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

AALBORG UNIVERSITY
DENMARK

Curriculum for the Master's program in Nanobiotechnology

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 Nanotechnology is stipulated. The program also follows the Joint programme 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.

Table of Contents

Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders

The Master's program in Nanobiotechnology is organised in accordance with the Ministry of Higher Education and Science's Ministerial Order 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) with subsequent changes. Further reference is made to Ministerial Order no. 258 of March 18, 2015 (the Admission Order) and Ministerial Order no. 114 of February 3, 2015 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation

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

1.3 Board of Studies affiliation

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

1.4 Body of External Examiners

The Master's program is associated with the Body of External Examiners for Engineers (Ingeniørernes landsdækkende censorkorps (mat, fys, samf)).

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

2.1 Admission

Applicants with a legal claim to admission (retskrav):

Applicants with the following degree are entitled to admission:

- Bachelor of Science (BSc) in Engineering (Nanotechnology with specialisation in Biotechnology), Aalborg University

Applicants without legal claim to admission:

- Bachelor of Engineering in Nanotechnology, Aalborg University

2.2 Degree designation in Danish and English

The Master's program in Nanobiotechnology entitles the graduate to the designation civilingeniør, cand.polyt.(candidatus/candidate polytechnices) i nanobioteknologi. The English designation is: Master of Science (MSc) in Engineering (Nanobiotechnology).

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 graduate of the Master's program has competencies acquired through an educational program that has taken place in a research environment.
>
> The graduate of the Master's program can perform highly qualified functions on the labor market on the basis of the educational program. Moreover, the graduate has prerequisites for research (a Ph.D. program). Compared to the Bachelor's degree, the graduate of the Master's program has developed her/his academic knowledge and independence, so that the graduate can independently apply scientific theory and method in both an academic and occupational/professional context.

2.5 Competence profile of the program:

Students graduating with a degree in Nanobiotechnology have acquired the following knowledge, skills and competencies:

Knowledge	• has knowledge in the major areas within nanobiotechnology that covers advanced gene technology, reaction engineering, high throughput systems, molecular electronics, molecular simulations, self-assembling systems, reaction at interfaces, and spectroscopic methods such as MS and NMR • can understand and reflects over theory, methods and experiments within the mentioned areas
Skills	• should be able to apply up-to-date methods to describe and solve problems on a scientific level within nanobiotechnology • can evaluate problems and select among the scientific theories, methods, tools and general skills within the mentioned areas in order to find a solution based on a scientific analyses • can communicate research-based 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 Organisation of the Program

The program is structured in modules and organised 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 that are defined in the curriculum.

The program is based on a combination of academic, problem-oriented and interdisciplinary approaches and organised 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

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).

Overview of the Master's program in Nanobiotechnology:

Semester		Code	Module	ECTS	Assessment	Exam
1		NB1-1	Nanobioengineering	15	7-point scale	Internal
		NB1-2	Advanced Gene Technology	5	7-point scale	Internal
		NB1-3	Reaction Engineering and Molecular Electronics	5	7-point scale	Internal
		NB1-4	Molecular Simulations	5	Pass/fail	Internal
2		NB2-1	Characterisation of Nanobiostructures	15	7-point scale	External
		NB2-2	Self-assembling Systems	5	Pass/fail	Internal
		NB2-3	Physics and Chemistry of Surfaces	5	7-point scale	Internal
		NB2-4	NMR and MS	5	7-point scale	Internal
3		NB3-1	Advanced Nanobiotechnology	+15	Pass/fail	Internal
	A or	Electives	Test and Validation	5	Pass/fail	Internal
			Materials Chemistry	5	7-point scale	Internal
			Synthesis and Characterization	5	Pass/fail	Internal
	B or		Study at another university*	30	Transfer of credits	Transfer of credits
	C or		Academic Internship*	30	7-point scala	Internal
	D		Long Master'sThesis*	+30	7-point scale	External
4		NB4-1	Master's Thesis	30	7-point scale	External

The project on the 3rd semester can either be 15, 20, 25, or 30 ECTS, dependent on how many elective courses are chosen. The project on the 3rd semester can also be extended to become a Long Master's Thesis which goes over 2 semesters and will thereby be equal to 60 ECTS. The Long Master's thesis can also be combined with 2 or 3 elective courses, which means that a Long Master's thesis can either be 45, 50, or 60 ECTS if no elective courses are chosen.

