The Faculty of Engineering and Science
The Study Board for Mathematics, Physics and Nanotechnology

Curriculum for the Master's Program in Mathematical Engineering

Aalborg University
September 2017

Campus Aalborg

Preface:
Pursuant to Act 261 of March 18, 2015 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in Mathematical Engineering is stipulated. The program also follows the Joint program regulations and the Examination Policies and Procedures for The Technical Faculty of IT and Design, The Faculty of Engineering and Science, and The Faculty of Medicine.

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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders

The Master's program in Mathematical Engineering is organised in accordance with the Ministry Higher Education and Science's Ministerial Order no. no. 1328 of November 15, 2016 on Bachelor's and Master's Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 1062 of June 30, 2016 on University Examinations (the Examination Order). Further reference is made to Ministerial Order no. 258 of March 18, 2015 (the Admission Order) and Ministerial Order no. 114 of February 13, 2015 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation

The Master's program falls under the Faculty of Engineering and Science.

1.3 Board of Studies affiliation

The Master's program falls under the Board of Studies for Mathematics, Physics and Nanotechnology.

1.4 Body of External Examiners

The Master's program is associated with the Body of External Examiners for Engineers (Ingeniørernes landsdækkende censorkorps (elektronik-delen)). The Body of External Examiners for Mathematics (Censorkorpset for matematik) can also be used.

Chapter 2: Admission, Degree Designation, Program Duration and Competence Profile

2.1 Admission

Applicants with a legal claim to admission (retskrav):
Applicants with one of the following degrees are entitled to admission:

- Bachelor (BSc) of Science in Mathematical Engineering, Aalborg University

Applicants without legal claim to admission:
Students with another Bachelor degree may, upon application to the Board of Studies, be admitted following a specific academic assessment if the applicant is considered as having comparable educational prerequisites. The University can stipulate requirements concerning conducting additional exams prior to the start of study.

2.2 Degree designation in Danish and English

The Master's program entitles the graduate to the designation civilingeniør, cand.polyt. (candidatus/candidata polytechnices) i matematik-teknologi. The English designation is: Master of Science (MSc) in Engineering (Mathematical Engineering).

2.3 The program's specification in ECTS credits

The Master's program is a 2-year, research-based, full-time study program. The program is set to 120 ECTS credits.

2.4 Competence profile on the diploma

The following competence profile will appear on the diploma:

A Candidatus graduate has the following competency profile:

A Candidatus graduate has competencies that have been acquired via a course of study that has taken place in a research environment.
A Candidatus graduate is qualified for employment on the labour market on the basis of his or her academic discipline as well as for further research (PhD programs). A Candidatus graduate has, compared to a Bachelor, developed his or her academic knowledge and independence so as to be able to apply scientific theory and method on an independent basis within both an academic and a professional context.

2.5 Competence profile of the program:

The graduate of the Master's program:

Knowledge

- has knowledge in one or more of the areas applied mathematics, engineering science, and their interaction. The knowledge should, in selected areas, be based on the highest level of international research.
- can understand and on a solid mathematical and engineering basis reflect over the area's knowledge base and be able to identify relevant mathematical and technological problems.

Skills

- excels in the subject area's(s') scientific methods and tools and general skills related to employment within the subject area(s)
- can evaluate and select among the subject area's(s') scientific theories, methods, tools and general skills and, on a scientific basis, advance new analyses and solutions
- can communicate scientific knowledge and discuss professional and scientific problems with both peers and non-specialists

Competencies

- can manage work and development situations that are complex, unpredictable and require new solutions.
- can independently initiate and implement discipline-specific and interdisciplinary cooperation and assume professional responsibility.
- can independently take responsibility for own professional development and specialization

Chapter 3: Content and Organization of the Program

The program is structured in modules and organized as a problem-based study. A module is a program element or a group of program elements, which aims to give students a set of professional skills within a fixed time frame specified in ECTS credits, and concluding with one or more examinations within specific exam periods. Examinations are defined in the curriculum.

