Examination Regulations for the Master's Programme "Mathematics" (MSc) at the University of Münster (WWU) of 11 February 2020

This is a translation of the original German text and is intended for your information only. Under German law only the official German version of the "Prüfungsordnung für den Masterstudiengang Mathematics an der Westfälischen Wilhelms-Universität Münster vom 11. Februar 2020" is legally binding. It was published in the *Amtliche Bekanntmachungen* (AB Uni; "Official Announcements") on 11 February 2020, pp. 153 to 292[…].

In accordance with § 2 (4) and § 64 (1) of the Higher Education Act of the Federal State of North Rhine-Westphalia (HG NRW) in its version of the Act on the Future of Higher Education (*Hochschulzukunftsgesetz*) of 16 September 2014 (GV. NRW 2014, p. 547), most recently amended on 12 July 2019 (GV. NRW 2014, p. 525), in the corrected version of 24 September 2019 (GV. NRW 2014, p. 593), the University of Münster (WWU) has issued the following regulations:

Contents

Attachment: **Glossary of English-German translations**
Appendix: **Module descriptions**

§ 1
Scope of the Examination Regulations

The following examination regulations apply to the master's programme "Mathematics" at the University of Münster (WWU).

§ 2
Goal of the Programme and Aim of the Examination

(1) This master's programme builds on the knowledge acquired in a prior undergraduate degree programme. In addition to conveying the academic fundamentals of the subject of study, it aims to provide students with the knowledge, skills and methods necessary to meet the demands of the professional world in the field of mathematics. Students are trained to evaluate complex academic problems in an independent and responsible manner and apply the insights gained in practice.

(2) The master's examination determines whether the students have acquired the necessary knowledge and skills for their prospective professional field, particularly in the areas of research and teaching.

§ 3
Master's Degree

After successfully completing the programme, the student is awarded the academic degree of "Master of Science" (MSc).

§ 4
Admission to the Programme

The admissions requirements for this programme are specified in the current version of the "Admissions Regulations for the Master's Programme 'Mathematics' of the University of Münster".

§ 5
Administration of the Programme

(1) An examinations officer (*Prüfungsbeauftragte/r*) is appointed by the head of the Faculty of Mathematics and Computer Science (FB 10) to organise the examinations in the master's programme "Mathematics" and undertake further tasks as put forth in these examination regulations. Unless otherwise directed by the head of faculty, the examinations officer for the master's degree programme is the Dean of Studies of the Faculty of Mathematics and Computer Science (FB 10).

(2) The examinations officer ensures that the stipulations put forth in these regulations are observed. In particular, he/she is responsible for recognising degree-relevant examinations and required coursework.

(3) The head of the Faculty of Mathematics and Computer Science is responsible for resolving contested decisions taken during the examination process. He/she may delegate this task to the Dean of Studies.

(4) The head of the Faculty of Mathematics and Computer Science regularly reports to the faculty on developments concerning examinations and the duration of studies, as well as suggests amending the examination regulations as necessary. He/she may delegate this task to the Dean of Studies.

(5) The head of faculty, Dean of Studies and examinations officer can be contacted via the Examinations Office (*Prüfungsamt*) responsible for the departments of the Faculty of Mathematics and Computer Science.

§ 6
Admission to the Master's Examination, Alignment Studies from the Bachelor's Phase

(1) Admission to the master's examination occurs via enrolment in the master's programme "Mathematics" at the University of Münster, assuming the student remains enrolled at the University.

(2) If the student gains admission on the condition that he/she completes alignment studies (*Angleichungsstudien*) from the bachelor's phase in accordance with the admissions regulations for the master's programme "Mathematics", the student may begin the master's thesis once the alignment studies are completed. The requirements for completion of alignment studies are specified by the "Examination Regulations for the Bachelor's Programme 'Mathematics' of the University of Münster" in their current version. Examinations in alignment studies are not considered in the calculation of the overall grade of the master's examination.

§ 7
Standard Duration, Workload and Credits

(1) The standard duration of the programme is two academic years. One academic year consists of two semesters.

(2) In order to obtain the master's degree, students must earn a total of 120 credits (*Leistungspunkte*, *LP*). Academic credit serves as a quantitative measure of a student's overall workload. This includes attending courses as well as time spent on pre- and post-preparation of the course content (i.e. course attendance and self-study time), taking examinations, preparing for examinations, including term papers and the master's thesis, as well as, if applicable, work placements or other types of courses. One credit is equivalent to 30 hours of academic work. The workload for one academic year thus amounts to 1,800 hours. Consequently, the entire master's programme has a workload of 3,600 hours. One credit is equivalent to one ECTS (European Credit Transfer System) point.

§ 8
Content of the Programme

(1) In addition to the master's thesis (30 credits), the master's programme "Mathematics" consists of the following modules (see attached module descriptions, which form part of these regulations, for more details):

Mandatory modules:
Ma-V "Broadening Courses" (18 credits)
Ma-K "Personal Enrichment" (6 credits),
Ma-E "Specialisation Supplement and Research Skills" (12 credits),
Ma-M "Master's Thesis" (30 credits).

Elective mandatory modules:

- For master's programmes with no minor subject, the student must complete three modules from the list of specialisation modules **Ma-S1** to **Ma-S11** (18 credits each).
- For master's programmes with one minor subject, students must complete two modules from the list of specialisation modules **Ma-S1** to **Ma-S11** (18 credits each) and elective mandatory modules worth 18 credits in total from the approved minors listed in the appendix. The examinations officer is responsible for approving additional minors upon the student's written request and in consultation with the corresponding faculty.
- In both cases, at least 9 credits in theoretical mathematics and 9 credits in applied mathematics from the selected specialisation modules and broadening courses must be included in the overall grade. (All specialisation modules are assigned to the area of either theoretical or applied mathematics in the module manuals. The classification of the broadening courses as either theoretical or applied mathematics is provided by the corresponding module description, or course announcement in the course catalogue.)

(2) A course or degree-relevant examination in this degree programme can only count once. The same course or requirement may not be counted toward an additional module of this master's programme. Consequently, the student must complete another course or examination in the other module.

(3) Students are required to earn a total of 120 credits to complete the master's programme, of which the master's thesis accounts for 30 credits.

(4) In the mandatory Ma-V module "Broadening Courses", students may complete up to three thematically varied examinations; switching is not permitted and the choice is binding. If a student takes three course examinations from those listed in § 8 (1), the two best grades are weighted 50% each to form the final module grade. The other completed examinations are listed in the transcript of records (ToR).

(5) Students may take courses in up to five specialisation modules from the list Ma-S1 to Ma-S11. They can then choose which examination should be included in the calculation of the overall grade. The other completed examinations are listed in the transcript of records (ToR).

(6) Students may take up to two minor subjects. Switching to another minor is not permitted once studies have commenced. Students can decide which of the completed minor subjects should count towards the overall grade or whether an additionally completed specialisation module in accordance with §8 (5) should count towards the overall grade instead. Students must successfully complete at least one minor subject or additional specialisation module. Any other examinations taken are listed in the transcript of records (ToR).

§ 8a
Recognition of Academic Achievement and Failed Master's Examinations Taken during the Bachelor's Phase (Additional Module)

(1) If the student passed degree-relevant examinations as part of a master's module during the bachelor's phase in accordance with the "Examination Regulations of the Bachelor's Programme 'Mathematics'" of 4 February 2010, these must be credited toward the student's master's programme. It is not permitted to retake the module or examinations which have already been passed during the master's phase in order to improve the grade. A request to have these examinations recognised is not required.

(2) If the student attempted to complete a master's module during the bachelor's phase and failed the examination, and thereafter gains admission to the master's programme without having completed the module, all failed attempts are counted against the permitted number of retakes for the corresponding examination in the master's programme.

§ 9
Types of Courses

(1) The following types of courses are offered: lectures, seminars, advanced research seminars, practical classes, reading courses, internships, research seminars and tutorials.

(2) The mathematics courses are generally held in English.

§ 10
Structure of the Programme and the Examination, Module Descriptions

(1) The programme is divided into module. Modules are units of instruction varying in topic, content and duration which lead to partial qualifications, defined in a learning goal related to the respective academic objective. Modules can consist of courses with different teaching and learning formats. Modules usually consist of courses offered in the same semester, or over several semesters. In accordance with the module descriptions, the students may have a choice of courses within a module.

(2) The master's examination is taken in cumulative form over the course of the programme. It consists of the degree-relevant examinations of the modules as well as the master's thesis. The master's thesis is considered a separate module.

(3) The module descriptions define the internal structure of the modules and state the number of credits obtainable. One credit is equivalent to an average workload of 30 hours.

(4) A module is successfully completed if all module-related coursework has been completed and all degree-relevant examinations have been passed. Students earn a certain number of credits per module as specified in the respective module descriptions.

(5) Admission to a module can – in accordance with the module descriptions – depend on certain conditions, in particular the successful completion of one (or several) other module(s).

(6) The module descriptions also specify if admission to individual courses is contingent on the candidate possessing specific prerequisite knowledge.

(7) Admission to a course, to coursework or an examination can – in accordance with the module descriptions – depend on whether the student previously attended another course or successfully completed coursework of the same module.

(8) The module descriptions specify how frequently each module is offered. In addition to modules offered on a regular basis, there may be some elective mandatory modules which are offered only sporadically depending on the available teaching capacity in the faculty. Details concerning the regularity of modules are provided under no. 9 (Other) in the module descriptions.

(9) The module descriptions may also stipulate that degree-relevant examinations and required coursework can be submitted in electronic form or completed via electronic communication.

§ 11
Required Coursework and Degree-relevant Examinations, Registration

(1) The prerequisites for participation in specific courses are outlined in the module descriptions.

(2) In addition to degree-relevant examinations (*Prüfungsleistungen*), students may have to pass a module final examination (*Modulabschlussprüfung*) and complete additional coursework (*Studienleistungen*). Such examinations and coursework may include written examinations, oral presentations, term papers, work placements, practical classes, oral examinations, talks or minutes. All required coursework and degree-relevant examinations have to be completed in the language determined by the requirements of the subject. The instructor announces at the beginning of the course in which language the coursework or examination is to be completed. If a degree-relevant examination or required coursework is assigned to a module but not to a specific course, the language of instruction is specified in the course announcement.

(3) The type, duration and scope of the degree-relevant examinations are outlined in the respective module descriptions. These examinations form part of the master's examination and can refer to one or more module courses, or to the entire module.

