Programme-specific Section of the Curriculum for the MSc Programme in Mathematics-Economics at the Faculty of Science, University of Copenhagen 2009 (Rev. 2019)

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

1.1 Title
The MSc Programme in Mathematics-Economics leads to a Master of Science (MSc) in Mathematics-Economics with the Danish title: *Cand.scient.econ* (*candidatus/candidata scientiarum oeconomice*).

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-Economics is a research-based interdisciplinary programme, the objective of which is to educate economists with a sound understanding of mathematics and statistics and the application of these disciplines within economic theory. Through a synthesis of the mathematical, statistical and economic fields of study, the mathematics-economist learns to handle theoretical and practical economic issues.

2.2 General programme profile
The study programme is an interdisciplinary programme offered by the Faculty of Science and the Faculty of Social Sciences with each faculty supplying a share of the compulsory courses. On the one hand, the study programme gives future economists with an interest in mathematics and statistics the opportunity to work with modern mathematical approaches and techniques. On the other hand, future mathematicians and statisticians obtain a good understanding of the areas of application of the economic subjects.

The programme's key subject areas are mathematics, statistics (including probability theory) and economics (including finance, actuarial mathematics and operations research). Moreover, computer science is included in the programme as a subject.

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-Economics qualifies students to become professionals within business functions and/or areas such as:

- A PhD programme
• Economist positions requiring good analytical skills and use of mathematics, statistics and IT.
• Work within the financial sector.
• Work within the public administration.
• Work within the consulting sector.

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 courses and other study activities.

3.1 Competence profile
On completion of the programme, an MSc in Mathematics-Economics has acquired the following:

Knowledge about:
• Selected research-active areas of economics and statistics, to a high level.
• Vector autoregressiv models, including unit root inference and co-integration.
• Economic stabilization policy with emphasis on monetary policy.
• The game-theoretic approach to industrial organization.
• Optimal stopping problems for investment and consumption in a stochastic environment.

Skills in/to:
• Read and understand economic and statistical original literature.
• Communicate economic and mathematical issues on a scientific basis.
• Account orally and in writing for inquiries into open economic issues.

Competences in/to:
• Structure a study of open economic questions, especially of an econometric or finance-related nature and divide it into smaller easily accessible challenges.
• Further develop and adapt economic models for real-life challenges.
• Conduct independent, stringent argumentation.
• Independently take responsibility for his or her own professional development and specialisation.
• Scientifically reflect on mathematical methods for analysing and resolving economic questions.

4 Admission requirements
With a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen the student is granted reserved access and guaranteed a place on the MSc Programme in Mathematics-Economics if the student applies before the application deadline during the first application period after the completion of the Bachelor’s degree.

4.1 Applicants with a Bachelor’s degree in Mathematics-Economics
Applicants with a Bachelor's degree in Mathematics-Economics from the University of Copenhagen are directly academically qualified for admission to the MSc Programme in Mathematics-Economics.
4.2 Applicants with a closely related Bachelor’s degree
Applicants with a Bachelor’s degree in Actuarial Mathematics or Mathematics from the University of Copenhagen may be admitted if the programme includes:

- Subject elements in microeconomics at least 15 ECTS.
- Subject elements in macroeconomics at least 15 ECTS.
- Subject elements in finance at least 7.5 ECTS.
- Subject elements in statistics on a measure theoretical basis at least 15 ECTS.

4.3 Applicants with a related Bachelor’s degree
Applicants with a Bachelor’s degree in Actuarial Mathematics, Mathematics, Mathematics-Economics, Economics, Physics, Computer Science or Chemistry from the University of Copenhagen or other Danish or international universities may also be admitted if their programme includes the following elements:

- Subject elements in mathematical analysis at least 22.5 ECTS.
- Subject elements in linear algebra at least 7.5 ECTS.
- Subject elements in microeconomics at least 15 ECTS.
- Subject elements in macroeconomics at least 15 ECTS.
- Subject elements in mathematical finance, equivalent in content to the course NMAA05076U Finansiering 1, at least 7.5 ECTS.
- Subject elements in statistics on a measure theoretical basis at least 15 ECTS.

4.4 Other applicants
The Faculty may also admit applicants who, after an individual academic assessment, are deemed to possess educational qualifications equivalent to those required in Subclauses 4.1-3.

4.5 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.

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

However, subject elements passed before the completion of the bachelor’s program 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 BSc programme which are to form part of the MSc programme to which the student has a legal right of admission (§9-courses) cannot be included in the overall assessment.
5 Prioritisation of applicants
If the number of qualified applicants to the programme exceeds the number of places available, applicants will be prioritised as follows:

1) Applicants with a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen seeking admission by way of direct extension of their completed BSc programme.
2) Applicants with a Bachelor’s degree in Mathematics-Economics from the University of Copenhagen.
3) Applicants with a Bachelor’s degree in Mathematics or Actuarial Mathematics from the University of Copenhagen.
4) Other applicants.

If the number of qualified applicants within a category exceeds the number of places available, applicants will be prioritised according to the following criteria (listed below in prioritised order):

- Total number of ECTS within mathematics, statistics and economics.

