JÖNKÖPING UNIVERSITY
School of Engineering

UTBILDNINGSPLAN

Production Engineering and Management (master), 120 högskolepoäng

Programstart: Hösten 2021

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Examensbenämning

Teknologie Masterexamen med huvudområdet Produktionssystem, inriktning Production Engineering and Management.

Degree of Master of Science (120 credits) with a major in Production systems, specialisation in Production Engineering and Management.

Programbeskrivning

Background

Today's manufacturing companies face challenge of becoming adaptive to changes in the business environment in which they operate. Because of changes in customer demands and new technologies, manufacturing companies need to increase their capability and flexibility to handle increased product variants in a cost-efficient manner. To do that companies introduce and implement various strategies and tools in their manufacturing systems such as reconfigurable and platform-based production, increase levels of automation and digitalization. Fast information exchange and coordination between product development and production development is also a key for success. Furthermore, the international competition induces a need for continuous development of the Swedish manufacturing industry both technologically as well as strategically with the ambition to contribute to a sustainable society. Future manufacturing companies are also challenged by the European Union mission for moving the industry towards a circular economy by the year 2050.

It has become of utmost importance for large as well as small and medium-sized manufacturing companies in Sweden to understand and improve their capabilities to re-use existing company knowledge and/or invest in flexibility to respond to new trends and changes. It is further crucial that the companies have increased understanding of production system design process so that the system is able to handle increased number of product variants, shorter delivery times to the customers and high delivery precision. This requires the companies to take a holistic view of manufacturing including its preconditions and possibilities, respectively.

Competitive production systems therefore require engineers with an overall understanding of production requirements and possibilities. Engineers need to have advanced knowledge about the design and functionality of production system.

The Master programme P*roduction Engineering and Management* provides you with skills to carry out engineering work and manage improvements in a production system. It prepares the student with knowledge regarding flexible and adaptive production systems that can proactively respond to industrial changes. The programme builds knowledge in manufacturing strategies including reconfigurable production systems, production engineering and automation. Furthermore, the students will gain knowledge of interaction between product development and production development which contribute to an efficient product realization process in a sustainable way.

Objectives

The Master programme *Production Engineering and Management* aims to contribute with knowledge and understanding about competitive production in an industrial context. Graduates will increase their understanding in various strategies, as well as utilization of methods and tools for improving production responsiveness to changes in a business environment. In various courses management aspects are included to provide students with skills in leading production development aiming to improve a production system's performance and efficiency as well as to increase the system's flexibility and responsiveness to changes. Furthermore, the programme offers a holistic view and understanding of how various organizational functions need to be coordinated and integrated to achieve various goals associated with the development of new product and introduction of the new product in an existing or new production system. This includes, among others, aspects related to selection of technologies and methods, degrees of automation and flexibility, and maintenance preparation. Graduates will be highly skilled engineers with sustainable, innovative mindset for future development of complex and digitalized industry.

Post-graduation employment areas

After graduating the programme, the graduated student will be able to have leading roles in the production development for new products or manage continuous technology improvements in existing production system, able to have a leading role in project management related to preparing for new production solutions in a product realization project, able to design production solutions based on customer needs or manage an industrial production line. The programme offers the opportunity to continue with postgraduate studies within production system filed.

Programme Supportive Research

The research area of industrial product realization includes three sub-areas – *production systems* , *material and manufacturing*, and *machine design*. There is a clear connection between the master program and the research carried out in the research area of industrial product realization. These three sub-areas bridge knowledge between research and education in two directions. The ambition is to transfer knowledge from research as well as integrate students to contribute and extend knowledge related to different sub-areas relevant to ongoing research.

Production systems

The subject area of production systems includes the scientific study of processes, methods, and tools, and organisation, for the manufacturing of physical products and associated services. Focus in the subject area is on development of production systems and solutions, operation and management of production systems, integrated with other relevant processes in organisations active on regional, national and global markets. Within the subject area theories concerning production engineering, flexibility, automation, production system development, integrated product- and production development, quality engineering and maintenance management are addressed. Research in the field is based on a holistic view on production and its interaction with

the entire product realisation process, including the interface with customers and suppliers. Production systems include the technology, people and organisation, which co-operatively realises an identified customer need into products and associated services. A systematic approach is applied, and efforts are made to achieve an understanding and knowledge of central elements of production systems.