(4) Degree-relevant examinations or required coursework can be completed in the form of group work as long as the candidate's contribution is clearly distinguishable from that of the other members to enable individual evaluation, e.g. by means of separate sections, page numbers or other objective criteria. If the coursework requirement in a mathematical module calls for the successful completion of exercises, or if the degree-relevant examination or

required coursework in a mathematical module calls for a presentation (including written paper thereof), the instructor must announce at the beginning of the course whether the requirement can be completed in the form of group work or not. All other degree-relevant examinations and required coursework must be completed individually unless otherwise stated in the corresponding module descriptions.

(5) In order to take part in any degree-relevant examination or coursework, students must register in advance normally by electronic means, i.e. online. The registration deadlines are announced via notice board or electronically; registration is generally possible up to one week prior to the date of the examination. Students may withdraw their registration for required coursework without explanation by informing the Examinations Office in writing or electronically within the time period given in sentence 2. Students may withdraw their registration for degree-relevant examinations without explanation by informing the Examinations Office in writing or electronically up to one week prior to the date of the examination. Cancellation of registration at shorter notice is only permitted for reasonable cause (e.g. illness). The reasons must be duly substantiated, e.g. by a medical certificate; § 22 applies accordingly. Registration and withdrawal deadlines may vary for courses or modules offered in other subjects. These conditions are regulated in the respective module descriptions.

(6) In the case of written and oral examinations, the student must specify upon registration (and especially before taking the examination) whether the examination is to count as required coursework or a degree-relevant examination, provided the module description offers the student a choice in the matter. The decision to have the test recognised as coursework or a degree-relevant examination is binding.
(7) Courses, degree-relevant examinations and required coursework may only be transferred between a specialisation module and the supplementary module in agreement with the supervisor who issues the confirmation as required by the module description for Ma-E "Specialisation Supplement and Research Skills", that one of the specialisation modules in combination with the supplementary module meets the requirements for writing the master's thesis.

(8) Degree-relevant examinations which can count toward both specialisation modules and broadening courses can be transferred between the corresponding specialisation modules, or between the corresponding specialisation module and a broadening course before the binding registration for the examination (to determine whether it is a specialisation or broadening examination). Required coursework which can count toward the specialisation modules and the broadening courses may be transferred elsewhere even after the coursework is completed.

§ 11a
Multiple-choice Examinations

(1) Degree-relevant examinations may also consist of or include multiple-choice sections. In the case of pure multiple-choice examinations, all examinees receive the same questions. All examination questions must be related to the content of the module and ensure reliable examination results. When preparing the questions, the responsible instructor must specify which answers will be recognised as correct. Examination questions must be checked for correctness with respect to the stated educational objective of the module before the examination paper is graded. Should examination questions be found to be erroneous or misleading in this regard, they may not be considered for grading and only the remaining questions may be taken into account. Reducing the number of multiple-choice questions may not lead to a disadvantage for the examinees. An examination consisting entirely of multiple-choice questions is graded as passed if at least 50 percent of the questions are answered correctly or if the number of correct answers is not more than 10 percent below the average performance of all examinees.

(2) If the candidate has correctly answered the minimum number of items required to pass, the examination is graded according to the following criteria:

"*sehr gut*/excellent" if at least 75 percent,

"*gut*/good" if at least 50 percent, but less than 75 percent,

"*befriedigend*/satisfactory" if at least 25 percent, but less than 50 percent,

"*ausreichend*/pass" if none or less than 25 percent

of the additional examination questions are answered correctly.

(3) The requirements listed above also apply to degree-relevant examinations which are only partially comprised of multiple-choice sections. The overall grade of the examination is then calculated from the weighted arithmetic mean of the multiple-choice section and the other part of the examination. The parts are weighted according to their share of the overall examination in percent.

§ 12
Master's Thesis

(1) The master's thesis should demonstrate that a student is capable of independently working on a scientifically challenging topic from the field of mathematics within a specified period of time and that he/she is able to document the results appropriately. As a rule, the thesis should be 40 to 60 pages long.

(2) An examiner appointed in accordance with § 14 sets the topic of the master's thesis and supervises the thesis process. The student has the right to propose both the topic and supervisor of his/her choice.

(3) Upon receiving the student's application, the topic of the master's thesis is assigned to the student by the Examinations Office on behalf of the examinations officer. Topics can only be assigned on the condition that the student has already earned a total of 72 credits and a statement has been issued, confirming that the selected courses in the supplementary module together with those from a specialisation module can serve as preparation for the master's thesis. If the student gained admission on the condition that he/she complete alignment studies in accordance with the admission regulations for the master's programme "Mathematics", the topic of the master's thesis may only be assigned upon completion of the alignment studies. The date of the topic assignment must be put on record.

(4) The master's thesis must be completed within six months. The topic, task and scope of the thesis are to be limited in such a manner that the time allocated will suffice. The student is permitted to change his/her topic only once, and only within a month of receiving the topic.

(5) In substantiated cases, the candidate may submit a petition to extend the submission deadline of the master's thesis for a duration of time commensurate to the given reason. Reasons for such an extension could include severe illness of the candidate or immutable technical difficulties, the need to look after one's children aged 12 years and under, nursing or caring for a spouse, a registered civil partner or direct relative or first-degree relative by marriage if such care or assistance is necessary. The examinations officer is responsible for deciding on and granting extensions (see § 12 (5) sentences 1 and 2). Upon request of the examinations officer, the candidate must present proof of a "valid reason". Instead of extending the deadline, the examinations officer can, with regard to sentence 2, also assign a new topic for the master's thesis if the candidate was unable to work on the thesis for longer than six months. In this case, the assignment of a new topic does not count as a second attempt at the master's thesis in the sense of § 17 (2).

(6) The master's thesis is to be written in English. The thesis may be written in a language other than English with prior approval of the examinations officer. The master's thesis must include a title page, a table of contents and a list of works and sources cited. All parts of the thesis that contain wording or content taken from other sources must be identified as such and cited accordingly. The candidate must attach a written declaration to the thesis which

states that he/she has written the thesis himself/herself, has not used sources and means other than those indicated and has identified all direct quotes. Such a declaration must also be made regarding tables, sketches, drawings, graphic illustrations etc.

§ 13
Acceptance and Grading of the Master's Thesis

(1) Candidates are required to submit two copies of the master's thesis (typewritten, bound and paginated) as well as two digital copies in a suitable format for a possible plagiarism check to the Examinations Office by the given deadline. Its submission is only considered on time and complete if both the bound and digital copies are submitted to the Examinations Office before the deadline. The head of faculty informs candidates which digital form is considered suitable in agreement with the Examinations Office. The head of faculty may delegate this duty to the Dean of Studies. The date of submission must be put on record. If the master's thesis is submitted after the deadline or not in due form, it is graded as a fail (*nicht ausreichend*, 5.0) (see § 22 (1)). § 12 (5) remains unaffected.

(2) The master's thesis must be read and graded by two examiners. One of the examiners should be the person who assigned the topic. The second examiner is appointed by the examinations officer of the master's programme "Mathematics" and can be proposed by the candidate. Both grades must conform to § 18 (1) and be justified in written form. The overall grade is then determined as the arithmetic mean (see § 18 (4) sentences 4 and 5), provided the difference between the grades is no greater than 2.0. If the difference is greater than 2.0 or if one examiner grades the thesis as a fail while the other grade is at least a pass, then a third examiner is to be appointed by the examinations officer to grade the master's thesis. In this case, the grade is calculated as the arithmetic mean of the three examiners' grades. The grade can only be a pass (4.0) or better, however, if at least two of the examiners grade the thesis with a pass (4.0) or better.

(3) The grading period for the master's thesis may not exceed six weeks, or 16 weeks if a third examiner is involved.

§ 14
Examiners and Assessors

(1) The examinations officer appoints examiners to grade the degree-relevant examinations. The instructor of the respective course is generally appointed as an examiner. The examinations officer may permit the respective instructor to choose an alternative examiner for written examinations. The examinations officer may likewise permit the responsible Examinations Office to select examiners for the oral examinations. The assessors responsible for grading oral examinations are appointed by the examiner. The examinations officer appoints first examiners for the master's thesis and second examiners upon their recommendation.

(2) Any individual who regularly holds relevant courses in the subject of the degree-relevant examination or master's thesis is entitled to serve as an examiner in accordance with § 65 (1) (HG NRW). The examinations officer for the master's programme "Mathematics" is responsible for deciding on exceptions to this rule.

(3) Only individuals who hold a relevant *Diplom*, master's degree or academic qualification of an equivalent or higher-level degree can serve as an assessor.

(4) Examiners and assessors are independent in their actions. For written examinations, academic staff members can carry out preliminary marking on behalf of the examiner.

(5) Oral examinations are conducted by an examiner in the presence of an assessor. Before determining the grade, the examiner must hear the assessor's evaluation. The grade and key themes of the oral examination are recorded in minutes which are signed by the examiner and the assessor.

(6) All written degree-relevant module examinations are graded by a single examiner. The master's thesis is graded in accordance with § 13.

(7) The examination must be graded by at least two examiners if an oral or written degree-relevant examination is the final attempt before a possible permanent fail of the master's examination. In this case, the grade is calculated as the arithmetic mean of the two individual grades. § 18 (4), sentences 4 and 5 apply accordingly.

(8) Students of the same degree programme may attend oral examinations if the candidate does not object. This does not apply to the discussion of the grade and its announcement to the candidate.

§ 15
Recognition of Required Coursework and Degree-relevant Examinations

(1) Required coursework (*Studienleistungen*) and degree-relevant examinations (*Prüfungsleistungen*) from within the same programme at other German universities are recognised upon request unless these differ substantially with the prescribed objectives of the programme; a determination of equivalence is not conducted. The same applies to required coursework and degree-relevant examinations completed in other degree programmes at the University of Münster or other German universities.

(2) Based on the recognition procedures outlined in § 15 (1), the student must upon request be granted placement at a semester determined by the ratio of number of credits recognised to total number of credits obtainable in the programme. If the first place after the decimal is smaller than five, the semester number is rounded down. Otherwise it is rounded up.

(3) § 15 (1) and (2) apply accordingly to the recognition of required coursework and degree-relevant examinations completed in state-recognised distance-learning study programmes, in distance-learning units developed by the state of North Rhine-Westphalia together with the other German states or the federal government, at state or state-recognised universities of cooperative education (*Berufsakademien*), in degree programmes at foreign state or state-recognised universities or in further education study programmes (see § 62 HG NRW).