6 Structure of the programme
The compulsory subject elements, restricted elective subject elements and the thesis constitute the central parts of the programme (Section 21 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:

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

6.1.1 Compulsory subject elements
All of the following subject elements are to be covered (30 ECTS):

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Block</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAA05025U</td>
<td>Econometrics 2: Statistical Analysis of Econometric Time Series</td>
<td>StatØ2</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK10018U</td>
<td>Macroeconomics 3 – Business Cycles and Monetary Stabilization Policy</td>
<td>MakØk3</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK11020U</td>
<td>Microeconomics 3 – Industrial Organization</td>
<td>MikØk3</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA09045U</td>
<td>Finance 2: Dynamic Portfolio Choice</td>
<td>Fin2</td>
<td>7.5</td>
</tr>
</tbody>
</table>

6.1.2 Restricted elective subject elements
30 ECTS are to be covered as subject elements from the following list:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Block</th>
<th>ECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAK11003U</td>
<td>Advanced Probability Theory 1 (VidSand1)</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA05117U</td>
<td>Stochastic Processes in Non-Life Insurance (SkadeStok)</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16004U</td>
<td>Computational Finance (AAM)</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA05115U</td>
<td>Stochastic Processes in Life Insurance (LivStok)</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16005U</td>
<td>Computational Statistics</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK17007U</td>
<td>Monte Carlo Methods in Insurance and Finance*</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK19001U</td>
<td>Applied Operations Research</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA09044U</td>
<td>Operations Research 2: Advanced Operations Research (OR2)</td>
<td>Block 2</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16019U</td>
<td>Survival Analysis</td>
<td>Block 2</td>
<td>7.5</td>
</tr>
</tbody>
</table>
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 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.
6.1.4 Thesis
The MSc Programme in Mathematics-Economics 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.

The principal supervisor can be from the Department of Economics, the Faculty of Social Science.

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

For students admitted in September the academic mobility in the MSc Programme in Mathematics-Economics is placed in block 1+2 of the 2\textsuperscript{nd} year.

For students admitted in February the academic mobility in the MSc Programme in Mathematics-Economics is placed in block 3+4 of the 2\textsuperscript{nd} 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 in 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 Amendment
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 Tables

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

<table>
<thead>
<tr>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td><strong>2nd year</strong></td>
<td></td>
<td></td>
<td>Thesis</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

<table>
<thead>
<tr>
<th>Block 3</th>
<th>Block 4</th>
<th>Block 1</th>
<th>Block 2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1st year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td><strong>2nd year</strong></td>
<td></td>
<td></td>
<td>Thesis</td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

*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 are missing, it can be found in the curriculum above.

1 General changes for students admitted in the academic year 2018/19

Students admitted to the MSc programme in the academic year 2018/19 must finish the programme as listed in the curriculum above with the following exceptions.

Restricted elective subject elements

30 ECTS are to be covered by subject elements from the following list:

- Restricted elective subject elements offered as part of this curriculum (see above)
- NMAK18010U Topics in Stochastic Calculus Discontinued* 7.5 ECTS
- NMAK17000U Modeling and Implementation in OR Discontinued* 7.5 ECTS
- NMAK16002U Bayesian Statistics Discontinued* 7.5 ECTS

*See course specific changes below

2 General changes for students admitted in the academic year 2017/18

Students admitted to the MSc programme in the academic year 2017/18 must finish the programme as listed in the curriculum above with the following exceptions.

Restricted elective subject elements

30 ECTS are to be covered by subject elements from the following list:

- Restricted elective subject elements offered as part of this curriculum (see above)
- NMAK17000U Modeling and Implementation in OR Discontinued* 7.5 ECTS
- NMAK16002U Bayesian Statistics Discontinued* 7.5 ECTS

*See course specific changes below

3 General changes for students admitted in the academic year 2016/17

Students admitted to the MSc programme in the academic year 2016/17 must finish the programme as listed in the curriculum above with the following exceptions.

Structure of the programme

Effective from the academic year of 2017/2018 for all students, the required amount of restricted elective subject elements has been reduced from 45 to 30 ECTS, and correspondingly, the amount of elective subject elements has been increased from 15 to 30 ECTS. All subject elements previously passed as restricted elective can count as elective.

Restricted elective subject elements

30 ECTS are to be covered by subject elements from the following list:

- Restricted elective subject elements offered as part of this curriculum (see above)
- NMAK13005U Introduction to Extreme Value Theory Block 2 7.5 ECTS
- NMAK16006U Consumption-Investment-Insurance Problems** Block 3 7.5 ECTS
- NMAK16009U Gams and Modelling Discontinued* 7.5 ECTS
- NMAK14013U Modelling Dependence in Discrete Time Discontinued* 7.5 ECTS
- NMAK15001U Operations Research 3: Hierarchical Optimization and Equilibrium Discontinued* 7.5 ECTS

*See course specific changes below.

