AALBORG UNIVERSITY

The Study Board of
Biotechnology, Chemical and
Environmental Engineering

The M.Sc.Eng. Programme in Chemistry

Study Regulations
1st to 4th Semester

The Faculty of Science and Engineering
Aalborg University
2012

Preface

Pursuant to Act no. 985 of 21st October 2009 on Universities (The University Act) the following study regulations are stipulated.

The Study Regulations are approved by the Study Board of Biotechnology, Chemical and Environmental Engineering at Aalborg University. The study regulations cover the Master's Programme in Chemistry in Aalborg.

Aalborg University, ??? 2012

Niels T. Eriksen

Chair of Study Board

Approval date: ??? 2012

Dean of Faculty of Science and Engineering

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Chapter 1. Legal basis of the Study Regulations

1.1 The Ministerial Order Basis

The Master's programme in Chemistry is organized in accordance with the Ministry of Science, Technology and Innovation's Ministerial Order no. 338 of 6 May 2004 on Bachelor's and Master's Programmes at Universities (the Ministerial Order of the Study Programmes) and the Framework Provisions of the Faculty of Science and Engineering.

1.2 The Faculty of Science and Engineering affiliation

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

1.3 The Study Board affiliation

The 1st to 4th semesters of the Master's programme fall under the Study Board for Biotechnology, Chemical and Environmental Engineering.

Chapter 2. Admission, title, programme duration and competence profile

2.1 Admission

Admission to the Master's programme in Chemistry requires a Bachelor's degree in either Chemistry, Environmental Engineering, or Biotechnology, or a similar degree.

2.2 Degree/title in Danish, Latin and English

Successful completion of the Master's programme entitles the student to use the title cand.polyt. i kemi. The corresponding English title is: Master of Science (MSc) in Engineering (Chemistry).

2.3 The programme's specification in ECTS

The Master's programme is a 2-year, research based, full-time study programme. The programme is set to120 ECTS.

2.4 The programme's competence profile

The competence profile below will appear on the diploma:

A graduate of the Master's programme has competences acquired through a course of study that has taken place in a research environment.

A graduate of the Master's programme can handle highly qualified functions in the labour market. In addition, the graduate of the Master's programme has the requirements to undertake research training (a Ph.D. programme). A graduate of the Master's programme has; compared to a Bachelor's degree, developed their professional knowledge and independence, so that they can independently use scientific theory and method within academic as well as business/professional contexts.

Description of qualifications:

Individuals who attain the MSc degree in Chemistry

Knowledge

- Are to have knowledge within chemistry that in selected areas, such as separation technology, materials technology and polymer technology, is based on the highest international research.
- Are to be able, on a scientific basis, to understand and reflect over the knowledge in the above-mentioned areas and be able to identify scientific problems.

Skills

- Are to master the scientific methods and tools of the above-mentioned areas and master the general skills that are tied to work within the area of chemistry.
- Are to be able to evaluate and select among the scientific theories, methods, tools and general skills of biotechnology, and set up, on a scientific basis, new analysis and solution models
- Are to be able to communicate research based knowledge and discuss professional and scientific problems with both peers and non-specialists.

Competences

- Are to be able to carry research and development in the area of separation technology, materials technology and polymer technology.
- Are to be able to independently initiate and carry out discipline specific and cross-disciplinary cooperation and to assume professional responsibility within the

area of chemistry.

- Are to be able to independently take responsibility for their own professional development and specialization.

Chapter 3. Content of the Study Programme

Outline of the Master's programme in Chemistry

Semester	Module		ECTS	Grading	Assessment
1.	Materials Technology		15	7-point scale	Internal
	Materials Chemistry		5	7-point scale	Internal
	Processing of Materials		5	7-point scale	Internal
	Physical Chemistry of Materials		5	7-point scale	Internal
2.	Macromolecular Chemistry		15	7-point scale	Internal
	Polymer Chemistry		5	Pass/fail	Internal
	Supramolecular Chemistry		5	7-point scale	Internal
	Carbohydrate Chemistry		5	7-point scale	Internal
3.	Elec-tives	Individual semester	30	Variable	External
		External studies	30	Pass/fail	
		Long Master's thesis project	30		
4.	Master's thesis Project		30	7-point scale	External

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

Aalborg University organizes a number of cross-disciplinary 5 ECTS modules at 3rd semester. If one or more of these are followed, the master's thesis project will be reduced in size accordingly.

