JÖNKÖPING UNIVERSITY
School of Engineering

PROGRAMME SYLLABUS

Product Development and Materials Engineering (master), 120 credits

Programmestart: Autumn 2017

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PROGRAMME SYLLABUS

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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

In an era of digitalization much of the product development is done on virtual computer models making elaborate predictions of the product behavior in all phases of the product life cycle. This development has led to more optimized products with better performance as well as reduced development times and at the same time less environmental impact. There is also a development towards more individualized products, customized to better meet the needs of the costumer. By designing families of products, rather than individual and by automating repetitive design work, customized products can be produced faster and to a lower cost, making them accessible to a higher number of customers. This is further enhanced by the advancements of additive manufacturing making the rapid manufacture of prototypes and products possible.

These developments have sparked a need of engineers who have specialist knowledge and at the same time have an insight in the whole product realization process. The graduates from Product Development and Materials Engineering is a response to this need. In their professional careers, the graduates from the program will be able to help businesses to integrate the steps of the product and production chain as well as contributing with the needed expertize helping companies globally and in the region of Jönköping to stay competitive.

Objectives

The program Product Development and Materials Engineering aims to develop the knowledge, skills and experience needed to realize advanced products using modern computing and information technology. This includes the modeling and analysis of products and production processes as well as formulating and solving advanced engineering problems such as optimizing the product function, enhancing performance, choosing materials and manufacturing processes and at the same time addressing the sustainability of the products.

The program also aims to provide deepened knowledge concerning materials and manufacturing, structural design, material properties and their effect on products and production processes.

Post-graduation employment areas

After completing the program, the graduates will be qualified for positions with companies in need of experts who at the same time have a broad approach to product realization. Examples of working tasks include design and design analysis or material development to improve properties or customizing materials for particular applications. Further, graduates will perhaps work with improving the product development process in companies by automating repetitive tasks by the use of commercial software or by coding their own software.

Research

Opportunities for employment may emerge in companies with design and manufacturing capabilities or with consultant firms.
The program also serves as a preparation for scientific research qualifying for enrollment as Ph. D students in universities or institutes. Examples of research areas include product development, materials and manufacturing, material science and simulation and optimization.

Programme Supportive Research

In the University of Jönköping, the scientific research that the program is based upon is carried out in two fields: “Product Development” and “Materials and Manufacturing”. In the field of Product Development, there are two scientific specializations both represented in the program, one in Computer Supported Engineering Design (CSED) and the other in Simulation and Optimization. In the field of Materials and Manufacturing, there is a range of specializations: foundry technology, solidification and microstructure modelling, materials characterization and properties modelling, Surface technology, and Simulation methodology in casting.

Computer Supported Engineering design

The objective of the scientific research within this specialization is to prescribe how to use product and process knowledge as a competitive factor in the manufacturing industry. It involves investigating how companies can formalize and manage their knowledge on products and production processes for the retrieval and reuse when developing new products or making product variants. The CSED group works mainly with knowledge modelling and with making experimental software system for the efficient retrieval and reuse of knowledge. The group also works with the integration of the different steps in the product development process and how to organize and support it. The specialization is represented in the product development progression of the program encompassing four different courses.

Simulation and Optimization

The specialization is involved both in developing the foundation of finite elements calculations by for example developing new types of element formulations and material models as well as methods to handle highly non – linear problems. The groups also explore new applications domains of FEA as for example how to make a finite element model of human tissue for finding the optimal pressure distribution on prostheses or making finite element models of metal microstructures to predict material behaviors on the microscopic level. This specialization is represented in three two courses in the engineering analysis progression of the program.

Materials and manufacturing

Materials and manufacturing is the largest research group. It is involved in fundamental and applied research on the properties of cast iron and light metal alloys. It can e.g. involve developing predictive models for material properties or finding additives and casting methods that can reduce the defects in cast components as well as finding the actual causes of the defects. The research can also involve developing computer models of heat transfer in casts and for the prediction of the phases emerging in alloys.
All the specializations of materials and manufacturing are represented to a varying extent in the

courses of the program and in particular solidification and microstructure modelling, Surface technology, and Simulation methodology in casting that are represented in three different courses in the material and manufacturing progression in the program with dedicated courses for each of the specializations.

