Programme-specific Section of the Curriculum for the MSc Programme in Statistics at the Faculty of Science, University of Copenhagen 2010 (Rev. 2016)

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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 Statistics leads to a Master of Science (MSc) in Statistics with the Danish title: Cand.scient. (candidatus/candidata scientiarum) i statistik.

1.2 Affiliation
The programme is affiliated with the Study Board for 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 Statistics is a research-based programme, the objective of which is to provide the student with the knowledge of and insights into the main fields and methodologies of mathematical statistics required to work independently within this field.

2.2 General programme profile
The programme provides a general introduction to the main fields of mathematical statistics, the underlying probability theory, and the calculation techniques required to solve practical statistical problems. It is subsequently possible to specialise within one of these fields.

Statistics, Mathematics and Computer Science are the key subject areas of the programme.

2.3 General structure of the programme
The MSc Programme is set at 120 ECTS credits.

There are no defined specialisations in this programme.

2.4 Career opportunities
The MSc Programme in Statistics qualifies students for a PhD programme, and depending on the academic specialisation it may also be targeted at business functions and/or areas such as:

- Health research.
- Statistical functions in the pharmaceutical industry.
- The financial 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 subject elements and other study activities.
3.1 Competence profile
On completion of the programme, an MSc in Statistics has acquired the following:

Knowledge about:
- Selected research-active fields.
- Stochastic processes.
- Statistical models applicable to broad classes of data.
- Likelihood methods and likelihood-adjacent methods.
- Conditioning and Markov properties of probability distributions.
- Sufficiency, ancillarity and other factorization properties of statistical models.
- Frequentistic and Bayesian principles of statistical inference.

Skills in/to:
- Read and understand mathematical and statistical original literature.
- Communicate mathematical questions and issues on a scientific basis both with fellow experts and with specialists in other fields.
- Account orally and in writing for statistical inquiries into open problems.
- Apply general asymptotic methodologies to specific probabilistic models.
- Develop probabilistic models for specific statistical applications.
- Analyse concrete data sets using standard as well as tailor-made statistical models.

Competences in/to:
- Conduct an independent statistical analysis on a measure theoretical foundation of complex experiments and observational studies and divide it into smaller easily accessible challenges.
- Investigate open statistical problems using probability theory methods.
- Develop new statistical solution models.
- Independently take responsibility for his or her own professional development and specialisation.
- Moreover, a holder of an MSc degree in Statistics can scientifically reflect on methods for analysing and resolving questions in statistics and probability theory.

4 Admission requirements
With a Bachelor’s degree in Mathematics with the BSc elective course package (bachelorvalgfagpakken) in Statistics from the University of Copenhagen the student is granted reserved access and guaranteed a place on the MSc Programme in Statistics 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 closely related Bachelor’s degree
Applicants with a Bachelor’s degree in Actuarial Mathematics, Mathematics-Economics or Mathematics are directly qualified for admission to the MSc Programme if their BSc Programme contains subject elements in statistics on a measure theoretical basis (at least 15 ECTS credits).

Applicants with a Bachelor's degree in Mathematics with the BSc elective subject course package (studieretning) in Mathematical Modelling from the University of Aarhus are also directly qualified for admission to the MSc Programme.
4.2 Applicants with a Bachelor’s degree in Science and IT
Applicants with a Bachelor’s degree in Science and IT with specialisation in Mathematics and with the MSc admission course package in statistics from the University of Copenhagen are directly academically qualified for admission to the MSc Programme in Statistics.

4.3 Applicants with a related Bachelor’s degree
Applicants with a Bachelor’s degree in the field of Science from the University of Copenhagen and other Danish universities may be admitted if the programme includes:
- Subject elements in mathematical analysis, including measure theory (at least 22.5 ECTS credits).
- Subject elements in linear algebra (at least 7.5 ECTS credits).
- Subject elements in statistics on a measure theoretical basis (at least 15 ECTS credits).

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
4.5.1 Applicants from Nordic universities
Applicants with a Bachelor’s degree from Nordic universities must as a minimum document English language qualifications comparable to a Danish upper secondary school English B level.

4.5.2 Non-Nordic applicants
Applicants with a non-Nordic Bachelor’s degree must be able to document English proficiency corresponding to an IELTS test score of minimum 6.5 or a TOEFL test score of minimum 83 (Internet-based).

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, Actuarial Mathematics, Mathematics-Economics, Science and IT with specialisation in Mathematics and the MSc admission course package in Statistics from the University of Copenhagen.
2) Other applicants with a Bachelor’s degree from the University of Copenhagen.
3) Other applicants.

