



## General syllabus for third-cycle subject

Subject	Adopted	Registration number	Ks-kod
<b>Production engineering</b>	<b>25 Jan 2011</b>	<b>V-2018-0673</b>	<b>3.2.3</b>
	<i>Revised 13 June 2018</i>		

## General syllabus

**Adopted by the faculty council/education committee: 25 Jan 2011**

Revised: 13 Jun 2018

### Subject title in Swedish (and English translation)

*State also whether the subject has specialisations.*

Industriell produktion (Eng. Production Engineering)

### Subject description – Main content of the programme

Department of Production Engineering conducts first and second-cycle education, third-cycle education and research in a wide scope of production engineering. These activities cover most of the key areas in modern production development and processes with close links to manufacturing industries. The programme's hallmark is a diversity of backgrounds, perspectives and analysis levels.

The third-cycle subject area is multidisciplinary and specialised towards:

- Structuring and operational management of sustainable production systems.
- Control systems and module development for adaptive production systems.
- Computer support and information management for collaborations in all parts of a product's life cycle.
- Assembly systems and robotics.
- Precision engineering.
- Industrial metrology and surface characterisation.
- Dynamic and structural analysis for machine tooling.
- Process technology for adapting new industrial materials.

Economic and business aspects are an integral part of the entire subarea.

### Programme objectives based on Sweden's Higher Education Ordinance, Annex 2 – Qualifications Ordinance

*Each doctoral student's individual study plan shall be designed to guarantee the possibility of attaining the qualitative targets in the Higher Education Ordinance and KTH's objectives. Attainment shall be evaluated for each individual doctoral student. This shall be done annually by monitoring the individual study plan. The latter shall comment on how, vis-à-vis the goals (i.e. targets and objectives), the programme's courses and thesis work achieve progression. Other activities (e.g. supervision and outward-oriented operations in line with education and public outreach) shall also be factored into this.*

*State the programme elements for promoting goal attainment. Other details are to be given in an appendix to the subject's study plan.*

#### Knowledge and understanding

*For a Degree of Doctor, the doctoral student shall demonstrate:*

- *Wide expertise in, and a systematic understanding of, the research domain; and, deep and current specialist knowledge in a delimited part of the research domain.*
- *Familiarity with scientific methodology in general and the specific research domain's methods in particular.*

The overall "knowledge and understanding" goals are primarily attained through course participation

and own, supervised research. In other words, these intended learning outcomes are attained individually by each doctoral student through:

- Compulsory courses. The purpose of examination in compulsory third-cycle courses is to ensure that each doctoral student has acquired wide expertise in, and systematic understanding of, the research domain and a broad understanding of scientific methodology in general.
- Recommended courses. The recommended courses all satisfy the purpose of further ensuring the doctoral student's wide expertise, insights and ability. They do this without reducing (through being made obligatory) the need for space for specialist, optional courses. These latter are established individually with each doctoral student.
- Optional courses. These are normally the specialised, subject-specific courses that each doctoral student attends to improve himself/herself in his/her individual research specialisation and, thereby, ensure his/her specialist knowledge and specialised methodological know-how. These courses are identified in consultations between doctoral student and supervisor.

*Skills and abilities (communication ability included therein)*

*For a Degree of Doctor, the doctoral student shall:*

- *Demonstrate an aptitude for scientific analysis and synthesis, as well as for independent critical examination and assessment of new and complex phenomena, issues and situations.*
- *Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct research and other advanced assignments within given time frames and examine and evaluate this work.*
- *Via a thesis, demonstrate an ability to significantly contribute, through own research, to knowledge development.*
- *Demonstrate an ability, in both national and international contexts, to authoritatively present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.*
- *Demonstrate an ability to identify further knowledge needs.*
- *Demonstrate the potential (within research, education and other advanced, professional contexts) to contribute to societal development and others' learning.*

The overall "skills and abilities" goals are primarily attained through thesis work. However, there is support from courses and seminar activities. Students receive training in: studying, understanding and criticising scientific texts; and, being able to argue for or against own and others' results and interpretations. Training in communication also takes place through presentations at scientific conferences and internal seminars at the department (e.g. the "Friday seminar"). Doctoral students undertake departmental duties in the form of teaching. This helps to further develop communication abilities.

*Judgement and approach*

*For a Degree of Doctor, the doctoral student shall:*

- *Demonstrate intellectual independence and scientific probity as well as an ability to assess research ethicality.*
- *Demonstrate specialised insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.*

The overall "judgement and approach" goals are attained through supervision, faculty meeting discussions, courses and thesis work. The ability to assess research ethicality is trained in supervised thesis work and via ethics elements in the compulsory "Theory of science and research methodology" course. Intellectual independence is trained and tested in connection with the publishing of papers and

in thesis work in general.

