Curriculum for the Master’s Program in **Biomedical Engineering**

The Faculties of Engineering, Science and Medicine
Aalborg University
2010
COMMENTS AND REQUIREMENTS FOR STRUCTURING THE CURRICULUM FOR MASTER’S PROGRAMS

Introduction
The curriculum must be structured in modules of 5 ECTS credits (normally following a 15+5+5+5 structure). In each semester, there must be a project equal to a minimum of 15 ECTS credits. For each module, there must be an examination. One module can be examined in conjunction with another module. For each module, knowledge, skills and competencies are described.

The curriculum for Danish programs must be written in Danish (module descriptions, however can be in English). Curricula for international Master’s programs must be written in English.

In preparation for the administrative procedures at the faculty office, please send the “studieordningsoversigt” (see http://ins.aau.dk/Uddannelser/2332967) to the faculty together with the curriculum.

The curriculum is designed with the use of:
- The present template for the structure
- Instructions for descriptions of modules in curricula
- “New Danish Qualifications Framework for Further Education Programs” (in Danish only) http://www.uvm.dk/~media/Files/Udd/Videre/PDF07/07_europaeisk_kvalifikationsramme.ashx
- Inspirational material regarding the Danish Qualifications Framework (in Danish only)

A maximum of 1/3 of the program may be evaluated as Pass/Fail. This requirement is normally satisfied by grading according to the 7-point scale in all projects or the like.

A minimum of 1/3 of the program must be evaluated by external grading. There must be external grading of the Master’s thesis.

Competence profile and descriptions
A standard competence profile is entered into the template that is also included on the student’s diploma (Section 2.4). In addition, there must be a more detailed description of the competence profile that is divided into knowledge, skills and competencies (Section 2.5). The description of the level for Master’s programs from the Danish Qualifications Framework is also included and must be specified in relation to the relevant program.

Instructions and examples
Instructions in the template are marked in red and in parentheses. Examples and text that can be used as a starting point are marked in red.
Preface:
Pursuant to Act 985 of October 21, 2009 on Universities (the University Act) with subsequent changes, the following curriculum for the Master's program in Biomedical Engineering is stipulated. The program also follows the Framework Provisions and the Examination Policies and Procedures for the Faculties of Engineering, Science and Medicine.
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Chapter 1: Legal Basis of the Curriculum, etc.

1.1 Basis in ministerial orders
The Master’s program in Biomedical Engineering is organized in accordance with the Ministry of Science, Technology and Innovation’s Ministerial Order no. 338 of May 6, 2004 on Bachelor’s and Master’s Programs at Universities (the Ministerial Order of the Study Programs) and Ministerial Order no. 867 of August 19, 2004 on University Examinations (the Examination Order) with subsequent changes. Further reference is made to Ministerial Order no. 52 of January 28, 2009 (the Admission Order) and Ministerial Order no. 250 of March 15, 2007 (the Grading Scale Order) with subsequent changes.

1.2 Faculty affiliation
Kandidatuddannelsen hører under De Ingeniør-, Natur- og Sundhedsvidenskabelige Fakulteter, Aalborg Universitet. The Master’s program falls under the Faculties of Engineering, Science and Medicine, Aalborg University.

1.3 Board of Studies affiliation
The Master’s program falls under the Board of Studies for Biomedical Engineering and Sports Science

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

2.1 Admission
Admission to the Master’s program in Biomedical Engineering requires a Bachelor’s degree in Biomedical Engineering or the like.
(Insert all admission-qualifying Bachelor’s programs from other Danish universities – see the Coordinated Enrollment System (KOT) booklet)

Students with another Bachelor's degree, upon application to the Board of Studies, will be admitted after a specific academic assessment if the applicant is deemed to have 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 Sundhedsteknologi. The English designation is: Master of Science (MSc) in Biomedical 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 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:

The graduate of the Master’s program:

Knowledge and comprehension
- has knowledge of scientific communication and statistical methods (including experimental design and clinical studies) and of at least two of the following key areas within BME, based on the highest international level of research within the areas,
  • Signal processing and image analysis,
  • Pattern recognition /decision support,
  • Clinical information systems,
  • Sensory-motor control,
  • Rehabilitation technology,
  • Physiological/metabolic modeling,
- understands knowledge within the selected key areas of BME and is able to reflect on a scientific basis about this knowledge, and is able to identify scientific problems, either related to clinical research or basic research, within the area;

