Programme-specific Section of the Curriculum for the MSc Programme in Mathematics at the Faculty of Science, University of Copenhagen

2009 (Rev. 2024)

Contents

1 Title, affiliation and language

A shared section that applies to all BSc, part-time MSc and MSc Programmes at the Faculty of Science is linked to this programme-specific curriculum.

1.1 Title

The MSc Programme in Mathematics with a general profile in mathematics leads to a Master of Science (MSc) in Mathematics with the Danish title: *Cand.scient. (candidatus/candidata scientiarum) i matematik*.

1.2 Affiliation

The programme is affiliated with the Study Board of Mathematics and Computer Science, and the students can both elect, and be elected, to this study board.

1.3 Corps of external examiners

The following corps of external examiners is used for the central parts of the MSc Programme:

- Corps of External Examiners for Mathematics (*matematik*).

1.4 Language

The language of this MSc Programme is English.

2 Academic profile

2.1 Purpose

The MSc programme in Mathematics is a research-based programme, the objective of which is to provide the student with the mathematical knowledge of and insights into the main fields and methodologies of mathematics required to work independently within this field. The compulsory study programme can form the basis of working also with applied mathematics as well as teaching mathematics.

2.2 General programme profile

The study programme allows in-depth study of various aspects of the mathematical core fields of algebra, analysis and geometry, but also more specialised mathematical disciplines, metadisciplines such as the history and didactics of mathematics as well as important applications within the natural and social sciences.

Mathematics is the key subject area of the programme.

2.3 General structure of the programme

The MSc Programme is set at 120 ECTS.

There are no defined specialisations in this programme.

2.4 Career opportunities

The MSc Programme in Mathematics qualifies students to become professionals within business functions and/or areas such as:

- A PhD programme
- The financial sector.
- Software development.
- Teaching at upper secondary schools.

3 Description of competence profiles

Students following the MSc Programme acquire the knowledge, skills and competences listed below. Students will also acquire other qualifications through elective subject elements and other study activities.

3.1 Generic competence profile

Graduates holding an MSc in Mathematics have acquired the following:

Knowledge about:

- Fundamental background notions within contemporary mathematics.
- Selected research-active fields within mathematics.

Skills in/to:

- Read and understand mathematical original literature.
- Communicate mathematical ideas on a scientific basis.
- Account orally and in writing for inquiries into open mathematical problems.

Competences in/to:

- Structure an inquiry into open mathematical questions and divide it into smaller easily accessible challenges.
- Conduct independent, stringent argumentation.
- Independently take responsibility for own professional development and specialisation.
- Reflect on modern methodologies for analysing and solving mathematical problems at a scientific level.

4 Admission requirements

4.1 Bachelor's degrees that automatically fulfil the academic requirements

Applicants with one of the following Bachelor's degrees automatically fulfil the academic requirements for admission to the MSc Programme in Mathematics:

- Mathematics (*matematik*) from University of Copenhagen
- Mathematics with the BSc elective subject course package (*studieretning*) in Mathematics from Aarhus University
- Mathematics (*etfagsuddannelse*) from Aalborg University

4.2 Other Bachelor's degrees

Applicants with a Bachelor's degree, Professional Bachelor's degree or equivalent from Danish or international universities other than those listed in 4.1 are qualified for admission to the MSc Programme in Mathematics if the programme includes the following:

- Subject elements in mathematical analysis — at least 30 ECTS
- Subject elements in linear algebra and algebra — at least 22.5 ECTS
- Subject elements in geometry and topology — at least 15 ECTS

For informational purpose - Bachelor's degrees that have previously been assessed as qualifying meeting the specified ECTS

Applicants with a Bachelor's degree in Natural Science and IT from University of Copenhagen are qualified for admission if the programme includes the following:

- A specialisation in Mathematics as well as the MSc admission course package in Mathematics.

Applicants with a Bachelor's degree in Actuarial Mathematics or Mathematics-Economics from University of Copenhagen are qualified for admission if the programme includes the following:

- Subject elements in algebra (at least 15 ECTS).
- Subject elements in geometry and topology (at least 15 ECTS).

