecture introduces the security-relevant aspects in a software-engineering lifecycle, presents common vulnerabilities and attacks and ways to prevent them.	Successful participation in the exercise	Exam	6
MA-INF 3202	Mobile Communication	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding key concepts of wireless communication; Wireless Technologies: WiFi, Bluetooth; LoRa and LoRaWAN; Cellular phone networks (GSM, GPRS, 3G); Mobility Management (Mobile IP).	Successful participation in the exercise	Exam	6
MA-INF 3209	Seminar Selected Topics in Communication management	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to understand new research results presented in original scientific papers in the topic area of Communication Systems.	no	Seminar lecture	4
MA-INF 3216	Seminar Sensor Data fusion	S*	no	D: 1 semester FS: 2nd semester	Ability to understand new research results presented in original scientific papers in the topic area of Sensor Data Fusion.	no	Seminar lecture	4
MA-INF 3229	Lab IT Security	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of IT Security is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9
MA-INF 3233	Advanced Sensor Data Fusion in Distributed Systems	V, O	no	D: 1 semester FS: 2nd semester	The course discusses sophisticated algorithms such as the Distributed Kalman Filter, Accumulated State Density Filter and (Inverse) Covariance Intersection. This lecture shows how to model and overcome common measurement errors by an application of theoretical tools such as Bayes' rule and further derivations.	Successful participation in the exercise	Oral exam	6



Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3236	IT Security	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Selected active research fields of IT security are discussed. This includes risks and vulnerabilities of today's information technology as well as concepts to increase the level of IT security, their applications and their weaknesses.	Successful participation in the exercise	Exam	6
MA-INF 3237	Array Signal and Multi-channel Processing	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding and application of basic and advanced methods of array signal and multi-channel processing including data modeling, calibration, spatial filtering, direction finding, bearing accuracy, and bearings-only and direct localization.	Successful participation in the exercise	Oral exam	6
MA-INF 3238	Side Channel Attacks	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The theoretical and practical side channel effects of modern hardware are introduced as well as techniques to utilize these effects to circumvent security mechanisms. This includes covered channels as well as side channels attacks and microarchitectural attacks on modern CPUs.	Successful participation in the exercise	Exam	6
MA-INF 3239	Malware Analysis	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	The course covers advanced topics in malware analysis. Theoretical and practical aspects of malware analysis are covered.	Successful participation in the exercise	Oral exam	6
MA-INF 3304	Lab Communication and Communicating Devices	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of Communication Systems is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state of-the-art of the respective area.	no	Project work	9
MA-INF 3305	Lab Information systems	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of information systems is carried out. This includes test, documentation and presentation of the implemented software and the underlying ideas/concepts (paper and presentation).	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3310	Introduction to Sensor Data Fusion - Methods etc Applications	V, O	no	D: 1 semester FS: 3rd semester	Based on the Kalman filter as tracking scheme, further approaches to a wide spectrum of applications will be shown. All algorithms will be motivated by examples from ongoing research projects, industrial cooperations, and impressions of current demonstration hardware.	Successful participation in the exercise	Exam	6
MA-INF 3312	Lab Sensor Data fusion	P*	no	D: 1 semester FS: 3rd semester	In the lab, a practical task in the context of Sensor Data Fusion is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9
MA-INF 3317	Seminar Selected Topics in IT Security	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within the context of IT Security. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4
MA-INF 3319	Lab Usable Security and Privacy	P*	no	D: 1 semester FS: 2nd semester	The students carry out a practical task in the context of usable security and privacy, including user studies. They present and defend design decisions and classify their results into the state-of-the-art of the respective. area.	no	Project work	9
MA-INF 3320	Lab Security in Distributed Systems	P*	no	D: 1 semester FS: 2nd semester	The students will carry out a practical task (project) in the context of distributed security, including documentation of the implemented software/system. They present and defend design decisions and classify their results into the state-of-the-art of the resp. area.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3321	Seminar Usable Security and privacy	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within the context of Usable Security and Privacy. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4
MA-INF 3323	Lab Fuzzing	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	The Lab aims at understanding and extending current fuzzers (AFL++, libFuzzer, syzkaller, k afl and Jazzer).	no	Project work	9
MA-INF 3324	Lab Design of Usable Security Mechanisms	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	The students will carry out a practical task (project) in the context of usable security mechanisms, including test and documentation of the implemented software/system. They present and defend design decisions and classify their results into the state-of-the-art of the resp. area.	no	Project work	9
MA-INF 3140	Advanced Computers Forensics	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The course covers advanced topics in computer forensics. Therefore, theoretical and practical aspects of computer forensics are covered.	Successful participation in the exercise	Exam	6
MA-INF 3241	Practical Challenges in Human Factors of Security and privacy	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	In this course we will learn about and develop solutions for a specific challenge concerning human factors in security and privacy. After completing the unit students will be able to conduct related work searchers to get a deep understanding into the state of the art. They will be able to design, run and evaluate scientific studies in this area.	Successful participation in the exercise	Project work	6
MA-INF 3322	Applied Binary Exploitation	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to understand and apply methods for binary exploitation like stack and heap based attacks as well as fundamentals of fuzzing. Ability to understand complex case studies.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3242	Security of Distributed and Resource constrained systems	V, O	No	D: 1 semester, FS 1st, 2nd or 3rd Sem.	Ability to understand and analyze theoretical and practical cyber security challenges of distributed and resource-constrained systems, as well as the ability to select and apply appropriate solutions.	Successful participation in the exercise	Exam	6

