UNIVERSITY OF SOUTHERN DENMARK

Chapter 9

The programme specific part of the curriculum for:

Bachelor i teknisk videnskab (Innovation og business)

Bachelor of Science (BSc) in Engineering (Innovation and Business)

Curriculum 2015, Version 1.0

Applicable to students admitted September 2015 onwards

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 Profile

The study programme of Bachelor of Science in Engineering (Innovation and Business) combines mechatronics, innovation and business.The graduate is a market-oriented engineer who can discover and create new business opportunities based on a mechatronics technology platform. The graduate has special core competencies in:

- Mechatronics (mechanics, electronics and programming skills)
- Creativity skills for developing new product and production ideas
- Innovation management and participatory innovation
- Entrepreneurship
- Project management, team work and professional roles

These competences enable the graduate to work in various jobs, especially in interdisciplinary and cross-functional job functions. Jobs where the combination of both engineering and business competencies could be utilized. Understanding the process from development of new ideas to developing prototypes and testing to finnaly writing a business plan makes the graduate an important link between various functions and specialists within an organization. Emphasizing the international dimension during the education fosters opportunities within more global job functions Further, the programme has the intention to create new start-up companies and students could therefore also become entrepreneurs. Possible job profiles for a graduate are:

- Project manager
- Product or business development manager
- Technology manager
- International product manager
- Marketing manager
- Entrepreneur – start up of own business
- Intrapreneur – start up new business areas in existing companies
- Consultant

§2 Competence Profile

The study programme enables the students to handle the process from exploring and discovering new ideas to prototyping, manufacturing, and finally implementing their own business concept. The bachelor student is trained in fundamentals of engineering, innovation management, entrepreneurship and business administration as well as techniques to develop, produce and commerzialize mechatronic products.

The graduate will acquire the following overall knowledge, skills and competencies

Knowledge:

A: Has a solid understanding of the interplay between traditional engineering disciplines – mechanics, electronics and software.

B: Posesses knowledge about central theories and models within the subject fields of mechatronic product development and production, innovation management, participatory innovation, entrepreneurship and business administration.

C: Has knowledge about relevant methodologies within the subject fields of mechatronic product development and production, innovation management, participatory innovation, entrepreneurship and business administration.

D: Understands how theories and methodologies are applied in practice and in industrial settings and can reflect upon their use.

Skills:

A: Is able to apply specific skils in mechanical engineering. The ability to develop functioning prototypes using 3D CAD design and choosing the relevant materials and corresponding processes.

B: Is able to apply specific skills in electronics engineering. The ability to develop fully functional prototypes using analog circuits for signal conditioning.

C: Is able to apply specific skills in embedded design. The ability to develop prototypes based on microcontrollers and peripheral components for interfacing, as well as developing simple embedded programs using a high level language and the corresponding development methods.

D: Is able to apply product development techniques, project management methods and other working methods as well as social competences complementing the education towards excellent product driven entrepreneurship.

E: Basic creativity and innovation management skills, which allow generating, evaluating, selecting, and realizing product and business ideas. This encompasses creativity methods, moderator trainings and business case building.

F: Is able to form groups based on different techniques that can work successfully towards a goal.

G: Is able to argue for their theoretical focus and choice of methods and the consequences for their proposed solutions.

H: Is able to communicate academic results within the university as well as to other external stakeholder and partners who are not experts in the field.

Competencies:

A: Has the competences to initiate, develop and manage innovation projects or start-ups that involve many different stakeholders and different disciplines.

B: Has the competences to engage in interdisciplinary project work within the university as well as with partners outside the university such as companies, venture capitalists, or other financial or legal institutions.

C: Has the competences to identify the relevant knowledge to complete a business start-up and acquire the needed knowledge within a relevant network.

Qualification Matrix

BSc in Engineering – Innovation and Business	**DIB1IB** (1. sem)	MC-SMM (1. sem)	**(TIU2IB** (2. sem)	MC-DYM (2. sem)	**MBUS3IB** (3. sem)	**SENS3IB** (3. sem)	**EMB3** (3. sem)	**SOB4** (4. sem)	**EMB4** (4. sem)	**NAUCD1** (4. sem)	**MC-EXS** (5. sem)	**OPM5IB** (5. sem)	**INM5IB** (5. sem)	**BPRO6IB** (6. sem)	**SCM6IB** (6. sem)	**IBNBM2** (6. sem)
KNOWLEDGE:																
A		X		X	X			X			X			X		
B	X		X		X	X	X	X	X	X	X	X	X	X	X	X
C	X		X		X	X	X	X	X	X	X	X	X	X	X	X
D		X	X	X	X			X			X			X		
SKILLS:																
A	X	X	X	X	X			X			X			X		
B					X	X	X		X		X			X		
C							X	X	X		X			X		
D	X		X		X			X		X	X	X	X	X	X	X
E	X		X			X		X			X		X	X		X
F	X		X		X			X			X					
G	X		X		X			X			X			X		
H	X		X		X			X			X		X	X		
COMPETENCIES:																
A	X		X		X			X			X			X		
B	X		X		X			X			X			X		
C	X		X		X			X			X			X		