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.

3.1 1st semester – Materials Technology

3.1.1 Materials Technology

English title	*Materials Technology*
Danish title	*Materialeteknologi*
Placement	Autumn, 1st semester
Prerequisites	Inorganic Chemistry, Materials Chemistry, and Materials Physical Chemistry
Aim	To solve material technological problems in connection to industrial production and development
Learning outcomes	After the project unit the students should be able to Knowledge • Account for inorganic materials chemistry, synthesis and materials forming process Skills • Analyse and solve problems related to materials technology • Synthesize and characterize materials Competences • Clarifying the correlations among production process, materials selection, microstructure and properties
Content	Projects will deal with both scientific and industrial problems that should be solved with help of materials chemistry knowledge. Projects cover materials preparation, synthesis, characterization, development, post-treatment and application. Projects should be related to optimization of materials processing or development of

	new materials including nanomaterials. Projects should contribute to scientific understanding of physical and chemical process of materials. Objects of materials are mainly inorganic materials such as ceramics, glasses, cements, composites, refractory materials, thin films, inorganic nano-materials and hybrid-materials.
Duration	15 ECTS
Language	English or Danish
Assessment	Oral examination based on a written report
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.1.2 Materials Chemistry

English title	*Materials Chemistry*
Danish title	*Materialekemi*
Placement	Autumn, 1st semester
Prerequisites	Inorganic Chemistry and Physical Chemistry
Aim	The purposes of the course are to introduce both fundamental chemical principles of materials and nano-materials, and main methods for developing, optimizing, post-treating and characterizing 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 nano-materials 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 Characterization of inorganic materials 2. Nano-materials chemistry • Thin films • Nano-crystals and –particles • Carbon nanotubes and other inorganic nanotubes • Mesoporous materials

	• Nano wires • Production of polymer nanomaterials • Nano-structured polymer
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.1.3 Processing of Materials

English title	*Processing of Materials*
Danish title	*Materialeforarbejdning*
Placement	Autumn, 1st semester
Prerequisites	Material Chemistry
Aim	The purposes of the courses "Processing of Materials" and "Industrial Process Analysis and Environmental Audit" are to introduce students to basic knowledge about materials manufacturing, post-treatment and the impact of the manufacture conditions on the structure and properties of materials. In addition, the course is to introduce students basic knowledge both about the analysis of large-scale industrial systems and about methods and principles of environmental evaluation
Learning outcomes	After courses, students should be able to Knowledge • Clarify the correlations among chemical composition, structure, properties and manufacturing Skills • Conduct calculations of manufacture parameters and mechanical, physical and chemical properties • Apply some materials manufacturing technologies and their engineering applications • Predict certain properties of materials based on their manufacturing parameters • Design manufacturing and post-treatment processes that can improve physical and chemical performances of materials • Carry out analysis of large-scale production process Competences • Use principles and methods for environmental management
Content	Manufacturing of materials is an important task for chemists, chemical engineers in collaborating with mechanical engineers The courses cover the introduction to: • Application areas and development tendencies of plastics • Chemical performances of materials • Manufacturing technology of polymers • Manufacturing technology of ceramics, cements and glasses • Environmental analysis and management • Industrial processes by visiting several companies
Duration	5 ECTS

Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.1.4 Physical Chemistry of Materials

English title	*Physical Chemistry of Materials*
Danish title	*Materialers fysiske kemi*
Placement	Autumn, 1st semester
Prerequisites	Physical Chemistry and Analytical Chemistry
Aim	The course is comprised of two part: "Materials Physical Chemistry" and "Electrochemistry". The course "Materials Physical Chemistry" focuses on the thermodynamics, kinetics and phase transition in materials. The analytical methods for obtaining thermodynamic and kinetic data will be introduced to students. The course "Electrochemistry" aims to give students a deep theoretical and practical understanding of the modern electrochemistry and its applications in connection to quantitative analysis, metallic corrosion and materials manufacturing.
Learning outcomes	After the courses, students should be able to Knowledge • Understand and apply the link between electrochemistry and thermodynamics Skills • Explain and utilize phase diagram of materials • Solve physical chemical problems in the fields of materials science and chemcial processes • Collect and evaluate physical-chemical data by doing experiments such as the viscometric and calorimetric measurements • Design experimental routes for synthesis and treatment of new materials based on physical chemistry principles • Clarifying mechanisms behind the phase transitions • Apply different types of electron-ion conductor junction to understand their electrodynamic, thermodynamic and kinetic backgrounds • Use the different analytical methods based on electrochemical reactions • Apply the knowledge about chemistry, technology and economy of electrochemical processes in materials industry • Design the processes in batteries, accumulators and fuel cells
Content	The Physical Chemistry part covers • Materials thermodynamics • Chemical reaction kinetics and dynamics in materials • Phase equilibrium in materials • Order and disorder in solid • Experimental methods for collecting thermodynamic and kinetic data of materials, e.g., viscometric and calorimetric methods The Electrochemistry part covers • General electrochemistry • Analytical electrochemistry • Application of electrochemistry in materials science