### Elective modules – focus on Intelligent Systems

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4111	Intelligent Learning and Analysis Systems: Machine learning	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding of the core tasks, theoretical foundations, and most important paradigms and methods of machine learning. At the end of the module, students will be capable of choosing, applying, and adapting the appropriate methods and systems for particular predictive learning applications.	Successful participation in the exercise	Exam	6
MA-INF 4112	Intelligent Learning and Analysis Systems: Data mining etc Knowledge Discovery	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding of the core tasks and most important paradigms and methods of data mining and knowledge discovery. At the end of the module, students will be capable of choosing, applying, and adapting the appropriate methods and systems for data analysis applications.	Successful participation in the exercise	Exam	6
MA-INF 4113	Cognitive Robotics	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Probabilistic approaches to state estimation (Bayes Filters, Kalman Filter, Particle Filter), motion models, sensor models, self-localization, mapping with known poses, simultaneous mapping and localization (SLAM), iterated closest-point matching, path planning, place- and person recognition, object recognition.	Successful participation in the exercise	Exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4114	Robot Learning	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Reinforcement learning, Markov decision processes, dynamic programming, Monte Carlo methods, temporal-difference methods, function approximation, linear quadratic regulation, differential dynamic programming, partially observable MDPs, policy gradient methods, inverse reinforcement learning, imitation learning, learning kinematic models, perceiving and handling of objects.	Successful participation in the exercise	Exam	6
MA-INF 4201	Artificial Life	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Detailed understanding of the most important approaches and principles of artificial life. Knowledge and understanding of the current state of research in the field of artificial life.	Successful participation in the exercise	Exam	6
MA-INF 4203	Autonomous Mobile systems	V, O	no	D: 1 semester FS: 2nd semester	Requirements for the implementation of autonomous mobile systems, eg for: map making, dead reckoning, localization, SLAM methods, various principles of robot path planning; methods for action planning. Comparison of different learning paradigms for specific applications.	Successful participation in the exercise	Oral exam	6
MA-INF 4204	Technical Neural Nets V, Ü		no	D: 1 semester FS: 1st-3rd Sem.	Detailed knowledge of the most important fundamental neural network approaches and learning algorithms and their fields of application.	Successful participation in the exercise	Exam	6
MA-INF 4208	Seminar Vision systems	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Knowledge in advanced topics in the area of technical vision systems, such as image segmentation, feature extraction, and object recognition. Ability to understand new research results presented in original scientific papers and to present them in a research talk as well as in a seminar report.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4209	Seminar Principles of Data mining etc Learning Algorithms	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Acquiring in-depth knowledge in specialized topics in the area of machine learning and data mining. Acquiring the competence to independently study scientific literature, to present it to others and to discuss it with a knowledgeable scientific audience. Learn how to present scientifically prior to work by others, in writing and in presentations.	no	Seminar lecture	4
MA-INF 4211	Seminar Cognitive Robotics	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Knowledge in advanced topics in the area of cognitive robotics, such as robot perception, action planning, and robot learning. Ability to understand new research results presented in original scientific papers and to present them in a research talk as well as in a seminar report.	no	Seminar lecture	4
MA-INF 4212	Data Science and Big Data	V, O	no	D: 1 semester FS: 3rd semester	Detailed understanding of theoretical, algorithmic, and implementation aspects of processing massive data and data streams. At the end of the module, students will acquire in-depth knowledge of distributed processing systems and algorithmic techniques for analyzing data that cannot be stored in a single computer because of its enormous size and/or high rate at which the data arrive.	Successful participation in the exercise	Exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4213	Seminar Humanoid Robots	S*	no	D: 1 semester FS: 2nd semester	Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications. Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism , critical examination of algorithms and experimental results).	no	Seminar lecture	4
MA-INF 4214	Lab Humanoid Robots	P*	no	D: 1 semester FS: 2nd semester	Robot middleware, perception, state estimation, environment representations, navigation, and motion planning for humanoid robots. Self-competences (time management, goal-oriented work, ability to analyze problems theoretically and to find practical solutions), communication skills (collaboration in small teams, oral and written presentation of solutions, critical examination of implementations).	no	Project work	9
MA-INF 4215	Humanoid Robotics	V, O	no	D: 1 semester FS: 2nd-3rd Sem.	This lecture covers techniques for humanoid robots such as perception, navigation, and motion planning. Communicative skills (oral and written presentation of solutions, discussions in small teams), ability to analyze problems.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4216	Data Mining and Machine learning Methods in Bioinformatics	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The following topics are covered in the context of their application in bioinformatics: Short introduction to Bioinformatics and Biomedicine; Probability distributions and Bayesian inference, statistical hypothesis testing, linear models, logistic regression, Principal Component Analysis; clustering; Hidden Markov Models; Principles of Supervised Machine Learning; ElasticNet; Basics of deep learning.	Successful participation in the exercise	Exam	6
MA-INF 4217	Seminar Machine Learning Methods in the Life Sciences	S*	no	D: 1 semester FS: 2nd semester	In this seminar, a variety of machine learning techniques are discussed in the context of their application to solve real-world problems in biomedicine.	no	Seminar lecture	4
MA-INF 4218	Lab Modeling and simulation	P*	no	D: 1 semester FS: 2nd semester	Simulation and analysis of complex systems that arise, for example, in systems biology. Covered modeling approaches are Boolean Networks and ODEs.	no	Project work	9
MA-INF 4226	Lab Parallel Computing for Mobile Robotics	P*	no	D: 1 semester FS: 2nd semester	Parallel programming on the GPU, CUDA, shortest path planning, collision checking, visibility graph, A* algorithm. Ability to properly present and defend design decisions, to prepare readable documentation of software; skills in constructively collaborating with others in small teams over a longer period of time; ability to classify one's own results into the state-of-the-art of the resp. area.	no	Project work	9
MA-INF 4228	Foundations of Data Science	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Data science aims at making sense of big data. To that end, various tools have to be understood for helping in analyzing the emerging structures.	Successful participation in the exercise	Exam	9



Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4229	Pattern Recognition I	V, O	no	D: 1 semester FS: 2nd semester	Mathematical foundations (linear algebra, probability theory, optimization), feature selection, classification, clustering algorithms, neural networks.	Successful participation in the exercise	Exam	9
MA-INF 4230	Advanced Methods of Information retrieval	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding of advanced methods, data structures, and algorithms of information retrieval.	Successful participation in the exercise	Exam	6
MA-INF 4231	Seminar Advanced Topics in Information Retrieval	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Specialized topics in information retrieval. Independent, in-depth study of scientific literature, discussion and presentation.	no	Seminar lecture	4
MA-INF 4232	Lab Information Retrieval in practice	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical experience in designing and implementing information retrieval systems for specific applications.	no	Project work	9
MA-INF 4302	Advanced Learning systems	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Participants specialize and require in-depth knowledge of one particular class of learning algorithms, they acquire the necessary knowledge to improve existing algorithms and construct their own within the given class, all the way up to the research frontier on the topic.	Successful participation in the exercise	Exam	6
MA-INF 4303	Learning from Non-Standard data	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Detailed understanding of theoretical and algorithmic aspects of mining and learning with structured data. At the end of the module, students will acquire in-depth knowledge of mining and learning algorithms for graphs and other relational structures.	Successful participation in the exercise	Exam	6
MA-INF 4304	Lab Cognitive Robotics	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Robot middleware (ROS), simultaneous localization and mapping (SLAM), 3D representations of objects and environments, object detection and recognition, person detection and tracking, action recognition, action planning and control, mobile manipulation, human-robot interaction.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4306 Lab	Development and Application of Data Mining and Learning systems	P*	no	D: 1 semester FS: 3rd semester	Acquiring in-depth knowledge in the construction and development of intelligent learning systems for machine learning and data mining. The students learn how to work with existing state-of-the-art systems and apply them to application problems, usually extending them for the requirements of their particular task.	no	Project work	9
MA-INF 4308 Lab	Vision Systems	P*	no	D: 1 semester FS: 3rd semester	Basic matrix and vector computations with GPUs (CUDA). Classification algorithms, such as multi-layer perceptrons, support-vector machines, k-nearest neighbors, linear-discriminant analysis. Image preprocessing and data handling. Quantitative performance evaluation of learning algorithms for segmentation and categorization.	no	Project work	9
MA-INF 4309 Lab	Sensor Data interpretation	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Within the lab, an approach to sensor data interpretation is implemented. This can be an improvement of an existing source code or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented and a written report is submitted.	no	Project work	9
MA-INF 4310 Lab	Mobile Robots	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Basic knowledge and practical experience in design and implementation of control algorithms for simple structured robotic systems using real mobile robots. Working in 2 people groups.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4316	Graph Representation Learning	V, O	no	D: 1 semester FS: 1st semester	This lecture presents general approaches for machine learning (ML) on graph structured data. In particular, computational methods for graph representation learning such as graph neural networks (GNNs), graph kernels, as well as graph mining techniques will be discussed, analyzed, and applied. Qualification goals of the module are deep understanding of the trade-off between expressiveness of graph representation and computational complexity, as well as practical runtime of algorithms in the context of machine learning applications. Furthermore, the ability to implement, practically apply, and theoretically analyze graph representation, graph kernels, and graph mining algorithms.	Successful participation in the exercise	Exam	6
MA-INF 4319	Game AI	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	The lecture introduces classical AI techniques (tree search algorithms, state machines), softcomputing methods (genetic algorithms, fuzzy logic) and machine learning techniques (hidden markov models, reinforcement learning) for computer game AI (path planning, strategic decision making, behavior modeling).	Successful participation in the exercise	Oral exam	9
MA-INF 4322	Lab Machine Learning on Encrypted Data	P*	no	D: 1st semester FS: 2nd or 3rd Sem.	The goal of the lab is to understand how computations on encrypted data may work in one particular application that we are choosing together. Ideally, we can come up with a novel solution for performing an unconsidered algorithm.	no	Project work	9
MA-INF 4323	Pattern Recognition I	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Advanced optimization, latent factor models, manifold models, kernel methods, graph-based methods.	Successful participation in the exercise	Exam	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4324	Seminar Advanced Topics in Data Science	S*	no	D: 1 semester FS: 2. or 3rd semester	Specialized topics in data science. Independent, in-depth study of scientific literature, discussion and presentation.	no	Seminar lecture	4
MA-INF 4325	Lab Data Science in Practice	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical experience in designing and implementing data science workflows for specific applications.	no	Project work	9
MA-INF 4326	Explainable AI and Applications	V, O	no	D: 1 semester FS: 3rd semester	State-of-the-art Explainable AI methods, self-explainable neural syllogistic reasoning, applications in spatial reasoning.	Successful participation in the exercise	Exam	6
MA-INF 4327	Lab Biomedical Data Science	P*	no	D: 1 semester FS: 3rd semester	The goal of this lab is to start working on a small research project, which could result into a Master thesis project later on. Topics will be presented during the first meeting. In exceptional cases more than one student may work on one project. Students are expected to largely work independently on their project and regularly report intermediate results to their direct advisor.	no	Project work	9
MA-INF 4328	Spatio-Temporal Data Analytics	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding of advanced methods, data structures, and data analytics algorithms for spatio-temporal data.	Successful participation in the exercise	Exam	6

**Appendix 2: Module plan for the consecutive master's degree program "Cyber Security"****Explanations of the module plan:**

- Abbreviations of the event types: P = internship, S = seminar, Ü = scientific exercise, V = lecture.
- Marked with an asterisk (\*): courses in which, in accordance with Section 12 Paragraph 6, mandatory regular participation (compulsory attendance) is required as a prerequisite for taking exams. The obligation to participate is in addition to any other listed coursework.
- The course type(s) in the module are listed in the "Course Type" column.
- The "Duration/Subject Semester" column lists the duration (D) of the module (in semesters) and its placement in a subject semester (FS).
- In the "Academic achievements" column, only academic achievements are listed as a prerequisite for taking part in the examination. S.d. § 12 paragraph 4 or criteria for awarding ECTS credit points for modules without an examination are listed.

Further details about the modules, in particular about the courses offered for a module and the courses to be attended in the module, will be announced by the examination board before the start of the respective semester in accordance with § 8 paragraph 7 in the form of the module handbook.

**Mandatory area**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 0401	Master Thesis		At least 60 ECTS credits	D: 1 semester FS: 4th semester	Ability to write a scientific paper with your own new results.	no	master thesis	30
MA-INF 0402	Master Seminar	S*	The registration must be done together with the registration for the master's thesis take place	D: 1 semester FS: 4th semester	Ability to present self-developed results, ability to critically discuss one's own and others' results, also in a broader specialist context.	no	presentation	2
MA-INF 3236	IT Security	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Selected active research fields of IT security are discussed. This includes risks and vulnerabilities of today's information technology as well as concepts to increase the level of IT security, their applications and their weaknesses.	Successful participation in the exercise	Exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3244	Cyber Security seminar	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Goal is the discussion of current research related to Cyber Security. Each participant prepares a written report and a talk for a selected topic. In addition the seminar group analyzes and discusses current societal and political developments related to Cyber Security.	no	Seminar lecture	4
MA-INF 3245	Cyber Security Lab	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of Cyber Security is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9

**Subject-specific elective area**

In the subject-specific elective area, modules amounting to at least 54 CP must be completed. The following applies:

- At least 24 ECTS-LPs must be acquired in the subject-specific elective area of Cyber Security.
- At least 12 ECTS-LPs must be acquired from the subject-specific elective area of Computer Science. A maximum of one seminar module and a maximum of one lab module must be completed.

The examination board can approve additional compulsory elective modules and will announce these before the start of the semester in accordance with Section 8 Paragraph 7.

**Elective modules – Cyber Security**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3108	Secure Software Engineering	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The lecture introduces the security-relevant aspects in a software-engineering lifecycle, presents common vulnerabilities and attacks and ways to prevent them.	Successful participation in the exercise	Exam	6
MA-INF 3202	Mobile Communication	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding key concepts of wireless communication; Wireless Technologies: WiFi, Bluetooth; LoRa and LoRaWAN; Cellular phone networks (GSM, GPRS, 3G); Mobility Management (Mobile IP).	Successful participation in the exercise	Exam	6
MA-INF 3238	Side Channel Attacks	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The theoretical and practical side channel effects of modern hardware are introduced as well as techniques to utilize these effects to circumvent security mechanisms. This includes covered channels as well as side channels attacks and microarchitectural attacks on modern CPUs.	Successful participation in the exercise	Exam	6
MA-INF 3239	Malware Analysis	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	The course covers advanced topics in malware analysis. Theoretical and practical aspects of malware analysis are covered.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3140	Advanced Computers Forensics	V, O	no	D: 1 semester FS: 1st or 3rd Sem.	The course covers advanced topics in computer forensics. Therefore, theoretical and practical aspects of computer forensics are covered.	Successful participation in the exercise	Exam	6
MA-INF 3241	Practical Challenges in Human Factors of Security and privacy	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	In this course we will learn about and develop solutions for a specific challenge concerning human factors in security and privacy. After completing the unit students will be able to conduct related work searches to get a deep understanding into the state of the art. They will be able to design, run and evaluate scientific studies in this area.	Successful participation in the exercise	Project work	6
MA-INF 3322	Applied Binary Exploitation	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to understand and apply methods for binary exploitation like stack and heap based attacks as well as fundamentals of fuzzing. Ability to understand complex case studies.	Successful participation in the exercise	Oral exam	6
MA-INF 3242	Security of Distributed and Resource constrained systems	V, O	no	D: 1 semester, FS 1st, 2nd or 3rd Sem.	Ability to understand and analyze theoretical and practical cyber security challenges of distributed and resource-constrained systems, as well as the ability to select and apply appropriate solutions.	Successful participation in the exercise	Exam	6
MA-INF 3243	Tutor Internship Cybersecurity	P*	no	D: 1 semester FS 2nd or 3rd Sem.	Ability and experience in conveying and presenting specialist content, assessing and appreciating task solutions and argumentations, developing, implementing and applying teaching and learning tools.	no	Project work	9



