JÖNKÖPING UNIVERSITY
School of Engineering

PROGRAMME SYLLABUS

Materials and Manufacturing (master), 120 credits

Programmestart: Autumn 2024

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Programme code:	TAMM1	**Programmestart:**	Autumn 2024
Confirmed by:	Dean 2023-11-01	**Education Cycle:**	Second-cycle level
Version:	6		

Title of qualification

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

Programme overview

Background

In our daily lives, we are surrounded by and dependent on different types of engineering products and components. In a developing society the demand of this kind of products are constantly increasing. The threat from an exploited environment necessitates smarter products, better material selection and manufacturing processes. Access to new materials with unique properties and new manufacturing technology make it possible to realize new types of components and products. To stay competitive in today's global market it is necessary to shift towards manufacturing of knowledge intensive and high technological products with high value added and low price-sensitivity. Tomorrow's products have demands on performance, energy efficiency, environmental impact and costs. To be able to optimize design of engineering components it is essential to understand the influence of process parameters on the materials structures and their resulting properties.

This programme gives a general understanding of the theories behind materials and their manufacturing processes and their role in the entire product development process during the first year. Then in the second year it provides the unique opportunity for the students to choose between two tracks based on your own career interest: component realization or foundry technology.

Objectives

The program Product Development and Materials and Manufacturing aims to develop the knowledge, skills and experience needed to realize advanced products using modern computing and understanding of the relationship between manufacturing process, microstructure, and final material properties. This will provide the toolbox to contribute in the industry's competitiveness through cutting-edge expertise, innovation and commitment to global sustainability.

Post-graduation employment areas

After completing the program, the graduates will be qualified for positions with companies in need of experts in product realization. Examples of working tasks include design and design analysis, material development or development of the manufacturing process. You may also be responsible for purchasing components.
The programme also paves the way for research within related fields and builds a foundation for

third-cycle studies within the relevant research environments.

Programme Supportive Research
Materials and manufacturing is a specialization within the much broader research area of industrial product realization at JU. The research in the subject area of materials and manufacturing mainly supports the programme, but other subject areas like machine design and production systems also have supportive research.

The program has a close bond to the research conducted within the third-cycle subject area of materials and manufacturing at the School of Engineering. This research group is involved in fundamental and applied research on the properties of cast iron and light metal alloys as well as surface technology. The research contains elements of material testing, microstructure characterization, modeling, and simulation. A new branch of research within the fields of polymer technology is starting.

Other subject areas with possible contributions to the programme are machine design and production systems. The subject area of machine design includes methods and techniques for the design of components, in particular, the emphasis is laid on the use of computer-based tools for engineering design. The subject area of production systems has a research field with a holistic view of production and its interaction with the entire product realization process.

Educational concept at the School of Engineering
All degree programmes at the School of Engineering at Jönköping University (JTH) follow an education concept. The concept consists of several aspects that must be included in the programmes in order to guarantee quality and appeal as well as their ability to create professionally skilled, in-demand students. The concept places special emphasis on collaboration with industry and internationalisation as two essential tools to develop successful programmes and to attract national and international applicants. Furthermore, all the master’s programmes offered by the School of Engineering follow common guidelines that indicate the number of credits per each course (7,5, 15 or 30), the need of cross disciplines courses, and the Industrial Placement Course as mandatory or elective.

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 outcome, 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
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 ability to embrace interdisciplinary approaches

Programme-specific learning outcomes
Upon completion of the program, the intended learning outcomes provided for programme must also be met.
Knowledge and Understanding
10. demonstrate knowledge of the general properties of metals, polymers and ceramics and be able to link those properties to the atomic structure and microstructure.
11. demonstrate knowledge of how different manufacturing processes affect the structure of materials, and consequently, the properties of products, and how these processes can be controlled and managed.
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 and being able to understand and govern the use of modern computer based methods for this work.
Judgement and Approach
14. demonstrate the ability to critically examine the selection of materials and processes for development of engineering components based on functional, financial and environmental requirements.
15. demonstrate, in relation to manufacturing and engineering components, an understanding of questions of sustainability.

Contents

Programme principles
The program is a two-year program with two semesters each year. Each semester is divided into 2 periods. The length of the mandatory courses are 7.5 or 30 credits, and the elective courses have lengths of 3, 6 and 7.5 credits. The first year of the programme is common for both tracks and is campus based. The second year offers two possible tracks, component realization and foundry technology. The teaching of component realization is campus based and similar to the first year, but the teaching of foundry technology is fully online.

