# Master's Programme in Materials Physics for Nano and Quantum Technology

Masterprogram i materialfysik för nano- och kvantteknologi
120 credits

6MMNQ

Valid from: 2022 Spring semester

**Determined by**

Board of Studies for Electrical Engineering, Physics and Mathematics

**Date determined**

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**Offered first time**

Autumn semester 2021

**Offered for the last time**

**Replaced by**

# Purpose

The Master's programme in Materials Physics for Nano and Quantum Technology aims to provide students with specialist knowledge in materials physics, nano and quantum technology and make the students highly competitive in this rapidly developing field. The programme meets both national and international needs from universities, industry, and society in general.

The programme intends to provide an in-depth understanding in the physical processes and phenomenon laying the basis for advanced applications in materials science, and an understanding for the demand on sustainable materials in the strive for sustainable techniques. The programme gives the students an understanding for the interaction between materials, technology and the surrounding society.

After graduation from the programme the students will be well prepared for a career in materials-related research and development within industry or academia.

# Aim

After the completion of the master's programme the student is expected to have acquired the following knowledge and skills:

### Knowledge and reasoning in mathematics, natural sciences and engineering

Students graduated from the Master's programme in Materials Physics for Nano and Quantum Technology shall demonstrate knowledge and understading in materials physics including a broad knowledge in the area as well as advanced knowledge in certain areas. The focus is on advanced problems in the area of materials physics where the graduated shows good abilities to independently identify, formulate and solve problems as well as perform tasks within given time frames.

Students graduated from the Master's programme demonstrate a deep understanding of how concepts within classical and modern physics are used to understand physical phenomena related to material. A graduated student has been trained in using advanced research equipment for development of new knowledge in material-related issues, through experiments and computer simulations. The student has the ability to choose experimental methods and theoretical models for the material analyses.

Students graduated from the Master's programme can use mathematics as a language and a tool to describe physical phenomena.

The graduates hold overall knowledge within current research in physics.

### Personal and professional skills and attributes

Students graduated from the Master's programme in Materials Physics for Nano and Quantum Technology demonstrate

- individual and professional skills and attitudes required to be able to critically and systematically integrate knowledge as well as analyse, assess and handle complex issues even whith limited information
- abilities to take responsibility at work or during post graduate studies concerning work ethics, reliability, and respect for the expertise of other professionals.
- abilities to make relevant judgements regarding scientific, societal and ethical aspects

### Interpersonal skills: teamwork and communication

Students graduated from the Master's programme in Materials Physics for Nano and Quantum Technology demonstrate

- capabilities of teamwork and active collaboration within the group by sharing the tasks and responsibilities
- abilities to initiate, to plan, to carry out and to evaluate scientific or engineering projects
- cabilities to communicate in English, orally and in writing

This includes to present information, problems and solutions in a structured manner with relevant technical aids for different target groups.

### Planning, execution, and presentation of research or development projects with respect to scientific and societal needs and requirements

Students graduated from the Master's programme in Materials Physics for Nano and Quantum Technology demonstrate

- insight in societal conditions, including economic, social, and ecological aspects of sustainable development for knowledge development
- abilities to initiate, carry out and manage advanced projects using methods that are conventional in the field
- abilities to plan, implement and evaluate scientific or engineering projects
- an understanding of the implementation of scientific results into business and enterprise

# Content

The master's programme offers theoretical and experimental courses in physics with applications in advanced materials physics, as well as nano and quantum technology. The first semester give the student a solid foundation in quantum mechanics, modern optics, experimental physics, computational physics and solid state physics. Later on the student may specialise within materials physics by selecting courses in a particular subfield of certain interest. Possible subfields can be experimental methods in nano physics, theory and modelling, or quantum technology.

In a final independent degree project including literature studies the student will be part of current research and development in industry or academia.

The curriculum specifies which courses are given and when they are given, and during which semester the course is recommended to be taken. Each course is presented in a syllabus, where the course's objectives and content and the special prerequisites required to qualify for the course are described.

# Teaching and working methods

The Master´s programme comprises four semesters of full-time studies and leads to a Master of Science in Applied Physics or a Master of Science in Physics. The included courses are found in the curriculum and several courses are elective. Normally the content of the courses is presented at lectures, laboratory work and seminars. Laboratory projects and other assignments are parts of some courses and will be reported orally and/or in writing. Participation at lectures and problem-solving classes is usually voluntarily while laboratory work and seminars are compulsory. Finally, a 30 ECTS credits Master's Thesis in the main field of study must be completed.