*Studying at another university (including universities abroad), an academic internship at a company, and a Long Master's Thesis need to be approved by the board of studies.

3.0 Course in Problem Based Learning and Project Management 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 Programme Regulations.

3.1. Description of modules for 1st semester, NB1

3.1.1 Project module on 1st semester, NB1

Title: Nanobioengineering/Nanobioengineering.

The project is designed to cover a broad range of topics. It can be a theoretical or an experimental project dealing with all aspects relevant for manufacturing and engineering of biological/organic nanostructures.

Objective: Students who complete the module:

Knowledge

- must have knowledge about how to design, model and manufacture different biological/organic nanostructures
- must be able to understand the fundamental concepts of engineering and design of nanostructures based on organic/biological systems

Skills

- must be able to apply the design, engineering and manufacturing concepts in order to predict and fabricate the desired organic or bio-nanostructures
- must be able to evaluate the different methods used for production, design, and engineering of nanobiostructures

Competencies

- must have obtained the skills to design, model, fabricate and characterize nano-scale (bio)structures

Type of instruction: Supervised project work done in groups.

Exam format: Individual oral evaluation based on project report.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.1.2 Course modules on 1st semester, NB1

NB1-2: Course module Advanced Gene Technology/Avanceret genteknologi.

Prerequisites: The module builds on knowledge obtained by the module Gene Technology on 5th semester of the Bachelor in Nanotechnology as well as knowledge in Organic Chemistry and Biochemistry.

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about advanced gene expression systems
- Must have knowledge about high throughput screening methods
- Must have knowledge about advanced applications of gene technology in the areas of biotechnology, medicine, and nanotechnology

Skills:

- Must be able to apply the knowledge to solve real world problems
- Must be able to understand the principles
- Must be able to engineer (theoretically) new DNA based nano-devices

Competencies:

- Must have a deeper understanding of the principles and tools
- Must know how to engineer nano-devices for applications in the area of medicine and biotechnology

Type of Instruction: Lectures with problems.

Exam format: Individual written or oral evaluation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

NB1-3: Course module Reaction Engineering and Molecular Electronics/Engineering af reaktioner og molekylær elektronik.

Prerequisites: The module builds on knowledge in the area of Physical Chemistry, Inorganic and Organic Chemistry, Lab-on-a-Chip, Basic Quantum Mechanics, and Microbiology.

Objective: Students who complete the module:

Knowledge:

- Must acquire knowledge about basic design principles and modeling of chemical, biochemical, and biotechnological reactors
- Must acquire knowledge about micro-reactors and their application in biotechnology
- Must acquire knowledge on the underlying principles and the current state of molecular electronics

Skills:

- Must be able to apply the acquired knowledge to the design and performance evaluation of batch and continuous flow reactors
- Must be able to model chemical and biochemical reactors using COMSOL and other mathematical modeling software

Competencies:

- Must have working knowledge and basic skills for designing, modeling and evaluating of chemical, biochemical, and biotechnological reactors
- Must acquire an overview of the current progress in the area of molecular electronics

Type of instruction: Lectures and exercises.

Exam format: Individual oral evaluation.

Evaluation criteria: Besides the evaluation criteria stated in the Joint Programme Regulations, the grade requires participation in presentations and discussions of research papers and completion of an assignment.

NB1-4: Course module Molecular Simulations/Molekylær simulering.

Prerequisites: The module builds on knowledge obtained in the area of Organic Chemistry, Protein Physics, Basic Quantum Mechanics, and Physical Chemistry.

Objective: Students who complete the module: will have gained skills in the up to date computer modeling techniques of molecular dynamics and analysis of in silico modeled protein, peptide and membrane structures and function.

