



Chapter 9

The programme specific part of the curriculum for:

MASTER OF SCIENCE (MSc) IN ENGINEERING (INNOVATION AND BUSINESS)

Study Start: September 2011, Version 1.1

The curriculum is divided into general provisions (Chapters 1-8), a programme specific part (Chapter 9) and the module descriptions for the subjects studied for each programme. Students should familiarise themselves with all three parts in order to acquire a full overview of the rules that apply throughout the study programme.

§1 Job profiles

Innovation and Business is a master of science in engineering that combines innovation, business and engineering courses. The student becomes a market-oriented engineer who is able to deal with different types of products in which business skills and technology assessment are combined. A master of science in Innovation and Business provides the students with special core competencies within the following areas:

- Creativity, Design and Innovation management skills for managing innovation and developing product and business concepts
- Product driven entrepreneurship with emphasis on developing primarily mechatronic products
- Solid competencies in business administration and marketing for evaluating market and business opportunities
- Elaborated skills in Mechatronics

These competences enable the graduate to work in various jobs, especially interdisciplinary and cross-functional job functions are areas where the combination of both business and engineering skills could be utilized. Understanding the process from development of product ideas to develop a business plan makes the graduate an important link between various specialists within an organization. Emphasizing the international dimension during the education fosters opportunities within more global job functions. Finally, graduates have the possibility to pursue a career within academia. Possible job profiles for a graduate are:

- **Open Innovation Engineer**
The Open Innovation engineer is able to create in an open R&D environment. His oral and written communication skills allow him/her to exchange and realize ideas creatively and dynamically. The profound economical and technological knowledge allows him/her to recognize and realize market-oriented ideas faster and better than the competitors
- **Innovation Manager**
The Innovation Manager is able to coordinate and lead the innovation development process. His communicative, economical and technological skills allow him/her to manage innovation development across different departments and across companies.
- **Business Developer**
The Business Developer/Innovator is able to detect and analyze signals for change and development on the corporate level as well as on the institutional or regional level, in order to develop bearing strategies that are both economically and technologically sound. His/Her specific communication skills together with the profound knowledge of economies and technology allow him/her to coordinate and mediate between the institutional level and the corporate level.
- **Entrepreneur**
Entrepreneurs who are willing to combine expertise and entrepreneurship are able to take the challenge to develop, market, and manage an own idea from the beginning through to the end. Graduates of Innovation and business acquired the needed skills to develop an own product and to market it.

- **Innovation Process Designer**

The Innovation Process Designer is able to develop, to implement and to orchestrate the interdisciplinary and multidimensional process of innovation, independently of whether this process is situated on the institutional or the corporate level.

- **Strategic Procurement Engineer**

The strategic procurement engineer has the economical and technological knowledge as well as the communicative skills to adjust and coordinate institutional supply and demand with market supply and demand. While he/she does this he/she applies his/her knowledge in order to identify market chances and foster technologies that best serve the institutional medium and long-term goals, e.g. wind energy, sustainable materials, water management, waste management, etc.

- **Researcher (ph.d.-Student)**

The graduate has the possibility of entering academia and pursuing an academic career within the university. The societal demand for knowledge and innovation as a means to gain competitive advantage and improve quality of life increases the need for innovation researchers.

§2 Competence profile of the education

The student should after graduating as Master of science in Engineering in Innovation and Business have solid competences within the fields of mechatronics, innovation and business. The education will enable the students to handle the process from exploring and discovering new ideas to planning, managing and finally realizing an own business idea or concept, and the student has gained the knowledge to start up their company or to proceed with a career in industry or academia.

The graduate will have acquired the following competencies.