In the curriculum, it is specified which courses are compulsory (c), elective (e) or voluntary (v). Also the notation c/e could be found, which means that one of a group of courses should be selected. Courses not included in the curriculum must be approved by the programme board after consultation with the study counselor. The courses should be relevant for the programme.

# Entry requirements

- Bachelor's degree in physics, applied physics, materials science, electrical engineering or equivalent. The Bachelor's degree (equivalent to a Swedish Kandidatexamen) shall be from an internationally recognised university.
- 20 ECTS credits passed in mathematics/applied mathematics and/or application of mathematics, including calculus in several variables, linear algebra and Fourier transforms
- 30 ECTS credits passed in fundamental physics, including mechanics, optics, modern physics, electromagnetism and thermodynamics
- English corresponding to the level of English in Swedish upper secondary education (English 6/B). This is normally attested by means of an internationally recognised test
(Exemption from Swedish)

Selection for the January application round is based on merit rating (grade tariff) at three levels. If necessary, applicants within the same merit group will be selected by lot.

- Group 1: High
- Group 2: Good
- Group 3: Low

# Degree thesis

The thesis should be based on high quality scientific content and carried out in close contact with the research groups involved in the programme and within the main field of study.

# Degree requirements

- All compulsory and elective courses from the curriculum completed so that 120 ECTS is reached
- At least 90 ECTS on advanced level (A) including

  - 30 ECTS courses from the main field of study Applied Physics/Physics

  - 30 ECTS master's thesis in the main field of study Applied Physics/Physics

- Master's thesis (30 ECTS) on advanced level, in the main field of study Applied Physics/Physics, examined at the Faculty of Science and Engineering

Courses with overlapping content are not allowed to be included in the degree. Courses included in the Bachelor's degree can never be included in the Master's degree.

# Degree in Swedish

Teknologie masterexamen i Teknisk fysik eller Naturvetenskaplig masterexamen i Fysik, 120 hp

# Degree in English

Master of Science in Applied Physics or Master of Science in Physics, 120 credits

# Specific information

Graduate Level Courses

Certain PhD courses can be taken by master students. These course selections are subject to formal decision by the executive committee of the Program Board.

# Common rules

See also general regulations.

### Deviations from programme syllabus

If special circumstances prevail, the vice-chancellor may in a special decision specify the preconditions for temporary deviations from this programme syllabus, and delegate the right to take such decisions.

# Curriculum

## Semester 1 (Autumn 2022)

| Course code | Course name | Credits | Level | Timetable module | ECV |
|---|---|---|---|---|---|
| **Period 1** | | | | | |
| TFFM08 | Experimental Physics | 6* | A1X | 1 | C |
| TFFY54 | Quantum Mechanics | 6 | A1X | 2 | C |
| TFYA97 | Modern Optics | 6 | A1X | 4 | C |
| **Period 2** | | | | | |
| TFFM08 | Experimental Physics | 6* | A1X | 1 | C |
| TFYA90 | Computational Physics | 6 | A1X | 4 | C |
| TFYM01 | Solid State Physics I | 6 | A1X | 2 | C |

## Semester 2 (Spring 2023)

| Course code | Course name | Credits | Level | Timetable module | ECV |
|---|---|---|---|---|---|
| **Period 1** | | | | | |
| THEN24 | Communication, Ethics and Sustainable Development | 6* | G1F | - | C |
| TBMI26 | Neural Networks and Learning Systems | 6 | A1N | 2 | E |
| TFYA17 | Advanced Project Work in Applied Physics | 6* | A1F | - | E |
| TFYA38 | Optoelectronics | 6 | A1X | 3 | E |
| TFYB03 | Advanced Quantum Mechanics | 6 | A1X | 4 | E |
| TFYM02 | Solid State Physics II | 6 | A1X | 2 | E |
| TFYM04 | Growth and characterization of nanomaterials | 6* | A1X | 1 | E |
| TSBK07 | Computer Graphics | 6* | A1N | 4 | E |
| TSIT12 | Quantum Electronics and Quantum Optics | 6* | A1N | 1 | E |
| **Period 2** | | | | | |
| THEN24 | Communication, Ethics and Sustainable Development | 6* | G1F | - | C |
| TFYA17 | Advanced Project Work in Applied Physics | 6* | A1F | - | E |
| TFYA21 | Physical Metallurgy | 6 | A1F | 3 | E |
| TFYM04 | Growth and characterization of nanomaterials | 6* | A1X | 1 | E |
| TSBK07 | Computer Graphics | 6* | A1N | 1 | E |
| TSIT11 | Quantum Algorithms and Quantum Information | 6 | A1X | 3 | E |
| TSIT12 | Quantum Electronics and Quantum Optics | 6* | A1N | 1 | E |