	• Description of electron-ion conductor junction as electrochemical electrode • Electrolytes and their properties, redox reactions, conductivity and determination • Links between electrochemical potentials, thermodynamic parameters and concentrations • Electrochemical methods: Impedance spectroscopy, voltammetry, and other analytical methods and its instrumentation • Type of electrodes, electrode kinetics and electrode related effects • Description of the different type of batteries, accumulators and fuel cells
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.2 2nd semester – Synthesis and Chemistry of Polymers

3.2.1 Macromolecular Chemistry

English title	*Macromolecular Chemistry*
Danish title	*Makromolekylær kemi*
Placement	Spring, 2nd semester
Prerequisites	Organic Chemistry and Physical Chemistry
Aim	To give the students an extensive knowledge of the molecular design of natural and synthetic macromolecules, principles of production and characterisation of polymers from molecular architecture to properties.
Learning outcomes	After the project unit the students should be able to Knowledge • account for the chemistry, production and properties of selected natural and synthetic macromolecules Skills • analyse and solve problems related to industrial use of macromolecules Competences • chose relevant techniques for the characterisation of macromolecules and the study of their applications
Content	Projects will deal with both scientific and industrial problems related to the chemistry and application of macromolecules. Projects could cover macromolecule synthesis, modification and/or, characterisation, as well as, applications of macromolecules. Projects should contribute to a scientific understanding of the physical and chemical properties of macromolecules and their applications.
Duration	15 ECTS
Language	English or Danish
Assessment	Oral examination based on a written report

Grading	7-point scale
Assessment criteria	As stated in the framework provisions

3.2.2 Polymer Chemistry

English title	*Polymer Chemistry*
Danish title	*Polymerkemi*
Placement	Spring, 2nd semester
Prerequisites	Fundamental Organic Chemistry, Experimental Organic Chemistry
Aim	To introduce the students majoring in chemistry or engineering a broad knowledge of polymer chemistry, such as principles of polymerization, polymer morphologies, polymer properties and so on. Meanwhile, some basic experimental techniques will be included in the lab course.
Learning outcomes	After completion of the course the student should be able to Knowledge • Grasp different polymerization principles Skills • Design synthetic routes of functional monomers • Perform polymerization under various conditions • Modify polymer surfaces Competences • Characterize macromolecules: from chemical structure to molecular weights and distributions
Content	• Basic Principles: Molecular weight and polymer solutions, • Chemical Structure and Polymer Properties • Polymer Morphology • Step-reaction and ring opening polymerization and its lab course • Free radical polymerization and its lab course • Ionic Polymerization and its lab course • Vinyl polymerization with complex coordination catalysts • Characterization of polymers, Polyethers, sulfides, and related polymers, Polyamides and related polymers, Heterocyclic polymers, Miscellances orgainc polymers, Inorganic and partially inorganic polymers, Natural Polymers • Recent developments in the frontier research for novel polymerization technique of new materials • Lab course of polymer characterization and property studies
Duration	5 ECTS
Language	English
Assessment	Written report
Grading	Pass/fail
Assessment criteria	As stated in the framework provisions