4.3 Other applicants

The Faculty may also admit applicants who, after an individual academic assessment, are assessed to possess educational qualifications equivalent to those required in subclauses 4.1-4.

4.4 Language requirements

Applicants must as a minimum document English language qualifications comparable to a Danish upper secondary school English B level or English proficiency corresponding to the tests and scores required. Accepted tests and required minimum scores are published online at www.science.ku.dk.

4.5 Supplementary subject elements

The qualifications of an applicant to the MSc programme are assessed exclusively on the basis of the qualifying Bachelor's degree. Supplementary subject elements passed between the completion of the Bachelor's programme and the admission to the MSc programme cannot be included in the overall assessment.

However, subject elements passed before the completion of the Bachelor's programme may be included in the overall assessment. This includes subject elements completed as continuing education as well as subject elements completed as part of a former higher education program. A maximum of 30 ECTS supplementary subject elements can be included in the overall assessment.

Subject elements passed before completing the Bachelor's programme which are to form part of the MSc programme to which the student has a legal right of admission (§15-courses) cannot be included in the overall assessment.

5 Prioritisation of applicants

With a Bachelor's degree in Mathematics from University of Copenhagen the student is granted reserved access and guaranteed a place on the MSc Programme in Mathematics if the student applies in time to begin the MSc Programme within three years of the completion of the Bachelor's degree.

If the number of qualified applicants to the programme exceeds the number of places available, applicants will be prioritised according to the following criteria:

- Total number of ECTS within mathematics.

6 Structure of the programme

The compulsory subject elements, restricted elective subject elements and the thesis constitute the central parts of the programme (Section 30 of the Ministerial Order on Bachelor and Master's Programmes (Candidatus) at Universities).

6.1 Programme components

The programme is set at 120 ECTS and consists of the following:

- Restricted elective subject elements, 60 ECTS.
- Elective subject elements, 30 ECTS.
- Thesis, 30 ECTS.

6.1.2 Restricted elective subject elements

60 ECTS are to be covered as restricted elective subject elements from the following two lists:

1) 30 ECTS are to be covered as restricted elective subject elements from the following list:				
Course Code	**Course Title**	**Abbr.**	**Block**	**ECTS**
NMAA05014U	Algebra 3	Alg3	Block 1	7.5 ECTS
NMAA05038U	Algebraic Topology	AlgTop	Block 1	7.5 ECTS
NMAK15005U	Advanced Vector Spaces	AdVec	Block 1	7.5 ECTS
NMAK24007U	Brownian Motion	BM	Block 1	7.5 ECTS
NMAA05100U	Homological Algebra	HomAlg	Block 2	7.5 ECTS
NMAK10008U	Functional Analysis	FunkAn	Block 2	7.5 ECTS
NMAA06062U	Geometry 2	Geom2	Block 2	7.5 ECTS
NFKA09006U	Advanced Didactics of Mathematics	DidMatV	Block 2	7.5 ECTS
NMAK21004U	History of Mathematics 2: Expeditions into Mathematics in the Making, Research, and Uses of History for Teaching	Hist2	Block 3	7.5 ECTS
NMAK10019U	Differential Operators and Function Spaces	DifFun	Block 3	7.5 ECTS