### Sustainable development

*For a Degree of Doctor, the doctoral student shall:*

*- Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.*

It is considered that this goal is attained via, for example: adding a sustainability perspective to third-cycle courses; discussing environmental and ethical issues in seminars; and, optional, third-cycle courses on sustainable production and system development.

### **Specific entry requirements**

*Subject knowledge requirements and any language requirements are to be entered here.*

KTH's general entry requirements for admission to third-cycle education apply. Doctoral students are expected to be able to study and write scientific English and to speak English fluently.

### **Selection rules**

Admission of students to third-cycle education is decided by the head of the school. The selection basis is the degree of ability to benefit from third-cycle education. In the first instance, selection is based on documented material cited by the applicant. Other decision inputs such as applicant interviews and contacts with previous programme providers may also be important. Suitability for third-cycle education is determined by considering: grades; earlier activities; interests; and, capacity for independent judgement and critical analysis.

### **Content and examination of the course component**

Third-cycle education comprises a course component and a thesis requirement:

- A Degree of Licentiate requires 120 higher education credits (HECs), the thesis requirement providing at least 60 HECs and the course component at least 30 HECs (at least 15 of these being third-cycle and no more than 10 being first-cycle).
- A Degree of Doctor requires 240 higher education credits (HECs), the thesis requirement providing at least 150 HECs and the course component at least 60 HECs (at least 45 of these being third-cycle and no more than 10 being first-cycle).

It is recommended that most of the courses are taken in the first years of third-cycle education. However, acquiring specialist knowledge even later may often be relevant. It is important that course components are described and justified in the individual study plan. When selecting courses, third-cycle courses given by other university colleges, graduate schools and international networks should be taken into consideration.

All courses shall be approved by the doctoral student's principal supervisor and the director of the doctoral programme.

### **Compulsory courses for a Degree of Doctor**

To provide the necessary subject width and sufficient depth in specific areas for a Degree of

Doctor in the Production Engineering third-cycle subject area, at least 60 HECs from third-cycle courses are required. This includes the obligatory FMG3007 Scientific Methodology for Engineers course (7.5 HECs) or a similar course in scientific methodology.

### **Compulsory courses for a Degree of Licentiate**

For a Degree of Licentiate in the Production Engineering third-cycle subject area, at least 30 HECs from third-cycle courses are required. This includes the obligatory FMG3007 Scientific Methodology for Engineers course (7.5 HECs) or an equivalent course in scientific methodology.

### **Recommended courses**

There is a high degree of flexibility when deciding the courses that can be included in the programme. For each doctoral student, the course component shall be planned in consultation with the supervisors and, so that the courses are linked up with the knowledge gathering that is required in research projects, documented in the individual study plan.

If agreed with the principal supervisor, course points from previous programmes can be credited. When crediting, regulations in KTH's Qualifications Ordinance for third-cycle degrees shall be observed. For first and second-cycle study courses and programmes up to 240 HECs, there can be no transfer of credits. There can be no transfer of credits for courses required as part of the specific entry requirements for third-cycle education.

Further course components that the person responsible for the subject area and the student jointly assess as important for the academic paper/thesis work may also be included in the overall course component of a licentiate or doctoral degree. These credit-meriting activities may be: individual literature courses; advanced involvement in the department's research activities; or, other advanced operations linked to science. Transfer from such activities requires advance agreement between the principal supervisor and the student (the number of credits being established in the individual study plan). For the transfer of credits from massive open online courses (MOOCs) to be possible within the framework a doctoral or licentiate degree, said credits must be approved in advance by the doctoral programme's director (DA).

Courses in teaching and learning in higher education are a requirement if, during his/her programme, the doctoral student assists with KTH's first or second-cycle teaching.

The following courses are strongly recommended for all doctoral students in the Production Engineering third-cycle subject area:

- LH200V "Basic communication and teaching" (GKU), 3 HECs, (course in teaching and learning in higher education – compulsory for doctoral students who, during their programmes, assist with KTH's first or second-cycle teaching).
- AK3015 "The persevering researcher", 2 HECs.
- DS3102 Writing Scientific Articles, 5 HECs.

### **Scientific conferences**

Participation in scientific conferences is a central element in all third-cycle education and

qualifies for credits. The student's participation in, and presentation of his/her own paper at, an international scientific conference that is relevant to the subject receives 1 HEC. In total, no more than 5 HECs can be awarded for conference participation.