3.2.3 Supramolecular Chemistry

English title	*Supramolecular Chemistry*

Danish title	*Supramolekylær kemi*
Placement	2nd semester
Prerequisites	Organic Chemistry and Physical Chemistry
Aim	To introduce the students to supramolecular chemistry with focus on the physical chemistry of molecular interactions.
Learning outcomes	After completion of the course the student should be able to Knowlegde • document knowledge of the basic principles of the design of artificial ligands • account for the similarities and differences of the intermolecular forces • Understand the crystalization of macromolecules Skills • be able to make a basic thermodynamic description of molecular interactions account for the importance of solvents and additives on the strength of molecular interactions Apply theroies and methods for the analysis of molecular interactions • apply thermodynamic principles to determine the self-organization of molecules • apply the concepts of solubility parameters Competences • provide quantitative understanding of polymer blends and additives
Content	The course includes lectures and theoretical assignments, including • The basic concepts of supramolecular chemistry • Intermolecular forces and equilibrium considerations • Thermodynamics and solvent effects • Cation-and anion-specific ligands • The supramolecular chemistry of biological systems • The self-organization of molecules • Solvent solubility parameter • Polymer blends and additives • Macro phase and micro phase separation of polymers and block copolymers • Self-assembly of polymers • Crystallization of polymers
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.2.4 Carbohydrate Chemistry

English title	*Carbohydrate Chemistry*
Danish title	*Kulhydratkemi*
Placement	Spring, 2nd semester
Prerequisites	Organic chemistry and biochemistry
Aim	The student will obtain basic knowledge of the chemistry, biology and biosynthesis of carbohydrates as well as carbohydrate active enzymes and their catalytic reaction mechanisms. Furthermore the

	student will obtain knowledge of the structure, function and technical applications of oligo- and polysaccharides regarding industrial production and medical applications.
Learning outcomes	After completion of the course the student should be able to Knowledge • explain and show in depth understanding of the structure and chemical properties of mono- and disaccharides as well as oligo- and polysaccharides • demonstrate basic knowledge of industrially important carbohydrates including hydrocolloids and their gelation properties • explain essential aspects of glycobiology • demonstrate in depth knowledge of the substrate specificity, regio- and anomeric selectivity as well as the function and catalytic mechanisms of carbohydrate active enzymes • demonstrate knowledge of the enzymology related to degradation and modification of plant based biomass including starch, cellulose and pectin. Skills • carry out enzyme catalyzed starch liquefaction and saccharification • carry out enzyme catalyzed organic synthesis of glycoconjugates • carry out enzyme catalyzed organic synthesis of glycoconjugates • perform viscosimetric analysis • perform preparative solid phase extraction of glycoconjugtes and use reversed phase separation and charged aerosol detection for their analysis
Content	The course consists of lectures, theoretical exercises and individual studies focused on the following topics • Nomenclature, structure and isomers of pentoses and hexoses • Conformation of monosaccharides • Structure, chemical and physical properties of mono-and disaccharides, oligo- and polysaccharides • Technical and industrial utilization of carbohydrates including hydrocolloids • Glycosylation and glycobiology • Structure, function and catalytic mechanism of glycoside hydrolases • The cellulosome • Pectinolytic enzymes • Glycoside transferase and glucosidase catalysed reactions • Regioselective synthesis of sugar derivatives and glycoconugates
Duration	5 ECTS
Language	English
Assessment	Written or oral examination
Grading	7-point scale
Assessment Criteria	As stated in the framework provisions

3.3 3rd & 4th semester – Master Thesis

3.3.1 Master thesis project

English title	*Master's Thesis*
Danish title	*Kandidatspeciale*
Placement	3. and 4. semester (long Master's thesis), 4. semester (short Master's thesis)
Prerequisites	Completed 1.-2. semester or 1.-3. semester
Aim	To plan, conduct and report on a larger scientific research project within chemistry.
Learning outcomes	After completion of the project the student should be able to Skills • plan, execute and report an extensive individual research project within an agreed time frame • conduct technological development and research, and solve complicated technical problems using scientific methods Competences • compare and critically evaluate the results of the project in relation to existing knowledge and accepted theories within the subject area • consider economical consequences and impact on society, environmental and safety issues related to the project • communicate a balanced view of the results and conclusions of the project in well-organized written and oral presentation
Content	MSc projects will usually be related to ongoing research at the Section of Chemistry. However, a project might also be conducted in collaboration with a company or a Danish or foreign research institution. The MSc project will normally be carried out individually and contain both theoretical and experimental parts. The project outcome must be presented in an MSc thesis or a scientific paper in agreement with accepted scientific principles, written by the student
Duration	30-60 ECTS
Language	English or Danish
Assessment	Oral examination based on a written report
Grading	7-point scale
Assessment criteria	As stated in the framework provisions