## Semester 3 (Autumn 2023)

| Course code | Course name | Credits | Level | Timetable module | ECV |
|---|---|---|---|---|---|
| **Period 1** | | | | | |
| TATA75 | Theory of Relativity | 6* | A1F | - | E |
| TBMT57 | Biomedical Optics | 6 | A1F | 1 | E |
| TFYA18 | Mathematical Methods of Physics | 6 | A1N | 3 | E |
| TFYA36 | Chaos and Non-Linear Phenomena | 6 | A1N | 2 | E |
| TFYA40 | Analytical Mechanics | 6* | A1X | 1 | E |
| TFYA43 | Nanotechnology | 6 | G2X | 3 | E |
| TFYA99 | Project Course in Applied Physics, CDIO | 12* | A1F | 4 | E |
| TFYM03 | Nanophysics | 6 | A1X | 3 | E |
| TSIT03 | Cryptology | 6 | A1X | 2 | E |
| TSIT13 | Quantum Communication | 6 | A1N | 1 | E |
| **Period 2** | | | | | |
| TATA75 | Theory of Relativity | 6* | A1F | 3 | E |
| TDDE01 | Machine Learning | 6 | A1N | 1 | E |
| TFYA39 | Semiconductor Technology | 6 | A1X | 3 | E |
| TFYA40 | Analytical Mechanics | 6* | A1X | 3 | E |
| TFYA99 | Project Course in Applied Physics, CDIO | 12* | A1F | 4 | E |
| TFYB01 | Advanced Electromagnetics | 6 | A1N | 2 | E |
| TFYB02 | Elementary Particles and Quantum Fields | 6 | A1X | 1 | E |
| TSIN02 | Internetworking | 6 | A1X | 1 | E |
| TSIT02 | Computer Security | 6 | G2F | 2 | E |

## Semester 4 (Spring 2024)

| Course code | Course name | Credits | Level | Timetable module | ECV |
|---|---|---|---|---|---|
| **Period 1** | | | | | |
| TQXX30 | Degree project - Master's Thesis | 30* | A2E | - | C |
| **Period 2** | | | | | |
| TQXX30 | Degree project - Master's Thesis | 30* | A2E | - | C |

ECV = Elective / Compulsory /Voluntary
*The course is divided into several semesters and/or periods

# Common rules

## Structure and organisation of study programmes

The contents and design of the programmes are to be continuously revised such that new knowledge is integrated into courses and specialisations. Within one programme, several study specialisations or profiles may be available. The identities of the study specialisations or profiles and the regulations governing how these may be selected are given in the syllabus and curriculum for the particular field of study and programmes.

The structure and organisation of the programmes are to follow specified criteria that are summarised in the syllabus for each programme.

- The syllabus defines the aims of the study programme.
- The curriculum, which constitutes one part of the syllabus for the field of study, gives details of the terms in which the various courses have been timetabled, and their scheduling through the academic year.
- The course syllabus specifies, among other things, the aim and contents of the course, and the prior knowledge that a student must have, in addition to the admission requirements for the programme, in order to be able to benefit from the course.

## Qualification requirements

The qualification requirements specified in the Higher Education Ordinance 2007 apply to students admitted after 1 July 2007. A student who has completed components of a programme after 1 July 2007 has the right to be assessed with respect to the qualification requirements specified by the Higher Education Ordinance 2007. In addition, local regulations laid down by the faculty boards and university board apply, see http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva/Examina.

Higher Education Act Chapter 1, Section 8:

First-cycle courses and study programmes are to develop:

- the ability to make independent and critical assessments
- the ability to identify, formulate and solve problems autonomously, and
- the preparedness to deal with changes in working life.

In addition to knowledge and skills in their field of study, students shall develop the ability to:

- gather and interpret information at a scholarly level
- stay abreast of the development of knowledge, and
- communicate their knowledge to others, including those who lack specialist knowledge in the field.

## Qualifications within a study programme

Qualification requirements that are specific to a study programme are given in the syllabus for that programme.

## Admission requirements and matriculation and postponement of matriculation

A person who has been accepted for a study programme is to start their studies (matriculate) in the term that is specified in the decision about admission. The date and location of the compulsory matriculation procedure will be communicated to those admitted to the first term of the programme.

Regulations concerning admission requirements, matriculation and postponement of matriculation have been laid down in the admission regulations for Linköping University, http://styrdokument.liu.se/Regelsamling/VisaBeslut/622645.