The program is based on a combination of academic, problem-oriented and interdisciplinary approaches and organized based on the following work and evaluation methods that combine skills and reflection:

- lectures
- classroom instruction
- project work
- workshops
- exercises (individually and in groups)
- teacher feedback
- reflection
- portfolio work

Overview of the program:

All modules are assessed through individual grading according to the 7-point scale *or* Pass/Fail. All modules are assessed by external examination (external grading) or internal examination (internal grading or by assessment by the supervisor only).

Semester		Module	ECTS	Assessment	Exam
1st MATTEK7		Project – Information Processing in Technical Systems	15	7-point scale	Internal
		Information and Coding Theory	5	7-point scale	Internal
		Machine Learning	5	Pass/Fail	Internal
		Array and Sensor Signal Processing	5	Pass/Fail	Internal
2nd MATTEK8		Project – Signal/Data Processing Systems	15	7-point scale	External
		Compressive Sensing	5	Pass/Fail	Internal
		Bayesian Inference and Mixed Models (MAT8)	5	Pass/Fail	Internal
		Time Series and Econometrics (MATØK6)	5	7-point scale	Internal
3rd MATTEK9	A	Selected Advanced Topics in Mathematics and Technology with a focus on Mathematical Problems	30	7-point scale	Internal
	or B	Selected Advanced Topics in Mathematics and Technology with a focus on Technical Problems	30	7-point scale	Internal
	or C	Study at another university, must be approved by the Study Board	30	Transfer of credits	Transfer of credits
	or D	Long Master'sThesis[1], must be approved by the Study Board	+30	7-point scale	External
4th MATTEK10		Master's Thesis	30	7-point scale	External
Total			120		

The study board can cancel modules if the number of enrolled students is low.

A compulsory course in Problem Based Learning (PBL) and student responsibility is offered as an integrated part of all project modules to students not acquainted with PBL at Aalborg University.

[1] See module description for the Master's thesis. The Long Master's thesis, which must be of experimental character, is prepared in the 3rd and 4th semesters; the extent is 60 ECTS.

3.0 Course in Problem Based Learning and Student Responsibilities at Aalborg University

Title:
Problem Based Learning and Project Management (Problembaseret læring og projektledelse)

Objectives: The objective is to make newly started Master students coming from institutions other than AAU prepared to enter the problem based learning environment at AAU and manage study projects in close collaboration with peers.

Type of instruction: Three half day workshops centered around the individual student working with an individual challenge or curiosity in relation to using a PBL approach. Peer learning is also a hallmark, since the students will discuss and reflect their individual challenges/curiosities in a peer learning group.

Learning outcomes: After completion of the course the student should be able to

Day 1:

- describe and discuss the Aalborg PBL model based on the three key words: group work, project work, problem orientation
- identify an initial individual challenge when using a PBL approach

Day2:

- develop and practice peer feedback skills
- practice collaborative learning in a group
- design a plan of action to deal with an initial individual PBL challenge or curiosity

Day 3:

- practice presentation skills
- practice critical skills when giving feedback to peers
- reflect on own and peer skills in relation to PBL practice

Exam format: Internal assessment during the course/class participation according to the rules in the Examination Policies and Procedures of Faculty of Engineering and Science, Aalborg University. In this case the assessment is primarily based on the oral performance during the course, which means that the student has to be active during the course time and participate in discussions. The course is an integrated part of the project for those not acquainted to the Aalborg PBL model, and is a precondition for participation in the project examination. In this way there will be no diploma for the course and it will not be visible on the academic transcripts.

Evaluation criteria: The criteria for the evaluation are specified in the Joint program regulations.

3.1 Descriptions of modules

3.1.1 Project on 1'st semester, MATTEK7

Project: Information Processing in Technical Systems / Informationsbehandling i teknologiske systemer

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- have knowledge about modern statistical signal processing and its application to information processing systems
- have knowledge about information and coding theory and their application to information and communication technology systems
- have knowledge about machine learning and its applications to technical science

Skills:

- must be able to perform an analysis of complex theoretical problems, where there is a need for tools from statistical signal processing, information theory and machine learning
- must be able to handle problems with noisy data and signals
- must be able to design algorithms solving a given technical problem

Competencies:

- must be able to discuss and reason at the given level using mathematical terms from modern signal processing, information theory, coding theory and machine learning
- must be able to both orally and in writing to present precise and reproducible documentation for the solutions developed

Exam format: Group exam based on a written report.