During the first year there are 7 mandatory courses and one mandatory elective course. Students without passed courses in multivariable calculus must take a course in Multivariable Calculus 7.5 credits, the other students must choose Integrated Product Realization, 7.5 credits. All courses the first year are 7.5 credits each and two courses are always run in parallel. Each course is run for a half semester or a period. A short presentation of the mandatory courses are given below.

The course materials and manufacturing technology contains metallic materials and their manufacturing processes. You will learn about the relationship between manufacturing, material properties and product requirements. The course in thermodynamics will provide background knowledge for deeper understanding of phase transformations. It also contains computational thermodynamics. Polymer technology is offered as a co-read course and deals with polymers, polymer based composites and manufacturing aspects. Surface technology provides basic knowledge in the field. The surface of a component often hosts very important characteristics of the final product requirements. Microstructural engineering introduces physical metallurgy. The foundation of this course is important to be able to understand and predict phase transformations in metals and alloys. Numerical analysis lays the mathematical foundation for courses in FDM and FEM during the second year. This course is possible to co-read by other master programs. Continuum mechanics focus on material modelling.

The tracks start the second year and are described below.

Component realization
This track has 4 courses of 7.5 credits each during the first semester. Applications of Computational Fluid Dynamics and heat transfer contains FDM computations and relevant cases for manufacturing using polymers. FEA and Optimization Driven Design. The optimization course will also contain cases with polymers. In the second period in parallel with polymer and composite technology. This is offered as a co-read course. The last two are FE and Optimization driven design and microstructure and process simulation. The FE course will contain polymer cases and FEA is used in practice. In the microstructure and process simulation course the focus is prediction and simulation of phase transformation and modelling of manufacturing processes.

This track has an elective course in the second period of the first semester. Here it is possible to study Materials and Process Selection, Industrial Placement Course or Advanced CAD, all 7.5 credits courses. The track ends with a Final Project Work of 30 credits. The environment is international with possibility of students from all over the world. The final project work could be done abroad at research partners with the department, both at universities and at companies. It is also possible to go abroad during the first semester of the second year but then courses with similar contents needs to be studied for an approved degree.

Foundry Technology
This track is offered completely online the first semester and focused on casting of metallic materials. The courses are 3 or 6 credits and two courses are run in parallel. These courses are also offered as single courses to professionals. Two course blocks are run in parallel within the track.

The first block contains Component Casting, two courses on liquid metal processing, moulding materials and environmental impact assessment. This block starts with an overview of casting processes and casting materials. It goes in-depth on preparation of melts and on moulding materials and finishes with the environmental impact of castings.

The second block starts with a course in solidification and is followed by a course in casting defects and in modelling and simulation of the casting process. The track ends with a 30 credits Final Project Work which could be done on Campus. The online semester could be studied anywhere in the world and the final project work could be done abroad at research partners with the department, both at universities and at companies.

Programme progression
The main idea of the programme is to prepare students for realization of engineering components based on quantitative methods. The programme is introducing the student to the

relationship between material properties, manufacturing technology and final product properties. A thermodynamics course lays foundation for physical metallurgy. This block also contains surface technology where part of the thermodynamics is utilized. A set of computational courses consisting of the foundations for FDM and FEM and material modelling is preparing for the second pillar of the programme. This pillar is especially important in the Component Realization track. The course on polymer and composite technology during the first year gives the students a broader background in the area of materials and manufacturing. The course is followed by calculation cases in the Component Realization track.

The track of Component Realization offers calculation-based courses with CFD and FEA and optimization. There is also a course about prediction of phase transformations and modelling of manufacturing processes. The calculation-based courses contain relevant cases within manufacturing and the influence of material and component properties. The track has an elective course before the final project work.

The Foundry Technology track has two course blocks running in parallel. The first block presents casting processes and casting materials and is followed by courses about melt treatment and about moulding materials. It is ended with a course about environmental impact of castings and methods on how to assess it. The second course block starts with a course about solidification of metals and alloys and is followed by a course on the common casting defects. The block ends with a course on the modeling and simulation of casting.

Elective block 1
Conditionally elective, see section 'Programme principals'. The course credits of the multivariable calculus will be included in the degree.

Elective block 2
Elective block of courses, see section 'Programme principals' under Component Realization. For the track of Component Realization the student are free to choose between Materials and Process Selection, Industrial Placement Course and Advanced CAD.