2) 30 ECTS are to be covered as restricted elective subject elements from the following list:				
Course code	**Course title**	**Abbr.**	**Block**	**ECTS**
NMAK16022U	Partial Differential Equations	PDE	Block 1	7.5 ECTS
NMAK15005U	Advanced Vector Spaces	AdVec	Block 1	7.5 ECTS
NMAK24006U	Computability, Turing Machines, and Gödel's Incompleteness Theorems		Block 1	7.5 ECTS
NMAK24000U	Stochastic Processes in Continuous Time		Block 1	7.5 ECTS
NMAA06020U	Categories and Topology	CatTop	Block 1	7.5 ECTS
NMAK16000U	Algebraic Geometry 2	AlgGeo2	Block 1	7.5 ECTS
NMAA05014U	Algebra 3	Alg3	Block 1	7.5 ECTS
NMAA05038U	Algebraic Topology	AlgTop	Block 1	7.5 ECTS
NMAK23014U	Topics in Operator Algebras		Block 1	7.5 ECTS
NMAK23000U	Advanced Number Theory		Block 1	7.5 ECTS
NMAK23007U	Introduction to Quantum Computing		Block 1	7.5 ECTS
NMAK21002U	Topics in Geometry*		Block 1	7.5 ECTS
NMAK24007U	Brownian Motion	BM	Block 1	7.5 ECTS
NMAK17002U	Complex Analysis 2*		Block 2	7.5 ECTS
NMAK16001U	Analytic Number Theory	AnNum	Block 2	7.5 ECTS
NMAK16008U	Experimental Mathematics*	XM	Block 2	7.5 ECTS
NMAK22000U	Analysis in Quantum Information Theory	AnQIT	Block 2	7.5 ECTS
NMAA05100U	Homological Algebra	HomAlg	Block 2	7.5 ECTS
NMAK10008U	Functional Analysis	FunkAn	Block 2	7.5 ECTS
NMAA06062U	Geometry 2	Geom2	Block 2	7.5 ECTS
NMAK23001U	Applied Algebra and Geometry		Block 2	7.5 ECTS
NMAK23008U	Invitation to Combinatorics		Block 2	7.5 ECTS
NMAK14020U	Quantum Information Theory	QIT	Block 2	7.5 ECTS
NFKA09006U	Advanced Didactics of Mathematics	DidMatV	Block 2	7.5 ECTS
NMAK24002U	Partial Differential Equations 2		Block 2	7.5 ECTS
NMAK24009U	Topics in Probability		Block 2	7.5 ECTS
NMAK16007U	Elliptic Curves		Block 3	7.5 ECTS
NMAK18005U	Introduction to Representation Theory		Block 3	7.5 ECTS
NMAK23012U	Operator Algebras	OpAlg	Block 3	7.5 ECTS
NMAK14009U	Commutative Algebra	KomAlg	Block 3	7.5 ECTS

2) 30 ECTS are to be covered as restricted elective subject elements from the following list:				
Course code	**Course title**	**Abbr.**	**Block**	**ECTS**
NMAK21000U	Geometric Topology	GeomTop	Block 3	7.5 ECTS
NMAA13036U	Introduction to Mathematical Logic		Block 3	7.5 ECTS
NMAK21004U	History of Mathematics 2: Expeditions into Mathematics in the Making, Research, and Uses of History for Teaching	Hist2	Block 3	7.5 ECTS
NMAK10019U	Differential Operators and Function Spaces	DifFun	Block 3	7.5 ECTS
NMAK20006U	Riemannian Geometry		Block 4	7.5 ECTS
NMAK17011U	Algebraic Number Theory	AlgNT	Block 4	7.5 ECTS
NMAK22018U	Algebraic Geometry	AlgGeo	Block 4	7.5 ECTS
NMAA09039U	Algebraic Topology II	AlgTop2	Block 4	7.5 ECTS
NMAK23009U	K-Theory	K-Theory	Block 4	7.5 ECTS
NMAK15003U	Advanced Mathematical Physics	AdvMathPhys	Block 4	7.5 ECTS
NMAK23004U	Graphs and Groups		Block 4	7.5 ECTS

*The course is not offered in 2024/25

6.1.3 Elective subject elements

30 ECTS are to be covered as elective subject elements.

- All subject elements at MSc level may be included as elective subject elements in the MSc Programme.
- BSc subject elements corresponding to 15 ECTS may be included in the MSc Programme.
- Projects. See 6.1.4 Projects.

6.1.4 Projects

- Projects outside the course scope may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 5 to the shared section of the curriculum.
- Projects in practice may be included in the elective section of the programme with up to 15 ECTS. The regulations are described in Appendix 4 to the shared section of the curriculum.
- Thesis preparation projects may not be included in the elective section of the programme. The regulations are described in Appendix 6 to the shared section of the curriculum.

6.1.5 Thesis

The MSc Programme in Mathematics with a General Profile in Mathematics includes a thesis corresponding to 30 ECTS, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the programme.

6.1.6 Academic mobility

The curriculum makes it possible to follow subject elements outside the Faculty of Science.