Conference participation must be planned in advance with the principal supervisor.

## **Higher education requirements**

### **Degree of Doctor**

*The award of a Degree of Doctor requires 240 HECs. The thesis shall provide at least 120 HECs in this.*

#### **Thesis**

*Quality and any other thesis requirements.*

Thesis work is a compulsory part of third-cycle education. Said work is aimed at the doctoral student developing an ability to make independent contributions to research and the scientific community. The thesis can be written either as a monograph or as a compilation of scientific papers. In this latter case, the thesis shall have a separately edited, introductory summary. Irrespective of form, the thesis is assessed as an entirety. A doctoral thesis can build on a licentiate dissertation.

The thesis shall normally be written in English. A thesis in Swedish requires permission from the director of third-cycle education (FA).

Continuous publication throughout third-cycle education enables individual assessment of the various parts of the thesis. It also provides opportunity for interaction with, and feedback from, other researchers. This can facilitate thesis work. Publications should be planned in the individual study plan.

To facilitate research project work and improve its quality, the research student shall take part in national and international conferences in the relevant area of knowledge.

A thesis for a Degree of Doctor shall include new theoretical or empirical research results that, in the chosen subject area, the doctoral student has developed via theoretical or empirical research projects. It shall also include an overview of earlier research in the chosen subject area and shall position the doctoral student's contribution in relation to earlier research. Regardless of whether the doctoral thesis is presented as a monograph or as a compilation of scientific papers, it shall be of such quality that it is assessed to equate to at least four papers published in internationally recognised, peer-reviewed scientific journals.

The quality of the individual doctoral student's research is ensured via an established peer process. Each doctoral student shall present his/her research on at least:

1. Two occasions for a Degree of Licentiate (research plan after around one year and licentiate seminar).
2. Three occasions for a Degree of Doctor (research plan after around 1 year, licentiate seminar – or “midway seminar” if the doctoral student is going directly to the Degree of Doctor – and final seminar 3 to 5 months before the public defence of the doctoral thesis).

These seminars are held within the “Friday seminar” framework in which all doctoral students and researchers linked to the programme actively participate. At each seminar, the manuscript is reviewed by an expert, external reviewer/opponent who is not involved in the doctoral student’s work. At each seminar, someone inside the programme’s supervisor assembly is appointed as chair.

Additionally, KTH’s and the School of Industrial Engineering and Management’s quality assurance procedures apply to the public defence of doctoral theses.

#### Courses

A Degree of Doctor in the subject requires 60 HECs from courses.

#### **Degree of Licentiate**

*The award of a Degree of Licentiate requires at least 120 HECs. An academic paper shall provide at least 60 HECs in this.*

#### Academic paper

*Quality and any other academic paper requirements.*

An academic paper for a Degree of Licentiate shall include an application of existing scientific knowledge that, via theoretical or empirical research projects, the student has developed in a new area. It shall also include an overview of earlier research in the subject area.

The licentiate dissertation shall be of such quality that it is judged capable of forming the basis of at least two papers that could be published in internationally recognised, peer-reviewed journals (or at equivalent conferences).

After approval by the principal supervisor, the academic paper is to be presented at a public seminar with an external reviewer.

#### Courses

A Degree of Licentiate in the subject requires 30 HECs from courses.

Appendix

Qualitative targets (KTH's objectives included therein), as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance) for concretising the subject and how the programme is structured to support the attainment of goals (targets and objectives) by doctoral students.