Evaluation criteria: Are stated in the Joint program regulations.

3.1.2. Courses on 1’st semester, MATTEK7

Information and Coding Theory / Information og kodningsteori

Prerequisites: The module builds on knowledge obtained by the modules Probability Theory and Linear Algebra.

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- knowledge of information theoretical concepts such as entropy, mutual information, divergence, the chain rule for entropy, empirical entropy
- knowledge of lossless data compression, entropy coding, lossy data compression (rate distortion theory)
- knowledge of channel capacity and error-correcting codes
- knowledge of joint source-channel coding and the separation principle

Skills:

- are able to give a theoretical description of the entropy of a signal and in practice estimate the entropy of simple signals
- are able to design efficient entropy codes for simple signals
- are able to use information inequalities to provide bounds on optimal performance of simple systems
- arte able to construct error-correcting codes with good properties and parameters
- are able to decode error-correcting codes efficiently (e.g. Reed-Solomon codes)
- understand the interaction between bitrate and distortion (reconstruction error) in connection with source coding
- understand the interaction between bitrate and error probability in connection with channel coding
- are able to perform calculations in finite fields

Competencies:

- have a good intuition and understanding of the concept of entropy and its significance regarding the information within a signal
- be able to use mathematical tools to discover and investigate the fundamental mathematical tools that describes data transmission, data reduction and data storage

Exam format: Individual oral or written exam. In order to participate in the course evaluation, students must have actively participated in course progress by way of one or several independent oral and/or written contributions.

Evaluation criteria: Are stated in the Joint program regulations.

Machine Learning / Machine Learning

Prerequisites: The module builds on knowledge obtained by the modules Probability Theory, Statistics and Linear Algebra.

Objective: The course gives a comprehensive introduction to machine learning, which is a field concerned with learning from examples and has roots in computer science, statistics and pattern recognition. The objective is realised by presenting methods and tools proven valuable and by addressing specific application problems.

Students who complete the module will gain knowledge, skills and competences as follows:

Knowledge:

- must have knowledge about supervised learning methods including K-nearest neighbours, decision trees, linear discriminant analysis, support vector machines, and neural networks
- must have knowledge about unsupervised learning methods including K-means, Gaussian mixture model, hidden Markov model, EM algorithm, and principal component analysis
- must have knowledge about probabilistic graphical models, variational Bayesian methods, belief propagation, and mean-field approximation
- must have knowledge about Bayesian decision theory, bias and variance trade-off, and cross-validation
- must be able to understand reinforcement learning

Skills:

- must be able to apply the taught methods to solve concrete engineering problems
- must be able to evaluate and compare the methods within a specific application problem

Competencies:

- must have competencies in analysing a given problem and identifying appropriate machine learning methods to the problem
- must have competencies in understanding the strengths and weaknesses of the methods

Organisation: Lectures followed by laboratory exercises, in addition to a mini-project where students will apply appropriate methods to application problems selected from a list of suggestions or proposed by the students themselves.

Exam format: Individual oral exam on the basis of the mini project and the lectures.

Evaluation criteria: Are stated in the Joint program regulations.

Array and Censor Signal Processing / Array- og sensor signalbehandling

Prerequisites: The module builds on knowledge obtained by the modules Stochastic Processes and Optimization Methods.

Objective: Students who complete the module:

Knowledge:

- must have knowledge about the Cramér-Rao lower bound (CRLB) as well as (asymptotic) optimal unbiased estimators such as minimum variance unbiased estimator, maximum likelihood, and least-squares
- must have knowledge about 1- and 2-dimensional spectral estimation methods such as the period gram, the Yule-Walker equations, subspace-based methods (MUSIC and ESPRIT), and filter-bank methods (Capon's method and Amplitude and Phase EStimation (APES))
- must have knowledge about fundamental terms and methods applied for design and analysis of adaptive filter such as Steepest descent, least-mean-square (LMS), normalized LMS (NLMS), affine projections (AP), recursive least-squares (RLS), transient and steadystate performance
- must have knowledge about terms and methods applied for design and analysis of multirate signal processing systems, such as Hilbert transform, Noble identities, poly-phase decomposition, commutators, re-sampling, as well as up- and down-sampling

