JÖNKÖPING UNIVERSITY
School of Engineering

PROGRAMME SYLLABUS

Materials and Manufacturing (one year master), 60 credits

Programmestart: Autumn 2020

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Programme code:	TAPU7	**Programmestart:**	Autumn 2020
Confirmed by:	Dean 2020-03-01	**Education Cycle:**	Second-cycle level
Version:	4		

Title of qualification

Degree of Master of Science (60 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 cast products and components. They can, for instance, be found in private cars, lorries, wind turbines and consumer electronics, and we are currently witnessing an increase in the use of cast components. This increase is propelled by, among other things, access to new materials with unique properties and the fact that it is very easy to remelt and recycle metal without compromising the quality of the new product.

The Swedish foundry industry's most important parameter of competition by far is a shift to manufacturing of increasingly knowledge-intensive and high-technological products with high value added and low price sensitivity. In an increasingly globalised and competitive casting market, the ability to continue developing innovative products and processes is decisive in maintaining a technological advantage. This requires large investments in in-service training for current as well as new personnel and support from an education and training system adapted to the needs of the "customers".

Objectives

Focusing on cast components and casting processes, the one-year master's programme in materials and manufacturing aims to provide the knowledge, skills and experience needed to be able to contribute in improving the foundry industry's competitiveness through cutting-edge expertise, innovation and commitment to global sustainability. The programme also aims to give those already employed in the foundry industry the opportunity to undergo further training.

Areas of employment after graduation

The programme provides a platform for work within development and manufacturing as well as work related to end users of cast components and casting processes. Graduates of the programme may have different roles at foundries or nearby producers. They may also design castings or be responsible for purchasing cast 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.

Research underpinning the programme

The programme is closely tied to the research conducted within the third-cycle subject area of materials and manufacturing at the School of Engineering. In addition, the programme is offered in close collaboration with Swerea SWECAST, the Swedish foundry industry's research institute, which is involved in the instruction. The instruction takes place within the framework of the Casting Innovation Center (CIC), which is a joint effort by the School of Engineering, the Swedish Foundry Association, Swerea SWECAST and the Swedish foundry industry.

The third-cycle subject area of materials and manufacturing
The research within the area of materials and manufacturing is interdisciplinary in character and may include everything from product development, component properties and component microstructure to production/manufacturing. The research is founded on such disciplines as fluid dynamics, technical mechanics, mechanics of materials , materials science and technology, materials physics, chemistry, simulation and optimisation. In terms of the product supply chain, the main part of the research is conducted in the intersection between design and manufacturing/application, paying special attention to product properties. The aim is to undertake basic research in order to solve problems related to materials and manufacturing of advanced cast components in close collaboration with the foundry industry and research institutes. The different steps of the product development process, from the design to the choice of materials and method of production, are all decisive in determining the properties of the final product. This is particularly true when it comes to casting of metals. Consequently, today, simulation and optimisation are integral in the development of complex components made from advanced materials.

Objectives
On completion of the programme, the student must fulfil the learning outcomes for the degree of master (60 credits) as laid down in the Higher Education Ordinance:
General learning outcomes
Knowledge and understanding
1. demonstrate knowledge and understanding in the main field of study, including both an overview of the field and specialised knowledge in certain areas of the field as well as insight into current research and development work, and
2. demonstrate specialised methodological knowledge in the main field of study.
Competence and skills
3. demonstrate the ability to 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 autonomously as well as to plan and, using appropriate methods, undertake advanced tasks within predetermined time frames,
5. demonstrate the ability in speech and writing to report clearly and discuss his or her conclusions and the knowledge and arguments on which they are based in dialogue with different audiences, and
6. demonstrate the skills required for participation in research and development work or 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, and
9. demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.

Programme-specific learning outcomes
On completion of the programme, the student must also fulfil the following programme-specific

learning outcomes:

Knowledge and understanding

10. demonstrate knowledge of the general properties of cast metals and their alloys and be able to link those properties to the atomic structure and microstructure of the metals and alloys.
11. demonstrate knowledge of how different casting 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 the ability to independently use advanced calculation programmes, construction tools and methods for modelling, analysing and optimising various casting techniques in terms of function, performance, choice of material, process management and costs in the development of cast components.
13. demonstrate the ability, by means of state-of-the-art computer-aided methods and tools for analysis, to run a structured and efficient process for development of new cast components as well as problem-solving and analysis of casting defects.

Judgement and approach

14. demonstrate the ability to critically examine the selection of materials and processes for development of cast components based on functional, financial and environmental requirements.
15. demonstrate, in relation to casting and cast components, an understanding of questions of sustainability.