(4) The basis for determining whether essential differences exist is a comparison of the content, workload and requirements of the respective coursework and examinations. The determination of equivalence should not be based on a schematic comparison, but rather on an overall assessment. For the equivalence of required coursework and degree-relevant examinations from foreign universities, the equivalence agreements of the Standing Conference of the Ministers of Education and Cultural Affairs of the Federal Republic of Germany (KMK) and the German Rectors' Conference (HRK) apply. In case of doubt concerning equivalence, the Central Office for Foreign Education (Zentralstelle für ausländisches Bildungswesen) may be consulted.

(5) If students are allowed to enter the programme at a higher semester after passing a placement examination, they receive academic credit in terms of both required coursework and degree-relevant examinations for the knowledge and skills they demonstrated in the placement examination. The examinations officer is legally bound by the assessments made in that examination.

(6) Additional skills and qualifications for which documentation is provided can be taken into consideration upon the student's request, provided that the required coursework and degree-relevant examinations which they replace are equivalent in terms of content and level. At most, up to half of the coursework and examinations can be replace in this way.

(7) If external examinations are recognised as degree-relevant examinations and the grading systems are comparable, the grades may be used to calculate part of the overall grade. In the case of non-comparable grading

systems, examinations are marked as passed (*bestanden*). The recognition of examinations is indicated in the degree certificate. If a module grade cannot be calculated due to the recognition of examinations from a non-comparable grading system, then this module is excluded from the calculation of the overall grade.

(8) The student is responsible for providing the documents necessary for deciding on recognition. These must include information on the knowledge and qualifications for which equivalence is to be recognised. If the student requests recognition for coursework from other degree programmes, the student must, as a rule, provide the corresponding examination regulations and module descriptions as well as the transcript of records (ToR) or equivalent document.

(9) The examinations officer of the master's programme "Mathematics" is responsible for recognising academic achievement. Before equivalence can be determined, members of staff representing the subject in question must be consulted.

(10) The student is to be informed about the decision on recognition within four weeks after the application has been made and the required documents have been submitted. Any rejection must be justified.

§ 16
Compensation for Disadvantages for Students with Disabilities or Chronic Illnesses

(1) If a student can demonstrate that he/she is partially or entirely unable to complete required coursework or degree-relevant examinations in their intended form due to a disability or chronic illness, the head of faculty must – at the student's request – make allowances with respect to the form and duration of the examination and the use of aids or assistants to ensure equal opportunity. The same applies to the requirements for participation in the modules and completion of the corresponding coursework and degree-relevant examinations as put forth in these examination regulations. The head of faculty may delegate this duty to the Dean of Studies.

(2) At the student's request, the faculty representative for students with disabilities must be consulted with regard to decisions specified in § 16 (1). If consultation with a representative is not possible within the faculty, the WWU Representative for Students with a Disability or Chronic Illness is to be consulted.

(3) Compensation for disadvantages as put forth in § 16 (1) is granted on a case-by-case basis. Students may be required to submit adequate documentation substantiating their chronic illness or disability. This includes, for example, medical certificates or, if applicable, a disability certificate (*Behindertenausweis*).

(4) Provided that the condition/status of the student's illness or disability will foreseeably remain unchanged, the compensation for disadvantages as put forth in § 16 (1) extends to all required coursework and degree-relevant examinations that have to be completed during the master's programme.

(5) If a female student is unable to complete required coursework or degree-relevant examinations in part or whole on account of maternity protection regulations, § 16 (1-3) apply accordingly.

§ 17
Passing and Retaking of the Master's Examination

(1) The master's examination has been passed when the candidate has passed all of the modules in accordance with § 8, § 10, § 11 and the module descriptions as well as the master's thesis with at least a passing grade (4.0; *ausreichend*) (§ 17 (1)). The candidate must have also obtained a total of 120 credits.

(2) If the candidate receives a fail for the master's thesis, he/she is granted one more attempt to write the thesis on a newly assigned topic. A third attempt is not allowed. During the second attempt, the topic can only be handed back if the candidate did not make use of this possibility in his/her first attempt.

(3) The terms for participating in and passing degree-relevant examinations and required coursework in modules offered by other departments/faculties are regulated by their corresponding requirements; details are provided in the module descriptions.

(4) Irrespective of § 17 (3), the following requirements for passing degree-relevant module examinations in mathematics apply: Students are granted three attempts at passing the examinations. The students are given at least two possible examination dates per year. For the second and additional dates, the examiner may administer an oral examination instead of a written examination in derogation of the respective module descriptions. The student may petition to retake one degree-relevant examination a fourth time if he/she failed the examination on the third attempt. The student may alternatively use this additional attempt to improve his/her grade in a module which has already received a passing grade; in the case of the mandatory "Broadening Courses" module, the student must specify whether he/she wishes to retake just one or both course examinations. The attempt to improve one's grade cannot result in a lower final module grade. After all permissible attempts to retake a failed module examination are exhausted, the module is considered permanently failed.

(5) Students are granted three attempts to pass degree-relevant examinations in the specialisation modules; § 17 (4), sentences 3-8 apply accordingly. Students are permitted to retake an examination in a different lecture (and accompanying practical class) on a second or third attempt; this only applies to lectures with accompanying practical classes.

(6) A grade is calculated for each completed minor subject. Students can choose which completed minor should count toward the calculation of the overall grade, or alternatively, whether the final grade of the specialisation module completed additionally in accordance with § 8 (5) should take the place of that of a minor subject. The other completed examinations are listed accordingly in the transcript of records (ToR).

(7) If the candidate has permanently failed a mandatory module (*Pflichtmodul*) or the master's thesis, or if he/she has permanently failed four specialisation modules, or two minors and three specialisation modules, then the master's examination is considered permanently failed.

(7) If the candidate has permanently failed the master's examination, he/she may request a university transcript listing all of the completed coursework/examinations and, if applicable, respective grades. In order to receive a transcript, the candidate must present his/her certificate of de-registration (*Exmatrikulationsbescheinigung*) and proof of the completed coursework/examinations. The transcript is signed by the head of the Faculty of Mathematics and Computer Science and authenticated with the faculty seal.

§ 18
Grading of Individual Examinations, Module Grades and Calculation of the Overall Grade

(1) With the exception of the examinations administered in the Ma-K module "Personal Enrichment", all degree-relevant examinations receive a grade. The following grades should be used:

1 = *sehr gut* (excellent)	=	an excellent achievement
2 = *gut* (good)	=	a significantly above-average achievement
3 = *befriedigend* (satisfactory)	=	an average achievement
4 = *ausreichend* (pass)	=	an adequate achievement, despite shortcomings
5 = *nicht ausreichend* (fail)	=	an inadequate achievement due to serious shortcomings

Intermediate values may be used to differentiate assessments by raising and lowering the grades by 0.3. The grades 0.7, 4.3, 4.7 and 5.3 are excluded, however. The module descriptions can allow for the grading of non-degree-

relevant coursework. In accordance with § 63 (2) HG NRW, the examinations administered in the Ma-K module "Personal Enrichment" are not graded. They may only receive a grade of either "pass" or "fail".

(2) Grades for oral degree-relevant examinations must be communicated to the student and the responsible Examinations Office within a one-week period, the grades for written degree-relevant examinations within an eight-week period. For the master's thesis, the provisions specified in § 13 (3) apply.

(3) The candidate receives electronic or written notification of grades obtained for degree-relevant examinations and the master's thesis. The time of notification must be put on record. Electronic notification occurs via the electronic examination administration system of the University of Münster. If the results of degree-relevant module examinations are communicated in written form, these should be posted in the designated area of the examiner's department. The list must identify the students who took part in the degree-relevant examinations by their student ID number and include information on legal remedies available. Students who do not pass a degree-relevant examination after the final attempt receive individual notification which includes information on the legal remedies available to him/her.

(4) With the exception of the Ma-K module, an overall grade is determined for each module on the basis of the individual degree-relevant examinations assigned to that module. If a module has only one degree-relevant examination, its grade is also the module grade. If a module consists of more than one degree-relevant examination, the final module grade is determined on the basis of those grades. Unless specified otherwise in the module descriptions, the weighting of the individual grades depends on the number of credits awarded for that examination. For the calculation of the Ma-V module grade, the provisions specified in § 8 (4) apply. For the calculation of the module grade, all decimal places except for the first are deleted without rounding. This results in the following grades:

≤1.5 = *sehr gut* (excellent)
1.6-2.5 = *gut* (good)
2.6-3.5 = *befriedigend* (satisfactory)
3.6-4.0 = *ausreichend* (pass)
›4.0 = *nicht ausreichend* (fail)

In accordance with § 63 (2) HG NRW, the Ma-K module is not graded.

(5) A grade is calculated for each completed minor subject; if the student completes more than one minor successfully, he/she can choose in accordance with § 17 (6) which minor grade should be included in the calculation of the overall grade. The minor grade is determined by aggregating all grades achieved in the minor subject modules, each weighted according to the credits awarded. If a minor consists of a single minor subject module, the grade achieved in this one module is also the minor grade. The grading procedure of the minor subject modules is based on the rules of the respective minor. If the student chooses to complete a specialisation module in place of a minor subject in accordance with § 8 (6) and § 17 (6), this grade replaces the minor grade.

(6) With regard to modules for the biology minor, the specific regulations of the Faculty of Biology apply.

(7) The grades of the modules, minor grade and the master's thesis form the overall grade. The grade of the master's thesis accounts for 32 percent of the overall grade. The Ma-E module "Specialisation Supplement and Research Skills" accounts for 8 percent of the overall grade. The Ma-V module "Broadening Courses" and the two elective mandatory modules from the specialisation list Ma-S1 to Ma-S11 each account for 15 percent of the overall grade. The minor grade accounts for 15 percent of the overall grade. If the student chooses to complete a specialisation module in place of a minor subject in accordance with § 8 (6) and § 17 (6), the grade of the respective specialisation module accounts for 15 percent of the overall grade.

(8) For the calculation of the overall grade, all decimal places except for the first are deleted without rounding. This results in the following grades:

≤1.5	= *sehr gut* (excellent)
1.6-2.5	= *gut* (good)
2.6-3.5	= *befriedigend* (satisfactory)
3.6-4.0	= *ausreichend* (pass)
›4.0	= *nicht ausreichend* (fail)

(9) In addition to the overall grade, as determined according to § 18 (7, 8), a comparative grade based on the ECTS grading scale is also calculated.

