JÖNKÖPING UNIVERSITY
School of Engineering

PROGRAMME SYLLABUS

Product Development, Product Development and Materials Engineering (master), 120 credits

Programmestart: Autumn 2016

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PROGRAMME SYLLABUS

Product Development, Product Development and Materials Engineering (master), 120 credits

Produktutveckling, Produktutveckling och material (master), 120 högskolepoäng

Programme code:	TAMP6	**Programmestart:**	Autumn 2016
Confirmed by:	Dean 2016-03-01	**Education Cycle:**	Advanced level
Version:	1		
Reg number:	JTH/2016-1472-312		

Title of qualification

Degree of Master of Science (120 credits) with a major in Product Development, specialisation in Product Development and Materials Engineering.

Programme overview

Background

As competition between companies is getting tougher as the number of products on the market increases, many are realizing the importance of product development and material knowledge as a competitive means. This programme covers the entire product development process, from conceptual engineering design to materials and manufacturing processes.
The steady increase in the use of computer support makes possible new methods, which are parallel to the entire product development process. With the help of advanced computer tools in design, materials and construction, real and virtual prototypes can be produced much faster, and the time needed for development can be shortened. That is why engineers with advanced knowledge in this interdisciplinary field are needed.
Big and small businesses alike have an increasing need to integrate the steps of the product and production chain. This creates a need for engineers with specialist knowledge who at the same times have an insight in the whole product development process. Sweden has a world class engineering and automotive industry with a range of suppliers in the region of Jönköping. They are all in need of employees with knowledge of product, production and materials to stay competitive.

Objectives

This Master programme aims to develop the knowledge, skills and experience that are needed to develop and design advanced products with the use of modern information technology regarding knowledge-management and modeling. A further aim of the programe is to provide skills in achieving technological calculations to optimize product function, performance, material choice and manufacturing processes. The programme also aims to provide deepened knowledge concerning technical material's manufacturing, structural design, properties and use in products. The programme also serves as a preparation for research within the areas of product development, materials and manufacturing, and simulation and optimization.

Post-graduation employment areas

After completing the programme the graduate will be qualified for positions with companies in need of a modern product development process using efficient tools . The programme also qualify for working in research in e.g. design, materials and production processes as well as in computer simulation of products.

Programme Supportive Research

In close cooperation with the programme, research carried out in the fields of Product development (specializing in Computer Supported Engineering Design and Simulation and Optimization) and Materials and Manufacturing specializing in Casting.

Product development focused on computer supported engineering design

Computer Supported Engineering Design

Implemented knowledge as a competitive factor in the manufacturing industry

Success in manufacturing companies is always based on deep knowledge of the product characteristics and the production processes used. This knowledge is stored in the minds of employees, written down in documents or implicit in proprietary computer codes. This is a knowledge structure that is often the company's most important asset. Using modern information technology, this knowledge can be structured and stored for later retrieval and automated reuse for new development projects.

Computer tools for automated engineering design

Functions for storage of knowledge and inferring conclusions from this are fundamental for design systems aimed at design synthesis tasks. The possibilities to create such systems for automated design have improved dramatically. The technology of Artificial Intelligence has provided rule-based programming tools as well as more implicit methods in the category of "computational intelligence". In combination with parametric CAD systems these techniques are suitable to capture experience, rules of thumb as well as algorithmic design rules.

Within this technical domain we try to establish generic guide lines for how Intelligent Design systems should be composed to match different design tasks. How cost and benefit should be balanced in different applications and how length of operational life, transparency and quality of these systems is assured. We seek to penetrate the potential and constraints of the technology in a systematic fashion so that companies who intend to carry out industrial applications can find optimal solutions. Since we always work with real industrial examples the technological contents naturally cover a wide spectrum.

Simulation and Optimization

The field of simulation has over the last 20-30 years had a tremendous development, especially the non-linear finite element method (FEM). Virtual experiments have been made possible by programming basic principles of nature into computers, e.g. simulations of crashworthiness and sheet mental forming. These kinds of virtual tests reduce both costs and lead times, and create better products for the consumers.