- Can understand, apply and reflect upon knowledge on an international research level within one or more subjects of the subject columns of the education
- Can understand and reflect upon the existing knowledge within the subject areas in a scientific way
- Is able to identify relevant scientific research problems within the subject area presented in the subject columns
- Can apply and evaluate different scientific methods and use them in relation to scientific writing
- Is able to evaluate the innovation process and select and realize promising product and business ideas. Through advanced innovation management skills, the student can from a theoretical point of view assess the innovation process. This encompasses analyzing both intra-organizational as well as inter-organizational aspects affecting how innovations should be managed and supported. The student can then identify and evaluate value networks in which there could exist potential for the co-creation of value important for growth and competitiveness
- Is able to understand the complexity and diversity of developing products and managing a project. Understanding the complexity is achieved through advanced skills in understanding the collaborative design process, product development techniques, project management methods and other working methods. Further, the student is able to analyze, plan and organize a project as well as use social competencies in the management process
- Is able to understand and apply design thinking and design approaches in the development of new products or business concepts
- Is able to apply advanced knowledge in mechatronics enabling the student to participate in development activities in industry or as entrepreneurs in the start up of their own company.
- Is able to analyze and evaluate business opportunities. Advanced competences in business administration enable the student, in a scientific way to evaluate business opportunities, integrating external information about e.g. markets, competitors, customers etc.

§3 Subject columns of the study programme

The competences are acquired by studying the topics in the below listed subject columns during the programme.

Innovation management

- Strategic innovation management
- Innovation process
- Internal and external innovation competences
- Value networks
- Customer/user innovation
- Controlling and budgeting innovation activities

Scientific methods

- Philosophy of science
- Academic writing skills
- Problem formulation and literature review
- Research methods
- Collecting, analyzing and interpreting data

Entrepreneurship and project management

- Business plan development and implementation
- Raising venture capital
- Establishment of a business/company
- Operation management and facilities
- Supply chain management
- Quality management
- Project management methods

Design and creativity

- Design thinking
- Design studies
- Professional roles (participatory innovation, social design and human centered design)
- Innovation and technology visions
- Creativity techniques
- Barriers to creativity

- Creativity organizations

Business administration and management

- Company analysis
- Management accounting
- Cost measurement
- Investment
- Financing
- Budgeting
- Organization design and changes
- Organizational management and strategy
- Technology management
- Marketing in a company or organization
- Global marketing management
- Consumer and business to business marketing
- Internet commerce

Mechatronic Product Development

A: Mechanical product development and manufacturing

- Methodical product development
- Sketching techniques
- 3 D modeling
- User-experienced design
- Selection of materials and technology
- Engineering mechanics
- Mathematical modelling
- Product documentation for preparing manufacturing
- Design review
- Prototyping
- Machine elements
- Strength of materials
- Operation management
- LEAN production
- Computer simulation of manufacturing

B: Intelligent electronic product development

- Electronic circuits and components
- Electronic simulation
- Analyzing and designing analogue circuit-realized systems
- Building LAB models
- Digital hardware design
- Embedded software
- Data communication
- Microprocessor/controller systems
- Programming
- Transducers, actuators and sensors
- Mathematical modelling

Personal competences:

- Communication skills
- Analytical and critical reflection skills
- Independent
- Creative and innovative
- Management skills
- Collaboration and process-oriented skills

§4 The semester themes of the study programme:

The study programme is on the master level not divided into semester themes which is the case for the bachelor level.

§6 Description of the 7th semester

VALUE ARGUMENT

The 7th semester introduces the students to different perspectives on innovation. The students learn about how innovation can be managed from a theoretical point of view as well as how innovation is understood and managed in practice. Thus, the semester combines theoretical and practical aspects of innovation. Furthermore, the students decide on a business or a technical elective. The knowledge provided will enhance the students' capabilities within strategic innovation management, innovation practice as well as enhance their competencies within a specific business or technology subject. This prepares them for the coming semesters where the gained understanding should be used in other related innovation courses as well as in the technical or business courses. The content of the courses provides the students with the foundation for coping with the courses defined in the 8th and 9th semester. The courses on the 7th semester should therefore provide the first steps on a more advanced ladder of knowledge which will be offered in the 8th and 9th semester.

The master programme gives the students the possibility of designing their studies flexibly and according to their interests. This means that the students can focus more on business or technology depending on their preferences. In the 7th semester the students have the choice of following either a business or a technical elective. The technical courses offered will be announced before the semester starts.