§ 19
Master's Certificate and Master's Diploma

(1) When a student has successfully completed the master's programme, he/she receives a master's certificate. This certificate contains the following information:

a) grade of the master's thesis
b) title of the master's thesis
c) overall grade for the master's examination
d) number of semesters required to complete the master's programme.

(2) The certificate bears the date of the day of the last degree-relevant examination.

(3) In addition to the certificate, the student receives a diploma of the same date, confirming the conferral of the master's degree (see § 3).

(4) Both the certificate and the diploma are issued with an English version of the same.

(5) The master's certificate and the master's diploma are signed by the head of the Faculty of Mathematics and Computer Science and authenticated with the faculty seal.

(6) If the master's thesis receives a grade of at least 1.0 and the overall grade is at least 1.3, the master's examination is awarded the appellation "passed with distinction" (*mit Auszeichnung*).

§ 20
Diploma Supplement with Transcript of Records

(1) In addition to the certificate, the student receives a diploma supplement which includes a transcript of records (ToR). The diploma supplement contains detailed information about the individual study programme, the courses and modules attended, the required coursework and degree-relevant examinations completed and their respective grades, along with the individual subject-related profile chosen by the student in the programme. The completed alignment studies and their respective grades can be included in the transcript of records upon the student's request.

(2) The diploma supplement is issued in accordance with the recommendations of the German Rectors' Conference (HRK).

§ 21
Access to the Examination Files

After completing each degree-relevant examination, students can, upon request, gain access to the examination papers, the examiners' assessments and examination minutes. Students are generally permitted to make copies or other faithful reproductions of the original documents while viewing the examination files. Requests must be filed with the examinations officer of the master's programme "Mathematics" via the Examinations Office no later than two weeks after the results of the examination are announced. The Examinations Office stipulates the time and place of access on behalf of the examinations officer. The same applies with regard to the master's thesis. § 29 VwVfG NRW remains unaffected.

§ 22
Absence, Withdrawal, Deception and Violation of Regulations

(1) A degree-relevant examination is considered a fail (*nicht ausreichend*, 5.0) if the student, for no valid reason, does not appear at the examination on the designated date, or if he/she withdraws for no valid reason after beginning an examination. The same applies if a written degree-relevant examination or the master's thesis is not completed within the allocated time limit. The possibility of an extension as given in § 12 (5) remains unaffected. Examples of valid reasons include an inability to take an examination due to illness, claims to maternity or paternity leave as provided by the Federal Parental Benefit Act (*Bundeselterngeld- und Elternzeitgesetz*), or nursing/caring for a spouse, a registered civil partner, a direct relative or a first-degree relative by marriage if such care or assistance is necessary.

(1a) If a student may not meet her academic requirements on account of the Maternity Protection Act (*Mutterschutzgesetz*), the administration of examinations is also not permitted.

(2) The reasons for absence or withdrawal according to § 22 (1) must immediately be submitted and substantiated in writing to the examinations officer. In the case of illness, the examinations officer may request a medical certificate. If the reasons given are not accepted, the student is notified in writing. If the student does not receive written notification within a four-week period, then the reasons have been accepted.

(3) If a student withdraws on account of illness, yet there is sufficient reason to believe that the student was capable of taking the examination or that another form of proof would be more appropriate, the examinations officer may request a medical certificate from a University-appointed physician (*Vertrauensarzt*) in accordance with § 63 (7) HG. With respect to § 22 (3) sentence 1, sufficient reasons exist e.g. if the student has failed to appear to more than four examinations or has withdrawn more than twice from the same examination due to illness in accordance with § 22 (1). The student is to be immediately notified of this decision and provided with the names of at least three physicians, designated by the University of Münster, from one of whom the student must obtain a medical certificate.

(4) If a student attempts to influence the outcome of a degree-relevant examination or the master's thesis through dishonest means such as the use of unauthorised material or devices, the examination is regarded as not having been completed and is considered a fail (*nicht ausreichend*, 5.0). A student who disrupts an examination may, usually after a warning by the invigilator, be excluded from continuing that particular examination. In this case, the degree-relevant examination is regarded as not having been completed and is considered a fail (5.0). In serious cases, the examinations officer may exclude the student from the master's examination entirely, in which case the master's examination is marked as permanently failed. The reason(s) for exclusion must be put on record.

(5) Adverse decisions must be immediately disclosed to the student concerned in written form by the examinations officer of the master's programme "Mathematics". The decision(s) must be justified and accompanied by information on the legal remedies available. Before a decision can be made, the student must be given the opportunity to state his/her case.

§ 23
Invalidity of Individual Examinations

(1) If a student knowingly manipulates the results of a degree-relevant examination or the master's thesis and if this fact comes to light only after the master's certificate has been issued, the head of faculty can retroactively correct the result and, if applicable, the grades of the degree-relevant examination(s) or the master's thesis accordingly and declare these examinations in part or whole as failed.

(2) If the requirements for admission to a degree-relevant examination or the master's thesis were not met and the student had no intention of acting dishonestly and if this fact becomes apparent only after he/she passed the degree-relevant examination in question, the successful completion of the examination rectifies the mistake. However, if the student is found to have deliberately gained admission through wrongful means, the head of faculty is responsible for deciding on the legal consequences, subject to the Administrative Procedures Act for North Rhine-Westphalia (Verwaltungsverfahrensgesetz für das Land Nordrhein-Westfalen, VwVfG NRW).

(3) If the requirements for admission to a module were not met and the student had no intention of acting dishonestly and if this fact becomes apparent only after he/she passed the module in question, the successful completion of the module rectifies the mistake. However, if the student is found to have deliberately gained admission through wrongful means, the head of faculty is responsible for deciding on the legal consequences, subject to the Administrative Procedures Act for North Rhine-Westphalia (Verwaltungsverfahrensgesetz für das Land Nordrhein-Westfalen, VwVfG NRW).

(4) If the requirements for enrolment in the programme and thus the requirements for admission to the master's examination were not met and the student had no intention of acting dishonestly and if this fact becomes apparent only after the master's certificate has been issued, the successful completion of the programme rectifies the mistake. However, if the student is found to have deliberately gained admission through wrongful means, the head of faculty is responsible for deciding on the legal consequences, subject to the Administrative Procedures Act for North Rhine-Westphalia (VwVfG NRW).

(5) Before a final decision is made, the student has the right to state his/her case.

(6) The erroneous certificate must be handed back and is replaced with a new certificate if applicable. A decision in accordance with § 23 (1), sentence 2 of (2), (3) and (4) is no longer possible after a period of five years from the issue date of the certificate.

§ 24
Revocation of the Master's Degree

A student may have his/her master's degree revoked if it becomes apparent at a later date that the student obtained it through deception or if essential requirements for conferral were erroneously presumed to have been met. § 23 applies accordingly. The head of the Faculty of Mathematics and Computer Science (FB 10) is responsible for such decisions.

§ 25
Coming into Force, Publication and Transitional Provisions

(1) These regulations (in their original German version) come into force on the day following their publication in the Official Announcements (*Amtliche Bekanntmachungen*) of the University of Münster. They apply to all students who began their studies in the master's programme "Mathematics" (MSc) in or after the winter semester of 2020/21.

(2) Studies under the examination regulations for the master's programme "Mathematik" at the University of Münster dated 18 October 2012 must be completed in the winter semester 2022/23. Students studying in a programme governed by the regulations specified in § 25 (2) sentence 1 can request to have their programme governed by the present version of the examination regulations. In such cases, students must submit their request to the Examinations Office by 31 March 2023. This request is irrevocable. All required coursework and degree-

relevant examinations which the student has already completed, along with any failed attempts, are recognised by these examination regulations provided that the required coursework/examinations correspond.

(3) Studies under the examination regulations for the master's programme "Mathematik" at the University of Münster dated 28 October 2013 must also be completed in the winter semester 2022/23 at the latest. Students studying in a programme governed by the regulations specified in § 25 (3) sentence 1 can request to have their programme governed by the present version of the examination regulations. In such cases, students must submit their request to the Examinations Office by 31 March 2023. This request is irrevocable. All required coursework and degree-relevant examinations which the student has already completed, along with any failed attempts, are recognised by these examination regulations provided that the required coursework/examinations correspond_____

Issued (in the original German version) upon resolution by the faculty board of the Faculty of Mathematics and Computer Science of the University of Münster on 15 January 2020. These regulations (in the original German version) are hereby announced.

Please note that in accordance with § 12 (5) of the Higher Education Act of the State of North Rhine-Westphalia (HG NRW) violations of procedural regulation as put forth by regulatory laws or other legal provisions pertaining to university autonomy may no longer be claimed after one year following this announcement, unless

1. the regulations were not properly announced,
2. the Rectorate previously raised an objection to the resolution passed by the deciding committee,
3. the University was issued a reprimand for the formal or procedural defect, and was informed of the violated legal provision and the fact that resulted in the defect,
4. the legal consequence of exclusion resulting from such reprimand was not included in the public announcement of the regulations.

Münster, [day month year] The Rector

Prof Dr Johannes Wessels

Glossary of English-German translations

alignment studies	*Angleichungsstudien*
broadening courses	*Verbreiterung*
Central Office for Foreign Education	*Zentralstelle für ausländisches Bildungswesen*
credit	*Leistungspunkt (LP)*
degree-relevant examination	*Prüfungsleistung*
disability certificate	*Behindertenausweis*
elective mandatory module	*Wahlpflichtmodul*
Examinations Office	*Prüfungsamt*
examinations officer	*Prüfüngsbeauftragte*/r
examiner	*Beisitzer*
faculty	*Fachbereich*
faculty board	*Fachbereichsrat*
German Rectors' Conference	*Hochschulrektorenkonferenz*
head of faculty	*Dekan*
mandatory module	*Pflichtmodul*
module final examination	*Modulabschlussprüfung*
required coursework	*Studienleistung*
Standing Conference of the Ministers of Education and Cultural Affairs of the Federal Republic of Germany (KMK)	*Kultusministerkonferenz*

Translation: Supportstelle Englisch, WWU Münster, 2020

Ma-V Broadening Courses

Degree programme	**Master of Science Mathematics**
Module	**Broadening Courses**
Module number	Ma-V

1	**Basic data**
Programme semester	1, 2 or 3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	M

2	**Profile**

Aim of the module / Integration in the curriculum

In this module, students will extend their general mathematical knowledge and/or acquire the necessary mathematical fundamentals required for a subsequent specialisation within the scope of one of the specialisation modules listed below.