3 Progression within the Programme

The progression of the innovation and business engineer are built on topics from six subject columns:

- Entrepreneurship – business administration
- Entrepreneurship - creativity, design and innovation management
- Technology – fundamentals of engineering
- Technology – mechatronics design and development
- Innovation practice – including user centered design, methods and personal learning
- Specialization / electives

The academic topics are interlinked during the individual semesters by semester themes. Throughout the course of study, students continually acquire the necessary academic knowledge, while at the same time gaining personal competencies. The columns include the following subjects and disciplines:

<u>Entrepreneurship – business administration:</u>

Consists principally of the academic fields: Business Administration (BUADM), Market research and Entrepreneurship (MAE) and New Business Models (NBM1, NBM2) with the following principal content:

BUADM: Business development, Business administration, Understanding the market and marketing models, Financial elements (cost, pricing, sales), Entrepreneurship, Market research and presentation.

MAE: The entrepreneurial process (Emergence and evaluation of opportunities, setting up an organization), the entrepreneurial content (Resources, networks and the business plan), the entrepreneurial context (Intrapreneurship), market intelligence and market research, creating a research design with a well-defined problem or management dilemma, appropriate methodology, data analysis and reporting.

NBM1: This course will focus on the contemporary understanding of business models. Different perspectives on business models will be addressed through topics such as value creation, appropriation and networks. The course will offer the foundation for future entrepreneurs and managers to understand and develop new business models.

NBM2: The concepts of a circular economy, The triple top-line, a new business paradigm, New opportunities for local content as a business driver, The role of business in the quality driven society, Creating a positive agenda for prosperity, Environment, Society and Governance as business drivers, How to use KPIs as a measure of success introducing a new business model, The concept of inclusive business as a new business model.

Progression in this subject column happens through the student's ability to first understand and apply existing theory and models and later on develop new solutions to existing problems in business.

Entrepreneurship – creativity, design and innovation management:

Consists principally of the academic fields: Innovation and creativity (INC), Operations Management 1 (OPM1), Operations management 2 (OPM5IB), Innovation Management (INM5IB), Supply Chain Management (SCM6IB) with the following principal content:

INC: Ethnographic basic principles, field, informants, ethnography
Role of the ethnographer: ethics and empathy
Working practice and user context
Techniques for interviews and observation
Data processing: categories and theory

Presentation of knowledge: user portraits, personae, working scenarios.

OPM1: Integrated Product Development, Manufacturing Strategy and Concepts, Factory Planning - Layout Strategy, Capacity planning, Aggregate planning, Inventory Management, Material Requirement Planning MRP to ERP, Scheduling - Shop Floor Control, Computer simulation of manufacturing concepts- and logistics systems, Simulation methods, Discrete/continuous simulation, Stochastic simulation.

OPM5IB: Lean Manufacturing and Management, Value Stream mapping, Flow oriented manufacturing, Just In Time – Kanban, Standardized work, Visual Management, Quality Management, Statistical Process Control - SPC, 6 sigma.

INM5IB: Models of Innovation, The underpinnings of profits: Assets, competences and knowledge, Sources and transfer of innovation, Recognizing the potential of an innovation, Reducing uncertainty: the role of technological trends, market regularities and innovation strategy, Choosing a profit site: Dynamic competitive analysis, Strategies for sustaining profits, Innovation audits.

SCM6IB: Understanding supply chain management, Setting up a supply chain audit and an external customer audit, Lead time analysis and supply chain objectives, Planning inventory flows, Integrating material flows Planning facility location, Location strategies, Inventory in the supply chain, Demand forecasting, inventory replenishment methods and systems, Managing uncertainty and related stocking locations, The role of transportation, Sourcing and negotiation.

Progression in this subject column happens through the student's ability to progress from discovering and creating new ideas to developing prototypes and finding possible and realistic manufacturing set-ups.

Technology – fundamentals of engineering:

Consists principally of the academic fields: MATH1 and MATH2 with the following principal content:

MATH1: Integration techniques; Differentiation techniques; Taylor and Maclaurin series; Functions of several variables; Differential equations; Vectoral algebra and matrices.

MATH2: Complex numbers; Laplace transformation; Fourier series; Data handling.

Progression through this column enhances the student´s ability to understand the underlying physical circumstances and to use the relevant mathematical models in an engineering context.

Technology – mechatronics design and development:

Consists principally of the academic fields: Mechanical Design (DES), Mechanics 1 (MECH1), Mechanics 2 (MECH2), Sensors and Actuators (SAA), Electronics (ELEC), Embedded Systems 1 (EMB3) and Embedded Systems 2 (EMB4) with the following principal content:

DES: Modelling with primitive solid elements; Modelling with parametric solid elements; Modelling with curves and sketches; 3D assembly modelling with solid components; Design of technical drawings with section views and dimensions including tolerances; Making technical drawings on the basis of a 3D assembly model; Making an exploded view on the basis of a 3D assembly model; Making a parts list on the basis of a 3D assembly model.

MECH1: Forces and couples; Isolation of mechanical systems made up of one or more solids; Dry friction; Torsion of circular members; Internal effects; Design of beams for bending; Mechanical material parameters for metals and polymers; Electromagnetic material parameters; Thermal Properties.