Materials and Manufacturing
The subject area of materials and manufacturing focuses on the knowledge of how components, primarily but not limited to cast components, can be designed, and manufactured and how the material microstructures and properties of components can be influenced and controlled. This subject area includes experimental methods for material production and characterization, in term of microstructure and properties, as well as modelling/simulation. This research is multidisciplinary and is supported by disciplines such as physics, fluid dynamics, applied mechanics, solid mechanics, material science, materials technology, and chemistry, as well as simulation and optimisation. The research approach is to link the different steps, related to product design, from material design to manufacturing technology, including pre- and post-treatment, to microstructure and final properties. Once linked, these steps can be used as inputs to a localized properties component optimization.

Machine design
The subject area of machine design and industrial design includes methods and techniques for the design of mechanical products/components; an essential element of industrial product realisation. Emphasis is the machine design is laid on the use of computer-based tools for engineering design. This subject area includes both synthesis and analysis to create, optimise and evaluate design solutions regarding – for example – manufacturability, strength, performance, cost and environmental aspects. Within this subject area, computer support of various kinds, such as simulation and optimization, are important for the virtual development and verification of products. In the industrial design emphasis is laid on interaction with the user and how to design producible products with applicable material selection, form and function for industrial purposes. In this subject area the students are provided with different design methodologies and knowledge in interaction in design including realisation of industrial design results both through virtual and physical prototypes.

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 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.

Mål
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 and understanding of requirements placed on a production system based on the turbulent, competitive environment in which a production system operates
11. demonstrate knowledge and understanding of the state-of-the art in the research in the field of design of production systems, including advanced engineering materials, manufacturing processes and different types of automation solutions
12. demonstrate knowledge on the dependencies between material properties, manufacturing processes and product design

Competence and Skills

13. demonstrate the ability to apply different methods, tools used for development, deployment, operation and maintenance of a production system
14. demonstrate the ability to theoretically and practically measure and evaluate different production capabilities and to understand the connection between these capabilities, the company's organisation, and overall corporate goals
15. demonstrate the ability to report and discuss how product development activities and decisions affect efficiency of a productions system
16. demonstrate the ability to use tools and methods to solve problems related to product realization and in particular application of quality management principles, practices, and tools
17. demonstrate the ability to work in a multi-disciplinary project and be able to go into the role of a leader to drive the project towards goals following time plans

Judgement and Approach

18. demonstrate the ability to value and reflect over obtained results toward predetermined objectives
19. demonstrate understanding of the multidisciplinary nature of a product realization process
20. demonstrate the ability to evaluate economic and sustainability impacts regarding the choice

of a product design, material, or manufacturing processes.

Innehåll

Programme principles

Holistic knowledge is required to ensure efficient production systems. This is true for large as well as small and medium-sized enterprises. Therefore, the programme has a holistic view of production including development of the production system and its interaction with the entire product realization process. The first part of the programme focuses on design and development of production systems including an outlook into manufacturing reconfigurability strategies, automation, and production engineering to give the student a deep understanding in the main field of study. Thereafter, management of production systems is in focus where simulation tools will be introduced for analysis of a production system. Furthermore, taking a holistic view of the product realization process allows the students to understand the importance of integration of organizational functions, persons' knowledge, and competences to achieve designing of the right product but also secure its industrialization and production ramp-up to the required volumes, quality, and cost. Consequently, integration of persons from organisational functions such as product development, production and logistics is a key towards smooth introduction of a newly developed or face-lift products in a new or existing productions system.

A fundamental principle of the programme is for students to have the opportunity to link theory to industrial practice. Therefore, it is particularly important that students apply the knowledge they have acquired during their studies. Thus, a substantial part of the studies is carried out in projects where the students can apply theories to analyse and solve problem from praxis. The projects combine various theory areas of the program and function as important instruments giving students profound understanding of and increasing their abilities for the integration needed between different actors and competence areas. In each project, the individual contribution will be crucial and contribute to coaching each student to actively contribute.