Teaching content

The teaching content depends on the chosen courses and are announced in the course catalogue. The following list of contents of possible courses selectable within the module is not complete:

Differential geometry I (winter semester; Theoretical Mathematics):
Hopf-Rinow theorem for inner metric spaces. Riemannian manifolds. Geodesics. Levi-Civita connection. Curvature tensor. Jacobi fields. Gauss's lemma. First and second variation formula. Synge's lemma. Bonnet-Myers theorem. Rauch comparison theorem. _x005F_x005F_x005F_x005F_x005F_x000B_Cartan-Hadamard theorem. Preissman theorem. Submanifolds. Gauss equations, Theorema Egregium. Minimal surfaces.

Functional analysis (winter semester; Theoretical Mathematics):
Normed vector spaces and locally convex spaces. Continuity of linear maps. Hahn-Banach theorem. Conclusions from the Baire category theorem. Dual spaces and weak topologies. Hilbert spaces. Compact operators and Fredholm operators. Gelfand-Naimark theorem and spectral theory.

Higher algebra (winter semester; Theoretical Mathematics):
The topics may vary depending on the focus, but generally include:
Categories, functors, universal objects, adjoint. Artinian rings, Noetherian rings and modules. As well as a continuation of the lecture on contents from commutative algebra or the Artin-Wedderburn theory and representation theory of finite groups.

Algebraic topology (winter semester; Theoretical Mathematics):

Categories and functors. Axioms for homology. CW complexes and cellular homology. Cohomology. Products. Duality. Optional: singular (co)homology, simplicial (co)homology, superpositions, fundamental group, homotopy theory.

Differential topology I (infrequently; Theoretical Mathematics):
Immersions. Submersions. Regular points and values. Submanifolds as inverse images of regular values. Sard's theorem. Embedding theorems. Vector fields and fluxes. Sprays. Exponential map and tubular neighbourhood. Isotopies. Transversality theorems. Pontryagin-Thom construction.
Optional: Morse theory. Intersection homology. Jordan curve theorem. Brouwer fixed-point theorem. Euler characteristic. Poincaré-Hopf theorem. Lefschetz fixed-point theorem. Morse functions, classification of 2-manifolds.

Geometric analysis (infrequently; Theoretical Mathematics):
Basic concepts of Riemannian geometry. Operators and PDEs on manifolds. Sobolev spaces and embedding theorems. Elliptic regularity theory. Maximum principles. Harnack's inequality. Eigenvalues and geometry: Boundary value problems, isoperimetric inequality, calculus of variations (direct methods). Basic concepts of geometric measure theory.

Numerics of partial differential equations I (winter semester; Applied Mathematics):
Space discretization methods (finite differences, finite elements) for elliptical boundary value problems, stability concepts, convergence analysis, error estimations. Time and space discretization methods for parabolic (and hyperbolic) evolution equations, stability, error estimation

Partial differential equations I (winter semester; Applied or Theoretical Mathematics):
Basic types of partial differential equations. Separation of the variables. Characteristics. Laplace's equation and solution of the Dirichlet problem. Mean value property of harmonic functions. Maximum principles. Variational methods, regularity question. Weak solutions. Elliptic equations. Evolution equations (especially heat and wave equations). Existence and uniqueness issues.

Probability (summer semester; Applied Mathematics):
Consolidation of measure theory, independence, conditional expectation, finite and infinite product spaces, Markov kernels, terminal sigma algebra, 0-1 laws, filtration, stopping times, optional sampling, martingales, martingale convergence theorem, uniform integrability and convergence in the pth mean, characteristic functions, multivariate normal distribution, types of convergence, central limit theorem, characterisation of real distributions by means of moments.

Teaching content for statistics (winter semester, alternating with financial mathematics; Applied Mathematics):
Estimation theory, maximum likelihood estimators, best unbiased estimators, method of moments, linear models, regression, test theory, Neyman-Pearson lemma, testing at monotone likelihood ratios, two-tailed tests, optional: Chi^2 goodness-of-fit test, Kolmogorov Smirnov test, testing in linear models.

Teaching content for financial mathematics (winter semester, alternating with statistics; Applied Mathematics):
Informal introduction to financial markets and their derivatives. Mathematical financial market models in discrete time. Characterisation of arbitrage-free markets. Characterisation of complete markets. Valuation of derivatives in complete and incomplete markets. The Black-Scholes model and the Black-Scholes formula. Valuation of D erivatives in the Black-Scholes model.
Optional: Portfolio optimisation, risk measures, modelling of financial market risks.

Learning outcomes

Students broaden their mathematical horizon in two freely electable fields and are therefore able to cover a large section of modern mathematics and apply the corresponding methods. In addition, the lectures qualify students for subsequent participation in corresponding specialisation modules in the master's degree programme, if the necessary basic knowledge had not yet been acquired previously.

3	Structure					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	90
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	90
3	Lecture	Lecture	Lecture 2	M	60 (4 SWS)	90
4	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	
Elective options within the module			The following courses are offered regularly and can be taken within this module. Differential geometry I (winter semester; Theoretical Mathematics) Functional analysis (winter semester; Theoretical Mathematics) Higher algebra (winter semester; Theoretical Mathematics) Algebraic topology (winter semester; Theoretical Mathematics) Differential topology I (infrequently; Theoretical Mathematics) Geometric analysis (infrequently; Theoretical Mathematics) Numerics of partial differential equations (winter semester; Applied Mathematics) Partial differential equations (winter semester; Applied or Theoretical Mathematics) Probability (summer semester; Applied Mathematics) Statistics (winter semester, alternating with Financial Mathematics; Applied Mathematics) Financial mathematics (winter semester, alternating with Statistics; Applied Mathematics) If all specialisations included in the overall grade are from only one of the areas of applied mathematics or theoretical mathematics/logic, Section 8 (1) must be observed when choosing the courses, since there are restrictions in this module regarding the performances that are included in the module grades. In addition, all four-hour lectures with tutorial assigned to a specialisation module of the master's programme can be chosen, provided that the student does not attend them as part of a specialisation module. The assignment to the area of theoretical mathematics or applied mathematics then corresponds to the assignment of the respective module to one of these areas. In addition, the Faculty will offer further courses that can be attended as part of this module. These are marked as such in the course catalogue, and the assignment to one of the areas of theoretical mathematics or applied mathematics will then be announced in the course catalogue. Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.			

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade

1	MCE	Written or oral exam. The type of degree-relevant examination will be announced by the lecturer in a suitable manner in good time.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2	50%
2	MCE	Written or oral exam. The type of degree-relevant examination will be announced by the lecturer in a suitable manner in good time.		3 and 4	50%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
1	Completion of weekly exercises for both courses in a scope specified by the lecturers and announced at the beginning of each course. Admission to the examinations is dependent on the successful completion of the exercises for the respective course to the required extent; this will be announced in good time and in an appropriate manner at the beginning of the course.		Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2	Completion of weekly exercises for both courses in a scope specified by the lecturers and announced at the beginning of each course. Admission to the examinations is dependent on the successful completion of the exercises for the respective course to the required extent; this will be announced in good time and in an appropriate manner at the beginning of the course.		Generally, 40–50% of the assigned exercises must be completed correctly.	2	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	2 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	1 CP
	no.2	1 CP
Required coursework	no. 1	5 CP
	no. 2	5 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every semester

Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Possible subject-specific requirements for a particular course will be announced in the course catalogue.

Ma-S1 Specialisation in Differential Geometry

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Differential Geometry**
Module number	Ma-S1

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research fields in differential geometry. Passing the module provides a professional basis for writing a master's thesis in a field of differential geometry.	
Teaching content	
Contents may vary greatly. As a rule, however, a foundation is laid by selecting from the following items. Differential geometry II: Toponogov's theorem, sphere theorems, Riccati comparison, Bishop-Gromov inequality, soul theorem, Morse theory on loop spaces Geometric evolution equations: Maximum principles for geometric evolution equations and applications, e.g. for the Ricci flow and mean curvature flow, compactness theorems and applications Lie groups: Structure of Lie groups and Lie algebras, matrix groups, simple Lie groups and Killing form, Cartan decomposition, root systems, isometry groups, symmetric spaces Homogeneous spaces: Lie groups, structure of homogeneous spaces, symmetric spaces, homogeneous Einstein spaces Alexandrov spaces: Collapsed manifolds, structure of Alexandrov spaces General theory of relativity	
Learning outcomes	

Students will be acquainted with current research areas in differential geometry. Their geometric intuition will be sharpened and they will learn to use this abstract skill in solving concrete mathematical problems.

3	Structure					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	
Elective options within the module			Generally, two lectures are to be selected from the following list of courses: Differential geometry II Geometric evolution equations Lie groups Homogeneous spaces Alexandrov spaces General theory of relativity The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative.			

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	

2	Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Expected prior knowledge: Course content of the advanced module Differential Geometry from the bachelor's degree programme. In addition,

	students are advised to attend the lecture “Topology” or “Differential topology”, which, according to schedule, is offered in the winter semester. Furthermore, the bachelor’s lecture “Partial differential equations” is a good complement, which, according to schedule, is offered in the summer semester. Passing the module provides the basis for writing a master’s thesis in a field of differential geometry. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Theoretical Mathematics.

Ma-S2 Specialisation in Geometric Structures

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Geometric Structures**
Module number	Ma-S2

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**

Aim of the module / Integration in the curriculum

The module will acquaint students with current research areas in a field of the geometric structures listed below. Passing the module provides a professional basis for writing a master's thesis in the relevant field.

Teaching content

Contents may vary greatly. As a rule, however, a foundation is laid by selecting from the following items:

Geometric analysis: Complements of Riemannian geometry and basic concepts of spectral geometry, potential theory, operators and PDEs on manifolds, Sobolev spaces and embedding theorems, elliptic regularity theory, maximum principles, Harnack's inequality, existence theorems for Ricci curvature and scalar curvature.

Index theory: Clifford algebras, spin structures and Dirac operators, characteristic classes, Atiyah-Singer index theorem, cobordism and surgery, positive scalar curvature on spin manifolds.