Contents

Programme progression

The courses within the programme provide the knowledge and skills needed within the main field of study. The first course block begins with the course Component Casting, which covers substantial parts of the main field of study and provides knowledge of casting processes and design as well as the microstructure and properties of cast components. This course on the basic level lays the foundation for succeeding courses of the programme. The two succeeding courses, Melting and Casting of Ferrous Alloys and Moulding Materials in Foundry Technology, provide deepened knowledge of melting and casting of ferrous alloys as well as moulding materials and core production. Concluding the course block, the course Environmental Impact Assessment of Castings teaches the student to identify and calculate the environmental impact of cast components. Throughout the course block, the student's knowledge of casting is gradually deepened. With the help of computer-aided tools and virtual laboratory exercises, the knowledge acquired is put into practice. Having gained insights and tools with which the environmental impact of cast components can be estimated, the student will be able to assess such components from a sustainable environment perspective.

The second course block provides knowledge of testing and characterisation of both the mechanical and physical properties of materials. The block begins with the course Material Testing and Characterisation, which covers microscopic characterisation, including practical applications. Failure Analysis provides knowledge of the ductility and tensile strength of metallic materials. Failure analysis methods are explained and applied to real-world cases. The course builds on knowledge of methods for structure and fracture characterisation. Concluding the block, Cast Design and Calculation provides knowledge of cast design as well as cost and environmental impact calculation. The course block affords the student the opportunity to acquire knowledge of and apply methods for evaluation of cast material structures and properties. Faced with real-world cases, the student selects and applies practical methods of characterisation to analyse the reasons behind failures. Advanced computer-aided tools are utilised to design cast components, and thus, to produce new geometries.

The third course block begins with the course Microstructural Engineering. The course provides

an understanding of microstructure formation in connection with solidification and heat treatment. The relation between the microstructure and cast component properties is discussed. The next course is Analysis of Casting Defects. It provides knowledge of different types of casting defects, including causes and remedies. The course builds on knowledge of how solidification affects the structure. The final course of the block is Modelling and Simulation of Casting, in which the thermal conduction and solidification are calculated analytically and numerically. In the initial part of the course block, the aim is for the student to understand the formation of the cast material microstructure. Real-world cases allow the student to apply the knowledge acquired in the analysis of casting defects. Furthermore, the student is given the opportunity to apply numerical methods to simulate the solidification process.

Each of the course blocks exhibits a gradual progression from theory to application of knowledge and, ultimately, critical evaluation. Drawing on current research, most of the courses provide insights into the systematic search for new knowledge that is at the core of science. The real-world cases incorporated in the programme afford the student the chance to apply his or her knowledge to real problems, independently and in groups. All of this functions as a platform for the concluding degree project, in which the student conducts research or carries out development work on the basis of a relevant research question.

Courses

Mandatory courses

Course Name	**Credits**	**Main field of study**	**Specialised in**	**Course Code**
Final Project Work in Product Development	15	Product Development	A1E	TETT27
Moulding Materials in Foundry Technology	3	Product Development	A1F	TFGS26
Cast Design and Calculation	3	Product Development	A1F	TGKS26
Analysis of Casting Defects	3	Product Development	A1F	TGAS27
Failure Analysis	6	Product Development	A1F	THAS26
Component Casting	6	Product Development	G1F	TGJK17
Material Testing and Characterisation	6	Product Development	A1N	TMRR28
Microstructural Engineering	6	Product Development	A1N	TMER27
Environmental Impact Assessment of Castings	3	Product Development	A1F	TMGS27
Modelling and Simulation of Casting	6	Product Development	A1F	TMSS27
Melting and Casting of Ferrous Alloys	3	Product Development	A1N	TSGR26

Programme overview

Year 1

Semester 1		Semester 2	
Period 1	Period 2	Period 3	Period 4
Component Casting, 6 credits	Environmental Impact Assessment of Castings, 3 credits	Failure Analysis, 6 credits	Cast Design and Calculation, 3 credits
Melting and Casting of Ferrous Alloys, 3 credits	Moulding Materials in Foundry Technology, 3 credits	Material Testing and Characterisation, 6 credits	

Year 2

Semester 3		Semester 4	
Period 1	Period 2	Period 3	Period 4
Analysis of Casting Defects, 3 credits	Modelling and Simulation of Casting, 6 credits	Final Project Work in Product Development, 15 credits	
Microstructural Engineering, 6 credits			

Teaching and examination

The main part of the programme is offered as distance learning. The programme is made up of courses that, among other things, address issues and challenges of importance to the foundry industry. The forms of examination applied in the courses are written exams, take-home exams, project work with presentations, written assignments and on-campus laboratory sessions. The forms of examination and assessment are specified in the respective course syllabi. The grades 5, 4 and 3 are all passing grades.

Prerequisites

Bachelor of Science (ie. the equivalent of 180 ECTS credits at an accredited university) in Materials and Manufacturing, Mechanical Engineering, Chemical Engineering, Engineering Physics or equivalent. For Bachelor of Science in Chemical Engineering or Applied Physics, relevant courses in Materials Science, Manufacturing Technology, Thermodynamics and Solid Mechanics must be included. For Chemical Engineering relevant courses in physics must also be included. In addition, 21 credits in Mathematics and proof of English proficiency is required.

Qualification Requirements

To obtain a Degree of Master of Science (60 credits) with a major in Product Development, specialisation in Materials and Manufacturing, students must complete a minimum of 60 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"