Skills:

- must be able to compare the estimation performance of unbiased estimators by using the CRLB
- must be able to apply methods and algorithms for parametric and non-parametric spectral estimation on 1- and 2-dimensional signals
- must be able to implement fundamental adaptive filters such as the (normalized) leastmean-square filter, the affine projection filter, and the recursive least-squares filter
- must be able to apply fundamental methods for analysis, design, and implementation of poly-phase filters

Competencies:

- must have competencies in analysing a given problem which in its solution requires advanced signal processing methodologies and next identify appropriate methods and algorithms to solve the problem

- must have competencies in understanding the strengths and weaknesses of the methods

Exam format: Individual oral or written examination.

Evaluation criteria: Are stated in the Joint program regulations.

3.2.1 Project on 2'nd semester, MATTEK8

Project: Signal/Data Processing Systems / Signal/databehandlende systemer

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- must have knowledge about compression of one and two dimensional signal/data representations
- must have knowledge about classical and Baysian statistical methods for processing of noisy signals
- must have knowledge about simulation techniques and in particular about Markov chain and Monte Carlo methods
- must have knowledge about how sparse representations and statistical techniques influences real-world data/signals

Skills:

- must be able to use Baysian and hierarchical statistical methods to analyse time series and lattice data and to evaluate the validity of the results obtained
- must be able to use compressed signal/data representations on real or synthetic data and be able to evaluate the quality of the signal/data reconstruction

Competencies:

- are able to communicate results of statistical analyses to non-specialists within advanced signal processing
- are able to independently develop statistical models suitable for analysis of real-world signals such as noisy digital images or communication signals
- are able to use sparse representations and/or statistical methods to solve a given practical problem and, if needed, make minor adjustments to the methods to obtain the wanted functionality

Type of instruction: Project work.

Exam format: Group exam based on a written report.

Evaluation criteria: Are stated in the Joint program regulations.

3.2.2. Courses on 2'nd semester, MATTEK8

Compressive Sensing / Komprimeret signal-/dataanalyse og syntese

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- must have knowledge of compressed (sparse) representation of signals/data in one and two dimensions
- must have knowledge of the concepts measurement matrix and dictionary
- must have knowledge of hardware realizations at block level, which use compressive representation of signals/data (e.g. multi-coset and random demodulator architectures)
- must have knowledge of the relation between compressed representation and classical representation of signals/data
- must have knowledge of key concepts and methods within compressed signal/data representation
- must have knowledge of formulation of signal/data reconstruction as different types of optimization problems (e.g. Greedy Pursuit and Orthogonal Matching Pursuit)

Skills:

- must be able to apply compressed signal/data representation in analysis- and/or synthesis-related applications
- must be able to simulate and assess the quality of signals/data which are represented in compressed form

Competencies:

- must be able to assess when compressed signal/data representation is appropriate
- must be able to formulate the basic elements for a given signal/data type and assess the signal/data quality in relation to the number of signal/data components

Exam format: Exam format: Individual oral or written exam. In order to participate in the course evaluation, students must have actively participated in course progress by way of one or several independent oral and/or written contributions.

Evaluation criteria: Are stated in the Joint program regulations.

Bayesian Inference and Mixed Models / Bayesiansk inferens og modeller med tilfældige effekter

Prerequisites: The module builds on knowledge obtained by the module Statistical Inference for Linear Models.

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- have knowledge of the general linear model with random effects
- have knowledge of maximum likelihood inference for the general linear model with random effects
- have knowledge of prediction of random effects
- have knowledge of Bayesian inference
- have knowledge of prior distributions in Bayesian inference
- have knowledge of computational aspects of Bayesian inference

Skills:

- can for a specific dataset identify possible sources of random variation and formulate a relevant model with random effects
- can perform maximum likelihood- and Bayesian inference for the formulated model

Competencies:

- can account for methodology and practical inference for different approaches to models with random effects

Exam format: Individual oral or written exam. In order to participate in the course evaluation, students must have actively participated in course progress by way of one or several independent oral and/or written contributions.