**Degree of Doctor**

<p><b>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</b></p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p><b>Concretisation and adaptation of goals to Production Engineering</b></p>	<p><b>Programme elements for promoting goal attainment</b></p>
<p><i>Demonstrate: wide expertise in, and a systematic understanding of, the research domain; and, deep and current specialist knowledge in a delimited part of the research domain.</i></p>	<p>Demonstrate: wide expertise in, and a systematic understanding of, research in production engineering; and, deep and current specialist knowledge in the research focus areas detailed in the subject's study plan.</p>	<p>It is considered that this goal is attained by, for example, taking part in third-cycle courses and reading and following relevant scientific literature. Goal attainment can be checked via, for example: the writing of well-balanced introductions and backgrounds to scientific papers, conference submissions and the introduction to the doctoral thesis; and, the ability to present and discuss (at conferences and seminars) own and others' research results.</p>
<p><i>Demonstrate familiarity with scientific methodology in general and the specific research domain's methods in particular.</i></p>	<p>Demonstrate familiarity with scientific methodology in general and with commonly used methods in the production engineering research domain in particular.</p>	<p>It is considered that this goal is attained and checked via: taking part in compulsory third-cycle methodology courses; and, in scientific papers, identifying and using current (for the area) methods in solving proposed research issues.</p>
<p><i>Demonstrate an aptitude for scientific analysis and synthesis, as well as for independent critical examination and assessment of new and complex phenomena, issues and situations.</i></p>	<p>Demonstrate an aptitude for scientific analysis and synthesis as well as for independent, critical review and assessment of new and complex phenomena, issues and situations.</p>	<p>It is considered that this goal is attained and checked via, for example, having: identified not previously observed phenomena and, as a result thereof, proposed new research issues; contributed a scientific explanation; and, drawn relevant conclusions in scientific papers and conference submissions that the doctoral student has written/co-written.</p>
<p><i>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct</i></p>	<p>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct research and other advanced</p>	<p>It is considered that this goal is attained and checked via, for example: critical examination of work in the domain (summarised in the scientific papers that the doctoral student has written/co-written and in the doctoral</p>

<p><b>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</b></p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p><b>Concretisation and adaptation of goals to Production Engineering</b></p>	<p><b>Programme elements for promoting goal attainment</b></p>
<p><i>research and other advanced assignments within given time frames and examine and evaluate this work.</i></p>	<p>assignments within given time frames and examine and evaluate this work.</p>	<p>thesis); and, based on the foregoing knowledge, appropriate choice of methodology for solving proposed research issues. The final assessment of goal attainment here is made by the examining committee at the public defence of the thesis.</p>
<p><i>Via a thesis, demonstrate an ability to significantly contribute, through own research, to knowledge development.</i></p>	<p>Via a thesis, demonstrate an ability to significantly contribute, through own research, to knowledge development in the production engineering research domain.</p>	<p>It is considered that this goal is attained and checked via a thesis approved by an examining committee.</p>
<p><i>Demonstrate an ability, in both national and international contexts, to authoritatively present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</i></p>	<p>Demonstrate an ability, in both national and international contexts, to authoritatively present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</p>	<p>It is considered that this goal is attained via, for example: presentations at scientific conferences; and/or, presentations in an industrial context. It is considered that it is attained and checked via a thesis that is defended in public and approved by an examining committee.</p>
<p><i>Demonstrate an ability to identify further knowledge needs.</i></p>	<p>Demonstrate an ability to identify further knowledge needs.</p>	<p>It is considered that this goal is attained via, for example, the need for new knowledge having been identified and having led to proposals for new research. To a certain extent, this is documented in scientific papers and should be discussed in the thesis.</p>
<p><i>Demonstrate the potential (within research, education and other advanced, professional contexts) to contribute to societal development and others' learning.</i></p>	<p>Demonstrate the potential (within research, education and other advanced, professional contexts) to contribute to societal development and others' learning.</p>	<p>It is considered that this goal is attained via, for example: teaching in first and second-cycle education or in company presentations; contributing to supervision of degree projects; or, transferring knowledge to any industrial partners.</p>
<p><i>Demonstrate intellectual independence and scientific probity as well as an ability to assess research ethicality.</i></p>	<p>Demonstrate intellectual independence and scientific probity as well as an ability to assess research ethicality.</p>	<p>It is considered that this goal is attained via ethical aspects having been assessed and discussed with the supervisor (to the extent that this has been relevant in selecting and framing research problems). The impact the</p>

<p><b>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</b></p> <p><i>For a Degree of Doctor, the doctoral student shall:</i></p>	<p><b>Concretisation and adaptation of goals to Production Engineering</b></p>	<p><b>Programme elements for promoting goal attainment</b></p>
		<p>research results will have on society in general should be discussed with the supervisor. Intellectual independence is made evident through the research student’s own initiatives being clearly explained in the thesis. Scientific probity is checked via, for example, the plagiarism check to which the thesis is subjected.</p>
<p><i>Demonstrate specialised insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</i></p>	<p>Demonstrate specialised insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</p>	<p>By taking part in and monitoring discussions and debates in the local scientific environment (the department) and in a wider context.</p>
<p><i>(KTH’s objectives for ESD) Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</i></p>	<p>Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</p>	<p>It is considered that this goal is attained via, for example: adding a sustainability perspective to third-cycle courses; discussing environmental and ethical issues in seminars; and, optional, third-cycle courses on sustainable production.</p>