3.4 Problem-based Learning (PBL) and Student Responsibility at Aalborg University

3.4.1 Problem-based Learning (PBL) and Student Responsibility at Aalborg University

English title	*Problem-based Learning (PBL) and Student Responsibility at Aalborg University*
Danish title	*Problembaseret læring og studerendes ansvar for læring på Aalborg University*
Placement	Spring, 2nd semester
Prerequisites	None, but the course is compulsory for students not acquainted

	with the Aalborg PBL model
Aim	To introduce the students majoring in chemistry or engineering a broad knowledge of polymer chemistry, such as principles of polymerization, polymer morphologies, polymer properties and so on. Meanwhile, some basic experimental techniques will be included in the lab course.
Learning outcomes	After completion of the course the student should Knowledge • know about the organization at Aalborg University and where to ask for help in different matters • know about how to communicate both in the project groups and during courses • know how a semester is structured and for the different examination forms used at Aalborg University • know how project work and laboratory work are carried out at Aalborg University including safety issues in the laboratories • know about issues concerning plagiarism and its consequences • know about the software which is used during the study • know about the IT systems used and how to get started • know about the specialist student counselors and how they may provide assistance Skills • be able to use problem-based learning and group work in project and courses at Aalborg University • be able to use Moodle to find lecture plans, timetables, and other relevant information Competences • be able to apply the concepts, theories and methods for problem-based learning and group work • be able to account for the considerations involved in the process of formulating project reports in practice.
Content	Lectures, discussions and group work. The course will take place during two Wednesday afternoons.
Duration	
Language	English
Assessment	Internal assessment during the course/class participation according to the rules in the Examination Policies and Procedures, Addendum to the Framework Provision of the Faculty of Engineering and Science, Aalborg University. In this case the assessment is primarily based on the oral performance during the course. This 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 and a precondition for participation in the project examination for those who are not acquainted with the Aalborg PBL model. Consequently, no diploma will be issued for the course nor will it appear on the academic transcripts.
Grading	Passed/failed
Assessment criteria	As stated in the framework provisions

Chapter 4. Entry into force, interim provisions and revision

The study regulations are adopted by the Study Board of Biotechnology, Chemical and Environmental Engineering, approved by the Dean of the Faculties of Engineering, Science and Medicine and take effect from 1st September, 2010.

Students who wish to complete their studies under the former study regulations from 2007 must conclude their education by the summer examination period 2010 at the latest, since examinations under the former study regulations are not offered after this time.

In accordance with the Framework Provisions and the Handbook on Quality Management for the Faculties of Engineering, Science and Medicine at Aalborg University, the study regulations must be revised 5 years at the latest after their taking effect.

The current, valid version of the study regulations is published at www.ses.aau.dk.

Chapter 5. Chapter 5: Other rules

5.1 3rd semester

On the 3rd semester in accordance with the framework provisions section 5.3 the students have on their own initiative the following options instead of an ordinary project.

- Documentation of the semester project through a scientific article
- Individual project preparing a scientific report or article
- Transversal studies
- Relevant internship
- Long dissertation (Master thesis) on 3rd and 4th semester on programmes experimental in nature.

The particular wishes of the students must be approved by the study board prior to semester start.

5.2 Rules for written assignments including the Master's thesis and its scope

An evaluation of the student's spelling and writing ability enters into the assessment of all written work, regardless of what language it is written in. Orthographic and grammatical correctness and stylistic proficiency are taken as a basis for the evaluation of language performance. Language performance must always enter in 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 above applies unless other rules are stated in connection with the individual examination.

The Master's thesis must include a summary in a foreign language (English, French, Spanish or German subject to the study board's approval). If the project is written in a foreign language (English, French, Spanish or German) the summary can be written in Danish subject to the study board's approval. The summary must be at least 1 page and may be at most 2 pages (the summary is not counted in any fixed minimum and maximum page count per student). The summary enters into the evaluation of the project as a whole.

5.3 Credit transfer

Students with other programme elements from other Master's programmes can obtain credit/admission subject to the study board's evaluation of the individual application (meritering).

5.4 Rules for the maximum period of enrolment

The Master's programme must be completed within 4 years at the latest following enrolment, excluding leaves of absence.

5.5 Rules for examinations

The rules for examinations appear in "Examination Policies and Procedures" published on the Faculties of Engineering, Science and Medicine's website www.tek-nat.aau.dk.

5.6 Exemption

In the case of unusual circumstances, the study board can grant exemptions from those parts of the study regulations that are not fixed by law or ministerial order. Exemption regarding an examination applies to the immediate examination.