MECH2: Absolut speed and acceleration; Coordinate systems; General equations of motion; Translation; Fixed-axis rotation; Work and energy; Linear Momentum

SAA: Sensor characterisation; Accuracy and error estimation; Basic understanding of semiconductor materials; Electromechanical, thermal, radiation and electromagnetic transducers; Simple actuators.

ELEC: A/D and D/A converters; Operational amplifiers; Feedback; Diodes; Bipolar junction transistors; FET transistors; Transistor used as a switch; Computer simulations; Methods for EMC correct circuits.

EMB3: Numbering systems; Programming in C, including: simple data types, control structures, functions, arrays, structs, pointers, bitwise operators, microcontroller systems.

EMB4: Logic components; Boolean algebra; Latches and flip-flops; State machines; Microcontroller hardware; Peripheral units; Interrupts.

Progression through this column enhances the student's ability to develop mechanical components and mechatronic products and systems, based on mechanics, electronics and embedded technologies.

Innovation practice – including user centered design, methods and personal learning:

Consists principally of the academic fields: Semester Project 1 (SPRO1IB), Semester Project 2 (SPRO2IB), Semester Project 3 (SPRO3IB), Semester Project 4 (SPRO4IB), Experts in Teams (MC-EXS), Theory of Science (THS), User Centered Design 1 (NAUCD1) and the Bachelor Thesis (BPRO) with the following principal content:

SPRO1IB: The project is divided into 5 supervision phases. Each phase will be introduced by a lecture about the topic, and at the end of each phase there will be a deliverable. Students will work in groups of 4-5. The main topics are: Ideation, Concept, Product development, Market and users, Implementation.

SPRO2IB: The students will work in groups of 4-5. By following the steps of methodized design the students will develop a mechatronic product or device that addresses the needs of a focus group. The main topics are: Interplay between technology and use, Role of technology, Role of user, Product design and the product development process.

SPRO3IB: The students will work in groups of 4-5. The technical part of the project will focus on development of an electronic product or the production process of a developed electronic product. The business modeling part will focus on creating a business model based on the selected product and corresponding technologies. The main topics are: Making a business out of a newly developed product, Navigating between technological opportunities/necessities and business opportunities/necessities, Specifying and building prototypes of electronic circuits using existing sensors.

SPRO4IB: The students will work in groups of 4-5 and be responsible of designing and specifying the entire production facility for a chosen or given product. The production/logistics is simulated.

Critical elements of the facility are built in a physical scale model to test the mechatronics components and the functional integration.

MC-EXS: The students will be challenged by a complex product development situation. They will work together in large teams in a project with many stakeholders where the ability to cooperate with different people (engineers and non-engineers) and the ability to organize the project as well as the ability to use one's own expertise is a "must" to achieve a satisfying result. Theory of Science will be completed.

THS: Scientific understanding, methods and limitations will take their starting point in practical and tangible activities related to science theoretical methodology performed during semester projects and they will be put into perspective by means of different science theoretical positions, e.g. positivism, critical rationalism and paradigm theory, ethical aspects of science and technology, the relation between technology, society and the engineer takes its starting point in similar specific considerations and experiences from previous semester projects. Topics from the history of science, technology and engineering will be covered by the main topics above, and specific problems related to this have been studied in previous semester projects.

NAUCD1: Principles for engaging users in product and user interface design: User studies, video design techniques, user ethnographies, experience modeling, Design of button & display type user interfaces. Interaction styles and tangible user interfaces. User interface prototyping and use scenario design, User participation and user workshops. Reflective design practice: Event-driven design strategy, design methods development.

BPRO: The Bachelor Thesis is a working process with the purpose of documenting the students engineering-specific competencies attained during the programme within a limited, course-relevant and engineering-specific subject. The selected problem can be investigated from a theoretical, experimental or a practical point of view.

Progression through the projects enhance and develop personal and learning competencies, while at the same time the academic competencies are learned in depth and brought to maturity in "real" projects, thus giving personal competencies in the areas of: Commitment, Initiative, Responsibility, Ethics, Establishment, Ability to put personal learning into perspective and learning competencies in the area of: Analysis and assessment of data material; Communication of working results using approaches that require reflection, cooperation and independency.

Specilization / electives:

Focusing on specific interests and enhancing skills in a certain domain may be done by choosing electives in the fourth, fifth and sixth semesters (15 ECTS points in total). The courses will be in the domain of the MCI research, e.g.: Nanotechnology, Embedded Control Systems, Dynamic Mechatronic Systems, Innovation Management, Production and manufacturing technologies or innovation practice or in the domain of the social scienc faculty – e.g. business administration – business management courses.