**Elective modules – Computer Science with a focus on algorithms**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1103	Cryptography	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Basic private-key and public-key cryptosystems: AES, RSA, group-based. Security reductions. Key exchange, cryptographic hash functions, signatures, identification; factoring integers and discrete logarithms; lower bounds in structured models.	Successful participation in the exercise	Exam	9
MA-INF 1105	Algorithms for Data Analysis	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Advanced algorithmic techniques and data structures relevant to analysis tasks for Big Data. Qualification goals: In-depth insights into selected methods and techniques of modern algorithms with respect to Big Data and/or analysis tasks (technical) as well as presentation of solutions and methods, critical discussion of applied methods and techniques (soft skills).	Successful participation in the exercise	Oral exam	6
MA-INF 1106	High Performance Computing: Modern Architectures and Trends	V	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding principles of computer architecture in modern HPC systems at component and system level, as well as the implication for application (parallel) programming.	no	Oral exam	4
MA-INF 1209	Seminar Advanced Topics in Cryptography	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding research publications, often written tersely. Distilling this into a presentation. Determination of relevant vs. irrelevant material. Developing a presentation that fascinates fellow students.	no	Seminar lecture	4
MA-INF 1221	Lab Computational Analytics	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Design and implementation of efficient exact and approximate algorithms and data structures for computational analytics problems. Qualification goals: Ability to design, analyze, and implement efficient algorithms for computational analytical problems. Further, the ability to work constructively with others in small teams.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 1222	Lab High performance Optimization	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical study of optimization problems and their solution using state-of-the-art methods and modern computing devices. Qualification goals: Ability to design, analyze, and implement efficient algorithms for computational analytical problems and the use of high performance computing systems. Further, the ability to work constructively with others in small teams.	no	Project work	9
MA-INF 1223	Privacy Enhancing Technologies	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Fully homomorphic encryption (FHE). Zero-Knowledge techniques, in particular: Non-interactive zero-knowledge proof (NIZKs). Secure multi-party computations (MPC). Anonymization, TOR. Pseudonymization. Blinding. Weaker privacy notions, like differential privacy.	Successful participation in the exercise	Exam	9
MA-INF 1309	Lab Efficient Algorithms: Design, Analysis and Implementation	P*	no	D: 1 semester FS: 3rd semester	Within the lab, current algorithms are implemented and evaluated. At the end of the lab, each project is presented and a written report is submitted.	no	Project work	9
MA-INF 1316	Lab Cryptography	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to properly present and defend design decisions, to prepare readable documentation of software; skills in constructively collaborating with others in small teams over a longer period of time; ability to classify one's own results into the state-of-the-art of the resp. area.	no	Project work	9
MA-INF 1332	Seminar Focus Topics in High Performance Computing	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Goal of the seminar is the discussion of current research related to High Performance Computing (HPC). Each participant selects a topic from the list and prepares a written report and a talk.	no	Seminar lecture	4

**Elective modules – Computer Science with a focus on graphics, vision, audio**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2201	Computer Vision	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding linear filters, Hough transform, image segmentation, graph cuts, mean shift, active contours, level sets, MRFs, expectation maximization, background subtraction, temporal filtering, active appearance models, shape models, optical flow, 2D tracking, camera models, 2D /3D features, stereo, 3D reconstruction, 3D pose estimation, deformable meshes, RGBD vision.	Successful participation in the exercise	Exam	9
MA-INF 2212	Pattern Matching and Machine learning for Audio signal Processing	V, O	no	D: 1 semester FS: 2nd semester	Understanding basic concepts and methods from pattern matching and machine learning in the context of audio signal processing.	Successful participation in the exercise	Exam	6
MA-INF 2213	Advanced Computers vision	V, O	MA-INF 2201 – Computer Vision	D: 1 semester FS: 2nd or 3rd Sem.	Understanding linear methods for classification and regression, random forests, neural networks, SVMs, prototype methods, nearest neighbors, Gaussian processes, metric learning, structured learning, and their applications to image classification, object detection, action recognition, pose estimation, face analysis, tracking.	Successful participation in the exercise	Oral exam	6
MA-INF 2216	Lab Visual Computing P*		no	D: 1 semester FS: 1st-3rd Sem.	Within the lab, a practical task in the context of visual computing is added (eg from a research paper), including testing and evaluation.	no	Project work	9
MA-INF 2218	Video Analytics	V, O	MA-INF 2201 – Computer Vision	D: 1 semester FS: 2nd-3rd Sem.	Understanding approaches for video clip classification, temporal video segmentation, spatio-temporal action detection, anticipation, and weakly supervised learning.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 2219	Seminar Visualization and Medical Image Analysis	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within Visualization and Medical Image Analysis. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4
MA-INF 2220	Lab Visualization and Medical image Analysis	P*	no	D: 1 semester FS: 2nd semester	Carrying out a practical task in the context of visualization or medical image analysis. Making, implementing, and defending design choices, documentation, testing and evaluation, presenting results.	no	Project work	9
MA-INF 2308	Lab Graphics	P*	no	D: 1 semester FS: 3rd semester	Within the lab, a computer graphics approach is implemented. This can be a demo application, an improvement of an existing source code, or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented and a written report is submitted.	no	Project work	9
MA-INF 2309	Lab Audio	P*	no	D: 1 semester FS: 3rd semester	Understanding, implementing and evaluating methods and algorithms from audio signal processing in the context of a small research project. Documenting and presenting the obtained results and implementation.	no	Project work	9
MA-INF 2314	Image Processing, Search and Analysis I	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	This lecture introduces fundamental signal processing techniques (Fourier transforms, digital filters) and transformations of range and domain of images for artistic effects (warping, morphing).	Successful participation in the exercise	Exam	9