Variational methods: Calculus of variations and Euler-Lagrange equations as central techniques, the first and second variation of the surface integral and first consequences, analysis of the second variation and its geometric significance, regularity theory especially for the model case of minimal surfaces, singularities of minimal surfaces and asymptotic resolutions, basic applications in physics and geometry.

Geometric group theory: Presentations of groups, word metric, structure of free groups, fundamental groups, graphs and trees, residual finiteness, Milnor-Svarc lemma, word problem, growth behaviour, Milnor-Wolf theorem.

Spaces of non-positive curvature and Gromov hyperbolic spaces: Topology of metric spaces, geodetic spaces, CAT(0) condition, fixed-point theorem, types of isometries, fixed-point properties of groups, Gromov-Hausdorff distance and convergence, Tits boundary, Busemann functions.

Buildings and groups: Coxeter groups, buildings, groups with BN pairs, classical groups, simple Lie groups, simplicity criteria, Bruhat decomposition, Steinberg group, Solomon-Tits theorem.
Learning outcomes
Students will be introduced to current research areas in a field of the above-mentioned geometric structures. Their geometric intuition will be sharpened and they will learn to use this abstract skill in solving concrete mathematical problems.

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	
Elective options within the module			Generally, two lectures are to be selected from the following list of courses: Geometric analysis Index theory Variational methods Geometric group theory Spaces of non-positive curvature Buildings and groups The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative.			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	

1	Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2	Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**

Usability in other degree programmes	none

9	**Miscellaneous**
	Expected prior knowledge: Course content of the bachelor's module Differential Geometry, possibly also of the bachelor's module Topology. Passing the module provides the basis for writing a master's thesis in one of the work areas of the geometrical structures group. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Theoretical Mathematics.

Ma-S3 Specialisation in Operator Algebras and Noncommutative Geometry

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Operator Algebras and Noncommutative Geometry**
Module number	Ma-S3

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**

Aim of the module / Integration in the curriculum

The module will acquaint students with current research areas in operator algebras and/or noncommutative geometry. Passing the module provides a professional basis for writing a master's thesis in the relevant field.

Teaching content

Lecture "Operator algebras":
Commutative Banach algebras and C*-algebras,
general C*-algebras,
spectral theory and functional calculus,
approximate units. Ideals and quotients.
positive functionals and the GNS construction.
representations of C*-algebras.

In addition, a selection from the following topics will be covered:
Constructions of C*-algebras and examples, multiplier algebras,
tensor products, elementary theory of von Neumann algebras, K-theory.

Contents may vary considerably in the second part of the module. As a rule, however, a foundation is laid by selecting from the following topics:

K-theory for C*-algebras,
nuclearity and exactness of C*-algebras,
von Neumann algebras,
structural properties for C*-algebras and von Neumann algebras,
C*-dynamical systems and crossed products,
representation theory of locally compact groups,
noncommutative geometry,

operator spaces, mathematical physics
Learning outcomes
Students will become acquainted with current research areas in operator algebras and/or noncommutative geometry, and they will be enabled to carry out independent scientific work in this field.

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture Operator Algebras	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial Operator Algebras	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	
Elective options within the module			In addition to the lecture “Operator algebras”, the second part of the module will consist of lectures in the total scope of 4 hours of instruction per week (SWS) in the field of operator algebras/noncommutative geometry, which can have different contents depending on the courses offered. Possible topics of such courses could include: K-theory for C*-algebras, nuclearity and exactness of C*-algebras, von Neumann algebras, the fine structure of C*-algebras and von Neumann algebras, C*-dynamic systems and crossed products, representation theory of locally compact groups, noncommutative geometry, operator spaces, mathematical physics Lectures/seminars approved for this module are indicated as such in the course catalogue. The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative. The department will endeavour to offer a suitable lecture each summer term which is not based on the contents of the “Operator algebras” lecture, so that the module may also be started in the summer term. However, it is recommended to start the module in the winter term with the “Operator algebras” lecture.			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade

1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
1	Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.		Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2	Seminar presentation with written paper		Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP

	no. 2	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Students are expected to have sound knowledge of functional analysis, such as that acquired in the advanced Functional Analysis course provided regularly in the bachelor's degree programme Mathematics, which can also be taken within the module ``Broadening Courses''. Passing the module provides the basis for writing a master's thesis in operator algebras/noncommutative geometry. The frequency in which this module is offered as indicated under 7 assumes sufficient demand and teaching capacity. If sufficient capacity is available, the department will endeavour to make it possible for the module to be started in the summer semester. This module is assigned to Theoretical Mathematics.

Ma-S4 Specialisation in Topology

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Topology**
Module number	Ma-S4

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research areas in topology. Passing the module provides a professional basis for writing a master's thesis in a field of topology.	
Teaching content	
Contents may vary greatly. As a rule, however, a base is provided by selecting from the following topics. Homotopy theory, cohomology operations, spectral sequences. Fibre bundles and characteristic classes. Topological K-theory, bordism theory. Stable homotopy theory, higher category theory. Classification of manifolds. Algebraic K-theory and L-theory. Geometric group theory, group homology. Spin geometry and index theory.	
Learning outcomes	
Students will be acquainted with current research areas in topology.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120

2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	
Elective options within the module			Generally, two lectures are to be selected from the those published in the course catalogue: The corresponding lectures are indicated in the course catalogue. The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative.			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	

5	**Requirements**

Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Students are expected to have knowledge of the course content of the foundational modules in the bachelor's degree programme, of the foundational extension module Theoretical Mathematics and of the short advanced module Topology from the bachelor's degree programme. Passing the module provides the basis for writing a master's thesis in a field of topology. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Theoretical Mathematics.

Ma-S5 Specialisation in Group Theory and Representation Theory

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Group Theory and Representation Theory**
Module number	Ma-S5

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research areas in algebra, group theory and representation theory. Passing the module provides a professional basis for writing a master's thesis in a field of algebra, group theory and representation theory.	
Teaching content	
Contents may vary greatly depending on the selected course. This is usually a basic lecture or an advanced lecture from the areas mentioned under "Elective options".	
Learning outcomes	
Students will learn the fundamentals of the respective fields and be acquainted with current research fields of algebra, group theory and representation theory.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	

Elective options within the module	Generally, two lectures are to be selected from the following list of courses: Algebraic geometry Algebraic groups Representation theory of algebras Geometric group theory Homological algebra P-adic representation theory The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative. Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the	4	

		beginning of the respective seminar.		

5	Requirements
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	CP allocation	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	7 CP
Total CP		18 CP

7	Module administration
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	Recognition
Usability in other degree programmes	none

9	Miscellaneous
	Knowledge of the teaching material of the bachelor's module Higher Algebra is expected. Passing the module provides the basis for writing a master's thesis in a field with algebraic specialisation. A course with similar content that has already been completed and graded in another module cannot be completed and graded again within the scope of this module. In case of doubt, the module representative decides on the admissibility of such a course. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand.

	This module is assigned to Theoretical Mathematics.

Ma-S6 Specialisation in Applied Analysis

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Applied Analysis**
Module number	Ma-S6

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will introduce students to current research areas in applied analysis. Passing the module provides the basis for writing a master‘s thesis in a field of applied analysis.	
Teaching content	
The courses offered deal with current research topics in applied analysis, especially the theory of partial differential equations, and their relation to scientific problems, e.g.: Partial differential equations II: nonlinear partial differential equations, (indirect) variational methods, non-variational methods, concrete modelling and application examples Partial differential equations III: systems of partial differential equations, homogenisation/limitation methods, concrete modelling and application examples, optimal control, viscosity solutions, dynamic programming Calculus of variations: Euler-Lagrange equations, 2nd variation, Hamilton-Jacobi equations, existence and regularity of minimizers, convex and non-convex variational problems, relaxation and Gamma-convergence,	

concrete application examples
Fluid dynamics:
Transport, turbulence, phase transitions

Dynamic systems:
Fluxes, branching, oscillations, averaging and perturbation theory and
concrete application examples

Theory of inverse problems
Mathematical theory of image processing
Theory of nonlinear optimisation
Regularisation methods for ill-posed problems
and concrete applications

Learning outcomes
Students will be introduced to current research areas in applied analysis.

3	**Structure**

Module components

No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	240
5	Practical Course	Practical Course	Student Project	EM	30 (2 SWS)	240

Elective options within the module	Generally, a lecture with tutorial and written or oral examination is to be selected from a typical list of courses, such as Partial differential equations II Calculus of variations Dynamic systems Theory of inverse problems In the following semester, students are generally to attend another four-hour lecture from this list or another suitable further lecture without tutorial. Depending on what is offered, however, this part can also be used for a reading class, seminar or internship, in the scope of which a presentation on the topic is to be given. Upon agreement with the module representative, the order of the two parts can be changed. The module can be started in the winter semester or the summer semester, depending on the offered courses. Important: no courses may be selected which correspond in content to courses which have already been and will be evaluated in the bachelor's phase or in another module of the master's degree programme Mathematics.

4	**Examination structure**

Degree-relevant examination(s)

No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering lecture 1 and covering the exercises for lecture 1. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	3 hours (written examination) or 30 minutes (oral examination)	1 and 2	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		The type and scope of coursework required for lecture 2 will be announced by the lecturer at the beginning of the lecture. This is either the completion of exercises on a reduced scale or an independent presentation (45 minutes) or an oral examination (about 20 minutes) on the contents of this lecture.		3	
3		Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	
4		Project work	The scope and type will be announced by the lecturer in a suitable manner at the beginning of the course.	5	

5	**Requirements**

Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	2 CP
	Course no. 4	1 CP
	Course no. 5	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	6 CP
	no. 3	7 CP
	no. 4	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Knowledge of the subject matter of the bachelor's module Partial Differential Equations is expected. Passing the module provides the basis for writing a master's thesis in a field of applied analysis. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Applied Mathematics.

Ma-S7 Specialisation in Numerics and Scientific Computing

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Numerics and Scientific Computing**
Module number	Ma-S7

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**

Aim of the module / Integration in the curriculum

The module will introduce students to current research areas in numerics and scientific computing. Passing the module provides the basis for writing a master‘s thesis in a field of numerics and scientific computing.