§4 Semester Themes

Semester	SEMESTER THEMES
6.	**Bachelor Project**
5.	**Experts in Teams**
4.	**Starting Business**
3.	**Making Business**
2.	**Technology in Use**
1.	**Discover Innovation and Business**

§5 Semester Modules

<table>
<tr><td>Semester</td><td colspan="20">Modules</td></tr>
<tr><td>6</td><td colspan="10">BPRO6IB
Bachleor Project</td><td colspan="5">SCM6IB
Supply Chain Management</td><td colspan="5">IBNBM2
New Business Models 2</td><td colspan="5">Elective</td></tr>
<tr><td>5</td><td colspan="10">MC-EXS
Experts in Teams</td><td colspan="5">OPM5IB
Operation Management (OPM2)</td><td colspan="5">INM5IB
Innovation Management</td><td colspan="5">Elective</td></tr>
<tr><td>4</td><td colspan="10">SOB4IB
Starting your Own Business (SPRO4IB, OPM1)</td><td colspan="5">EMB4
Embedded Systems (EMB2)</td><td colspan="5">NAUCD1
User Centered Design</td><td colspan="5">Elective</td></tr>
<tr><td>3</td><td colspan="10">MBUS3IB
Making Business (SPRO3IB, NBM1)</td><td colspan="10">SENS3
Sensors & Electronics (SAA, ELEC)</td><td colspan="5">EMB3
Embedded Systems (EMB1)</td></tr>
<tr><td>2</td><td colspan="15">TIU2IB
Technology in Use (SPRO2IB, MAE, INC)</td><td colspan="10">MC-DYM
Dynamics and Mathematics (MECH 2, MATH 2)</td></tr>
<tr><td>1</td><td colspan="15">DIB1IB
Discover Innovation and Business (SPRO1IB, DES, BUADM)</td><td colspan="10">MC-SMM
Statics, Materials and Mathematics (MECH 1, MATH1)</td></tr>
<tr><td>ECTS POINTS</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td><td>8</td><td>9</td><td>10</td><td>11</td><td>12</td><td>13</td><td>14</td><td>15</td><td>16</td><td>17</td><td>18</td><td>19</td><td>20</td><td>21</td><td>22</td><td>23</td><td>24</td><td>25</td><td>26</td><td>27</td><td>28</td><td>29</td><td>30</td></tr>
</table>

Workshop training is also included during the first year. The workshop training is mandatory and assessed on a pass / fail basis.

§6 Description of the 1st Semester

SEMESTER THEME

”Discover Innovation and Business”

VALUE ARGUMENTATION

Innovation and Business addresses a complex field, where measurement and control-oriented scientific disciplines such as engineering and business administration, are in a dynamic and interdependent relationship with users and practice. This often entails uncertainty and paradox intentions that require negotiation of meaning, and a holistic understanding of the context, in order to solve the emerging challenges.

Therefore, the first semester of the programme confronts the students with the complexity at the meeting point of technology, business, innovation and use.

COMPETENCE GOALS

Knowledge

- The knowledge of the different phases involved in an innovative product development process and their importance and impact on the final result
- Knowledge of the creative and innovative product development process
- Basic understanding of market driven business development
- Knowledge of cost and pricing strategies related to new business development
- An understanding of the financial aspect of new business development
- The knowledge of machine designs according to DS/ISO standards
- The knowledge to choose the optimal routine to problem solving, with more subjects involved, and stating the reasons for the choice (ex. The choice of an applicable coordinate system)
- Understanding statics of beams and engineering structures
- Understanding of properties of metals and polymers, both mechanically and electrically
- Understanding complications when going into nonlinear regime, both mechanically and magnetically
- Understanding basic calculus and matrix algebra
- Mastering different differentiation and integration techniques
- Using Taylor series, Maclaurin series and differentials for approximations
- Solving simple ordinary differential equations
- Performing basic matrix calculations, matrix inversion, and determining eigenvalues

Skills

- The ability to combine technical-, business- and process knowledge into an innovative development project
- The ability to write documentation and prepare presentations
- The ability to apply preliminary marketing management and market research techniques
- The ability to leverage business administration into the innovation process

- Basic skills in designing by means of a modern 3-dimensional (3D) design tool
- The ability of producing a 3D assembly of a simple mechanical model
- The ability of drawing up technical documentation according to DS/ISO standards as to dimensional tolerances, geometrical tolerances and surface quality
- The ability of making an assembly drawing of a simple mechanical model
- The ability of making an exploded drawing of a simple mechanical model
- The ability of drawing up part lists on the basis of a three dimensional assembly model
- The ability of estimating materials manufacturing properties and its properties at use
- The ability to distinguish between theory and methods
- The ability to calculate forces, moments, couples of statically determinate structures by use of equilibrium conditions in two dimensions
- The ability to calculate external and internal effects on loaded beams
- The ability to calculate simple deformations (1D) based on simple stresses and material data
- The ability to calculate resistances of simple metal wires based on material data

Competencies

- The ability to consider different strategies to solve 2 dimensional statics problems
- The ability to analyze the statics of simple engineering products
- The ability to select proper materials for given problems
- The ability to master basic mathematics necessary for further engineering studies
- The ability to understand an engineering problem or model described in mathematical terms
- The ability to extract information from a mathematical model of an engineering problem
- The ability to participate in complex projects where technology- and business issues interact
- The ability to work in small teams (4 – 5 members) and the understanding of one's own impact on the project
- The ability to identify and search for necessary information/knowledge in order to achieve a desired result
- The preliminary understanding of the dynamics of working in teams and how to organize and plan project work
- The understanding of the complexity of projects with stakeholders from outside the team and users involvement
- The ability to present one's ideas and results to an audience with equal knowledge.
- An entrepreneurial orientation towards market and business development

SEMESTER STRUCTURE

DIB1IB – Discover Innovation and Business (20 ECTS)
MC-SMM – Statics, materials and Mathematics (10 ECTS)

DIB1IB and MC-SMM are mandatory and constitute parts of the first year examination.