**Elective modules – Computer Science with a focus on Security, Information and Communication Management**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3209	Seminar Selected Topics in Communication management	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Ability to understand new research results presented in original scientific papers in the topic area of Communication Systems.	no	Seminar lecture	4
MA-INF 3216	Seminar Sensor Data fusion	S*	no	D: 1 semester FS: 2nd semester	Ability to understand new research results presented in original scientific papers in the topic area of Sensor Data Fusion.	no	Seminar lecture	4
MA-INF 3229	Lab IT Security	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of IT Security is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9
MA-INF 3233	Advanced Sensor Data Fusion in Distributed Systems	V, O	no	D: 1 semester FS: 2nd semester	The course discusses sophistic algorithms such as the Distributed Kalman Filter, Accumulated State Density Filter and (Inverse) Covariance Intersection. This lecture shows how to model and overcome common measurement errors by an application of theoretical tools such as Bayes' rule and further derivations.	Successful participation in the exercise	Oral exam	6
MA-INF 3237	Array Signal and Multi-channel Processing	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding and application of basic and advanced methods of array signal and multi-channel processing including data modeling, calibration, spatial filtering, direction finding, bearing accuracy, and bearings-only and direct localization.	Successful participation in the exercise	Oral exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3304	Lab Communication and Communicating Devices	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of Communication Systems is carried out. This includes test and documentation of the implemented software/system. The results achieved are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9
MA-INF 3305	Lab Information systems	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	In the lab, a practical task in the context of information systems is carried out. This includes test, documentation and presentation of the implemented software and the underlying ideas/concepts (paper and presentation).	no	Project work	9
MA-INF 3310	Introduction to Sensor Data Fusion - Methods etc Applications	V, O	no	D: 1 semester FS: 3rd semester	Based on the Kalman filter as tracking scheme, further approaches to a wide spectrum of applications will be shown. All algorithms will be motivated by examples from ongoing research projects, industrial cooperations, and impressions of current demonstration hardware.	Successful participation in the exercise	Exam	6
MA-INF 3312	Lab Sensor Data fusion	P*	no	D: 1 semester FS: 3rd semester	In the lab, a practical task in the context of Sensor Data Fusion is carried out. This includes test and documentation of the implemented software/system. The achieved results are discussed in the context of the state-of-the-art of the respective area.	no	Project work	9
MA-INF 3317	Seminar Selected Topics in IT Security	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within the context of IT Security. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 3319	Lab Usable Security and Privacy	P*	no	D: 1 semester FS: 2nd semester	The students carry out a practical task in the context of usable security and privacy, including user studies. They present and defend design decisions and classify their results into the state-of-the-art of the respective. area.	no	Project work	9
MA-INF 3320	Lab Security in Distributed Systems	P*	no	D: 1 semester FS: 2nd semester	The students will carry out a practical task (project) in the context of distributed security, including documentation of the implemented software/system. They present and defend design decisions and classify their results into the state-of-the-art of the resp. area.	no	Project work	9
MA-INF 3321	Seminar Usable Security and privacy	S*	no	D: 1 semester FS: 2nd semester	Understanding new research results reported in conference or journal papers within the context of Usable Security and Privacy. Presenting them in context of the respective state of the art, based on an independent literature search.	no	Seminar lecture	4
MA-INF 3323	Lab Fuzzing	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	The Lab aims at understanding and extending current fuzzers (AFL++, libFuzzer, syzkaller, kafl and Jazzer).	no	Project work	9
MA-INF 3324	Lab Design of Usable Security Mechanisms	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	The students will carry out a practical task (project) in the context of usable security mechanisms, including test and documentation of the implemented software/system. They present and defend design decisions and classify their results into the state-of-the-art of the resp. area.	no	Project work	9

**Elective modules – Computer Science with a focus on Intelligent Systems**

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4111	Intelligent Learning and Analysis Systems: Machine learning	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding of the core tasks, theoretical foundations, and most important paradigms and methods of machine learning. At the end of the module, students will be capable of choosing, applying, and adapting the appropriate methods and systems for particular predictive learning applications.	Successful participation in the exercise	Exam	6
MA-INF 4112	Intelligent Learning and Analysis Systems: Data mining etc Knowledge Discovery	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Understanding of the core tasks and most important paradigms and methods of data mining and knowledge discovery. At the end of the module, students will be capable of choosing, applying, and adapting the appropriate methods and systems for data analysis applications.	Successful participation in the exercise	Exam	6
MA-INF 4113	Cognitive Robotics	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Probabilistic approaches to state estimation (Bayes Filters, Kalman Filter, Particle Filter), motion models, sensor models, self-localization, mapping with known poses, simultaneous mapping and localization (SLAM), iterated closest-point matching, path planning, place- and person recognition, object recognition.	Successful participation in the exercise	Exam	6
MA-INF 4114	Robot Learning	V, O	no	D: 1 semester FS: 1st or 2nd Sem.	Reinforcement learning, Markov decision processes, dynamic programming, Monte Carlo methods, temporal-difference methods, function approximation, linear quadratic regulation, differential dynamic programming, partially observable MDPs, policy gradient methods, inverse reinforcement learning, imitation learning, learning kinematic models, perceiving and handling of objects.	Successful participation in the exercise	Exam	6



Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4201	Artificial Life	V, O	no	D: 1 semester FS: 1st-3rd Sem.	Detailed understanding of the most important approaches and principles of artificial life. Knowledge and understanding of the current state of research in the field of artificial life.	Successful participation in the exercise	Exam	6
MA-INF 4204	Technical Neural Nets V, Ü		no	D: 1 semester FS: 1st-3rd Sem.	Detailed knowledge of the most important fundamental neural network approaches and learning algorithms and their fields of application.	Successful participation in the exercise	Exam	6
MA-INF 4208	Seminar Vision systems	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Knowledge in advanced topics in the area of technical vision systems, such as image segmentation, feature extraction, and object recognition. Ability to understand new research results presented in original scientific papers and to present them in a research talk as well as in a seminar report.	no	Seminar lecture	4
MA-INF 4209	Seminar Principles of Data mining etc Learning Algorithms	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Acquiring in-depth knowledge in specialized topics in the area of machine learning and data mining. Acquiring the competence to independently study scientific literature, to present it to others and to discuss it with a knowledgeable scientific auditorium. Learn how to present scientifically prior to work by others, in writing and in presentations.	no	Seminar lecture	4
MA-INF 4211	Seminar Cognitive Robotics	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Knowledge in advanced topics in the area of cognitive robotics, such as robot perception, action planning, and robot learning. Ability to understand new research results presented in original scientific papers and to present them in a research talk as well as in a seminar report.	no	Seminar lecture	4