Evaluation criteria: Are stated in the Joint program regulations.

Time Series and Econometrics / Tidsrækkeanalyse og økonometri

Prerequisites: The module builds on knowledge obtained by the module Statistical Inference for Linear Models.

Objectives: Students who have completed the module meet the following criteria:

Knowledge:

- know about conditioning in the multivariate normal distribution as well as ordinary and generalized least squares methods
- are able to understand a time series as a stochastic process and understand the connection between stochastic processes and dynamical systems, and in particular the Box-Jenkins models (ARMA-type models)
- know about various stationarity and non-stationarity concepts for Time Series: Weak and strong stationarity, causality, autocovariance- and autocorrelation functions, integrated models, long memory models, volatility models, and basic state-space models
- know about various modern time series and econometric models within financial econometrics and financial engineering in discrete time

Skills:

- are able to interpret the statistical and possibly econometric properties of time series
- are able to implement all phases in a classical time series analysis: Identification, estimation, diagnostic checking, prediction, and statistical/econometric interpretation
- are able to use correlograms and other graphical tools in the identification phase
- are able to apply and make themselves acquainted with new statistical methods to analyse time series

Competencies:

- are able to apply the concepts from time series in an econometric or other broader context
- are able to perform qualified econometric analyses of financial and other data including estimation and prediction using available software
- are able to reflect on the discipline's approach to academic problems at a high level and the discipline's relationship to other subject areas
- are able to involve the knowledge area in solving complex problems and thus achieve a new understanding of a given subject area

Exam form: Individual oral or written exam. In order to participate in the course evaluation, students must have actively participated in course progress by way of one or several independent oral and/or written contributions.

Evaluation criteria: Are stated in the Joint program regulations.

3.3.1 Projects on 3'rd semester, MATTEK9

Project A

Selected Advanced Topics in Mathematics and Technology with a Focus on Mathematical Problems / Specialisering i videregående matematiske og teknologiske emner med fokus på matematiske problemstillinger

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- must have extensive knowledge of relevant theory and methods within one or more selected areas of mathematics, and to a lesser degree, knowledge about one or more areas within engineering science
- must have extensive knowledge about one or more applications of the theory and methods
- must be able to understand, and to reflect scientifically over knowledge within mathematics and engineering science and to be able to identify mathematical and technological problems

Skills:

- are able to independently to apply relevant mathematical theory and methods to identification, statement and analysis of technological problems
- are able to communicate research based knowledge, and is able to discuss professional and scientific problems with peers both within mathematics and engineering science, as well as with non-specialists

Competencies:

- are able to independently to initiate and complete interdisciplinary development projects based on advanced mathematical modelling and methods from engineering science, and is able in that context, to professionally take charge of implementing derived models and methods
- are able to independently to take charge of self-development and one's own professional development and specialization within mathematics and engineering science

Exam format: Group exam based on a written report.

Evaluation criteria: Are stated in the Joint program regulations.

Project B

Selected Advanced Topics in Mathematics and Technology with a Focus on Technical Problems / Specialisering i videregående matematiske og teknologiske emner med fokus på teknologiske problemstillinger

Objective: Students who have completed the module meet the following criteria:

Knowledge:

- must have extensive knowledge of relevant theory and methods within one or more selected areas of engineering science, and to a lesser degree, knowledge about one or more areas within mathematics
- must have extensive knowledge about one or more applications of the theory and methods
- must be able to understand, and to reflect scientifically over knowledge within mathematics and engineering science and to be able to identify mathematical and technological problems

Skills:

- are able to independently to apply relevant mathematical theory and methods to identification, statement and analysis of technological problems
- are able to communicate research based knowledge, and is able to discuss professional and scientific problems with peers both within mathematics and engineering science, as well as with non-specialists

Competencies:

- are able to independently to initiate and complete interdisciplinary development projects based on advanced mathematical modelling and methods from engineering science, and is able in that context, to professionally take charge of implementing derived models and methods

- are able to independently to take charge of self-development and one's own professional development and specialization within mathematics and engineering science

Exam format: Group exam based on a written report.