Teaching content

The offered courses deal with current research topics in scientific computing, e.g

Numerics of partial differential equations II:
Numerical methods for nonlinear partial differential equations, e.g. hyperbolic conservation equations and systems of partial differential equations with a focus on numerical analysis

Scientific computing:
Application-oriented treatment of numerical methods for solving partial differential equations, efficient solution methods for linear and nonlinear systems of equations, implementation aspects, parallelization and efficient software concepts

Numerical model reduction:
Numerical methods for model reduction, such as reduced basis methods, balanced truncation, tensor techniques, methods for dimension reduction or numerical multiscale methods

Inverse problems:
Theory and numerics of inverse problems,
Regularization methods for ill-posed problems,
image reconstruction methods and medical applications

Optimization:

Numerical methods for solving optimization problems including their numerical analysis, in particular linear optimization, convex optimization and nonlinear optimization as well as other topics, e.g. non-smooth optimization and optimal control.

Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.

Learning outcomes

Students will be introduced to current research areas in numerics and scientific computing.

3 Structure

Module components

No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	240
5	Practical Course	Practical Course	Student Project	EM	30 (2 SWS)	240

Elective options within the module	Generally, a lecture with tutorial and written or oral examination is to be selected from a list of courses, such as Numerics of partial differential equations II Numerics of inverse problems Numerical optimization In the following semester, students are generally to attend another four-hour lecture from this list or another suitable further lecture without tutorial. Depending on what is offered, however, this part can also be used for a reading class, seminar or internship, in the scope of which a presentation on the topic is to be given. Upon agreement with the module representative, the order of the two parts can be changed. The module can be started in the winter semester or the summer semester, depending on the offered courses.

4 Examination structure

Degree-relevant examination(s)

No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering lecture 1 and covering the exercises for lecture 1. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	3 hours (written examination) or 30 minutes (oral examination)	1 and 2	100%

Weight of the module grade for the final overall grade	15%

Required coursework

No.	Type	Duration/ Scope	Connection to course no. if appl.	
1	Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2	The type and scope of coursework required for lecture 2 will be announced by the lecturer at the beginning of the lecture. This is either the completion of exercises on a reduced scale or an independent presentation (45 minutes) or an oral examination (about 20 minutes) on the contents of this lecture.		3	
3	Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the beginning of the respective seminar.	4	
4	Project work	The scope and type will be announced by the lecturer in a suitable manner at the beginning of the course.	5	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
	Course no. 1	2 CP

Participation (= attendance time)	Course no. 2	1 CP
	Course no. 3	2 CP
	Course no. 4	1 CP
	Course no. 5	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	6 CP
	no. 3	7 CP
	no. 4	7 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Knowledge of the course content of one of the bachelor's modules Numerics of Partial Differential Equations or Partial Differential Equations is expected. Passing the module provides the basis for writing a master's thesis in a field of numerics and scientific computing. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Applied Mathematics.

Ma-S8 Specialisation in Probability and its Applications

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Probability and its Applications**
Module number	Ma-S8

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research fields in probability. Passing the module provides a professional basis for writing a master's thesis in a field of probability.	
Teaching content	
Probability and its Applications (contents may vary greatly depending on selected courses)	
Learning outcomes	
Students will be acquainted with current research areas in probability and its applications.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	M	60 (4 SWS)	210

Elective options within the module	Generally, two lectures are to be selected from the following list of courses: Probability II Probability III Large deviations theory Statistics II Nonparametric statistics Extreme value statistics Statistical methods of pattern recognition Time series Stochastic recurrence equations Stochastic analysis Advanced financial mathematics The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering lecture 1 and covering the exercises for lecture 1. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	3 hours (written examination) or 30 minutes (oral examination)	1 and 2	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		The type and scope of coursework required for lecture 2 will be announced by the lecturer at the beginning of the lecture. This is either the completion of exercises on a reduced scale or an independent presentation (45 minutes) or an oral examination (about 20 minutes) on the contents of this lecture.		3	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	2 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	6 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Knowledge of the subject matter of the bachelor's module Probability and its Applications is expected. Passing the module provides the basis for writing a master's thesis in probability and its applications. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Applied Mathematics.

Ma-S9 Specialisation in Stochastic Processes

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Stochastic Processes**
Module number	Ma-S9

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research areas in the field of algebra, number theory and algebraic geometry. Passing the module provides a professional basis for writing a master's thesis in an field of algebra, number theory and algebraic geometry."	
Teaching content	
Theory and Applications of Stochastic Processes. (contents may vary greatly depending on the selected courses)	
Learning outcomes	
Students will be acquainted with current research areas in probability.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	M	60 (4 SWS)	210

Elective options within the module	Generally, two lectures are to be selected from the following list of courses: Probability II Statistical mechanics Stochastic processes Point processes Lévy processes Stochastic models Markov processes Continued stochastic processes Ergodic theory Renewal theory Branching processes The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering lecture 1 and covering the exercises for lecture 1. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	3 hours (written examination) or 30 minutes (oral examination)	1 and 2	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		The type and scope of coursework required for lecture 2 will be announced by the lecturer at the beginning of the lecture. This is either the completion of exercises on a reduced scale or an independent presentation (45 minutes) or an oral examination (about 20 minutes) on the contents of this lecture.		3	

5	Requirements
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	CP allocation	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	2 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	6 CP
Total CP		18 CP

7	Module administration
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	Recognition
Usability in other degree programmes	none

9	Miscellaneous
	Knowledge of the subject matter of the bachelor's module Probability and Statistics is expected. Passing the module provides the basis for writing a master's thesis in the theory of stochastic processes. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Applied Mathematics.

Ma-S10 Specialisation in Logic

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Logic**
Module number	Ma-S10

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research areas in the field of logic. Passing the module provides a professional basis for writing a master's thesis in an field of logic.	
Teaching content	
Contents may vary greatly. As a rule, however, a base is provided by selecting from the following items: Morley's theorem Stable and NIP theories Application of model-theoretical methods to groups Model theory of valued fields Fraïssé limit constructions Recursion theory on ordinal numbers Recursion in higher type objects Ordinal number analyses of axiom systems Independence of combinatorial principles from axiom systems Constructibility Forcing, forcing axioms Descriptive set theory PCF theory Determinacy, large cardinals	
Learning outcomes	

Students will be acquainted with selected current research areas in at least one of the following fields:

Set theory
Model theory and its applications

Their intuition will be sharpened for the respective field, and they will learn to use this abstract skill in solving concrete mathematical problems.

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture Mathematical Logic III	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial Mathematical Logic III	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture Mathematical Logic IV	M	60 (4 SWS)	210
Elective options within the module						

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the degree-relevant examination may depend on the successful completion of the exercises for the corresponding course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.

Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
Total CP		18 CP

7	**Module administration**
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	Knowledge of the course content of the bachelor's module Logical Consolidation is expected. If logic is not a minor subject, then this module can be credited as a specialisation module. If logic is a minor subject, then this module is part of the minor subject studies and cannot also be credited as a specialisation module for the major studies of mathematics. In this case, the module grade will also be included in the overall result with 15%. Passing the module provides the basis for writing your master's thesis in a field of logic. This applies regardless of whether logic is a minor subject or not. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand. This module is assigned to Theoretical Mathematics.

Ma-S11 Specialisation in Number Theory and Arithmetic Geometry

Degree programme	**Master of Science Mathematics**
Module	**Specialisation in Number Theory and Arithmetic Geometry**
Module number	Ma-S11

1	**Basic data**
Programme semester	1-2 or 2-3
Credits (CP)	18
Workload (h) in total	540
Module duration	2 semesters
Module status (M/EM)	EM

2	**Profile**
Aim of the module / Integration in the curriculum	
The module will acquaint students with current research areas in the field of logic. Passing the module provides a professional basis for writing a master's thesis in an field of logic.	
Teaching content	
Contents may vary greatly depending on the selected course. This is usually a basic lecture or an advanced lecture from the areas mentioned under "Elective options".	
Learning outcomes	
Students will acquire the fundamentals of the respective fields and be acquainted with current research areas of algebra, algebraic geometry and number theory.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture 1	M	60 (4 SWS)	120
2	Tutorial	Tutorial	Tutorial	M	30 (2 SWS)	60
3	Lecture	Lecture	Lecture 2	EM	60 (4 SWS)	210
4	Seminar	Seminar	Seminar	EM	30 (2 SWS)	

Elective options within the module	Generally, two lectures are to be selected from the following list of courses: Algebraic geometry Algebraic number theory Arithmetic of function fields Galois representations and Galois cohomology Non-Archimedean analysis and geometry P-adic representation theory The module representative may approve further courses with a suitable subject-specific focus; these will be indicated accordingly in the course catalogue. The lecture in the summer semester can also be replaced by a suitable seminar or reading class approved by the module representative. Important: courses that correspond in content to courses that have already been graded during the bachelor phase or in another module of the master's degree programme Mathematics may not be selected.

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Written or oral examination covering a four-hour lecture, usually lecture 1 or lecture 2, and the exercises. The type of degree-relevant examination will be announced by the lecturer (or examiner) in good time and in a suitable manner.	2-3 hours (written examination) or 20-30 minutes (oral examination)	1 and 2 or 2 and 3	100%
Weight of the module grade for the final overall grade		15%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		Completion of weekly exercises for the lecture with tutorial in a scope specified by the lecturer. Admission to the examination may depend on the successful completion of the exercises for the respective course to the required extent. This and the required extent will be announced in a suitable manner in good time at the beginning of the course.	Generally, 40–50% of the assigned exercises must be completed correctly.	2	
2		Seminar presentation with written paper	Presentation: usually 60-90 minutes. Further details as well as the required scope of the written paper will be announced in a suitable manner in good time at the	4	

		beginning of the respective seminar.		

5	Requirements
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	In order to present the exercises in the practical classes, lecturers can make it compulsory for the students to participate in the practical classes.

6	CP allocation	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	8 CP
	Course no. 4	1 CP
Degree-relevant examination(s)	no. 1	2 CP
Required coursework	no. 1	5 CP
	no. 2	7 CP
Total CP		18 CP

7	Module administration
Frequency	Every winter semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	Recognition
Usability in other degree programmes	none

9	Miscellaneous
	Knowledge of the course content of the bachelor's module Higher Algebra is expected. Passing the module provides the basis for writing a master's thesis in a field with algebraic specialisation. A course with similar content that has already been completed and graded in another module cannot be completed and graded again within the scope of this module. In case of doubt, the module representative decides on the admissibility of such a course. The frequency in which this module is offered as indicated under 7 assumes sufficient teaching capacity and demand.

	This module is assigned to Theoretical Mathematics.