**Degree of Licentiate**

<p><b>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</b></p> <p><i>For a Degree of Licentiate, doctoral students shall:</i></p>	<p><b>Concretisation and adaptation of goals to Production Engineering</b></p>	<p><b>Programme elements for promoting goal attainment</b></p>
<p><i>Demonstrate knowledge and understanding in the research domain (current specialist knowledge in a delimited part of this included therein) and specialised knowledge of scientific methodology in general and the specific research domain’s methods in particular.</i></p>	<p>Demonstrate knowledge and understanding in the production engineering research domain (current specialist knowledge in a delimited part of this included therein) and specialised knowledge of scientific methodology in general and the specific research domain’s methods in particular.</p>	<p>It is considered that this goal is attained by, for example, taking part in third-cycle courses and reading and following relevant scientific literature. Goal attainment can be checked via, for example: the writing of well-balanced introductions and backgrounds to scientific papers, conference submissions and the introduction to the licentiate dissertation; and, the ability to present and discuss (at conferences and seminars) own and others’ research results.</p>
<p><i>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct a limited research project and other advanced assignments within given time frames and, thereby, to contribute to knowledge development and to evaluate this work.</i></p>	<p>Demonstrate an ability to critically, independently, creatively and with scientific precision identify and formulate issues as well as plan and use appropriate methods to conduct a limited research project and other advanced assignments within given time frames and, thereby, to contribute to knowledge development and to evaluate this work.</p>	<p>It is considered that this goal is attained and checked via, for example: critical examination of work in the domain (summarised in the scientific papers that the doctoral student has written/co-written and in the licentiate dissertation); and, based on the foregoing knowledge, appropriate choice of methodology for solving proposed research issues.</p>
<p><i>Demonstrate an ability, in both national and international contexts, to present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</i></p>	<p>Demonstrate an ability, in both national and international contexts, to clearly present and discuss, orally and in writing, research and research results in dialogues with the scientific community and society in general.</p>	<p>It is considered that this goal is attained via, for example: presentations at scientific conferences; and/or, presentations in an industrial context. It is considered that it is attained and checked via a dissertation that is discussed at a licentiate seminar and approved by an examiner.</p>
<p><i>Demonstrate the skills necessary to independently participate in research and development work and to work independently in other advanced operations.</i></p>	<p>Demonstrate the skills necessary to independently participate in research and development work and to work independently in other advanced operations.</p>	<p>It is considered that this goal is attained via, for example: the need for new knowledge having been identified and having led to proposals for new research; and, the transferring of knowledge to any</p>

<p><b>Qualitative targets as per the Higher Education Ordinance (Appendix 2 – Qualifications Ordinance)</b></p> <p><i>For a Degree of Licentiate, doctoral students shall:</i></p>	<p><b>Concretisation and adaptation of goals to Production Engineering</b></p>	<p><b>Programme elements for promoting goal attainment</b></p>
		<p>industrial partners. To a certain extent, this is documented in scientific papers and should be discussed in the thesis.</p>
<p><i>Demonstrate an ability to assess research ethicality in own research.</i></p>	<p>Demonstrate an ability to assess research ethicality in own research.</p>	<p>It is considered that this goal is attained via ethical aspects having been assessed and discussed with the supervisor (to the extent that this has been relevant in selecting and framing research problems). The impact the research results will have on society in general should be discussed with the supervisor. Scientific probity is checked via, for example, the plagiarism check to which the thesis is subjected.</p>
<p><i>Demonstrate insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</i></p>	<p>Demonstrate insight into the possibilities and limitations of the discipline, its societal role and the responsibility people bear for how it is used.</p>	<p>By taking part in and monitoring discussions and debates in the local scientific environment (the department) and in a wider context.</p>
<p><i>Demonstrate an ability to identify his or her need for further knowledge and take responsibility for his or her own knowledge development.</i></p>	<p>Demonstrate an ability to identify his or her need for further knowledge and take responsibility for his or her own knowledge development.</p>	<p>It is considered that this goal is attained via, for example: the need for new knowledge having been identified and having led to proposals for new research; or, participation in third-cycle courses or workshops. To a certain extent, this is documented in the individual study plan.</p>
<p><i>(KTH's objectives for ESD) Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</i></p>	<p>Demonstrate knowledge of, and an ability to make, relevant environmental and ethical decisions in order to be able to contribute to sustainable societal development.</p>	<p>It is considered that this goal is attained via, for example: adding a sustainability perspective to third-cycle courses; discussing environmental and ethical issues in seminars; and, optional, third-cycle courses on sustainable production.</p>