To start the next course in the program, the students must be registered and attended the courses before.

The programme progression is based on the courses in the programme plan, where some are mandatory and some elective. The elective courses are selected from the offers in the table below.

Programme progression

The programme begins with a course in *Integrated Product Realization* which provides overview of a product realization process and focuses on integration between persons from different organizational functions. The aim with this course is to show the role of a production engineer in the context of product realization process. In parallel with this course, the students will have an opportunity to deepen their knowledge in the design and development of a production system in a course titled *Production Development I - Strategy and System*. This course offers knowledge regarding production system development approaches supporting proactive mindset, as well as deepens students' knowledge in manufacturing changeability and reconfigurability. In semester 1, period 2, students will further delve in the knowledge of integration of product engineers and production engineers during product realization process in the course *Integrated Product and Production development*. This course demonstrates and offers knowledge of the impact of various design decisions into the possibility to achieve desired and cost-efficient production system. This course builds on the two courses in the semester 1, period 1 and provides deeper knowledge into the connection between product development and production, as well as delves into various tools to analyse and improve product's manufacturability. During semester 1, the

students will have an opportunity to further deepen their knowledge of manufacturing strategies and development of a production system in the course on *Automation and Production Technology*.
This course aims to explore the area of automation and robotics in combination with other production technologies to contribute to knowledge about technologies utilized in a production system. This course provides further examines development of efficient, flexible production solutions.

Semester 2 starts with a course in *Production Development II - Virtual Tools and Modelling* which focuses on different modelling tools for design and improvement of a production system including multi-objective optimization for production system development. This course is oriented to more practical work and hands on when it comes to development of a production system. This course extends students' knowledge in analysing and improving production productivity, as well as the role of maintenance to enhance productivity. This course builds on the knowledge students have gained during courses in semester 1.
Students who apply to the programme and have less than 21 ECTS in mathematics must take a course in *Mathematical Statistics*. Mathematical Statistics course becomes compulsory for students who have less the 21 ECTS in mathematics, and it is important for students to increase their mathematical statistical knowledge and successfully complete the course in *Production Development II - Virtual Tools and Modelling*. If a student has equal or more than 21 ECTS in mathematics, then the student can select one of the courses included in the table of Elective courses offered in the frame of this programme. Semester 2 concludes with a course in *Materials in Design*. This course is important and provides knowledge of selecting materials and production processes to fulfil product specifications. It further extends students' knowledge of the link between material selection, product design and production. In parallel with this course, a course in *Developing Sustainable Supply Chain Operations* contributes to an understanding of quality engineering tools that support analysis and improving of production systems.

Semester 3 begins with a course in *Research and Inquiry Methodology*. This course prepares students for planning and conducting scientific studies and provides knowledge of methods for data collection and analyses. This course is important for securing the quality of students' final thesis projects. During Semester 3, including both period 1 and period 2, students are offered a course oriented toward practical work where through forming of multidisciplinary groups an industrial problem in the field of integrated product and production is solved. The students will learn also about planning and conducting projects. The course is titled *Project Course* and it is a compulsory course for the students staying at JTH, Sweden. During Semester 3, period 2, students are offered to select among the elective courses, see Table titled Elective courses. Only courses offered in the programme syllabus can be selected. During semester 3 a student has the possibility to study abroad. Requirements for a student studying abroad are that the student needs to replace and read courses in Research and Inquiry methodology equivalent to 7,5 or more credits, a project-based course(s) equivalent to 7,5 or more credits, as well as course(s) within the subject areas and in the frame of the Production Engineering and Management programme. One of these courses, for students studying abroad, can be the *Industrial Placement in Production Engineering and Management*. The Programme Manager must approve in each individual case the elective courses for a student that intend to study abroad.

Semester 4 includes a course in *Final Project Work in Production Systems*. This course provides further scope and depth in areas taught in the various courses in the program. When writing up the thesis the student uses the knowledge and experience gained during the program to carry out a research and development project based on an industrially or socially relevant problem.