COMPETENCE GOALS

The competence goals for the 7th semester are the following:

- Be able to understand and apply relevant theory, models, concepts and methods within Strategic Innovation Management, Design , Business and Technology
- Be able to define relevant research problems within the central subject areas such as e.g. innovation management
- Be able to integrate relevant sources when answering research problems
- Be able to apply the gained knowledge on real-life cases
- Be able to present findings and structure a presentation
- Be able to apply scientific methods in academic writing

MODULES

The 7th semester contains the following modules:

IBSTM– Strategic Innovation Management (10 ECTS)

IBINP – Innovation Practice (10 ECTS)

Electives equivalent to 10 ECTS:

- Business: BPL – The Business Plan (10 ECTS)
- Technology: MCIECS – Introduction to Embedded Control Systems (10 ECTS) or MCCOS – Control Systems (10 ECTS)

IBSTM and IBINP are constituent, obligatory modules.

CONTEXT

IBSTM: The course will answer fundamental questions such as: What is an innovation? What are the challenges of cross-functional coordination? How does culture support or hold up from innovating? What are emerging trends in innovation management?

IBINP: The course deals with conceptions of the innovation process in industrial organisations. The complex relational view on industrial practice. The role of collaboration in the innovation of new products and services. The relationship between design and innovation. Practical organization of co-innovation activities. Business modeling with design materials. As this is a research field in rapid development, lectures will be based on conference papers, and students will learn to write a short scientific argument, in which they relate their own practice to project experience and literature.

The electives consist of either a business course or a technical course. The business course offered in 2011 consists of the module BPL (10 ECTS). The technology course in 2011 consist of either the module MCIECS (10 ECTS) or the module MCCOS (10 ECTS). Whether the student takes the business or the technology intro module depends on their interests. The focus in BPL is to provide the student with a comprehensive framework for developing and implementing a business plan. MCIECS is an introductory project that provides students with basic knowledge and practical skills needed to continue their studies in the following semesters. The scope and contents of the project are determined depending on the background and previous experience of the students. MCCOS aims at providing graduate students with knowledge on theoretical and practical elements of control systems based principally on state-space theory.

§7 Module Descriptions: 7th Semester

Module descriptions for Msc (Eng) study programme in Innovation and Business, applicable for students enrolled in September 2011 are available in the Course Database under Course Descriptions: Autumn 2011.

§8 Description of the 8th Semester

VALUE ARGUMENT

Innovation by businesses is achieved in many ways, with much attention given to formal research and development for radical innovations. However, innovations can also emerge from less formal learning-by-doing modifications of practice, by combining professional experience and in many other ways. The profiling course running on the 8th Semester intends to discuss the variety of sources that can lead to both radical and incremental innovations seen from a firm perspective. Knowledge on how companies can profit from innovation in value networks is discussed. The value creation that can happen in the complex nature of value networks is thus considered and the variety of sources of innovation is emphasized. Regarding user innovation as one possible source, a great deal of innovation is done by those actually implementing and using technologies and products as part of their everyday lives. Further, users may also reveal their innovations, using methods like open source, sharing knowledge within networks of innovation or other types of user communities in order to stimulate and discover new innovation potential. The purpose is thus, to give the students a thorough understanding on an international research level, of the complex nature of how different sources of innovation can influence and mediate innovation processes and how.

Emphasizing that the programme should have a certain degree of flexibility the students can in the 8th semester choose if they prefer to follow a more business oriented path or a more technology oriented path. In particular this means that the students can decide if they would like to enhance their knowledge within the field of participatory innovation building upon the knowledge gained in the 7th semester course Innovation Practice. Alternatively, if the students should like to deepen their knowledge within business they can choose the course “Organizational Management and Strategy”

Moreover, the students will get a deeper understanding of mechatronic design and the confidence and knowledge to undertake mechatronic design and build projects.

Finally, students will get familiar with how to conduct scientific work and write academic papers. In the course MCSMS the students will learn how to build a research design and construct their arguments accordingly.