Courses

Mandatory courses

Course Name	Credits	Main field of study	Specialised in	Course Code
Chemical Thermodynamics	7.5		A1N	TCHR21
Final Project Work in Product Development	30	Product Development	A2E	TETT23
Materials and Manufacturing Technology	7.5	Product Development	A1N	TTTR21
Continuum Mechanics	7.5	Product Development	A1F	TMMS22
Microstructural Engineering	7.5		A1F	TMES22
Numerical Analysis	7.5		A1N	TNAR22
Polymer and Composite Technology	7.5	Product Development	A1N	TPKR21
Surface Technology	7.5	Product Development	A1F	TYTS22

Elective courses

Course Name	Credits	Main field of study	Specialised in	Course Code

Advanced CAD[3]	7.5	Product Development	A1N	TACR21
FEA and Optimization Driven Design[1]	7.5	Product Development	A1F	TFOS22
Multivariable Calculus[3]	7.5		G1F	TFVK17
Moulding Materials in Foundry Technology[2]	3	Product Development	A1N	TFGS22
Analysis of Casting Defects[2]	3	Product Development	A1F	TGAS22
Integrated Product Realization[3]	7.5	Production Systems, Product Development	A1N	TIPR22
Component Casting[2]	6	Product Development	G1F	TKGK11
Materials and Process Selection[3]	7.5	Product Development	A1F	TKAS22
Environmental Impact Assessment of Castings[2]	3	Product Development	G1F	TMKK11
Modelling and Simulation of Casting[2]	6	Product Development	A1F	TMSS22
Industrial Placement Course in Materials and Manufacturing[3]	7.5	Product Development	A1F	TNMS22
Manufacturing Process Simulations[1]	7.5	Product Development	A1F	TTPS22
Liquid Metal Processing - Aluminum Alloys[2]	3	Product Development	A1F	TALS22
Liquid Metal Processing – Ferrous Alloys[2]	3	Product Development	A1N	TJLS22
Solidification Processing[2]	3	Product Development	A1F	TSPS22
Applications of Computational Fluid Dynamics and Heat Transfer[1]	7.5	Product Development	A1F	TTBS22

[1] Elective block 1

[2] Elective block 2

[3] Elective block 3

Programme overview

Year 1

Semester 1		Semester 2	
Period 1	Period 2	Period 3	Period 4
Materials and Manufacturing Technology, 7.5 credits	Chemical Thermodynamics, 7.5 credits	Numerical Analysis, 7.5 credits	Continuum Mechanics, 7.5 credits
Integrated Product Realization [3], 7.5 credits	Polymer and Composite Technology, 7.5 credits	Surface Technology, 7.5 credits	Microstructural Engineering, 7.5 credits
Multivariable Calculus [3], 7.5 credits			

Year 2

Semester 3		Semester 4	
Period 1	Period 2	Period 3	Period 4
Analysis of Casting Defects [2], 3 credits	*Advanced CAD [3], 7.5 credits*	Final Project Work in Product Development, 30 credits	
Applications of Computational Fluid Dynamics and Heat Transfer [1], 7.5 credits	*Environmental Impact Assessment of Castings [2], 3 credits*		
Component Casting [2], 6 credits	*Industrial Placement Course in Materials and Manufacturing [3], 7.5 credits*		
FEA and Optimization Driven Design [1], 7.5 credits	*Manufacturing Process Simulations [1], 7.5 credits*		
Liquid Metal Processing - Aluminum Alloys [2], 3 credits	*Materials and Process Selection [3], 7.5 credits*		
Liquid Metal Processing – Ferrous Alloys [2], 3 credits	*Modelling and Simulation of Casting [2], 6 credits*		
Solidification Processing [2], 3 credits	*Moulding Materials in Foundry Technology [2], 3 credits*		

[1] Elective block 1

[2] Elective block 2

[3] Elective block 3

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 credits in materials and manufacturing, mechanical engineering, chemical engineering, product development or engineering physics or equivalent. The bachelor's degree should comprise a minimum of 15 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 Materials and Manufacturing, students must complete a minimum of 120 credits in accordance with the current programme syllabus 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
The School of Engineering's quality assurance process involves continuous development and quality assurance of degree programmes and courses. This means, among other things, that great importance is attributed to student feedback and that a proactive approach is taken to the development of degree programmes and courses. The quality assurance process is carried out following applicable steering documents.

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"