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4212	Data Science and Big Data	V, O	no	D: 1 semester FS: 3rd semester	Detailed understanding of theoretical, algorithmic, and implementation aspects of processing massive data and data streams. At the end of the module, students will acquire in-depth knowledge of distributed processing systems and algorithmic techniques for analyzing data that cannot be stored in a single computer because of its enormous size and/or high rate at which the data arrive.	Successful participation in the exercise	Exam	6
MA-INF 4213	Seminar Humanoid Robots	S*	no	D: 1 semester FS: 2nd semester	Current research papers from conferences and journals in the field of humanoid robotics covering fundamental techniques and applications. Self-competences (time management, literature search, self-study), communication skills (preparation of the talk, clear didactic presentation of techniques and experimental results, scientific discussion, structured writing of summary), social skills (ability to formulate and accept criticism, critical examination of algorithms and experimental results).	no	Seminar lecture	4
MA-INF 4214	Lab Humanoid Robots	P*	no	D: 1 semester FS: 2nd semester	Robot middleware, perception, state estimation, environment representations, navigation, and motion planning for humanoid robots. Self-competences (time management, goal-oriented work, ability to analyze problems theoretically and to find practical solutions), communication skills (collaboration in small teams, oral and written presentation of solutions, critical examination of implementations).	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4215	Humanoid Robotics	V, O	no	D: 1 semester FS: 2nd-3rd Sem.	This lecture covers techniques for humanoid robots such as perception, navigation, and motion planning. Communicative skills (oral and written presentation of solutions, discussions in small teams), ability to analyze problems.	Successful participation in the exercise	Oral exam	6
MA-INF 4228	Foundations of Data Science	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Data science aims at making sense of big data. To that end, various tools have to be understood for helping in analyzing the emerging structures.	Successful participation in the exercise	Exam	9
MA-INF 4230	Advanced Methods of Information retrieval	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Understanding of advanced methods, data structures, and algorithms of information retrieval.	Successful participation in the exercise	Exam	6
MA-INF 4231	Seminar Advanced Topics in Information Retrieval	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Specialized topics in information retrieval. Independent, in-depth study of scientific literature, discussion and presentation.	no	Seminar lecture	4
MA-INF 4232	Lab Information Retrieval in practice	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical experience in designing and implementing information retrieval systems for specific applications.	no	Project work	9
MA-INF 4302	Advanced Learning systems	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Participants specialize and require in-depth knowledge of one particular class of learning algorithms, they acquire the necessary knowledge to improve existing algorithms and construct their own within the given class, all the way up to the research frontier on the topic.	Successful participation in the exercise	Exam	6
MA-INF 4303	Learning from Non-Standard data	V, O	no	D: 1 semester FS: 2nd or 3rd Sem.	Detailed understanding of theoretical and algorithmic aspects of mining and learning with structured data. At the end of the module, students will acquire in-depth knowledge of mining and learning algorithms for graphs and other relational structures.	Successful participation in the exercise	Exam	6

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4304	Lab Cognitive Robotics	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Robot middleware (ROS), simultaneous localization and mapping (SLAM), 3D representations of objects and environments, object detection and recognition, person detection and tracking, action recognition, action planning and control, mobile manipulation, human-robot interaction.	no	Project work	9
MA-INF 4306	Lab Development and Application of Data Mining and Learning systems	P*	no	D: 1 semester FS: 3rd semester	Acquiring in-depth knowledge in the construction and development of intelligent learning systems for machine learning and data mining. The students learn how to work with existing state-of-the-art systems and apply them to application problems, usually extending them for the requirements of their particular task.	no	Project work	9
MA-INF 4308	Lab Vision Systems	P*	no	D: 1 semester FS: 3rd semester	Basic matrix and vector computations with GPUs (CUDA). Classification algorithms, such as multi-layer perceptrons, support-vector machines, k-nearest neighbors, linear-discriminant analysis. Image preprocessing and data handling. Quantitative performance evaluation of learning algorithms for segmentation and categorization.	no	Project work	9
MA-INF 4309	Lab Sensor Data interpretation	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Within the lab, an approach to sensor data interpretation is implemented. This can be an improvement of an existing source code or an implementation of a paper. Each participant selects a topic, defines an objective, and presents a work plan at the beginning of the project. At the end of the lab, each project is presented and a written report is submitted.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4310 Lab	Mobile Robots	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Basic knowledge and practical experience in design and implementation of control algorithms for simple structured robotic systems using real mobile robots. Working in 2 people groups.	no	Project work	9
MA-INF 4316 Graph	Representation Learning	V, O	no	D: 1 semester FS: 1st semester	This lecture presents general approaches for machine learning (ML) on graph structured data. In particular, computational methods for graph representation learning such as graph neural networks (GNNs), graph kernels, as well as graph mining techniques will be discussed, analyzed, and applied. Qualification goals of the module are deep understanding of the trade-off between expressiveness of graph representation and computational complexity, as well as practical runtime of algorithms in the context of machine learning applications. Furthermore, the ability to implement, practically apply, and theoretically analyze graph representation, graph kernels, and graph mining algorithms.	Successful participation in the exercise	Exam	6
MA-INF 4322 Lab	Machine Learning on Encrypted Data	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	The goal of the lab is to understand how computations on encrypted data may work in one particular application that we are choosing together. Ideally, we can come up with a novel solution for performing an unconsidered algorithm.	no	Project work	9
MA-INF 4324 Seminar	Advanced Topics in Data Science	S*	no	D: 1 semester FS: 2nd or 3rd Sem.	Specialized topics in data science. Independent, in-depth study of scientific literature, discussion and presentation.	no	Seminar lecture	4
MA-INF 4325 Lab	Data Science in Practice	P*	no	D: 1 semester FS: 2nd or 3rd Sem.	Practical experience in designing and implementing data science workflows for specific applications.	no	Project work	9

Module code	module name	Course type	participation requirements	Duration/ semester	Subject of the examination (content) and Qualification goal	Coursework	Exam form	ECTS LP
MA-INF 4326	Explainable AI and Applications	V, O	no	D: 1 semester FS: 3rd semester	State-of-the-art Explainable AI methods, self-explainable neural syllogistic reasoning, applications in spatial reasoning.	Successful participation in the exercise	Exam	6
MA-INF 4328	Spatio-Temporal Data Analytics	V, O	No	D: 1 semester FS: 2nd or 3rd Sem.	Understanding of advanced methods, data structures, and data analytics algorithms for spatio-temporal data.	Successful participation in the exercise	Exam	6

**Non-subject-specific elective area**

In the non-subject-specific compulsory elective area in accordance with Section 4 Paragraph 5, modules amounting to a maximum of 15 ECTS credits can be completed; Bachelor's modules are excluded from this. Modules from the subjects mathematics, psychology, economics, geography, photogrammetry, physics/astronomy and chemistry can be chosen for the non-subject-specific compulsory elective area of the consecutive master's degree program "Cyber Security". For these modules, the examination regulations of the relevant degree programs apply in accordance with the relevant examination regulations in the current version at the time of registration for the module examination. Computer Science and Cyber Security are not among the electable subjects. The list of selectable modules in the non-subject-specific compulsory elective area is announced by the examination board before the start of each semester in accordance with Section 8 Paragraph 7. Further modules in the non-subject-specific compulsory elective area can be approved individually by the Computer Science and Cyber Security Examination Board, provided that their content is not significantly similar to modules in the subject-specific compulsory elective area.