Education concept at the School of Engineering

All degree programmes at the School of Engineering at Jönköping University (JTH) follow an education concept. The concept can be seen as consisting of a number of different aspects that have to be included in the degree programmes in order to guarantee their quality and appeal as well as their ability to produce professionally skilled, in-demand students. The concept places special emphasis on collaboration with industry and internationalisation as two essential tools in developing successful programmes attracting many applicants.

In the concept for the Master's programmes, there are common learning outcomes regarding the areas leadership, project management, internationalisation, and sustainable development. There is also an Industrial Placement Course (IPC) included in all programmes, whereby students put their theoretical knowledge into practice. IPC is a 9 credit course (5 weeks practise at a company), and it is also possible to complete the course abroad.

Internationalisation means that, for example, the opportunity is provided to practise languages and intercultural communication through student exchanges with foreign universities. JTH has around 70 partner universities around the world, and takes part in a number of international student exchange programmes. There is an opportunity to spend part of the study period abroad and to accredit studies abroad towards the degree. All Master's programmes at JTH are given completely in English.

Objectives

After the completion of the programme, students must meet the intended learning outcomes, as described in The Higher Education Ordinance by Degree of Master (1-9), and also the intended learning outcomes, as described by JTH:

Common learning outcomes

Knowledge and Understanding

1. demonstrate knowledge and understanding in the main field of study, including both broad knowledge of the field and a considerable degree of specialised knowledge in certain areas of the field as well as insight into current research and development worK
2. demonstrate specialised methodological knowledge in the main field of study.

Competence and skills

3. demonstrate the ability to critically and systematically integrate knowledge and analyse, assess and deal with complex phenomena, issues and situations even with limited information
4. demonstrate the ability to identify and formulate issues critically, autonomously and creatively as well as to plan and, using appropriate methods, undertake advanced tasks within predetermined time frames and so contribute to the formation of knowledge as well as the ability to evaluate this work
5. demonstrate the ability in speech and writing both nationally and internationally to clearly report and discuss his or her conclusions and the knowledge and arguments on which they are based in dialogue with different audiences
6. demonstrate the skills required for participation in research and development work or autonomous employment in some other qualified capacity.

JTH. prove ability to apply acquired knowledge in practical work

JTH. prove ability to collaborate effectively in teams, especially in the presence of a strong multicultural dimension.

Judgement and Approach

7. demonstrate the ability to make assessments in the main field of study informed by relevant

disciplinary, social and ethical issues and also to demonstrate awareness of ethical aspects of research and development work
8. demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used
9. demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning
JTH. prove understanding of future professional engineering roles, including a sound awareness of an engineer's ethical responsibilities towards society and the need for economic, social and ecological sustainable development
JTH. prove ability to embrace interdisciplinary approaches through the application of a system perspective.

Programme-specific learning outcomes
Upon completion of the program, the intended learning outcomes provided for programme must also be met.
Knowledge and Understanding
10. 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.
11. display knowledge of how different manufacturing processes, with particular focus on casting, affects the structure of materials and, in turn, the product's properties.
Competence and skills
12. demonstrate ability to independently use advanced calculation programs, construction tools and methods to model, analyze and optimize different technical problems regarding functions, performance, material choice and costs.
13. 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.
Judgement and Approach
14.demonstrate ability to assess the validity of the results from methods and tools used on actual products.

Contents
Programme principles
The program consists of 12 mandatory and one mandatory elective course. The length of these courses vary. There are 6, 9, 12 and 30 credits courses in the program. There are two semesters each year. Fall semester starts the academic year with a duration from mid of august to early January. The spring semester is from January to end of May. There is a summer break in June to middle of August. Each of the four semesters encompass 30 credits i.e. 120 credits in total.

Year 1
The program starts in mid of August with an introductory course – "Industrial Product Realization, Process - Methods – Leadership". It is aimed at providing the students with a shared view on industrial product realization including leadership. The student is introduced to some of the scientific methods used in the main field of study as well an introduction to working in a multi-cultural environment. The course spans all five engineering master programs in JU.

In the introductory week of the first semester, the student must choose between a course in mathematics, specifically "Multivariate Calculus" or the course "Advanced CAD". The intent of the math course is to prepare students lacking undergraduate University studies in multivariate calculus for the courses "Non-linear Finite Element Analysis" and "Optimization Driven Design". In these two courses, knowledge of multivariate calculus is indispensable. Students that in their undergraduate studies have studied multivariate calculus shall instead choose the course

Advanced CAD. This course is useful in the future working career, but it can be replaced with the multivariate course and the student will still be qualified to graduate from the program. Students having an engineering bachelor's degree from JU have the necessary knowledge on multivariate calculus and should take the Advanced CAD course. Since the student must choose one of the two courses they are called mandatory elective.