COMPETENCE GOALS

The competence goals for the 8th semester are:

- Be able to understand how theoretical perspectives can be used to explain distributed innovation in value networks and how the linkages between these perspectives help to explain how innovation unfolds and can be managed
- Be able to use and apply theoretical and empirical support— both orally and in writing—to explain the sources of innovation.
- Be able to define relevant research problems within the above subject areas and make an appropriate research design, including research question, literature review, methodology and findings.
- Be able to understand and analyze advanced issues concerning mechatronics design

MODULES

The 8th semester contains the following modules:

- IBINV – Innovation in Value Networks (10 ECTS)
- MCSMS – Scientific Methods (5 ECTS)
- NAMDB1 – Mechatronics Design and Build (5 ECTS)
- Electives equivalent to 10 ECTS

The modules IBINV, NAMDB1 and MCSMS are constituent, obligatory modules.

CONTEXT

IBINV: This module deals with distributed sources of innovation by exploring different aspects of the innovation process that go beyond the boundaries of the firm. The course will particularly focus on the fact that innovation is result of the combination of knowledge and often requires firms to look outside for sources of knowledge and innovation.

NAMDB1: The courses NAMDB1 and NAMDB2 (5 ECTS each) provide students with an understanding of the Mechatronic Design Process. This involves knowledge about the ability to interface sensors and actuators to computers to provide data acquisition and control of mechatronic systems etc.

MCSMS: The goal of the course is to provide students with knowledge in scientific research methods. It will help the students to go through the theoretical and practical topics affecting the research process from start to finish. Within this course students will learn to provide the information that will allow solving managerial as well as research problems.

The electives: The students can choose between a business and a technical elective. The optional courses will be announced before semester start.

§8 Module Descriptions: 8th Semester

Module descriptions for Msc (Eng) study programme in Innovation and Business, applicable for students enrolled in September 2011 are available in the Course Database under Course Descriptions: Spring 2012.

§9 Description of the 9th Semester

VALUE ARGUMENT

The purpose of the 9th semester is to present the students to the multidisciplinary field of innovation research. Thus, the students will learn how to orient themselves on the map of innovation research and further understand interconnections, and to creatively apply and visualize the knowledge gained in the course. The student will also get advanced knowledge within the field of mechatronics building upon the knowledge gained in the previous semester. Finally, a business or a technical elective is offered, which can be seen as either the last building block in a three course business pillar or for those students having emphasized the technical courses as an opportunity to get more detailed knowledge on a business subject.

COMPETENCE GOALS

The competence goals for the 9th semester are:

- Be able to understand the main body of knowledge presented within the field of innovation research and apply relevant theory, models, concepts and methods on specified research problems.
- Be able to understand and analyze advanced issues concerning mechatronics design
- Be able to define relevant research problems within the profiling course and academic writing course
- Be able to understand and analyze research problems within a specific business context
- Be able to integrate relevant sources on an international research level when answering research problems

MODULES

The 9th semester contains the following modules:

Programme option 1:

IBDIN – Dynamics of Innovation (10 ECTS)
NAMDB2 – Mechatronics Design and Build (5 ECTS)
IBTPR – Thesis Proposal (5 ECTS)
Electives equivalent to 10 ECTS.

Or

Programme option 2:

IBDIN – Dynamics of Innovation (10 ECTS)
NAMDB2 – Mechatronics Design and Build (5 ECTS)
THS – Master Thesis (10 ECTS)
Elective equivalent to 5 ECTS

The modules IBDIN, NAMDB2 are constituent, obligatory modules.

CONTEXT

IBDIN: The course IBDIN (10 ECTS) views innovation as a social process where interactive learning between different actors (e.g. suppliers/producers, customers/users, universities, public procurers) is a central element.

NAMDB2: The aim of the module is to provide students with the opportunity to carry out research-orientated design and build projects in the general area of Mechatronics. The available projects will reflect the research interests of faculty within the Mads Clausen Institute as well as the interests of the students. Projects will, for example, encompass smart actuators (modelling and control), embedded systems and control engineering for a variety of different applications.

IBTPR: The students choose a topic relevant for the programme. Based on a comprehensive literature survey the students argue for their research problem, the chosen methodology and the data gathering technique/-s.

THS: The students choosing Programme option 2 will select a problem of interest and commence a 40 ECTS master thesis, which is to be completed in the 10th semester.

The elective module has a workload of either 10 ECTS or 5 ECTS depending on the choice of programme option. The students have the choice between a number of electives. The optional courses will be announced before semester start.

