



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

There are no defined specialisations in this programme.

### 2.4 Career opportunities

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

- A PhD programme
- 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 (*bachelorvalgfpakken*) 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 from the University of Copenhagen are directly qualified for admission to the MSc Programme in Statistics if their programme includes the following:

- Subject elements in statistics on a measure theoretical basis (at least 15 ECTS).

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 in Statistics.

## 4.2 Applicants with a Bachelor's degree in Natural Science and IT

Applicants with a Bachelor's degree in Natural 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 or other Danish or international universities may be admitted if the programme includes the following:

- Subject elements in mathematical analysis, including measure theory (at least 22.5 ECTS).
- Subject elements in linear algebra (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](http://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 with the BSc elective course package (*bachelorvalgfagpakken*) in Statistics 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, Actuarial Mathematics, Mathematics-Economics, Natural Science and IT with specialisation in Mathematics and the MSc admission course package in Statistics from the University of Copenhagen.
- 3) Other applicants with a Bachelor's degree 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 and statistics.

## 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):

• NMAK11005U	Discrete Models (DisMod)	Block 1	7.5 ECTS
• NMAK16010U	Graphical Models	Block 2	7.5 ECTS
• NMAK11022U	Regression (Reg)	Block 3	7.5 ECTS
• NMAK14028U	Project in Statistics (ProjStat)	Block 4	7.5 ECTS

#### 6.1.2 Restricted elective subject elements

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

• NMAK11003U	Advanced Probability Theory 1 (VidSand1)	Block 1	7.5 ECTS
• NMAK16005U	Computational Statistics	Block 1	7.5 ECTS
• NMAK15005U	Advanced Vector Spaces (AdVec)	Block 1	7.5 ECTS
• NMAA05025U	Econometrics 2: Statistic Analysis of Econometric Time Series (StatØ2)	Block 1	7.5 ECTS
• NDAK15014U	Advanced Topics in Machine Learning	Block 1	7.5 ECTS
• NMAK17010U	Stochastic Models and Inference for Genetic Data*	Block 1	7.5 ECTS
• NMAK17007U	Monte Carlo Methods in Insurance and Finance*	Block 1	7.5 ECTS
• NMAK18000U	An Introduction to Large Deviations*	Block 1	7.5 ECTS
• NMAK13005U	Introduction to Extreme Value Theory (IntroExtremValue)	Block 2	7.5 ECTS
• NMAK11011U	Advanced Probability Theory 2 (VidSand2)	Block 2	7.5 ECTS
• NMAK16019U	Survival Analysis	Block 2	7.5 ECTS
• NMAK17008U	Sparse Learning*	Block 2	7.5 ECTS
• NDAK15007U	Machine Learning (ML)	Block 2	7.5 ECTS
• NDAA09009U	Numerical Optimization (NO)	Block 3	7.5 ECTS
• NMAK17006U	Modern Topics in Statistics	Block 3	7.5 ECTS
• NMAK17005U	Machine Learning Methods in Non-Life Insurance	Block 3	7.5 ECTS
• NMAA13025U	Theoretical Statistics (TeoStat)	Block 4	7.5 ECTS
• NDAK14007U	Applied Programming (APP)	Block 4	7.5 ECTS
• NMAK16018U	Structural Equation Models*	Block 4	7.5 ECTS

\* The courses are not offered in the academic year 2019/20

### ***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 Statistics 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.

### ***6.1.5 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 Statistics is placed in block 1+2 of the 2<sup>nd</sup> year.

For students admitted in February the academic mobility in the MSc Programme in Statistics is placed in block 3+4 of the 2<sup>nd</sup> 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 <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**

	Block 1	Block 2	Block 3	Block 4
1st year	Restricted elective	Restricted elective	Restricted elective	Restricted elective
	Discrete Models	Graphical Models	Regression	Project in Statistics
2nd year	Elective	Elective	Thesis	
	Elective	Elective		

Compulsory
  Restricted elective
  Elective
 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 - MSc Programme in Statistics\***

	Block 3	Block 4	Block 1	Block 2
1st year	Restrictive elective	Restrictive elective	Restrictive elective	Restrictive elective
	Regression	Project in Statistics	Discrete Models	Graphical Models
2nd year	Elective	Elective	Thesis	
	Elective	Elective		

Compulsory
  Restricted elective
  Elective
 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
• NMAK16002U	Baysian Statics	Discontinued*	7.5 ECTS

\*See course specific changes below

### 1 General changes for students admitted in the academic years 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 as subject elements from the following list:

• Restricted elective subject elements offered as part of this curriculum (see above)			
• NMAK17001U	Causality*	Block 2	7.5 ECTS

\* The course is not offered in the acadmic year 2019/20.