CONTEXT

The academic fields of the 1st semester build upon the entry requirements, especially in relation to mathematics (A-level) and physics (B-level). For instance, this is evident in MATH1 where the student is introduced to further differentiation and integration techniques as well as studying differential equations more advanced as encountered in high school mathematics. In MECH1 the concept of force and Newton's Laws included in the entry requirements are developed in order to analyze the static equilibrium conditions for mechanical structures.

DIB1IB consists of:
SPRO1IB (10ECTS) – a project work that introduces students to the different fields related to discovering innovation and business. DES (5 ECTS), - Introduces CAD as a usable tool for understanding and developing mechanical drawings and constructing prototypes. BUADM (5 ECTS) – Basic business administration, marketing and economics. The MC-SMM module contains two academic fields: MECH1 – 5 ECTS: Statics and Materials and MATH1 – 5 ECTS: Calculus and Matrix Algebra.

§7 Description of the 2nd semester

SEMESTER THEME

”Technology in Use”

VALUE ARGUMENTATION

In the interplay between technology and use, emotions and intuition often play an important role. We can see this for example in the enormous resources invested in the car industry in order to develop the “right” sound of a closing door or the “right” brand smell. Behind these emotional and sensual experiences, that make products successful, we often find state-of-the-art engineering and marketing, but also a variety of users who we need to understand before things can be done “right”.

Based on the gathered experiences and knowledge from the previous semester, the students now focus on creating ideas in regards to selected technologies and they will explore the complex relationship between technology and use. The students will further enhance their knowledge, skills and competencies in the subject columns: mechatronics design and development and fundamentals of engineering.

COMPETENCE GOALS

Knowledge

- Understand interdependencies between technology and use.
- Identify suitable technologies and implement creative ideas on working prototype level.
- Knowledge about the key concepts and the terminology used in market research and entrepreneurship.
- Knowledge about how to define and understand entrepreneurship and intrapreneurship and to understand the paradoxes in play.
- Knowledge about insights the market research process and how research designs are formulated
- Understand and analyze human technology interaction and usability
- Understand kinematics and kinetics of particles and rigid bodies
- Understand calculus and statistics

Skills:

- The ability to, from a technical point of view, continuously improve the product/idea by studying the human-technology interaction
- The ability to, from a business point of view, continuously improve the product/idea
- The ability to describe, analyse and evaluate key theories, as well as develop hands-on experience with simulation games in entrepreneurship reflecting real-life situations
- The ability to determine appropriate data collection methods for their market research study which will be implemented and carried out.
- The ability to collect and analyse data which can be used as input for evaluating business opportunities
- The ability to use creativity techniques in idea generating processes
- The ability to examine user’s working practice and everyday life with the purpose to create suitable and user friendly products

- The ability to analyze and interpret collected data to be used to create user-oriented interactive products
- The ability to choose appropriate coordinate systems to analyse the motions of particles and rigid bodies in 2 dimensions

- The ability to calculate position, velocity, acceleration, force, moment of force, linear and angular momentum in particle and rigid body dynamics by use of equations of motion, work-energy relations and conservation theorems

- The ability to understand complex numbers, including their relationship with trigonometric functions. Using Laplace transforms for the solution of ordinary differential equations and using statistics to analyze data sets.

Competencies:

- Competencies in analyzing and assessing the potential of a new product idea or a new venture.
- Competencies in analyzing the potential of a product, conducting solid industry and market research, setting up an organization to run the business and understanding the importance of funding and financing the venture.
- Competencies in creating an argumentation line which can support their conclusionsT

- The ability to consider different strategies to solve 2 dimensional engineering mechanics problems

- The ability to analyse the dynamics of simpler engineering products

- The ability to analyse one-dimensional periodic and semi-infinite problems through the application of Laplace transforms and Fourier series. The ability to handle simple stochastically problems.

- The ability to work in small groups and being aware of one's own role in every phase of a technical and business related user-oriented development process
- The ability to turn abstract theory and data into product technology
- The ability to use market market research methods and interpret the results for entrepreneurship
- The ability to setup a product development process

SEMESTER STRUCTURE

TIU2IB – Technology in Use (20 ECTS)
MC-DYM - Dynamics and Mathematics (10 ECTS)

Both modules are mandatory. TIU2IB constitutes part of the first year examination, together with the 1st semester modules.

CONTEXT

TIU2IB: Technology in Use contains:
Semester project SPRO2IB (10 ECTS). The focus is on understanding interdependencies between tecnolology and use, and using this knowledge in a development process. INC1 (5 ECTS) – Concerns creativity, technology and use, MAE (5ECTS) – provides students with knowledge about the key concepts and the terminology used in market research and entrepreneurship.