Knowledge:

- Must have knowledge about modern force fields
- Must have knowledge about protein folding and function
- Must have knowledge about the general building blocks of proteins and their chemistry
- Must be able to evaluate protein structures
- Must be able to apply the principals of protein structures and functions to real problems

Skills:

- Must be able to apply principals of Molecular dynamics simulations to real problems
- Must be able to evaluate modeled protein structures and function
- Must be able to apply the properties and chemistry of the aminoacids to real world problems
- Must be able to evaluate results from molecular dynamics simulations

Competencies:

- Must have a basic understanding of molecular modelling
- Must have a general understanding of the physics of protein dynamics and force field based modeling strategies
- Must have a general knowledge molecular simulations

Type of instruction: Lectures with accompanying problem solving session.

Exam format: Individual continuous evaluation based on active participation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.2 Description of modules for 2nd semester, NB2

3.2.1 Project on 2nd semester, NB2

Title: Characterisation of Nanobiostructures/Karakterisering af nanobiostrukturer.

Prerequisites: The module builds on knowledge obtained by the project on NB1 (1st semester).

The project is designed to cover a broad range of topics. It can be a rather more theoretical or experimental project dealing with all aspects relevant for manufacturing and characterization of biological/organic nanostructures.

Objective: Students who complete the module:

Knowledge:

- Must have knowledge about methods and tools used for production and characterization of biological/organic nanostructures
- Must be able to understand the fundamental concepts behind the methods and tools used for production and characterization of biological/organic nanostructures

Skills:

- Must be able to produce biological/organic nanostructures and must be able to investigate their properties by using different methods and tools
- Must be able to evaluate the different methods used for production and characterization of nano(bio)structures

Competencies:

- Must have obtained the skills to produce and characterize biological/organic nanostructures by using different tools

Type of instruction: Supervised project work done in groups.

Exam format: Individual oral evaluation based on project report.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.2.2 Courses on 2nd semester, NB2

NB2-2: Course module Self-Assembling Systems/Selvorganiserende biostrukturer.

Prerequisites: The module builds on knowledge obtained in the area of Physical Chemistry, Inorganic and Organic Chemistry, and Biochemistry.

Objective: Students who complete the module:

Knowledge:

- Must acquire knowledge about basic principles of self-assmbling behavior in nature, forces involved in the process, ways to model and design a self-assembling system
- Must acquire knowledge about application of self-assembly for drug-delivery, thin films and nano-arrays

Skills:

- Must be able to use Langmuir-Blodgett technique as well as other methods to fabricate monolayers, micelles and vesicles
- Must be able to apply the acquired knowledge to critically read and understand research papers on the subject of self-assembly

Competencies:

- Must acquire an overview of the current progress in the areas of self-assembly and drug delivery

Type of instruction: Lectures and exercises.

Exam format: Individual oral or written evaluation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

NB2-3: Course module Physics and Chemistry of Surfaces/Overfladefysik og -kemi

Prerequisites: The module is built on knowledge obtained in the area of General and Physical Chemistry

Objectives: Aim of the course is to provide knowledge about specific aspects as well as physical and chemical phenomena occurring at surfaces and interfaces.

Knowledge should be acquired within the following topics:

- Structure of crystalline surfaces as well as the methods and techniques for their preparation and characterisation;
- basic thermodynamics and kinetics of surface processes including phenomena of surface tension and adsorption/desorption;
- major interaction forces near the interfaces including van der Waals and double-layer forces;
- physi- and chemi-sorption at surfaces and catalysis;
- structure of interfaces, wetting theory, hydrophobicity, membranes and growth of thin films;
- reactions at interfaces and electrochemistry.

Skills: The student will become skilled in solving problems within the topics listed above and will be able to apply theories and methods of surface physics and chemistry.

Competencies: that are acquired develop and strengthen the knowledge and understanding of theory and methods in surface science, as well as their applications. Based on the skills acquired in this module the student should be able to reflect on and discuss topics from surface science.

Type of instruction: Lectures supported by problem solving classes.

Exam format: Individual oral or written evaluation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

NB2-4: Course module NMR and MS/NMR og MS.

Prerequisites: The module builds on knowledge obtained in the area of Organic and Physical Chemistry.