For students admitted in September the academic mobility for the MSc Programme in Mathematics is placed in block 1+2 of the 2nd year.

For students admitted in February the academic mobility for the MSc Programme in Mathematics is placed in block 3+4 of the 2nd year.

Academic mobility requires that the student follows the rules and regulations regarding pre-approval and credit transfer.

In addition, the student has the possibility to arrange similar academic mobility in other parts of the programme.

7 Exemptions

In exceptional circumstances, the study board may grant exemptions from the rules in the curriculum specified solely by the Faculty of Science.

8 Commencement etc.

8.1 Validity

This subject specific section of the curriculum applies to all students enrolled on the programme – see however Appendix 2.

8.2 Transfer

Students enrolled on previous curricula may be transferred to the new one as per the applicable transfer regulations or according to an individual credit transfer by the study board.

8.3 Amendments

The curriculum may be amended once a year so that any changes come into effect at the beginning of the academic year. Amendments must be proposed by the study board and approved by the Dean.

Notification about amendments that tighten the admission requirements for the programme will be published online at www.science.ku.dk one year before they come into effect.
If amendments are made to this curriculum, an interim arrangement may be added if necessary to allow students to complete their MSc Programme according to the amended curriculum.

Appendix 1 The recommended academic progression

The table illustrates the recommended academic progression. The student is allowed to plan an alternative progression within the applicable rules.

Tables for students admitted to the programme in September (summer):

Table – General profile in Mathematics

	Block 1	Block 2	Block 3	Block 4
1st year	Restricted elective	Restricted elective	Restricted elective	Restricted elective
	Restricted elective	Restricted elective	Restricted elective	Restricted elective
2nd year	Elective	Elective	Thesis	
	Elective	Elective		

Tables for students admitted to the programme in February (winter):

Table – General profile in Mathematics*

	Block 3	Block 4	Block 1	Block 2
1st year	Restricted elective	Restricted elective	Restricted elective	Restricted elective
	Restricted elective	Restricted elective	Restricted elective	Restricted elective
2nd year	Elective	Elective	Thesis	
	Elective	Elective		

*This table is only relevant for students who begin the MSc Programme in February (block 3)

Appendix 2 Interim arrangements

The Shared Section of the BSc and MSc Curricula for Study Programmes applies to all students.

The interim arrangements below only consist of parts where the current curriculum differs from the rules and regulations that were previously valid. Therefore, if information about relevant rules and regulations is missing, it can be found in the curriculum above.

1 General changes valid for students admitted in the academic year 2023/24

Students admitted to the MSc Programme in the academic year 2023/24 must finish the programme as listed in the curriculum above with the following exceptions.

Compulsory subject elements

All of the following subject elements are to be covered (7.5 ECTS):

Course Code	Course Title	Abbr.	Block	ECTS
NMAK15005U	Advanced Vector Spaces	AdVec	Block 1	7.5 ECTS

Restricted elective subject elements

22,5 ECTS are to be covered as restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 1 in this curriculum (see above)				
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

30 ECTS are to be covered ad restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 2 in this curriculum (see above)				
NMAK23010U	Logic in Analysis and Topology		Discontinued*	7.5 ECTS
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

2 General changes valid for students admitted in the academic year 2022/23

Students admitted to the MSc Programme in the academic year 2022/23 must finish the programme as listed in the curriculum above with the following exceptions.

Compulsory subject elements

All of the following subject elements are to be covered (7.5 ECTS):

Course Code	Course Title	Abbr.	Block	ECTS
NMAK15005U	Advanced Vector Spaces	AdVec	Block 1	7.5 ECTS

Restricted elective subject elements

22,5 ECTS are to be covered as restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 1 in this curriculum (see above)				
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

30 ECTS are to be covered as restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 2 in this curriculum (see above)				
NMAA13034U	Introduction to K-Theory	K-Theory	Discontinued*	7.5 ECTS
NMAA07012U	Introduction to Operator Algebras	IntroOpAlg	Discontinued*	7.5 ECTS

Restricted elective subject elements offered in list 2 in this curriculum (see above)				
NMAK18009U	Topics in Mathematical Logic		Discontinued*	7.5 ECTS
NMAK23010U	Logic in Analysis and Topology		Discontinued*	7.5 ECTS
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

3 General changes valid for students admitted in the academic year 2021/22

Students admitted to the MSc Programme in the academic year 2021/22 must finish the programme as listed in the curriculum above with the following exceptions.