The progression between the courses is also built to gradually move from a development focus to a focus having skills to develop a production system. Sustainability, digitalization as well as

managerial aspects relevant for designing a production system will be integrated throughout the courses included in the programme.

Kurser

Obligatoriska kurser

Kursbenämning	**Hp**	**Huvudområde**	**Fördjupning**	**Kurskod**
Automation och produktionsteknik	7,5	Produktionssystem	A1F	TAPS21
Developing Sustainable Supply Chain Operations	7,5	Produktionssystem	A1F	TSSS22
Examensarbete i Produktionssystem	30	Produktionssystem	A2E	TEUT23
Forskningsmetodik	7,5	Produktionssystem, Produktutveckling	A1N	TFMR22
Integrerad produkt och produktionsutveckling	7,5	Produktionssystem, Produktutveckling	A1F	TIPS22
Integrerad produktframtagning	7,5	Produktionssystem, Produktutveckling	A1N	TIPR21
Konstruktionsmaterial	7,5	Produktutveckling	A1N	TKMR22
Production Development I - Strategy and System	7,5	Produktionssystem	A1N	TP1R21
Produktionsutveckling II - virtuella verktyg och modellering	7,5	Produktionssystem	A1F	TPVS22
Projektkurs	15	Produktionssystem, Produktutveckling	A1F	TPJS22

Valbara kurser

Kursbenämning	**Hp**	**Huvudområde**	**Fördjupning**	**Kurskod**
Avancerad CAD[2]	7,5	Produktutveckling	A1N	TACR21
Hållbar produktion[2]	7,5	Produktionssystem	A1N	K00039 91
Industrial Placement in Production Engineering and Management[2]	7,5	Produktionssystem	A1F	TPES22
Matematisk statistik[1]	7,5		G1F	TMSK17
Produkt- och produktionsplattformar[1]	7,5	Produktionssystem, Produktutveckling	A1F	TPDS22

[1] Valbart block 1

[2] Valbart block 2

Programöversikt

Årskurs 1

Termin 1		Termin 2	
Period 1	Period 2	Period 3	Period 4
Integrerad produktframtagning, 7,5 hp	Automation och produktionsteknik, 7,5 hp	Produktionsutveckling II - virtuella verktyg och modellering, 7,5 hp	Developing Sustainable Supply Chain Operations, 7,5 hp
Production Development I - Strategy and System, 7,5 hp	Integrerad produkt och produktionsutveckling, 7,5 hp	*Matematisk statistik [1], 7,5 hp*	Konstruktionsmaterial, 7,5 hp
		Produkt- och produktionsplattformar [1], 7,5 hp	

Årskurs 2

Termin 3		Termin 4	
Period 1	Period 2	Period 3	Period 4
Forskningsmetodik, 7,5 hp	*Avancerad CAD [2], 7,5 hp*	Examensarbete i Produktionssystem, 30 hp	
Projektkurs, 15 hp			
	Hållbar produktion [2], 7,5 hp		
	Industrial Placement in Production Engineering and Management [2], 7,5 hp		

[1] Valbart block 1

[2] Valbart block 2

Undervisning och 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

Förkunskapskrav
Examen om minst 180 hp med lägst 90 hp i huvudområdet maskinteknik, industriell organisation och ekonomi eller byggnadsteknik eller motsvarande svensk eller utländsk utbildning. Dessutom krävs 15 hp i matematik och 15 hp examensarbete samt kunskaper i Engelska 6/Engelska B eller motsvarande.

Villkor för fortsatta studier
To begin the second year, at least 30 credits from the programme's first year must be completed.

Examenskrav
För Teknologie masterexamen med huvudområdet Produktionssystem, inriktning Production Engineering and Management krävs fullgjorda kurser om minst 120 högskolepoäng(hp) enligt gällande utbildningsplan varav minst 60 hp inom huvudområdet Produktionssystem samt 21 hp Matematik.
Dessutom krävs avlagd Högskoleingenjörs/Teknologie kandidatexamen eller motsvarande svensk eller utländsk examen.

Kvalitetsutveckling
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.

Övrigt
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"