Objective: Students who complete the module:

Knowledge

- should have knowledge about the theoretical background of NMR and MS, especially about how to get signals and interpretation of signals
- should have knowledge about the experimental process how NMR and MS data are collected

Skills

- should be able to interpret 1D and 2D NMR spectra which means to be able to predict a spectrum from a given structure, find an unknown structure based on a given spectrum or be able to assign NMR signals to atoms within a structure
- should be able to evaluate applications for NMR and MS for chemical/biotechnological/nanotechnological problems
- should be able to interpret MALDI MS and ESI MS spectra
- should be able to use correct concept, nomenclature, and symbols from the NMR and MS literature

Type of instruction: Lectures with problems.

Contents: The following topics are part of that module:

NMR:
The physical background for NMR: Nuclear spin, spin in a magnetic field, CW-NMR, FT-NMR, radiofrequency pulses; Spectral parameters: chemical shift, scalar and dipolar coupling; Spectroscopic technique: 1D experiments with one or more pulses; Experimental aspects: construction of NMR spectrometer, experimental NMR, signal treatment, Nuclear Magnetic Relaxation: spin-lattice or spin-spin relaxation and their dependence on molecular mobility, nuclear Overhauser effect; 2D-NMR: meaning of 'chemical shift labeling', magnetization transfer between spins, acquisition of the indirect dimension, homonuclear 2D-NMR (COSY, TOCSY, NOESY), heteronuclear 2D-NMR (HSQC, HMQC); Dynamic NMR Spectroscopy: chemical shift, lineshape analysis, 'coalescence', timescale for NMR; Interpretation of NMR spectra: assignment of signals, structure determination of small molecules; selected topics of modern, applied NMR, i.e.: NMR of macromolecules, 'magnetic resonance imaging', description of NMR based on quantum mechanics, metabolic profiling via NMR; Problems: Interpretation of spectra, identification of compounds based on their spectra, collecting data on the in-house spectrometer, theoretical calculations.

MS:
History of MS development and applications within biotechnology and chemistry, physical concept behind MS ionization (matrix-assisted laser desorption ionization/electro-spray); mass analyzer (time-of flight, quadrupol, ion-field). MS/MS sequencing, iondetection, reflectron. Application of on-line chromatography (HPLC, GC, CE). Special applications for different MS, i.e. MALDI-TOF-MS and nano-spray followed by MS/MS for analysis of proteins. Interpretation of spectra of organic molecules (proteins, peptides and DNA sequences, carbohydrates) and problems to support the theory behind it. Introduction to mass spectrometry based bioinformatics.

Exam format: Individual written or oral evaluation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.3 Description of modules for 3rd semester, NB3

3.3.1 Project on 3rd semester, NB3

The project on the 3rd semester can either be a normal semester project of up to 30 ECTS or can be combined with the Master's thesis to a **Long Master's Thesis**. In case of a separate project, the scope of the project can vary between 15, 20, 25, and 30 ECTS dependent on how many elective courses are chosen by the student. A Long Master's Thesis can vary between 45, 50, and 60 ECTS dependent on how many elective courses are taken by the student.

Students on the 3rd semester have also the possibility to study at another Danish or international university (**go abroad**), as well as they can spend the semester at a company performing an **academic internship**.

Studying at another university (including universities abroad), an academic internship at a company, and a Long Master's Thesis need to be approved by the board of studies.

Title: Advanced Nanobiotechnology/Avanceret Nanobioteknologi.

Prerequisite: The module builds on knowledge obtained by the project on NB2 (2nd semester).

This project focuses on all kinds of advanced biostructures and their static and dynamic properties.

If the project is less than 30 ECTS the workload of the project is reduced in accordance to the number of ECTS.

Knowledge:

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject

Skills:

- Ability to approach, describe, and solve a specific problem using the tools available
- Ability to explore and achieve sufficient understanding of the state-of-the-art methods and principles used in the project
- Ability to define the limits of the project
- Ability to reflect over the obtained results

Competence:

- should be able to identify, formulate, and analyze independently a problem
- should have the necessary skills to identify and apply the relevant scientific theories and methods to the formulated problem

Contents: Different advanced nanobiostructures will be manufactured and/or modeled and their static and dynamic properties will be characterized using state-of-the-art scientific tools, techniques and theories.

Exam format: Individual oral evaluation based on project report.

Evaluation criteria: Are stated in the Joint Programme Regulations.

Title: Academic Internship / Projektorienteret forløb i en virksomhed

Prerequisites: This module is based on knowledge obtained on the 1st and 2nd Semester of the MSc in Physics Programme.