### 2 General changes for students admitted in the academic years 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

As the required amount of restricted elective subject elements has been reduced from 45 to 30 ECTS, correspondingly, the amount of elective subject elements has been increased from 15 to 30 ECTS. All subject elements previously passed as restricted elective will count as elective.

#### Restricted elective subject elements

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

• Restricted elective subject elements offered as part of this curriculum (see above)			
• NMAK17001U	Causality**	Blok 2	7.5 ECTS
• NMAK16021U	Weak Convergence of Probability Measures	Discontinued*	7.5 ECTS
• NMAK14013U	Modelling Dependence in Discrete Time	Discontinued*	7.5 ECTS
• NMAK16017U	Statistical Inferens for Markov Processes	Discontinued*	7.5 ECTS

\* See course specific changes below.

\*\* The course is not offered in the acadmic year 2019/20.

### 3 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 as listed in the curriculum above with the following exceptions.

#### Structure of the programme

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 to 30 ECTS and the 22.5 ECTS are added to the restricted elective part of the programme.

From the academic year 2017/18 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.

#### Compulsory subject elements

Effective from the academic year 2016/17, the following subject elements are no longer compulsory:

• NMAK11003U	Advanced Probability 1 (VidSand1)	Block 1	7.5 ECTS
• NMAK11011U	Advanced Probability 2 (VidSand2)	Block 2	7.5 ECTS
• NMAA13025U	Theoretical Statistics (TeoStat)	Block 4	7.5 ECTS
• NMAA13024U	Conditioning and Markov Properties (Beting)	Discontinued*	7.5 ECTS

\* See course specific changes below.

#### Restricted elective subject elements

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

• Restricted elective subject elements offered as part of this curriculum (see above)			
• NMAK15019U	Phase-type distributions: Theory and applications**	Blok 1	7.5 ECTS
• NMAK17001U	Causality**	Blok 2	7.5 ECTS
• NMAK15017U	Inference in Hidden Markov Models	Discontinued*	7.5 ECTS
• NMAK15021U	Statistical Methods and Probability in Bioinformatics	Discontinued*	7.5 ECTS
• NMAK15022U	Stereology	Discontinued*	7.5 ECTS
• NMAK14022U	Statistics for non-linear time series models	Discontinued*	7.5 ECTS
• NMAK16021U	Weak Convergence of Probability Measures	Discontinued*	7.5 ECTS
• NMAK14013U	Modelling Dependence in Discrete Time	Discontinued*	7.5 ECTS
• NMAK16017U	Statistical Inference for Markov Processes	Discontinued*	7.5 ECTS
• NMAK15014U	Gaussian Graphical Models	Discontinued*	7.5 ECTS
• NMAK15013U	Functional Data Analysis	Discontinued*	7.5 ECTS
• NMAK15020U	Statistical Computing	Discontinued*	7.5 ECTS

\* See course specific changes below.

\*\* The courses are not offered in the academic year 2019/20.

### 4 Course specific changes

Cancelled course	Interim arrangement
Baysian Statics (NMAK16002U), 7.5 ECTS	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.

Conditioning and Markov Properties (Beting), (NMAA13024U), 7.5 ECTS	<p>The course was a compulsory course in the academic year 2015/16 or earlier.</p> <p>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.</p> <p>The course is equivalent to Graphical Models (NMAK16010U), 7.5 ECTS.</p>
Functional Data Analysis (NMAK15013U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 or earlier.</p> <p>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.</p>
Gaussian Graphical Models (NMAK15014U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 or earlier.</p> <p>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.</p>
Inference in Hidden Markov Models (NMAK15017U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 or earlier.</p> <p>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.</p>
Modelling Dependence in Discrete Time (NMAK14013U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2016/17 and 2015/16.</p> <p>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.</p>
Statistical Computing (NMAK15020U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 or earlier.</p> <p>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.</p> <p>The course is identical with Computational Statistics (NMAK16005U), 7.5 ECTS.</p>
Statistical Inference for Markov Processes (NMAK16017U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2016/17 and 2015/16.</p> <p>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.</p>
Statistical Methods and Probability in Bioinformatics (NMAK15021U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 or earlier.</p> <p>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.</p>
Statistics for non-linear time series models (NMAK14022U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 and earlier.</p> <p>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.</p>
Stereology (NMAK15022U), 7.5 ECTS	<p>The course was a restricted elective course in the academic year 2015/16 and earlier.</p>

	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.
Topics in Stochastic Calculus (NMAK18010U) 7.5 ECTS	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.
Weak Convergence of Probability Measures (NMAK16021U), 7.5 ECTS	The course was a restricted elective course in the academic year 2016/17 and 2015/16.  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.

## 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.