Compulsory subject elements

All of the following subject elements are to be covered (7.5 ECTS):

Course Code	Course Title	Abbr.	Block	ECTS
NMAK15005U	Advanced Vector Spaces	AdVec	Block 1	7.5 ECTS

*See discontinued courses below

Restricted elective subject elements

22,5 ECTS are to be covered as restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 1 in this curriculum (see above)				
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

30 ECTS are to be covered as restricted elective subject elements from the following lists:

Restricted elective subject elements offered in list 2 in this curriculum (see above)				
NMAK21007U	Random Matrices		Discontinued*	7.5 ECTS
NMAK14005U	Algebraic Geometry	AlgGeo	Discontinued*	7.5 ECTS
NMAA13034U	Introduction to K-Theory	K-Theory	Discontinued*	7.5 ECTS
NMAA07012U	Introduction to Operator Algebras	IntroOpAlg	Discontinued*	7.5 ECTS
NMAK18009U	Topics in Mathematical Logic		Discontinued*	7.5 ECTS
NMAK23010U	Logic in Analysis and Topology		Discontinued*	7.5 ECTS
NMAK11003U	Advanced Probability Theory 1	VidSand1	Discontinued*	7.5 ECTS
NMAK11011U	Advanced Probability Theory 2	VidSand2	Discontinued*	7.5 ECTS

*See discontinued courses below

6 Discontinued courses

Course Code	Course Title	ECTS	Interim agreement
NMAK11003U	Advanced Probability Theory 1	7.5	The course was restricted elective in the academic year 2023/24 or earlier. Offered the last time: 2023/24 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2024/25.
NMAK11011U	Advanced Probability Theory 2	7.5	The course was restricted elective in the academic year 2021/22 or earlier. Offered the last time: 2023/24 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2024/25.

Course Code	Course Title	ECTS	Interim agreement
NMAK14005U	Algebraic Geometry (AlgGeom)	7.5	The course was restricted elective in the academic year 2021/22 or earlier. Offered the last time: 2021/22 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2022/23.
NMAA13034U	Introduction to K-Theory (K-Theory)	7.5	The course was restricted elective in the academic year 2022/23 or earlier. Offered the last time: 2022/23 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2023/24.
NMAA07012U	Introduction to Operator Algebras (IntroOpAlg)	7.5	The course was restricted elective in the academic year 2022/23 or earlier. Offered the last time: 2022/23 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2023/24.
NMAK23010U	Logic in Analysis and Topology	7.5	The course was restricted elective in the academic year 2023/24 or earlier. Offered the last time: 2023/24 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2024/25.
NMAK21007U	Random Matrices	7.5	The course was restricted elective in the academic year 2021/22 or earlier. Offered the last time: 2021/22 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2022/23.
NMAK18009U	Topics in Mathematical Logic	7.5	The course was restricted elective in the academic year 2022/23 or earlier. Offered the last time: 2022/23 Last exam if applicable (cf. SCIENCE's Teaching and exam rules): 2023/24.

Appendix 3 Description of objectives for the thesis

After completing the thesis, the student should have:

Knowledge about:

- Scientific problems within the study programme's subject areas.
- A suitable combination of methodologies/theories based on international research for use in his/her work with the problem formulation.
- Theories/models on the basis of an organised value system and with a high degree of independence.

Skills in/to:

- Apply and critically evaluate theories/methodologies, including their applicability and limitations.
- Assess the extent to which the production and interpretation of findings/material depend on the theory/methodology chosen and the delimitation chosen.
- Discuss academic issues arising from the thesis.
- Draw conclusions in a clear and academic manner in relation to the problem formulation and, more generally, considering the topic and the subject area.
- Discuss and communicate the academic and social significance, if any, of the thesis based on ethical principles.

Competences in/to:

- Initiate and perform academic work in a research context.
- Solve complex problems and carry out development assignments in a work context.