Evaluation criteria: Are stated in the Joint program regulations.

3.4.1 Project on 4'th semester, MATTEK10

Master's Thesis / Kandidatspeciale
The student has the possibility to write a Long Master's Thesis (over 2 semesters: 60 ECTS), if the thesis is of experimental character. The amount of experimental work must reflect the allotted ECTS.

Objectives: Students who have completed the module meet the following criteria within at least one central mathematical/statistical area:

Knowledge:

- have expert understanding within one or a few selected elements of a central mathematical or engineering science subject area based on international research on a high level, or has a broader insight into a central mathematical or engineering subject area regarding theories and methods as well as central elements and their interrelationships
- must be able to understand and on a scientific basis reflect upon the knowledge of the subject area and be able to identify scientific problems within mathematics and engineering science

Skills:

- must be able to identify, formulate and to analyze a scientific mathematical technological problem independently, systematically and critically
- must be able to relate the problem to the mathematical and engineering subject area, including explaining the choices that have been made in connection to the delimitation of the problem
- must be able to independently make and justify the choice of mathematical theories and scientific theoretical and/or experimental methods
- must be able to independently and critically evaluate the chosen theories and methods as well as the analyses, results and conclusions in the project, both during and at the end of the project period
- must be able to evaluate and choose between the scientific theories, methods, tools, and general skills within the mathematical subject area

Competencies:

- must be able to control work and development situations which are complex, unpredictable and require new mathematical and/or engineering models or methods for solution
- must be able to initiate and complete mathematically and/or engineering oriented collaborations, and if relevant also interdisciplinary collaborations, as well as assume professional responsibility
- must be able to independently assume responsibility for own professional development and specialisation

Exam format: Group exam based on project report.

Evaluation criteria: Are stated in the Joint program regulations.

Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculty of Engineering and Science and enters into force as of 1'st September 2017.

Students who wish to complete their studies under the previous curriculum from 2016 must conclude their education by the summer examination period 2018 at the latest, since examinations under the previous curriculum are not offered after this time.

Chapter 5: Other Provisions

5.1 Rules concerning written work, including the Master's thesis

In the assessment of all written work, regardless of the language it is written in, weight is also given to the student's spelling and formulation ability, in addition to the academic content. Orthographic and grammatical correctness as well as stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always be included as an independent dimension of the total evaluation. However, no examination can be assessed as 'Pass' on the basis of good language performance alone; similarly, an examination normally cannot be assessed as 'Fail' on the basis of poor language performance alone.
The Board of Studies can grant exemption from this in special cases (e.g., dyslexia or a native language other than Danish).

The Master's thesis must include an English summary.[2] If the project is written in English, the summary must be in Danish.[3] The summary must be at least 1 page and not more than 2 pages. The summary is included in the evaluation of the project as a whole.

5.2 Rules concerning credit transfer (merit), including the possibility for choice of modules that are part of another program at a university in Denmark or abroad

In the individual case, the Board of Studies can approve successfully completed (passed) program elements from other Master's programs in lieu of program elements in this program (credit transfer). The Board of Studies can also approve successfully completed (passed) program elements from another Danish program or a program outside of Denmark at the same level in lieu of program elements within this curriculum. Decisions on credit transfer are made by the Board of Studies based on an academic assessment. See the Joint program regulations for the rules on credit transfer.

5.3 Rules for examinations

The rules for examinations are stated in the Examination Policies and Procedures published by the Faculties of Engineering, Science and Medicine on their website.

5.4 Exemption

In exceptional circumstances, the Board of Studies study can grant exemption from those parts of the curriculum that are not stipulated by law or ministerial order. Exemption regarding an examination applies to the immediate examination.

5.5 Rules and requirements for the reading of texts

At programs that are taught in Danish, it is assumed that the student can read academic texts in modern Danish, Norwegian, Swedish and English and use reference works, etc., in other

[2] Or another foreign language (upon approval from the Board of Studies.
[3] The Board of Studies can grant exemption from this.

European languages. At programs taught in English, it is assumed that the student can read academic text and use reference works, etc., in English.

5.6 Additional information

The current version of the curriculum is published on the Board of Studies' website, including more detailed information about the program, including exams.