§8 Description of the 3rd Semester

SEMESTER THEME

"Making Business"

VALUE ARGUMENTATION

In order to transform an idea into innovation, a product needs to be manufactured and finally sold e.g. accepted by the market.. In this semester the students will learn about, and understand relevant aspects of production, product optimization and how to develop a business model around the product they develop and try to commerzialize.

COMPETENCE GOALS

The student will during the semester gain the following:

Knowledge:

- Understand the dimensions, purpose and development of business models
- Understand the main technological issues in using analog electronics
- Understand the use of sensors in electronic products
- Knowledge about the key concepts of developing new business models incorporating the society and the environment in the modeling process
- Knowledge about the key drivers of sustainable economic development and the impact on the way companies conduct business in the future
- Knowledge about the circular economy and the triple top-line as a new business paradigm
- Understand the functionality of basic components and technologies used in analog electronics
- Understand the basic methods used in development of analog electronics
- Understand the use of sensors in electronic products
- Understanding the fundamentals of frequency characteristics for active and passive filters
- Understand A/D and D/A conversion methods
- Knowledge concerning basic methods of creating EMC correct designs
- Profound knowledge of the physics behind selected transducers and actuators
- Knowledge of basic programming technics
- Knowledge of the syntax of a high level programming language
- A basic knowledge of the steps in design and implementation of embedded software

Skills:

- Developing and presenting a business model
- Use of a business model for the purpose of product/business development
- The ability to find, specify and use existing sensors as part of a electronic development process
- The ability to build prototypes for proof of concept of specified electronic circuits with the use of sensors and actuators.
- The ability to specify the requirements for a product or production process that will be implemented by the use of electronic circuits.
- The ability to describe, analyze and evaluate key theories of business innovation for quality performance
- The ability to understand and evaluate the economic benefits of lifting value creation from materials flow

- The ability to understand and evaluate the barriers and drivers of converting production based operations to becoming a service provider delivering performance instead of selling a product.
- The ability to construct analog circuits for interfacing sensors to A/D converters
- The ability to analyze DC- and AC- circuits
- The ability to construct basic passive and active filters
- The ability to measure the frequency response for a given electronic circuit
- The ability to use computer simulations as part of the development of electronic circuits
- The ability to specify the requirements for a product that will be implemented by the use of electronic circuits.
- The ability to do error estimation in a simple system with a sensor and automatic measurement instrumentation
- The ability to choose the optimum sensor with the emphasis on reliability and accuracy
- The ability to analyze smaller programs
- The ablility to design smaller programs from a textual description
- The ability to implement smaller programs
- The ability to make structured tests of smaller programs

Competencies:

- The ability to structure and develop a complete business model in a complex context, based on electronic products
- The ability to navigate between technological opportunities/necessities and business opportunities/necessities when creating a new business.
- The ability to specify, and do proof of concept prototyping with analog electronics and the use of existing censors
- The ability to, from a given specification, develop the required electronic circuit – fulfilling the specification. This includes the ability to choose the relevant technology, methods and components.
- The ability to develop applications using sensors and actuators

SEMESTER STRUCTURE

MBUS3IB – Making Business (15 ECTS)
SENS3 – Sensors and Electronics (10 ECTS)
EMB3 – Embedded Systems (5 ECTS)

All the modules are mandatory.

CONTEXT

MBUS3IB – Making Business contains:
SPRO3IB, - a semesterproject where students learn to create a business model – based on a product they develop with the goal of producing and selling it. NBM1 – New Business Models1 (5 ECTS) – concerns the theory of understanding and developing business models.

SENS3 – Sensors and Electronics contains:
ELEC (5 ECTS) concerns analysis and constructions of elctronical systems. SAA (5 ECTS) deals with analysis and constructions of systems with sensors and actuators.

EMB3 – Embedded Systems (5 ECTS) contains:
Theory and hands-on exercises in higl level programming for embedded systems.

§9 Description of 4th semester

SEMESTER THEME

"Starting Business"

VALUE ARGUMENTATION

Even with a good product and a good business model it is a complex process to start a business. Talking to banks to get money, talking to landlords to negotiate rent for storage/production/shop/office, hiring your first employee,tax issues,registering your business; etc.In this project students will take their product and go through the process of turning a business model for a product (almost) into reality.