## Admission to a later part of a programme

Admission to a part of a study programme is used here to refer to admission with the purpose of completing the programme and taking a degree. Admission to a later part of a programme may take place only if sufficient resources and space on the programme are available. Furthermore, the applicant must satisfy the entry requirements for the relevant term of the programme, as specified in http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva/Tekniska_fakulteten.

## Interruption in studies

Notification of an interruption in studies is to be made through a web form Forms. If such a notification is not made and if the student does not do a course registration during the first term during which the interruption is to take place, the interruption will be considered to be a withdrawal. An interruption in studies must cover a complete term, and notification of interruptions can be given for a maximum of two consecutive terms. Notification of resumption of studies is to take place at the course registration for the term that follows the interruption.

A student who is taking an interruption in studies may during this period retake examinations. The student is responsible that registration for courses is carried out at the correct times in preparation for the resumption of studies.

## Withdrawal from a study programme

A student who wishes to withdraw from a study programme must notify the study guidance counsellor. A student who leaves the studies without giving notification of an interruption in study and who fails to register on a course for the immediately subsequent term is considered to have withdrawn. A student who has withdrawn may return to the study programme if a vacancy is available that is not

required for students returning after an interruption in study, and not required for students who are changing their location of study and/or study programme.

## Courses within a study programme

The curriculum for the various years of a study programme specify which courses are mandatory (m), elective (e) and voluntary (v). If a student wishes to study a different combination than the one specified in the curriculum, an application must be made to the faculty programme board.

### Voluntary courses

The course specified as voluntary (labelled with "v") in the programme syllabus are assessed solely as voluntary courses, and credits from these may not contribute to the requirements for a degree.

## Courses from another study programme or third-cycle courses

To include courses in a degree from another study programme or third-cycle courses, the student need to apply to and be granted this from the faculty programme board. If such a decision is not taken, such courses are regarded as voluntary courses.

When selecting a course from another programme, the admission requirements specified in the course syllabus should be satisfied.

Admission is granted to the extent that resources allow, provided that places are available on the course.

Admission to third-cycle courses requires studies at Master's level, i.e. year 4-5 or admitted to a Master's programme. Information can be obtained from the relevant director of advanced studies.

### Students taking a master's programme in engineering

Students taking a master's programme in engineering can apply to take courses given in Term 7 and later terms of the programme from all engineering master's programmes. Admission to courses at Term 7 or higher requires the possession of at least 150 credits within the programme to which the student has been admitted.

### Students taking a Bachelor of Science (Engineering)

Students taking Bachelor of Science (Engineering) degrees may apply to take courses specified in the programme syllabuses of all Bachelor of Science (Engineering) programmes.

### Students taking a Bachelor of Science

Students taking Bachelor of Science degrees may apply to take courses specified in the programme syllabuses of all Bachelor of Science programmes.

## Single-subject courses, courses from other faculties, or other

## Higher Education Institutions

To include single-subject courses, courses from another faculty, or courses from other Higher Education Institutions in a degree, the student need to apply to and be granted this from the faculty programme board.

## Registration for programme courses

Registration for courses that are given as part of a study programme must be made during the specified period, which has been preliminarily set to 1-10 April for the autumn term, and 1-10 October for the spring term. Information about course registration is published on the Study councellors webpages or in programme rooms, sent to students by email, and disseminated at scheduled information meetings.

## Registration for programme courses as single-subject courses

Admission to a programme course as a single-subject subject course may take place only if sufficient resources and space on the course are available. Furthermore, the applicant must satisfy the entry requirements for the relevant course.

In the event of a scarcity of resources, the board of LiTH can decide to limit the possibilities of taking courses that are part of a programme as freestanding courses.

## Study planning

Students who require support in planning their continued studies can contact the study guidance counsellor of the programme. Study planning involves the student and the study guidance counsellor together drawing up an individual plan for studies during the subsequent term. The individual plan may allow the student to deviate from the general curriculum.

Completed first-cycle courses are a precondition for successful studies at more advanced levels. For this reason, study planning is based on giving priority to courses from earlier years of study that have not been completed. If further capacity is available, new courses may be taken.

Study planning takes place on a regular basis if the student:

- does not satisfy the requirements for progression to later terms. In order for a student to be able to participate in courses from later years in such cases, a decision of exemption is required.
- does not satisfy the requirements for starting a degree project.