The development has come so far that non-linear finite element analysis (FEA) is becoming an industry standard also for small-and medium-sized companies. Simulation driven design reduces both costs and lead times by reducing the number of physical prototypes and experiments. This virtual development process can also be automated by combining FEA with optimization methods. We call such an automated design process for Optimization Driven Design (ODD). The introduction of ODD is the next big step for large companies and will also be important to take for small- and medium-sized companies in a near future. In particular our research is focused on non-linear FEA, topology optimization and surrogate optimization for both deterministic and non-deterministic problems.

Materials and manufacturing focused on casting

The research within Materials and manufaturing is multidisciplinary and could comprise research areas such as product development, properties of components, internal material structures and related properties of components, production/manufacturing aspects etc. The research has support within a wide spectrum of subject areas: e.g. fluid dynamics, solid mechanics, material science, material technology, material physics, chemistry, as well as simulation and optimization. In the product development chain, the main part of the research is conducted in the interface between engineering design on one side and manufacturing/usage aspects on the other, with a special focus on product properties. The overall goal of the operation is to conduct fundamental research with the purpose of solving problems related to material science and manufacturing of advanced cast metal components, in close cooperation with

industry and research institutes.
The different steps in the product development process, from conceptual design to material selection and manufacturing method, all have a decisive influence on the final properties of the component. This is especially true for metal casting and for shaping of polymers. As a consequence, it is natural that simulation and optimization tools/methodologies today are indispensable when designing and manufacturing complex shaped components of advanced materials.

Educational concept at the School of Engineering

All educational training at the School of Engineering in Jönköping (JTH), is determined by an educational concept. The concept offers a *holistic perspective*, where *Business Community Contacts, Internationalisation* and *Entrepreneural Drive* are key words. Besides technical knowledge within the programme, *Leadership and Communication, Professional Attitude* and *Sustainable Development* are important parts of the concept.
Business Community Contacts means that JTH has an established collaboration with the business communtiy in various forms throughout the training. An example is the course located directly in the business community *(Industrial Placement Course)*, which is part of all programmes. The aim with this course is to provide the students with an understanding for future professional tasks, and the ability to relate these to the training.
Internationalisation means that students e.g. are given the opportunity to train languages and intercultural communication through exchanges with foreign universities. JTH has approximately 70 partner universities all over the world, and participates in several international exchange programmes for students. There are opportunities to spend parts of the training abroad and account to the foreign credits in the exam. Due to this student exchange, a great number of courses at JTH are given in English.
Entrepreneural Drive is received through the holistic perspective of the training programme. Significant is the exchange with the business community, the leadership training, the association with professional work in project based courses, and the economy elements, among other things.
Leadership and Communication includes e.g. training in verbal and written communication, project based work, leading and motivating people and also to understand decision processes in companies and organizations.
Professional Attitude comes through basic knowledges in economics, marketing, and business planning. These knowledges are further developed and integrated in technical contexts. Engineers and technicians with such experiences are useful within a great number of areas in the business community.
Sustainable Development includes understanding of compatibility with a sustainable society and environmental and human aspects in the future productivity and products. The instructions are fully integrated in their technical context and treat social, economical and ecological aspects of sustainable development.
Project based Training is also a part of the educational concept. Assuming responsibility for projects of various sizes frequently occurs as a professional. As a preparatory step, the students are responsible for real projects in connection with the business community in some of the courses.
Student influence is a great and important part in JTH's continuous quality development. Through student representatives in all boards, councils and decision-making committees, the students actively influence their education.