Objective: Upon completion of the module (project or academic internship), the student can:

Knowledge

- Discuss the subject matter of the project specified within the area of the study programme

Skills

- Solve complex problems using theory and concepts within physics
- Evaluate and choose among potentially relevant theories, concepts and methodologies applied to solve problem within physics.
- Evaluate the relevance and limitations of the theories, concepts, methods and tools actually applied in the project
- Account for any choices made during the problem analysis and solution development
- Develop solution alternatives and evaluate the consequences of solution alternatives and make a well-informed choice based on that
- Plan, execute and report an extensive individual research project within an agreed time frame
- Write a well-structured project report, which meets all the usual requirements of an academic work, including:
    - Empirical background
    - Research problem/project objective
    - Relevant theory
    - Research design:
    - Presentation of data
    - Presentation and discussion of findings
    - Evaluation of the project; i.e., findings, methods and, if relevant, considerations regarding the limitations and generalizability of the study.
    - specific for internship: a personal reflection is required, a reflection on: how was it to work alone, full-time in a company, and, if applicable, in a different country with a different culture, language, industrial structure, etc.

Competences

- Analyze and solve an actual problem of industrial relevance through application of systematic research and development processes, including advanced analytical, experimental, and/or numerical methods and models.

- Work together with an organization and identify problems and finally develop solutions.
- Operationalize theoretical contributions in a practical setting
- Compare and critically evaluate the results of the project in relation to existing knowledge and accepted theories within the subject area
- Communicate a balanced view of the results and conclusions of the project in well-organized written and oral presentation

Organization: The student is included in the company's daily work and carry out independent project work on an industrial problem relevant for the company. Concurrent to the work in the company, the student makes a project report, which is evaluated after the ending of the internship.

Exam Format: Oral examination based on a written report

Evaluation criteria: As stated in the Joint Programme Regulations.

3.3.2 Electives on 3rd semester, NB3

Test and Validation/Test og validering

Recommended placement	MSc programme 3rd semester
Prerequisites	The module builds on knowledge obtained in the modules *Applied Statistics* and *Probability Theory*
Duration	5 ECTS
Aim	The aim of the course is to enable participants to apply generic and elementary as well as specific, advanced methods to planning, execution and validation of experiments and tests, thereby to verify the validity of model-based results against experimental results and vice versa. Due to the stochastic nature of principal parameters (model input data, test equipment precision etc.) verification will relate heavily (although not exclusively) on statistical and probabilistic methodologies. In continuation hereof, the course aims to introduce central validation concepts and criteria as applied in contemporary industry standards.
Objectives	Upon completion of the course, the student should be able to *Knowledge* • Understand methodology for design of experiments and test series and for reduction of ambiguity of experimental results, and for comparability with model predictions • Explain elementary and advanced quantification tools, and their application to validation between model and experiment data • Account for common contemporary methods and relevant specific industry standards • Understand processing methods for analog and digital data (continuous vs. discrete) *Skills*

	• scrutinize a non-trivial physical systems for appropriate experimental study • isolate principal measurable parameters • design an experiment matrix for systematic variation of parameters • perform a probabilistic study of the experimental data in order to quantify the influence of individual parameters • scrutinize a model (analytical or numerical) for comparison with an appropriate experimental study • isolate principal input parameters and their known or assumed statistical variations • perform a probabilistic study of the model in order to quantify the level of confidence • account for the level of coherence between test results and model predictions • Identify invalid data (outliers) • account for common errors and limitations in the processing of model data or experimentally obtained data *Competencies* • undertake experiment planning and execution for refinement and validation (or rejection) of model-based predictions of phenomena within their principal line of study.
Assessment	Oral examination based on submitted written assignment
Grading	Passed/Not passed
Evaluation criteria	Cf. Joint Programme Regulations