The students will during the semester:

- Participate in a project involving idea generation, concept, prototype, business plan, management, logistics/manufacturing and implementation
- Develop a manufacturing concept and be able to analyse, estimate and plan production
- Generate technical solutions involving intelligent dynamic systems with embedded software

COMPETENCE GOALS

Knowledge

- Knowledge about production philosophies, strategies and operation management
- Understand the market/technology context (regulations, institutions, competitors, etc.)
- To provide students with an understanding of how to go from product idea to a manufacturing concept, in order to enable them to analyze, estimate and plan production
- Obtain an understanding of how to take decisions with respect to economy and manufacturing when purchasing goods, planning manufacturing capacity/resources and planning production processes in detail
- To provide students with an insight in the possibilities of IT support of material and production planning and control
- During operations obtain understanding of material planning, scheduling, shop floor control and how to organize the work environment
- Knowledge of combinational and sequential circuits
- Insight in the function and the architecture of microcontroller systems
- Insight in interface circuits for microcontrollers
- Insight in timer/counter peripherals
- Knowledge of interrupt driven I/O
- Knowledge of hardware/software integration
- Knowledge of simple serial communication
- Understand basic concepts and theories of user centred design

Skills

- Planning and modeling of production facilities
- Design and specification of complex systems (products, production, logistics)
- Writing and presenting a business plan
- The ability to implement simple mechatronic systems for production cells controlled by an embedded system using interrupt driven I/O

- The ability to make a specification for a mechatronic system in a production cell
- To be able to specify the right manufacturing strategy in a global environment, design the factory layout and plan capacity
- The ability to analyze and design combinational and sequential circuits
- The ability to configure and make use of microcontroller peripherals
- The ability to implement programs for embedded systems
- The ability to make structured tests of smaller programs
- Master methods for investigating use practices, designing interactive products, and facilitating user collaboration

Competencies:

- Design and specify production equipment and systems
- Design and build specific elements of automation systems
- Economic justification of investments (Return of Investment models etc.)
- The understanding of the correlation between technical specifications for a production cell and the performance of the cell
- The understanding of the correlation between performance of the individual production cells and the overall performance of production facilities
- Advanced modeling and simulation tools will be introduced. The student will be able to simulate, analyze and design the manufacturing environment.
- The ability to, from a given specification, develop an embedded system – fulfilling the specification. This includes the ability to combine microcontroller hardware with software and setting up a system test.
- Reflect on methods development in the light of current litterature

SEMESTER STRUCTURE

SOB4IB – Starting your own Business (15 ECTS)
EMB4 – Embedded Systems (5 ECTS)
NAUCD1 – User Centered Design (5 ECTS)
Elective course equivalent to 5 ECTS

CONTEXT

SOB4IB – Starting your own business contains:
Semester project SPRO4IB (10 ECTS) - The main focus is on creating a business, based on a embedded systems product. OPM1 (5 ECTS) concerns manufacturing concepts, process strategy, layout strategy and capacity planning visualised by computer simulations.

EMB4 – Embedded Systems concerns:
The development of embedded systems and products.

NAUCD1 – User Centered Design concerns:
How physical, interactive prototypes actually work and can function as a means to create and evaluate user experiences.

§10 Description of 5th Semester

SEMESTER THEME

"Experts in Teams"

VALUE ARGUMENTATION

At this point, the students have gained profound knowledge about the process of bringing a product idea "all the way"; That is: from idea to working product (prototype) as well as developing the corresponding business model and (nearly) implementing it. This semester focusses on the complexity of working in a bigger organization – and the context of working in multidisciplinary teams as the basis of solving complex engineering tasks. The students will meet a "real world challenge" and learn how to solve it and deliver the product, in an environment with many stakeholders.

This includes that the students will:

- Participate in a collaborative innovation project, working in teams as "experts in teams"
- Gain understanding of their own strength and the focus of their profile compared with other engineering profiles
- Gain understanding of the complexity of the innovation process in a interdisciplinary environment
- Use theory of science as part of the problem solving process

COMPETENCE GOALS

Knowledge

- Knowledge and understanding of different approaches to problem solving – the user oriented approach, the technical approach and the business oriented approach
- Experience of project cooperation with many stakeholders, both internally and externally
- Insight in problem solving of complex interdisciplinary engineering tasks
- Insight in one's own personal preferences and how this is used to give the best impact on teamwork
- Insight in practical project management methods
- Insight in project organization methods
- Understanding of the philosophical aspects of science
- Understanding of aspects of the history of technology and the interaction with the surrounding
- Understanding and practical experience in the Lean Philosophy, Manufacturing and Management Principles.
- Insight into quality management and be able to describe how to implement quality control in the basic organization
- Understanding of why Lean philosophy and quality management to a 6 sigma level go together
- Understand and describe the dominant concepts and models within the selected innovation management literature

Skills

- The ability to solve complex, interdisciplinary engineering tasks in teamwork, based one one's own expertise

- The ability to dynamically organize project work, based on the individual participants competencies and personal preferences
- The ability to critically reflect on topics such as the delimitations of science, its development and divers views on scientific progress
- The ability to discuss topics like the relation between observations and theory and ethical aspects
- The ability to analyze and point out improvements for processes in a value stream and how to map these
- Be able to describe how to implement quality control in the basic organization
- Be able to design processes to obtain continuous and just in time flow of material and information
- Be able to discuss the development and maintenance of a complete quality control system according to ISO standards
  The ability to describe and use relevant concepts and models within innovation management
- The ability to apply relevant theoretical concepts to real life cases

Competencies

- The ability to work in projects with many stakeholders, both internally and externally
- The ability to participate in project management of technical development projects
- The ability to organize and plan teamwork in technical development projects
- The ability to do simple financial management tasks in development projects
- The ability to manage one's own participation and impact on all aspects of a development process
- The ability to respect and use other experts – giving the best quality and progress in development projects
- The ability to take into account, the ethical aspects and impact on the surrounding society, when developing new technology and products
- The ability to assess the innovation capabilities of a real life company by performing an innovation audit
- The ability to develop strategies and guidelines for improving a companies' innovation performance