Applicants are then prioritised according to their total number of ECTS credits within the relevant academic fields and the grades obtained.

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 credits and consists of the following:
- Compulsory subject elements, 30 ECTS credits.
- Restricted elective subject elements, 45 ECTS credits.
- Elective subject elements, 15 ECTS credits.
- Thesis, 30 ECTS credits.
6.1.1 Compulsory subject elements
All of the following subject elements are to be covered (30 ECTS credits):

<table>
<thead>
<tr>
<th>Subject Element</th>
<th>Course Title</th>
<th>Block</th>
<th>ECTS Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAK11005U</td>
<td>Discrete Models (DisMod)</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16010U</td>
<td>Graphical Models</td>
<td>2</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK11022U</td>
<td>Regression (Reg)</td>
<td>3</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK14028U</td>
<td>Project in Statistics (ProjStat)</td>
<td>4</td>
<td>7.5</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Subject Element</th>
<th>Course Title</th>
<th>Block</th>
<th>ECTS Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAK11003U</td>
<td>Advanced Probability Theory 1 (VidSand1)</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16005U</td>
<td>Computational Statistics</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16018U</td>
<td>Structural Equation Models</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK15005U</td>
<td>Advanced Vector Spaces (AdVec)</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK13005U</td>
<td>Introduction to Extreme Value Theory (IntroExtremValue)</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA05025U</td>
<td>Econometrics 2: Statistic Analysis of Econometric Time Series (StatØ2)</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK16017U</td>
<td>Statistical Inferens for Markov Processes</td>
<td>1</td>
<td>7.5</td>
</tr>
<tr>
<td>NDAA09009U</td>
<td>Numerical Optimization (NO)</td>
<td>3</td>
<td>7.5</td>
</tr>
</tbody>
</table>

6.1.3 Elective subject elements
15 ECTS credits are to be covered as elective subject elements.

BSc subject elements corresponding to 15 ECTS credits 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 credits. 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 credits. The regulations are described in Appendix 4 to the shared section of the curriculum.

6.1.4 Thesis
The MSc Programme in Statistics includes a thesis corresponding to 30 ECTS credits, as described in Appendix 2 to the shared curriculum. The thesis must be written within the academic scope of the programme.

6.1.5 Academic mobility
Academic mobility requires that the student follows the rules and regulations regarding pre-approval and credit transfer.
The academic mobility in the MSc Programme in Statistics is placed in block 1+2 of the 2nd year. This means that the curriculum makes it possible to follow subject elements outside the Faculty of Science.

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 http://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 - MSc Programme in Statistics

<table>
<thead>
<tr>
<th>Year</th>
<th>Block 1</th>
<th>Block 2</th>
<th>Block 3</th>
<th>Block 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td></td>
<td>Discrete Models</td>
<td>Graphical Models</td>
<td>Regression</td>
<td>Project in Statistics</td>
</tr>
<tr>
<td>2nd</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td></td>
<td>Thesis</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

Table - MSc Programme in Statistics*

<table>
<thead>
<tr>
<th>Year</th>
<th>Block 3</th>
<th>Block 4</th>
<th>Block 1</th>
<th>Block 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
</tr>
<tr>
<td></td>
<td>Regression</td>
<td>Project in Statistics</td>
<td>Discrete Models</td>
<td>Graphical Models</td>
</tr>
<tr>
<td>2nd</td>
<td>Restricted elective</td>
<td>Restricted elective</td>
<td></td>
<td>Thesis</td>
</tr>
<tr>
<td></td>
<td>Elective</td>
<td>Elective</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*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 2015/16
Students admitted to the MSc Programme in the academic year 2015/16 or earlier must finish the programme with the original curriculum structure under which they were admitted.

Structure of the programme
For students admitted to the MSc Programme in the academic year 2015/16 the MSc programme consisted of 52.5 ECTS credits compulsory subject elements, 22.5 ECTS credits restricted elective subject elements, 15 ECTS credits elective subject elements and a thesis corresponding to 30 ECTS credits.

From the academic year 2016/17 the programme has been changed in its composition of the compulsory and restricted elective subject elements. The amount of compulsory subject elements has been reduced from 52.5 ECTS credits to 30 ECTS credits and the 22.5 ECTS credits are added to the restricted elective part of the programme. As the change is considered an easing for students admitted in the academic year 2015/16 these students are transferred to the current curriculum.