Materials Chemistry/Materialekemi

Prerequisites:	The module builds on knowledge in the area of Inorganic Chemistry and Physical Chemistry.
Aim:	The purposes of the course are to introduce both fundamental chemical principles of materials and nanomaterials, and main methods for developing, optimising, post-treating and characterising materials regarding different physical and chemical performances. The focus will be placed on the relation between chemical composition, structure and properties. The two courses will introduce the current status of materials and nanomaterials technologies.
Learning outcomes:	After the course the students should be able to: Knowledge • Understand the fundamental principles of materials chemistry • Understand different application areas of materials and to optimize the production process of materials Skills • Prepare, characterize and modify materials to reach the target properties by using the materials chemistry knowledge and laboratory facilities • Design, synthesize, and produce nanostructured materials with given properties. • Characterize conventional materials and nano-materials

Content: Materials chemistry focuses on the fundamental principles and applications of both conventional and advanced inorganic materials. The course is divided into the following two parts.

1. General inorganic materials chemistry:
   - Glass chemistry
   - Ceramic chemistry
   - Metal chemistry
   - Cement chemistry
   - Characterisation of inorganic materials

2. Nanomaterials chemistry
   - Thin films
   - Nano-crystals and –particles
   - Carbon nanotubes and other inorganic nanotubes
   - Mesoporous materials
   - Nano wires
   - Production of polymer nanomaterials
   - Nano-structured polymer

Exam format: Individual oral evaluation.

Evaluation criteria: Are stated in the Joint Programme Regulations.

Synthesis and Characterization/Syntese og karakterisering

Prerequisites: The module builds on knowledge in the area of Electronic structures of solids and Nanofabrication.

Aim: Students completing the module will obtain:

Knowledge within the following areas:

- Optical characterisation techniques
- Ellipsometry
- Photo luminescense
- Electron microscopy
- Electron beam writing
- Thin film deposition
- Reactive ion etching
- Fucused ion beam lithography
- Atomic force microscopy

Skills that enables them to:

- Apply basic experimental techniques for geometrical characterisation of nanostructures
- Synthesise and characterise thin film
- Produce surface structures using particle beam lithography

Competencies:

- Be able to design fabrication processes for nano-scale components
- Be able to produce simple components
- Be able to analyse results and compare to basic limitations

Type of instruction: Lectures combined with theoretical and practical exercises.

Exam format: Individual continuous evaluation based on exercises given through the course.

Evaluation criteria: Are stated in the Joint Programme Regulations.

3.4 Description of modules for 4th semester, NB4

3.4.1 Project module on 4th semester, NB4

Title: Master's Thesis/Kandidatspeciale.
The student has the possibility to write a Long Master's Thesis (over 2 semesters), if the thesis is of experimental character. A Long Master's Thesis can be chosen as either 45, 50, or 60 ECTS. If choosing to do a Long Master's Thesis, the amount of experimental work must reflect the allotted ECTS.

Prerequisite: The module builds on knowledge obtained by the project on NB3 (3rd semester).

The project can cover the same topic as the 3rd semester project and should be approved by the Board of Studies.

The student should have the following knowledge, skills and competence:

Knowledge:

- Knowledge of the subject-specific methods as well as tools applied for the design, fabrication, characterization, and modeling of the biological and organic nanostructures described in the thesis
- Knowledge of the biological, physical, and (bio)chemical principles behind the subject of the thesis

Skills:

- Ability to approach, describe, and solve a specific problem using the tools available
- Ability to explore and achieve sufficient understanding of the state-of-the-art within the area of the thesis subject
- Ability to define the limits of the project
- Ability to demonstrate scientific and professional project work
- Ability to reflect over the obtained results

Competence:

- Applying the knowledge and skills obtained during the master program to solve the subject specific problem of the thesis with the support of the supervisor
- Evaluate the approach, methods, and materials used for the project to fulfill the goal of the project
- Be able to relate the problem to the relevant field/area and the obtained results
- Be able to make and justify decisions on the relevant theories and methods

Exam format: Individual oral evaluation based on project report.

Evaluation criteria: Are stated in the Joint Programme 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 1st of 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 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.[1] If the project is written in English, the summary must be in Danish.[2] 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 programme 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 Faculty of Engineering and Science 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.

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

5.5 Rules and requirements concerning the reading of texts

At programmes 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 European languages. At programmes taught in English, it is assumed that the student can read academic texts 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.

Bemærkninger: Studieordningen er blevet opdateret ift. retskravs- og adgangsgivende uddannelser i juni 2018