SEMESTER STRUCTURE

MC-EXS – Experts in Teams (15 ECTS)
OPM5IB – Operations Management (5 ECTS)
INM5IB – Innovation Mnagement (5 ECTS)
Elective course equivalent to 5 ECTS

CONTEXT

MC-EXS– Experts in Teams contains:
EXTS5 (12 ECTS). The main focus of the project is to design and develop a complex product concept. The students work in groups across the educational study programmes. THS (3 ECTS) is science theory introducing subjects like areas of recognition within natural science and methods and limitation of ethical aspects.

OPM5IB contains:
Production planning and control, forecasting, stock controlling, LEAN manufacturing and quality management.

INM5IB contains:
Theoretical and practical aspects of innovation management.

EXCHANGE POSSIBILITIES

The Faculty recommends and supports, that students go for a one semester exchange at another university. On the Innovation and Business bachelor programme the 5th semester can be used for this purpose. The Experts in Teams module (MC-EXS – 15 ECTS) and the elective course (5 ECTS) can be exchanged to elective courses at our partner universities – preferable including some project work. The remaining courses (INM5IB and OPM5IB - 10 ECTS) can be exchanged with relevant courses with similar content. The exchange programme must be approved by the Academic Study Board.

§11 Description of the 6th Semester

SEMESTER THEME

"Bachelor project"

VALUE ARGUMENTATION

The bachelor thesis must demonstrate students' ability independently to locate and formulate potential innovative engineering or marketing problems. The project must demonstrate technical business analyses, development of alternative concepts and creative solutions to the problem thus giving the student the possibility to:

- Be innovative and creative in product development from idea, concept, prototype, business plan, management, logistics\manufacturing until business establishment
- Apply knowledge and skills achieved during the study to solve complex engineering and business problems
- Acquire new knowledge within relevant engineering and business fields
- Co-operate with industrial companies throughout the project. In many projects the project will be carried out in close co-operation with industrial companies
- Apply theory of science in their project work
- Understand the importans of involving users in a design process

Additionally students learn about Supply Chain Management and add to their understanding of business models in the course New Business Models 2. They can choose 1 elective course on this semester.

COMPETENCE GOALS

The students will, during the semester, learn, gain and demonstrate the following competencies:

Knowledge:

- Shall be acquainted with the theory, methods and practice within the subject area of the study programme
- Understanding of the principles of supply chain management and logistics within a business context
- Understanding of the key concepts of developing new business models incorporating the society and the environment in the modeling process

Skills:

- Shall be able to account for and is be able to reflect on theories, methods and practice
- Shall be able to apply scientific methods and tools within the subject are of the study programme
- The ability to demonstrate how the supply chain is managed, resource levels are sized and how activity is planned
- The ability to conduct tactical decision making, and thereby contribute to implementing the supply chain strategy
- The ability to demonstrate familiarity with the concepts of supply chain management
- The student must demonstrate abilities in conducting supply chain audits, re-planning and reorganizing of existing distribution networks

- The ability to describe, analyze and evaluate key theories of business innovation for quality performance

Competencies:

- Shall be able to assess theoretical and practical problems and apply relevant analysis and problem-solving models
- Shall be able to communicate relevant professional and scientific problems and solutions either to professionals and non-professionals or to collaborators and users
- Shall be able to manage complex and development-orientated situations related to study or work
- Shall be able to independently be a part of discipline-specific and cross-disciplinary cooperation and to assume a professional approach
- Shall be able to identify his/her educational needs and to structure his/her learning in different learning environments
- Shall be able to communicate in writing in a clear and understandable manner
- The student will be able to do analysis and decision-making, monitoring and control across the supply chain network, and an acknowledgement of the position of supply chain management and logistics with regard to the overall structure of the organization, its suppliers and its customers

SEMESTER STRUCTURE

BPRO6IB – Bachelor Thesis (15 ECTS)
SCM6IB – Supply Chain Management (5 ECTS)
IBNBM2 – New Business models 2 (5 ECTS)
Elective course equivalent to 5 ECTS

BPRO6IB, SCM6IB and IBNBM2 are obligatory.

CONTEXT

BPRO6IB: The Bachelor Thesis

SCM6IB - Supply Chain Management concerns:
Integrating, coordinating and controlling the movement of materials, finished inventory and related information; from suppliers through a company, to meet customers' requirements.
IBNBM2: The students will be introduced to the principles, methodologies, and tools related to the circular economy and the Cradle to Cradle design philosophy in a business context.

§ 12 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 that are offered by the Faculty of Business and Social Sciences belong under the Danish corps of external examiners for business and social sciences.

§ 13 Entry into Force

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 23rd March 2010.
2. Curriculum 2014 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 on 29 April 2014 (Version 1.0).
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 18 March 2015 (Version 1.0).
4. Curriculum 2015 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 on 22 May 2015 (Version 1.0).