§10 Module Descriptions: 9th Semester

Module descriptions for Msc (Eng) study programme in Innovation and Business, applicable for students enrolled in September 2011 are available in the Course Database under Course Descriptions: Autumn 2012.

§11 Description of the 10th Semester

VALUE ARGUMENT

The student shall through the selected problem document his/her engineering-specific competencies attained during his/her work with a limited, relevant and engineering-specific subject.

COMPETENCE GOALS

The student

- shall be acquainted with relevant engineering skills based on the highest level of international research within the subject area of the course
- shall attain a good understanding of - and be able to reflect on - relevant knowledge within the subject area of the course
- shall be able to identify relevant scientific problems within the subject area of the course and be able to formulate clear and relevant research questions
- Shall be able to identify and review the relevant scientific literature and based on a literature review be able to develop a conceptual framework guiding the empirical work
- shall be able to apply scientific methods and tools within the subject area of the course
- shall be able to assess, select and apply scientific methods, tools and competencies within the subject area of the course
- shall be able to present novel analysis and problem-solving models
- shall be able to explain and discuss relevant professional and scientific problems
- shall be able to manage work and development situations that are complex and unforeseen and require new solution models
- shall be able to independently initiate and carry out discipline-specific and cross-disciplinary cooperation and to assume professional responsibility
- shall be able to independently take responsibility for his/her own professional development and specialization
- shall be able to disseminate research-based knowledge
- Shall be able to set up a clear framework for the thesis including a proper scientific structure with balanced sections
- shall be able to communicate in a clear and understandable manner

MODULES

10th semester contains:

THS – Master's Thesis (30 ECTS)

The module THS is a constituent, obligatory module.

§12 Module Descriptions: Semester 10

Module descriptions for Msc (Eng) study programme in Innovation and Business, applicable for students enrolled in September 2011 are available in the Course Database under Course Descriptions: Spring 2013.

§13 Qualifying Exams for Admission

1. Bachelors with automatic claim for admission

BSc (Eng) in Innovation and Business

Bachelors of Science in Engineering (Innovation and Business) from the Faculty of Engineering at the University of Southern Denmark have an automatic claim for admission on the MSc (Eng) in Innovation and Business study programme.

2. Other qualifying bachelor exams (from the University of Southern Denmark)

BSc (Eng) in Product Development and Innovation

Bachelors of Science in Engineering (Product Development and Innovation) from the Faculty of Engineering at the University of Southern Denmark are immediately entitled to admission for the MSc (Eng) in Innovation and Business study programme.

BEng in Interaction Design

Bachelors of Engineering in Interaction Design from the Faculty of Engineering at the University of Southern Denmark are immediately entitled to admission for the MSc (Eng) in Innovation and Business study programme.

BEng in Mechatronics

Bachelors of Engineering in Mechatronics from the Faculty of Engineering at the University of Southern Denmark are immediately entitled to admission for the MSc (Eng) in Innovation and Business study programme.

3. Other qualifying exams

BSc (Eng) and BEng from other universities

Bachelors of Science and Bachelors of Engineering from other Danish and foreign universities as well as other applicants with a corresponding education can be admitted to the study programme of MSc (Eng) in Innovation and Business. Such an admission is subject to an individual assessment of whether the applicant's academic qualifications correspond to those of the abovementioned BSc (Eng) / BEng from the Faculty of Engineering at the University of Southern Denmark.

§ 14 External examiners and Study Board

The study programme belongs under the Academic Study Board of the Faculty of Engineering and the Danish corps of external examiners for engineering education. Modules offered by the Faculty of Social Sciences belong under corps of the external examiners for social sciences.

§ 15 Entry into Force and Amendments

1. Approved by the Academic Study Board of the Faculty of Engineering and the Director of Studies on behalf of the Dean of the Faculty of Engineering 20th August 2010.
2. Study start September 2011 approved by the Academic Study Board of the Faculty of Engineering and the Director of Studies on behalf of the Dean of the Faculty of Engineering 20th September 2011.
3. Amendments approved by the Academic Study Board of the Faculty of Engineering and the Director of Studies on behalf of the Dean of the Faculty of Engineering 21st June 2012 (Version 1.1)