**Appendix 3: Procedure for determining course-related ability for foreign students  
Applicants who are not equal to Germans through or on the basis of international treaties  
for the consecutive master's degree program in "Computer Science" in accordance with Section 5  
Paragraph 6 of these examination regulations (PO)**

**I General principles**

(1) Access to the consecutive master's degree program in "Computer Science" requires the entry requirements listed in § 5 of the PO. In accordance with Section 5 Paragraph 6 of the PO, foreign applicants who are not treated as Germans by or on the basis of international treaties must prove their ability to study in a special examination in accordance with Section 5 Paragraph 6 of the PO.

(2) The examination to prove the ability to study in accordance with paragraph 1 is regulated in this appendix.

(3) The aim of the procedure is to determine whether an applicant has the necessary course-related skills that can be expected to successfully complete their studies.

(4) Sections 6 (recognition and crediting of study and examination achievements), 8 (examination board and office), 9 (examiners and assessors), 28 (inspection of the examination files) and 29 (invalidity of the master's examination, Revocation of the master's degree) of the PO applies accordingly.

**II. Application eligibility and procedure/admission to the examination**

(1) Foreign applicants who meet the remaining entry requirements listed in Section 5 of the PO or who are likely to meet them in accordance with Paragraph 5 Sentence 2 can take part in the procedure for determining their ability to study in accordance with Section I Paragraph 3.

(2) The application for admission to the examination procedure must be submitted electronically in German or English using the application forms provided by the examination board. Admission takes place in the summer or winter semester. The application deadline is January 1st/January 1st. July. Electronic receipt at the University of Bonn is decisive for compliance with the application deadline. The application deadline and the issuance of notices in accordance with Section VI are coordinated with the enrollment deadline.

(3) The following documents in German or English must be enclosed with the application in electronic form:

1. proof of formal qualifications in accordance with Section 5 Paragraphs 1 and 2 of the PO or a corresponding provisional certificate in accordance with Paragraph 5 Sentence 2;
2. a completed application form for applying for a place at a university;
3. a CV with a detailed description of your previous education;
4. proof of English language skills in accordance with Section 5 Paragraph 4 of the PO.

(4) The chair of the examination committee formed in accordance with Section 8 of the PO decides on the application for admission to the examination procedure.

(5) Admission will be refused if the application is incomplete. If the documents in accordance with paragraph 3 are not yet available at the time of submitting the application, a corresponding certificate from the responsible university and a list of the completed modules with their evaluation are sufficient to submit the application. The formal proof must be submitted by the applicant immediately upon receipt.



### **III. Carrying out the examination procedure**

(1) The examination committee formed in accordance with Section 8 of the PO is responsible for organizing the implementation of the examination procedure. The audit committee discusses and decides in non-public meetings. He appoints a committee to carry out the procedure; This consists of a chairperson and at least two other university lecturers from the "Computer Science" course. Decisions are made with a simple majority. In the event of a tie, the chairperson's vote decides.

(2) The examination board appoints the examiners in the examination process. Section 9 of the PO applies accordingly.

### **IV. Examination procedure**

(1) Based on the application documents, it is checked which level of training in computer science was achieved with the first degree. In particular, it is checked whether the applicant has the knowledge required for successful study in the consecutive master's program in "Computer Science" in the areas listed below:

- Mathematical foundations of computer science,
- Basics of theoretical computer science,
- Basics of programming, software technology and information systems,
- Basics of technical and system-related computer science.

The benchmark is the level of knowledge achieved in the bachelor's degree program in "Informatics" at the University of Bonn at the end of the 5th semester. The committee appointed by the examination board decides whether an examination to determine the ability to study must be carried out in order to classify the applicant's qualifications according to the criteria mentioned above.

(2) Applicants who have completed their bachelor's degree in the "Computer Science" course or in a related or comparable course of study at a university within the scope of the Basic Law or at a university in a member state of the European Union or a state that has signed the Convention on the Recognition of Qualifications in the higher education sector in the European region (Treaty of Lisbon) have been ratified, have thus provided proof of their ability to study and are exempt from the examination.

(3) The duration of the written examination is a maximum of three hours. The duration of the oral examination is a maximum of one hour. The form of the examination and the date of the examination will be communicated in writing to the applicants who meet the admission requirements for the examination to determine their ability to study in accordance with Section II. The exams take place in English.

(4) Section 18 of the PO applies accordingly.

### **V. Evaluation of the examination performance**

(1) The performance achieved in the written examination or oral examination is assessed with points. The maximum score is 100 points. Anyone who achieves at least 50 points passes the exam.

(2) If an applicant attempts to influence the result of the examination through deception or the use of unauthorized aids, the examination will be graded with "0" (zero) points overall. If such deception is discovered by a supervisor, the applicant can request that the decision be reviewed by the examination board.

(3) The written examination must be assessed by two examiners. The examination performance is assessed separately with points by the two examiners. The overall assessment of the examination performance results from the arithmetic mean of the individual assessments of the two examiners.

(4) The oral examination is taken either in front of several examiners or in front of one examiner in the presence of an expert assessor (§ 9 paragraph 1 of the PO) as an individual or group discussion. In the case of an examination by only one examiner, the examiner must hear the assessor before determining the result, excluding the applicant.

(5) Otherwise, Section 12 Paragraph 7 of the PO applies accordingly.

#### **VI. Announcement of the result and repetition of the examination procedure**

(1) The result of the oral examination must be communicated to the examinee immediately after the examination. In addition, the examination board informs the applicant of the result of the examination in a written notification. A negative decision must be accompanied by instructions on legal remedies. It contains the reasons for the negative decision.

(2) Applicants who have not successfully completed the examination procedure cannot take the examination procedure again until the following semester at the earliest; a new application is required for this. A second repetition is not possible.

#### **VII. Those who change their place of study**

For those changing study locations who were already enrolled in a master's degree program in computer science or a comparable degree program at another university, the examination committee checks the individual qualifications, including any examination procedure that may have taken place.

If the examination board determines the equivalence of the degree programs and the examination procedure, the applicant is exempt from taking part in the examination procedure at the University of Bonn.

#### **Appendix 4: Procedure for determining course-related suitability for foreign students**

##### **Applicants who are not equal to Germans through or on the basis of international treaties**

##### **for the consecutive master's degree program in "Cyber Security" in accordance with Section 5 Paragraph 6 of this**

##### **Examination regulations (PO)**

### **I General principles**

(1) Access to the consecutive master's degree program "Cyber Security" requires the entry requirements listed in Section 5 of the PO. In accordance with Section 5 Paragraph 6 of the PO, foreign applicants who are not treated as Germans by or on the basis of international treaties must prove their ability to study in a special examination in accordance with Section 5 Paragraph 6 of the PO.