Objectives

After the completion of the programme, students must meet the intended learning outcomes, as described in the Ordinance by Higher Education (m), and also the intended learning outcomes, as described by JTH (j):

Common learning outcomes

Knowledge and Understanding

1. demonstrate knowledge and understanding in their main field of study, including both broad

knowledge in the field and substantially deeper knowledge of certain parts of the field, together with deeper insight into current research and development work; and,(m)
2. demonstrate deeper methodological knowledge in their main field of study.(m)

Skills and Abilities

3. demonstrate an ability to critically and systematically integrate knowledge and to analyse, assess and deal with complex phenomena, issues and situations, even when limited information is available,(m)
4. demonstrate an ability to critically, independently and creatively identify and formulate issues and to plan and, using appropriate methods, carry out advanced tasks within specified time limits, so as to contribute to the development of knowledge and to evaluate this work,(m)
5. demonstrate an ability to clearly present and discuss their conclusions and the knowledge and arguments behind them, in dialogue with different groups, orally and in writing, in national and international contexts; and,(m)
6. demonstrate the skill required to participate in research and development work or to work independently in other advanced contexts.(m)
7. prove ability to independently apply acquired knowledge in practical work, and insights in future professional positions,(j)

Judgement and Approach

8. demonstrate an ability to make assessments in their main field of study, taking into account relevant scientific, social and ethical aspects, and demonstrate an awareness of ethical aspects of research and development work;(m)
9. demonstrate insight into the potential and limitations of science, its role in society and people's responsibility for how it is used; and(m)
10. demonstrate an ability to identify their need of further knowledge and to take re-sponsibility for developing their knowledge.(m)
11. prove insights in the professional engineering role and responsibility in the society, assuming human conditions and needs and the goals for economical, social and ecological sustainable development in the society,(j)
12. prove immersed ability to interdisciplinary manners and to apply a system perspective,(j)

Programme-specific learning outcomes

The intended learning outcomes provided for programmes, must also be met.

Knowledge and Understanding

13. display knowledge of the general properties of metals, polymers and ceramics as well as being able to make a connection to the structure of atoms and the microscopic level.
14. display knowledge of how different manufacturing processes, with particular focus on casting, affects the structure of materials and, in turn, the product's properties.

Skills and Abilities

15. demonstrate ability to independently use advanced calculation programmes, construction tools and methods to model, analyse and optimise different technical problems regarding functions, performance, material choice and costs.
16. demonstrate ability to employ a structured and effective process for the development of new products as well as for product care, and being able to understand and govern the use of modern computer based methods for this work.

Contents

Programme Principles

The programme consists of a number of courses that will advance the students' knowledge in Product development, Materials and manufacturing, and Simulation and optimization. These three fields reflects the scientific research being conducted at JTH.
All courses within the program are given in English.
Year 1
The programme starts with an introductory course aimed at providing a shared view on what is meant by industrial product realisation including the methodology and leadership. The courses

within product development: *Integrated Product Development* and *Computer Programming for Design Automation* address how the development of products is conducted and can be supported. XXXXXXXXXXXXX
In the courses *Materials and Design* and *Functional Materials and Surfaces* the selection of materials and surface coating of materials are elaborated.
The students also advance their knowledge in design analysis and optimisation of products in various stages of the product development process. In the courses *Non-linear FEA* and *Optimisation Driven Design* moderns analysis tools are used for this purpose. The understanding of the theory behind the tools is also extensively elaborated.
Year 2
The advancement within Product development, Materials and manufacturing, and Simulation and optimization continue in year 2 in the courses *Advanced Materials Technology, Computer Supported Engineering Design*, and *Modelling and Simulation of Casting*. By the start of the third semester the students are prepared to do an internship off campus to try their future role as experts in the course *Off Campus Integrated Theory and Practice in Product Development*. This involve practicing the knowledge gained earlier in the programme. The second semester year 2 in spent on a final project in which a research or development project based on a relevant issue is conducted and reported in a scientific way.

Programme progression

The courses within the three fields run in parallel throughout the whole programme, resulting in a broad knowledge within industrial product realisation. Within each field there is a progressive deepening, the introductory courses have a more basic character, followed by an increased degree of difficulty. The latter courses are more focused on a deep knowledge about the theory behind, and the practical use of computer based methods and simulation in product development. The final courses are also closer to the current research. Different project works are included in the education, these are supposed to train the students to work more independently, and with a scientific attitude, and also provide an opportunity to apply the knowledge to real problems. This creates the platform used as a basis for the final thesis project, where the student accomplishes a research or development project based on a relevant problem.