Compulsory subject elements
In the academic year 2016/17 the following subject elements are no longer compulsory:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>Block</th>
<th>ECTS-points</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAK11003U</td>
<td>Advanced Probability 1 (VidSand1)</td>
<td>Block 1</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAK11011U</td>
<td>Advanced Probability 2 (VidSand2)</td>
<td>Block 2</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA13025U</td>
<td>Theoretical Statistics (TeoStat)</td>
<td>Block 4</td>
<td>7.5</td>
</tr>
<tr>
<td>NMAA13024U</td>
<td>Conditioning and Markov Properties (Beting)</td>
<td></td>
<td>Discontinued*</td>
</tr>
</tbody>
</table>

* See course specific changes below.

Restricted elective subject elements
45 ECTS credits are to be covered as subject elements from the following list:

<table>
<thead>
<tr>
<th>Subject Code</th>
<th>Subject Name</th>
<th>ECTS-points</th>
</tr>
</thead>
<tbody>
<tr>
<td>NMAK15014U</td>
<td>Gaussian Graphical Models</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK15013U</td>
<td>Functional Data Analysis</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK15019U</td>
<td>Phase-type distributions: Theory and applications</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK15020U</td>
<td>Statistical Computing</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK15017U</td>
<td>Inference in Hidden Markov Models</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK15021U</td>
<td>Statistical Methods and Probability in Bioinformatics</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK14022U</td>
<td>Stereology</td>
<td>Discontinued*</td>
</tr>
<tr>
<td>NMAK14022U</td>
<td>Statistics for non-linear time series models</td>
<td>Discontinued*</td>
</tr>
</tbody>
</table>

* See course specific changes below.

2 General changes for students admitted in the academic year 2010/11 to 2014/15
Students admitted to the MSc Programme in the academic year 2010/11 to 2014/15 must finish the programme with the original curriculum structure under which they were admitted.
**Structure of the programme**

For students admitted to the MSc Programme in the academic year 2010/11 to 2014/15 the MSc Programme consisted of 52.5 ECTS credits compulsory subject elements, 7.5 ECTS credits restricted elective subject elements, 30 ECTS credits elective subject elements and a thesis corresponding to 30 ECTS credits.

From the academic year 2016/17 the programme has been changed in its composition of the compulsory and restricted elective subject elements. The amount of compulsory subject elements has been reduced from 52.5 ECTS credits to 30 ECTS credits and the 22.5 ECTS credits are added to the restricted elective part of the programme instead. The change is considered an easing for students admitted in the academic year 2010/11 to 2014/15.

Therefore, the structure of the programme for students admitted in the academic year 2010/11 to 2014/15 is set at 120 ECTS credits and consists of the following:

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

**Restricted elective subject elements**

30 ECTS credits must be covered by restricted subject elements.

22.5 ECTS credits may be covered by subject elements from the following list:

- Restricted elective subject elements offered as part of this curriculum (see above)

7.5 ECTS credits may be covered by subject elements from the following list:

- Other courses held by Department of Mathematical Sciences at the Faculty of SCIENCE on MSc level
- Project outside the course scope with the principal supervisor from the Department of Mathematical Sciences or the Department of Economics

**3 Course specific changes**

<table>
<thead>
<tr>
<th>Cancelled course</th>
<th>Interim arrangement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conditioning and Markov Properties (Beting), (NMMA13024U), 7.5 ECTS credits</td>
<td>The course was a compulsory course in the academic year 2015/16 or earlier.</td>
</tr>
<tr>
<td></td>
<td>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></td>
<td>The course is equivalent to Graphical Models (NMAK16010U), 7.5 ECTS credits.</td>
</tr>
<tr>
<td>Functional Data Analysis (NMAK15013U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 or earlier.</td>
</tr>
<tr>
<td></td>
<td>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>Gaussian Graphical Models (NMAK15014U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 or earlier.</td>
</tr>
<tr>
<td>Course Title</td>
<td>Notes</td>
</tr>
<tr>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Inference in Hidden Markov Models (NMAK15017U), 7.5 ECTS credits</td>
<td>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>Phase-type distributions: Theory and applications (NMAK15019U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 or earlier.</td>
</tr>
<tr>
<td>Statistical Computing (NMAK15020U), 7.5 ECTS credits</td>
<td>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>Statistical Methods and Probability in Bioinformatics (NMAK15021U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 or earlier.</td>
</tr>
<tr>
<td>Statistics for non-linear time series models (NMAK14022U), 7.5 ECTS credits</td>
<td>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>Stereology (NMAK15022U), 7.5 ECTS credits</td>
<td>The course was a restricted elective course in the academic year 2015/16 and earlier.</td>
</tr>
<tr>
<td></td>
<td>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>
</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.