Ma-E Specialisation Supplement and Research Skills

Degree programme	**Master of Science Mathematics**
Module	**Specialisation Supplement and Research Skills**
Module number	Ma-E

1	**Basic data**
Programme semester	3
Credits (CP)	12
Workload (h) in total	360
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	
This module will prepare students intensively for working on their master's thesis.	
Teaching content	
The courses deal with current topics of the research areas available at the Faculty.	
Learning outcomes	
The module Specialisation Supplement and Research Skills directly prepares students for working on a master's thesis in the chosen area of specialisation. To this end, students deepen their knowledge in one of the subjects they have chosen in the specialisation modules. They will be enabled to acquire current research work in this field and present it in oral and written form. They are able to apply very complex methods and results from this field of research creatively and are familiar with the important open questions in this field.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Lecture	Lecture	Lecture	EM	60 (4 SWS)	120

2	Seminar	Seminar	Seminar	EM	30 (2 SWS)	150
3	Course	Course	Reading Course	EM	30 (2 SWS)	150
4	Seminar	Graduate Seminar or Privatissimum	Graduate Seminar or Privatissimum	M	30 (2 SWS)	
Elective options within the module			In all mathematical fields of research in which specialisation modules are offered, the Faculty also offers corresponding advanced lectures, seminars or reading classes, provided that there is a need for them. In the first part, students need to choose a lecture (possibly with integrated tutorial) of 4 hours of instruction per week (SWS) or a seminar/reading class (i.e. one of the courses 1. or 2. or 3. of the above overview). In the second part, students will either attend an advanced research seminar in the chosen research area or be prepared for the topic of the master's thesis in regular consultation hours with a lecturer. With the lecturer who is to supervise his/her master's thesis, each student must agree in writing on the selection of the courses he/she intends to take under 1, 2 or 3 and under 4 . The confirmation that the selected courses together with the courses of a specialisation module can serve the preparation of a master's thesis has to be submitted to the Examinations Office.			

4	**Examination structure**				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	When choosing a lecture: Oral examination When choosing a seminar: Seminar presentation When choosing a reading class: Presentation or oral examination. The type of degree-relevant examination will be announced by the lecturer in a suitable manner in	c. 15 minutes usually 60-90 minutes (lecture) or c. 15 minutes (oral examination)	1 or 2 or 3	100%
Weight of the module grade for the final overall grade		8%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1		none			

5	**Requirements**
Module-related requirements for participation	No formal prerequisites for participation. However, see box 9 Other.
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.

Rules on course attendance	Current research topics, which are often not yet sufficiently documented in the specialist literature, will be presented and discussed by the participants in the seminars, reading classes, advanced research seminars and private tutorials. Participation in

6	**CP allocation**	
Participation (= attendance time)	Course no. 1	2 CP
	Course no. 2	1 CP
	Course no. 3	1 CP
	Course no. 4	6 CP
Degree-relevant examination(s)	no. 1	4 CP
	no.2	5 CP
Required coursework	None	
Total CP		12 CP

7	**Module administration**
Frequency	Every semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**
	The courses should be based on a course from a specialisation module. In some cases, it may be appropriate to attend less advanced courses as a supplement.

Ma-M Master's Thesis

Degree programme	**Master of Science Mathematics**
Module	**Master's Thesis**
Module number	Ma-M

1	**Basic data**
Programme semester	4
Credits (CP)	30
Workload (h) in total	900
Module duration	1 semester
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	
This module concludes the master's programme.	
Teaching content	
Generally, a master's thesis will be related to one of the supervisor's research areas. The task may consist of sophisticated literary work, in which details in proofs of mathematical results are to be supplemented or simplified. The aim can also be to apply a method from mathematical literature to the solution of a concrete problem.	
Learning outcomes	
The master's thesis is intended to show that the student is able to work on a scientifically sophisticated mathematical problem and to present the results appropriately.	

3	**Structure**					
Module components						
No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1			Master's Thesis			900

Elective options within the module	

4	Examination structure				
Degree-relevant examination(s)					
No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade
1	FME	Master's thesis	Usually 40-60 pages		100%
Weight of the module grade for the final overall grade		32%			
Required coursework					
No.		Type	Duration/ Scope	Connection to course no. if appl.	
1	none				

5	Requirements
Module-related requirements for participation	Issuing of the topic requires that the student has acquired 72 credit points and that the confirmation from the supplementary module according to its point 3. has been issued, stating that the courses selected there, together with the courses of a special
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	None

6	CP allocation	
Degree-relevant examination(s)	no. 1	30 CP
Total CP		30 CP

7	Module administration
Frequency	Every semester
Module representative	The list of current module representatives can be accessed at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB10)

8	Recognition
Usability in other degree programmes	none

9	Miscellaneous
	The time that topics are assigned is to be arranged with the supervisor.

	The scope specified in box 4 is a guideline only. Deviations are possible. For example, a shorter paper of very high scientific quality could be rated as good as or better than a longer paper of more average quality.

Ma-K Personal Enrichment

Degree programme	**Master of Science Mathematics**
Module	**Personal Enrichment**
Module number	Ma-K

1	**Basic data**
Programme semester	1-2
Credits (CP)	6
Workload (h) in total	180
Module duration	1-2 semesters
Module status (M/EM)	M

2	**Profile**
Aim of the module / Integration in the curriculum	
Promotion of individual study biographies in the light of students' strongly differing professional and further education goals.	
Teaching content	
The course content may vary greatly depending on the student's focus. Contents of the Career Service's seminars can be, for example: individual professional profile development, workshops with employers, soft skill seminars or application training. Programming courses are regularly offered for, among others, C++, Java, Python, R and Matlab.	
Learning outcomes	
Within the scope of this module, students strengthen key competences in areas that enable them, in their individual study and life situation, to better orientate themselves and prepare for after the master's degree. By integrating it into the formal curriculum, the acquisition of competencies becomes visible to third parties. The concrete learning outcomes vary according to the chosen course/focus. Overall, the courses in this module are intended to develop the students' ability to transfer and their ability to use their qualifications to	

position themselves for their path to the master's degree. The Career Service's seminars in particular help students strengthen their professional orientation and further develop their personal professional profile.

3	**Structure**

Module components

No.	Course category	Course form	Course	Status (M/EM)	Workload (h)	
					Attendance time (h) / SWS	Self-study (h)
1	Seminar	Seminar	Career Service Seminar (2 CP)	EM	15 (1 SWS)	45
2	Seminar	Seminar	Another Career Service Seminar (2 CP)	EM	15 (1 SWS)	45
3	Work placement	Industrial placement	Industrial placement (6 LP) (at least three weeks with full-time presence in the company)	EM		180
4			Working as a Tutor in Mathematics/Coaching for Tutors	EM	60 (4 SWS)	120
5	Language Courses			EM		
6	Programming Courses			EM		
7	Events/Modules delivered by the faculty which allow students to sharpen their scientific and professional profile.			EM		

Elective options within the module	The following can be selected, among others: a) an industrial placement b) seminars offered by the Career Service c) trainer function/tutor training d) language courses e) programming courses f) further courses/modules of Faculty 10, which enable students to sharpen their individual profile, e.g. also with regard to a doctorate These include in particular advanced degree seminars, suitable courses offered by the Mathematics Münster Graduate School, etc. Students who have no or almost no knowledge of German are recommended to choose a German language course. Students can only choose course no. 4 if they have successfully applied for a position as student assistant, as student assistant holding a bachelor's degree or as research assistant for a practice group for a mathematics course at Faculty 10 during their master's studies. No courses may be selected that have already been credited in the bachelor phase (with the exception of the tutorial training).

4	**Examination structure**

Degree-relevant examination(s)

No.	FME/ MCE	Type	Duration/ Scope	Connection to course no. if appl.	Weight in the module grade

	Depending on the selected courses, the number of degree-relevant examinations may vary. The degree-relevant examinations completed in this module are not graded. At least one degree-relevant examination must be completed. The degree-relevant examinations possibly offered for the courses no. 1, 2, 5 and 6 are determined by the requirements of the unit offering the course.				
1		Preparation of a placement report, which must be signed by the company and an instructor of the Faculty of Mathematics and Computer Science.	Before the start of the placement, the nature and length of the placement report will be discussed with the instructor of Faculty 10, who will clarify the suitability of the placement position.	3	
2		Participation in tutoring shadowing phases, active participation in tutor training, reflection report (Students who already completed the tutor training during their bachelor's studies can have this recognised.)	The duration and scope will be announced in a suitable manner in good time at the beginning of the tutor training course.	4	
3		According to the offered event/module		7	
Weight of the module grade for the final overall grade		0 %			
Required coursework					
No.	Type		Duration/ Scope	Connection to course no. if appl.	
1	Required coursework as determined by the Career Service			1	
2	Required coursework as determined by the Career Service			2	
3	Grading of exercises to an extent specified by the instructor.		The extent will be announced in a suitable manner in good time at the beginning of the course.	4	
4	Required coursework as determined by the language centre			5	
5	According to the requirements of the unit offering the service			6	
6	According to the requirements of the offered course/module			7	

5	**Requirements**
Module-related requirements for participation	none
Awarding credits	Academic credit is awarded upon completion of the entire module, i.e. when students have proven that they have achieved the learning outcomes in their entirety as provided by the module.
Rules on course attendance	Compulsory attendance depends on the requirements of the selected courses.

6	**CP allocation**	
	Course no. 1	0.5 CP

Participation (= attendance time)	Course no. 2	0.5 CP
	Course no. 3	4 CP
	Course no. 4	2 CP
	Course no. 5	According to the requirements of the unit offering the service
	Course no. 6	According to the requirements of the unit offering the service
	Course no. 7	Depending on the chosen course
Degree-relevant examination(s)	no. 1	2 CP
	no. 2	1 CP
	no. 3	Depending on the chosen course
Required coursework	no. 1	1.5 CP
	no. 2	1.5 CP
	no. 3	3 CP
	no. 4	According to the requirements of the unit offering the service
	no. 5	According to the requirements of the unit offering the service
	no. 6	Depending on the chosen course
Total CP		6 CP

7	**Module administration**
Frequency	Every semester
Module representative	The current module commissioners are available at go.wwu.de/mscmathematik-mv.
Responsible faculty	Faculty of Mathematics and Computer Science (FB 10)

8	**Recognition**
Usability in other degree programmes	none

9	**Miscellaneous**