Courses

Mandatory courses

Course Name	Credits	Main field of study	Specialised in	Course Code
Advanced Materials Technology	6	Product Development	A1N	TAMR27
Computer Supported Engineering Design	9	Product Development	A1F	TDKS27
Final Project Work in Product Development	30	Product Development	A2E	TEUV24
Functional Materials and Surfaces	6	Product Development	A1F	TFYS27
Industrial Product Realization, Process - Methods - Leadership	9	Production Systems, Product Development	A1N	TIFR26
Integrated Product Development	12	Product Development	A1F	TIPS25
Materials and Design	6	Product Development	A1N	TMDR26
Modelling and Simulation of Casting	6	Product Development	A1F	TMSS27
Industrial Placement Course in Product Development	9	Product Development	A1F	TNFS24

Non-linear Finite Element Analysis	9	Product Development	A1N	TOLR24
Optimization Driven Design	6	Product Development	A1F	TODS27
Computer Programming for Design Automation	6	Product Development	A1N	TPAR27

Elective courses

Course Name	Credits	Main field of study	Specialised in	Course Code
Advanced CAD[I]	6	Product Development	A1N	TACR26
Multivariable Calculus[I]	6		G1F	TFVK14

Programme overview

Year 1

Semester 1		Semester 2	
Period 1	Period 2	Period 3	Period 4
Industrial Product Realization, Process - Methods - Leadership, 9 credits	Materials and Design, 6 credits	Functional Materials and Surfaces, 6 credits	Computer Programming for Design Automation, 6 credits
Advanced CAD [I], 6 credits	Non-linear Finite Element Analysis, 9 credits	Integrated Product Development, 12 credits	Optimization Driven Design, 6 credits
Multivariable Calculus [I], 6 credits			

Year 2

Semester 3		Semester 4	
Period 1	Period 2	Period 3	Period 4
Advanced Materials Technology, 6 credits	Computer Supported Engineering Design, 9 credits	Final Project Work in Product Development, 30 credits	
Industrial Placement Course in Product Development, 9 credits	Modelling and Simulation of Casting, 6 credits		

Teaching and examination

Academic year is divided into two semesters and normally read two courses in parallel. Examination forms and grades are given by each course plan, respectively. The programme overview shows the programme structure for both years and may be changed during the programme. For updated programme overview see http://www.jth.hj.se

Prerequisites

The applicant must hold the minimum of a bachelor's degree (i.e the equivalent of 180 ECTS credits at an accredited university) with at least 90 ECTS credits in mechanical engineering, or equivalent. The bachelor's degree should comprise a minimum of 21 ECTS credits in mathematics. English proficiency is required.

Continuation Requirements

In order to begin the second year, at least 30 credits from the programme's first year must be completed.

Qualification Requirements

To obtain a Degree of Master of Science in Product Development, specialisation in Product Development and Materials Engineering, students must complete a minimum of 120 higher education credits in accordance with the current programme syllabus, at least 60 of which must be in the main field of study Product Development and 21 credits in Mathematics.

In addition a Degree of Bachelor of Science in Engineering/Degree of Bachelor of Science or an equivalent Swedish or foreign qualification is required.

Quality Development

Management councils , Head of Programmes, teachers and students work together with the development of the programmes and courses. All students get the opportunity to do a course evaluation after each completed course and before graduation time. The results of the evaluation are presented to the Head of Programmes, Head of Departments, Course Coordinators and to the Director of Education for further development.
Head of Departments, or corresponding, and Head of Programmes raise questions regarding the programme development within the Council of Programmes.
Student representatives, Director of Education and Study Counselor meet four times per year to discuss the recent completed courses within the programmes.
The chairman of students Educational Committee is a regular member in Council of Education.

Other Information

Course included in the programme can be read as a separate course, subject to availability. Prerequisites are stated in the syllabus.
Non-EU/EEA/Switzerland citizens pay tuition fees at the current rate. For further information see http://www.hj.se, / / Tuition and Application Fee / /