(2) The examination to prove the ability to study in accordance with paragraph 1 is regulated in this appendix.

(3) The aim of the procedure is to determine whether an applicant has the necessary course-related skills that can be expected to successfully complete their studies.

(4) Sections 6 (recognition and crediting of study and examination achievements), 8 (examination board and office), 9 (examiners and assessors), 28 (inspection of the examination files) and 29 (invalidity of the master's examination, Revocation of the master's degree) of the PO applies accordingly.

### **II. Application eligibility and procedure/admission to the examination**

(1) Foreign applicants who meet the remaining entry requirements listed in Section 5 of the PO or who are likely to meet them in accordance with Paragraph 5 Sentence 2 can take part in the procedure for determining their ability to study in accordance with Section I Paragraph 3.

(2) The application for admission to the examination procedure must be submitted electronically in German or English using the application forms provided by the examination board. Admission takes place in the summer or winter semester. The application deadline is January 1st/January 1st. July. Electronic receipt at the University of Bonn is decisive for compliance with the application deadline. The application deadline and the issuance of notices in accordance with Section VI are coordinated with the enrollment deadline.

(3) The following documents in German or English must be enclosed with the application in electronic form:

1. proof of formal qualifications in accordance with Section 5 Paragraphs 1 and 3 of the PO or a corresponding provisional certificate in accordance with Paragraph 5 Sentence 2;
2. a completed application form for applying for a place at a university;
3. a CV with a detailed description of your previous education;
4. proof of German and English language skills in accordance with Section 5 Paragraph 5 of the PO.

(4) The chair of the examination committee formed in accordance with Section 8 of the PO decides on the application for admission to the examination procedure.

(5) Admission will be refused if the application is incomplete. If the documents in accordance with paragraph 3 are not yet available at the time of submitting the application, a corresponding certificate from the responsible university and a list of the completed modules with their evaluation are sufficient to submit the application. The formal proof must be submitted by the applicant immediately upon receipt.

### **III. Carrying out the examination procedure**

(1) The examination committee formed in accordance with Section 8 of the PO is responsible for organizing the implementation of the examination procedure. The audit committee discusses and decides in non-public meetings. He appoints a committee to carry out the procedure; This consists of a chairperson and at least two other university lecturers from the "Cyber Security" course of study. Decisions are made with a simple majority. In the event of a tie, the chairperson's vote decides.

(2) The examination board appoints the examiners in the examination process. Section 9 of the PO applies accordingly.

### **IV. Examination procedure**

(1) Based on the application documents, it is checked which level of training in cyber security was achieved with the first degree. In particular, it is checked whether the applicant has the knowledge required for successful study in the consecutive master's degree program "Cyber Security" in the areas listed below:

- Basics of IT security,
- Mathematical foundations of computer science,
- Basics of theoretical computer science,
- Basics of programming, software technology and information systems,
- Basics of technical and system-related computer science.

The benchmark is the level of knowledge achieved in the bachelor's degree program "Cyber Security" at the University of Bonn at the end of the 5th semester. The committee appointed by the examination board decides whether an examination to determine the ability to study must be carried out in order to classify the applicant's qualifications according to the criteria mentioned above.

(2) Applicants who have completed their bachelor's degree in the "Cyber Security" course or in a related or comparable course of study at a university within the scope of the Basic Law or at a university in a member state of the European Union or a state that has signed the Convention on Recognition of qualifications in higher education in the European region (Treaty of Lisbon), have thus provided proof of their ability to study and are exempt from the examination.

(3) The duration of the written examination is a maximum of three hours. The duration of the oral examination is a maximum of one hour. The form of the examination and the date of the examination will be communicated in writing to the applicants who meet the admission requirements for the examination to determine their ability to study in accordance with Section II. The exams take place in English.

(4) Section 18 of the PO applies accordingly.

### **V. Evaluation of the examination performance**

(1) The performance achieved in the written examination or oral examination is assessed with points. The maximum score is 100 points. Anyone who achieves at least 50 points passes the exam.

(2) If an applicant attempts to influence the result of the examination through deception or the use of unauthorized aids, the examination will be graded with "0" (zero) points overall.

If such deception is discovered by a supervisor, the applicant can request that the decision be reviewed by the examination board.

(3) The written examination must be assessed by two examiners. The examination performance is assessed separately with points by the two examiners. The overall assessment of the examination performance results from the arithmetic mean of the individual assessments of the two examiners.

(4) The oral examination is taken either in front of several examiners or in front of one examiner in the presence of an expert assessor (§ 9 paragraph 1 of the PO) as an individual or group discussion. In the case of an examination by only one examiner, the examiner must hear the assessor before determining the result, excluding the applicant.

(5) Otherwise, Section 12 Paragraph 7 of the PO applies accordingly.

## **VI. Announcement of the result and repetition of the examination procedure**

(1) The result of the oral examination must be communicated to the examinee immediately after the examination. In addition, the examination board informs the applicant of the result of the examination in a written notice. A negative decision must be accompanied by instructions on legal remedies. It contains the reasons for the negative decision.

(2) Applicants who have not successfully completed the examination procedure cannot take the examination procedure again until the following semester at the earliest; a new application is required for this. A second repetition is not possible.

## **VII. Change of study location**

For those changing study locations who have already been enrolled in a master's degree program in cyber security or a comparable degree program at another university, the examination committee will check the individual qualifications, including any examination procedure that may have taken place.

If the examination board determines the equivalence of the degree programs and the examination procedure, the applicant is exempt from taking part in the examination procedure at the University of Bonn.

## **Appendix 5: Regulation of access to courses**

If a course is due to its nature or purpose or for other reasons of research and Teaching requires a limit on the number of participants and the number of applicants exceeds capacity, participation is regulated as follows:

Applicants should be considered in the following order:

**- Group 1:**

Students who are enrolled as students at the University of Bonn and are dependent on attending this course according to the study plan and are in the same or a higher semester than is planned for attending this course according to the study plan, if they a. were admitted too late to register for the course in the

first semester, or

b. were not taken into account at least once by drawing lots;

**- Group 2:**

Students who are enrolled as students at the University of Bonn in the semester or a higher semester in which they are dependent on attending this course according to the study plan and do not belong to group 1;

**- Group 3:**

all other students who are enrolled as students at the University of Bonn and can take part in this course according to the study plan;

**- Group 4:**

all other students.

The remaining entry requirements remain unaffected. Within the groups - with the exception of group 4 - priority will be given to those students who can demonstrate the largest number of ECTS credit points for this course of study or for another course of study at the University of Bonn that imports modules from this course of study. Then the lot decides.