Skills
- masters the BME’s scientific methods and tools, and masters general skills related to jobs within BME, either within the health care environment or in industry,
- is able to judge and to choose from the discipline’s scientific theories, methods, tools and general skills, and is able, on a scientific basis, to propose new models for analysis and problem solving within BME,
- is able to communicate research based knowledge and is able to discuss professional and scientific problems with fellow biomedical engineers, with health care personnel, including medical specialists, as well as with non-specialists;

Competencies
- is able to control situations that are complex, unpredictable and which require new solutions,
- is able to independently initiate and to perform collaboration within the discipline and interdisciplinary as well, and to take professional responsibility,
- is able to independently take responsibility for his or her 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:**

An overview of the ECTS credit breakdown for the various semesters by modules is shown in table form below.

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).

<table>
<thead>
<tr>
<th>Semester</th>
<th>Module</th>
<th>ECTS</th>
<th>Assessment</th>
<th>Exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>Project 1 – Processing and interpretation of medical signals and information</td>
<td>15</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Scientific methods and communication</td>
<td>5</td>
<td>Pass/Fail</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Elective 1.1</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Elective 1.2</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>2nd</td>
<td>Project 2 – Analysis and design of medical (information) systems</td>
<td>15</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td></td>
<td>Elective 2.1</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Elective 2.2</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td></td>
<td>Elective 2.3</td>
<td>5</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>3rd</td>
<td>Project 3 – Applied biomedical engineering and informatics (can be combined with 4th semester into a 60 ECTS points Master’s thesis)</td>
<td>30 or none</td>
<td>7-point scale</td>
<td>Internal</td>
</tr>
<tr>
<td>4th</td>
<td>Master’s thesis (can be combined with project 3)</td>
<td>30 or 60</td>
<td>7-point scale</td>
<td>External</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Elective courses 1.1 and 1.2 have to be chosen from
1.a Stochastic signals and processes
1.b Pattern recognition and decision support
1.c Databases and information systems
1.d Sensory-motor control

Elective courses 2.1, 2.2, and 2.3 have to be chosen from
2.a Advanced Signal Processing (requires 1.a)
2.b Image analysis and computer vision (requires 1.b)
2.c Software system development (requires 1.c)
2.d Rehabilitation technology (requires 1.d)
Description of the modules (projects and courses)

Title: Project 1 - Processing and interpretation of biomedical signals and information
Projekt 1 – Behandling og fortolkning af medicotekniske signaler og information

Prerequisites: Scientific methods and communication, running parallel with the project at the latest.

Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Project
Exam format: Oral
Title: Scientific methods and communication / Videnskabelige metoder og kommunikation

Prerequisites: None

Objective: Students who complete the module

Knowledge
- understand the scientific communication processes related to conference presentations and related to publishing in peer-reviewed scientific journals
- are able to organise a scientific publication
- have knowledge of qualitative and quantitative research methods.
- have knowledge of experimental designs
- have knowledge of validity and reliability of outcome measures
- understand bias and statistical power in experimental designs
- understand principles of epidemiological research designs
- understand evidence-based medicine
- understand and can reflect on proper conduct in scientific projects
- understand and can reflect on ethical concerns in biomedical sciences

Skills
- explain the principles of hypothesis-driven research and descriptive research
- critically read and judge experimental protocols in scientific articles
- design an experimental protocol in relation to a scientific project
- discuss principles for creating new and validated knowledge
- explain the process of and criteria for peer reviewed scientific communications
- discuss the importance of research ethics
- write an abstract for a scientific meeting and to respond to blind peer-review criticism.
- prepare a poster and an oral presentation for a scientific meeting

Competencies
- set up a plan for getting an overview of existing knowledge within a scientific/technical topic
- prioritize the validity of various sources of scientific information
- evaluate scientific presentations from a communicative viewpoint
- judge the validity of scientific literature

Type of instruction: Lectures and exercises

Exercises associated with the lectures will mainly be concerned with gradually creating an abstract describing the student group’s project work. Drafts prepared by the students are discussed with the lecturer and its iterative generation is related to the work plan for the project effort. Exercises will also focus on how to design experiments in order to be able to confirm or reject a hypothesis related to the project work.