In the courses Non-linear Finite Element Analysis and Optimization Driven Design analysis software tools are used advancing the students' knowledge in design analysis and optimization of products. The courses cover the theory of the used tools and methods.

The courses "Integrated Product Development" (IPD) and "Computer Programming for Design Automation" (CPfDA) address how the development of products is conducted in practice and how it can be supported. The IPD course focuses mainly on the integration of the stages of product development whereas CPfDA is focused on programming skills.
In the course "Materials and Design", the selection of materials and the relation between the material properties and the product design discussed. In the course "Functional Materials and Surfaces" coatings and the properties of surfaces are covered.

Year 2
The advancement within Product development, Materials and manufacturing, and Simulation and optimization continue year 2 in the courses "Microstructural Engineering", "Computer Supported Engineering Design", and "Modelling and Simulation of Casting". By the start of the third semester the students are prepared to do a short and focused internship off campus to get an insight in their future professional role in the "Industrial Placement Course". As a suggestion, the placement can be extended through the summer break between year 1 and year 2.

The third semester is the preferred international semester of the program. Students are encouraged to study at one of the JU partner universities outside Sweden or at one of the JU international campuses. These provide opportunities for internships, Final projects and University courses. When studying abroad, the third semester is replaced by equivalent courses at partner universities for inclusion in the master degree. Thus, the semester abroad will not add to the time spent to obtain the master degree. Note that is not mandatory to have an international semester to graduate from the program.

The whole second semester year 2 is spent on a cap stone project - Final Project Work in Product Development. In this course the students write their master thesis in cooperation with a company or research organization. The course will involve a research or development project resulting in a thesis report that comply with the scientific standards of JU. The report is orally presented and defended at the end of the education.

The names of the courses described above are abbreviated for readability reasons in the remainder of this program plan. The table below show the abbreviations that are used.

Programme progression

The program contains three different lines of progression:
- Product Development
- Materials and manufacturing
- Engineering analysis

The product development progression can be said to form an envelope for the program in that it takes the holistic view on product realization, integrating all progression courses to a complete view on product realization. A fourth line of progression can be identified in the in the Industrial

Placement Course in Product Developement and the final project. The two courses involve applying the knowledge gained in the courses and applying it practice. The Advanced Cad and Multivariable Calculus courses are outside the progression.

The figure 1 below show the progression between the courses in the four lines of progression. A course in the progression must be completed before starting on the next course in the progression.

Within each progression there is a successive deepening, the first courses in the progression have a more basic character, whereas the latter courses are more focused on insight and making accurate judgement.

Different projects are included in the courses with the purpose of training the students to work more independently in a scientific manner. The projects 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.

Elective block 1.

Conditionally elective, see section "programme principles". 6 credits from the Multivariable Calculus, 7,5 credits course will be included in the degree.

Courses

Mandatory courses

Course Name	Credits	Main field of study	Specialised in	Course Code
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
Microstructural Engineering	6	Product Development	A1N	TMER27
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]	7.5		G1F	TFVK17

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], 7.5 credits			

Year 2

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

Teaching and examination

Throughout the academic year, typically, two courses are taken in parallel. Examination forms and grades are given by each course module, respectively. The programme overview shows the programme structure for both years and may be changed during the programme. For updated programme overview visit http://www.ju.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. Proof of 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 (120 credits) with a major in Product Development, specialisation in Product Development and Materials Engineering, students must complete a minimum of 120 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.

Representatives of students and programme managers gather continuously to discuss the recently completed programme courses.

Other Information

If formal competence is missing, the applicant's substantial competence is tested if the applicant has acquired equivalent knowledge in some other way. The aim is to assess the collective competence and if the applicant has the opportunity to meet selected training. Substantial competence can be about knowledge and experience from working life, long-term mobility or other courses.

Course included in the programme can be read as a separate course, subject to availability. Prerequisites are stated in the syllabus.

Admission is under "Admission arrangements for first and second level" at Jönköping University.

This syllabus is based on "Regulations and guidelines for education at undergraduate, postgraduate and doctoral studies at Jönköping"