** The course is not offered in 2019/2020.
4 General changes for students admitted in the academic year 2015/2016
Students admitted to the MSc Programme in the academic year 2015/2016 must finish the programme as listed in the curriculum above with the following exceptions.

Structure of the programme
Effective from the academic year of 2017/2018 for all students, the required amount of restricted elective subject elements has been reduced from 45 to 30 ECTS, and correspondingly, the amount of elective subject elements has been increased from 15 to 30 ECTS. All subject elements previously passed as restricted elective can count as elective.

Restricted elective subject elements
30 ECTS are to be covered by subject elements from the following list:

| Restricted elective subject elements offered as part of the curriculum (see above) |
|---------------------------------|-----------------|
| NMAK13005U  | Introduction to Extreme Value Theory | Block 2 | 7.5 ECTS |
| NMAK16006U  | Consumption-Investment-Insurance Problems** | Block 3 | 7.5 ECTS |
| NMAK15013U  | Functional Data Analysis | Discontinued* | 7.5 ECTS |
| NMAK15011U  | Control Theory in Finance and Insurance | Discontinued* | 7.5 ECTS |
| NMAK10012U  | Optimization and Convexity (OK) | Discontinued* | 7.5 ECTS |
| NMAK15020U  | Statistical Computing | Discontinued* | 7.5 ECTS |
| NMAK15024U  | Topics in Financial Risk Management | Discontinued* | 7.5 ECTS |
| NMAK14022U  | Statistics For Non-Linear Time Series Models | Discontinued* | 7.5 ECTS |
| AØKA0805SU  | Contract Theory and the Economics of organization | Discontinued* | 7.5 ECTS |
| AØKK08206U  | Financial Frictions, Liquidity and the Business Cycle | Discontinued* | 7.5 ECTS |
| AØKA08102U  | Financial Markets | Discontinued* | 7.5 ECTS |
| NMAK16009U  | Gams and Modelling | Discontinued* | 7.5 ECTS |
| NMAK14013U  | Modelling Dependence in Discrete Time | Discontinued* | 7.5 ECTS |
| NMAK15001U  | Operations Research 3: Hierarchical Optimization and Equilibrium | Discontinued* | 7.5 ECTS |

*See course specific changes below.
** The course is not offered in 2019/2020.

5 Course specific changes

<table>
<thead>
<tr>
<th>Discontinued course</th>
<th>Interim arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Theory and the Economics of organization (AØKA0805SU), 7.5 ECTS.</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Control Theory in Finance and Insurance (AAM) (NMAK15011U), 7.5 ECTS</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Financial Frictions, Liquidity and the Business Cycle (AØKA0805SU), 7.5 ECTS.</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Financial Markets (AØKA08102U), 7.5 ECTS.</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
</tr>
<tr>
<td>Course Name</td>
<td>Course Code</td>
</tr>
<tr>
<td>----------------------------------------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Functional Data Analysis</td>
<td>NMAK15013U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
<td></td>
</tr>
<tr>
<td>Gams and Modeling</td>
<td>NMAK16009U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and 2016/17. The course was offered for the last time in the academic year 2016/17 and a third exam is offered in the academic year 2017/18.</td>
<td></td>
</tr>
<tr>
<td>Modelling Dependence in Discrete Time</td>
<td>NMAK14013U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and 2016/17. The course was offered for the last time in the academic year 2016/17 and a third exam is offered in the academic year 2017/18.</td>
<td></td>
</tr>
<tr>
<td>Operations Research 3: Hierarchical Optimization and Equilibrium</td>
<td>NMAK15001U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and 2016/17. The course was offered for the last time in the academic year 2016/17 and a third exam is offered in the academic year 2017/18.</td>
<td></td>
</tr>
<tr>
<td>Optimization and Convexity (OK)</td>
<td>NMAK10012U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
<td></td>
</tr>
<tr>
<td>Statistical Computing</td>
<td>NMAK15020U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
<td></td>
</tr>
<tr>
<td>Statistics for non-linear time series models (AAM)</td>
<td>NMAK14022U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
<td></td>
</tr>
<tr>
<td>Topics in Financial Risk Management (AAM)</td>
<td>NMAK15024U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier. The course was offered for the last time in the academic year 2015/16 and a third exam is offered in the academic year 2016/17.</td>
<td></td>
</tr>
<tr>
<td>Topics in Stochastic Calculus</td>
<td>NMAK18010U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2018/19. The course was offered for the last time in the academic year 2018/19 and a third exam is offered in the academic year 2019/20.</td>
<td></td>
</tr>
<tr>
<td>Modelling and implementation in OR</td>
<td>NMAK17000U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2018/19 and earlier. The course was offered for the last time in the academic year 2018/19 and a third exam is offered in the academic year 2019/20.</td>
<td></td>
</tr>
<tr>
<td>Bayesian Statics</td>
<td>NMAK16002U</td>
</tr>
<tr>
<td>The course was a restricted elective course in the academic year 2018/19 and earlier. The course was offered for the last time in the academic year 2018/19 and a third exam is offered in the academic year 2019/20.</td>
<td></td>
</tr>
</tbody>
</table>
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.