The culmination of the course is the SEMCON one-day-conference at the end of the semester, to which each student group contributes:
1) An abstract will be submitted online after which the abstract will be reviewed by an anonymous researcher. The group has to respond to the reviewers comments and change the abstract accordingly and resubmit it
for publication in the conference program.
2) A poster, to be mounted and presented on the conference day.
3) A short oral presentation.

Exam format: (The type of examination is described here. Any requirements concerning class participation must appear here.)


**Title:** Stochastic signals and processes  
**Stokstiske signaler og processer**

Prerequisites: None
Objective: Students who complete the module:

*Knowledge*
- Must have knowledge about…
- Must be able to understand…

*Skills*
- Must be able to apply…
- Must be able to evaluate…

*Competencies*
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam

**Title:** Pattern recognition and decision support  
**Mønstergenkendelse og beslutningsstøtte**

Prerequisites: None
Objective: Students who complete the module:

*Knowledge*
- Must have knowledge about…
- Must be able to understand…

*Skills*
- Must be able to apply…
- Must be able to evaluate…

*Competencies*
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam

**Title:** Databases and information systems
**Databaser og informationssystemer**

Prerequisites: None
Objective: Students who complete the module:

*Knowledge*
- Must have knowledge about…
- Must be able to understand…

*Skills*
- Must be able to apply…
- Must be able to evaluate…

*Competencies*
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam

**Title:** Sensory-motor control
**Sensorisk-motorisk kontrol**

Prerequisites: None
Objective: Students who complete the module:

*Knowledge*
- Must have knowledge about…
- Must be able to understand…

*Skills*
- Must be able to apply…
- Must be able to evaluate…

*Competencies*
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam
Title: Project 2 – Analysis and design of biomedical (information) systems
Projekt 2 – Analyse og design af medicotekniske (informations) systemer

Prerequisites: Project 1 and elective courses 1.1 and 1.2

Objective: Students who complete the module:

Knowledge
• Must have knowledge about…
• Must be able to understand…

Skills
• Must be able to apply…
• Must be able to evaluate…

Competencies
• Must have…

Type of instruction: Project

Exam format: Oral exam


Title: Advanced signal processing
Avanceret signalbehandling

Prerequisites: 1.a Stochastic signals and processes

Objective: Students who complete the module:

Knowledge
• Must have knowledge about…
• Must be able to understand…

Skills
• Must be able to apply…
• Must be able to evaluate…

Competencies
• Must have…

Type of instruction: Lectures and exercises

Exam format: Written exam


Title: Image analysis and computer vision
Billedbehandling og computer vision
Prerequisites: 1.b Pattern recognition and decision support

Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Lectures and exercises

Exam format: Written exam


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Prerequisites: 1.d Sensory-motor control

Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Lectures and exercises

Exam format: Written exam


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Prerequisites: 1.c Databases and information systems

Objective: Students who complete the module:
Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam

Title: Physiologic modelling
Fysiologisk modellering

Prerequisites: None
Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Lectures and exercises
Exam format: Written exam

Title: Project 3 – Applied biomedical engineering and informatics
Projekt 3 – Anvendt sundhedsteknologi of informatik

Prerequisites: Participants’ prerequisites for the module
Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…
Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Project
Exam format: Oral exam

Title: Master thesis
Speciale projekt

Prerequisites: Participants’ prerequisites for the module
Objective: Students who complete the module:

Knowledge
- Must have knowledge about…
- Must be able to understand…

Skills
- Must be able to apply…
- Must be able to evaluate…

Competencies
- Must have…

Type of instruction: Project
Exam format: Oral exam
Chapter 4: Entry into Force, Interim Provisions and Revision

The curriculum is approved by the Dean of the Faculties of Engineering, Science and Medicine and enters into force as of September 2010.

Students who wish to complete their studies under the previous curriculum from 2009 must conclude their education by the summer examination period 2012 at the latest, since examinations under the previous curriculum 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 curriculum must be revised no later than 5 years after its entry into force.

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 Framework Provisions 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

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

Completion of the Master's program
The Master’s program must be completed no later than four years after it was begun.

Rules and requirements concerning the reading of texts in foreign languages and a statement of the foreign language knowledge this assumes
It is assumed that the student can read academic texts in English.