Other situations in which study planning may be required:

- A student has fallen behind during the early part of a study programme and has failed to complete several courses.
- A student has not satisfied the entry requirements for a degree project before term 6 of an engineering degree.
- A student has applied for admission to a later part of a programme.
- Studies have been carried out abroad.
- A study programme is to be resumed after an interruption.

In these cases the study guidance counsellor supports the student in planning the continued studies, also in situations in which the student can register for the relevant courses without the need for a special decision for the continued studies.

## Part of education abroad

Students can exchange study at LiTH for study at an institute of higher education abroad, and/or work on a degree project abroad.

In the event that study (courses) at LiTH are exchanged for study abroad, the faculty programme director is responsible for a decision about a preliminary individual study plan, which is to be drawn up in advance. After the exchange, the student apply to credit completed courses from the exchange into their degree. The guideline for credit assessment in an exchange is that the courses should be in line with the program's orientation.

Regulations for entry requirements, ranking and nomination for study abroad through LiTH's exchange agreements and for the compulsory study abroad period within Ii (Industrial Engineering and Management – International) and Yi (Applied Physics and Electrical Engineering – International) can be found at: http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva/Tekniska_fakulteten.

## Degree project for Master's Degree in Engineering 300 credits, Master of Science (Two years), Master of Philosophy (Two years), Master of Science (One year), and master's degrees without prefix

General provisions for the degree project are given here. A specific faculty programme board may have supplementary regulations that are specific for a study programme. These are specified, where relevant, in the syllabus for the field of education and/or the degree project. Information about application, reflection documents, possible examiners etc. can be found at Information.

### General provisions

To be awarded a Master's Degree in Engineering 300 credits, Master of Science (Two years), Master of Philosophy (Two years), Master of Science (One year), or master's degree without prefix a student must carry out an approved degree project. The components of the degree project are described in the relevant course syllabus.

### Aim

The aim of the degree project is described in the relevant course syllabus, https://liu.se/studieinfo/en.

### Extent

Requirements for the extent of the degree project for each type of degree are given in the syllabus of the study programme.

### Locations for a degree project

The work is carried out in the form of:

- an internal degree project located at one of the participating departments at LiU
- an external degree project located at a company, government agency, or other organisation in Sweden or abroad, that an examiner has assessed is able to manage a degree project that satisfies the requirements, or
- a degree project within an exchange agreement in association with study abroad, whereby all study results are to be credited to the student by the relevant faculty programme board.

The main subject areas that are permitted within each study programme are described in the programme syllabus. Any individual subjects that may be relevant to the main subject area are to be determined by the relevant faculty programme board.

The examiner for a degree project within a certain subject area are determined by the faculty programme board that is responsible for general degrees within the main subject area. An up-to-date list is given at Information.

### Degree projects within agreements relating to study abroad

During study abroad that takes place within the framework of an agreement, the provisions of the host institute relating to degree projects are applied. The student is to consult the faculty programme board and together ensure that the proposed degree project is carried out in a main subject area that is permitted within the study programme. Approved main subject areas for degree projects are specified in the syllabus for the relevant programme.

A certificate confirming that the degree project has been approved and a copy of the degree project thesis (in PDF format) are to be submitted to the relevant faculty programme board.

### Selection of degree project

A degree project is to be selected in consultation with an examiner, who is also responsible that the specialisation, extent and level of the project satisfy the requirements specified in the course syllabus.

In cases in which issues relating to work-related copyright, patenting or remuneration may arise, provisions governing these should be established in

advance. A student working on a degree project may sign a confidentiality agreement in order to obtain access to confidential information necessary for the degree project. The supervisor and examiner, however, determine whether they are prepared to sign a confidentiality agreement, and thus the confidential information must not normally be of such nature that it is necessary to supervise or grade the work. The complete degree project thesis is to be published during the grading procedure, unless exceptional circumstances prevent this. If any part of the thesis should not be published, this must be approved in advance by the examiner and the relevant head of department. Note that final decisions relating to confidentiality are taken by an administrative court.

### Commencement of a degree project

Requirements that must be satisfied before a degree project can be started are given in the currently valid course syllabus, which can be obtained in the relevant programme syllabus at https://liu.se/studieinfo/en.

Notification of a degree project is to be carried out when the degree project starts, at Application. Registration of the degree project is to take place before work commences.

Before the start of the degree project, the examiner is to ensure that the student satisfies the conditions for commencement of the degree project within the relevant main subject area. Support in this can be obtained from the study guidance counsellor, who checks the general requirements for starting the degree project.

The student is also to notify the relevant department of the start of the degree project.

### Degree projects in collaboration with another student

In cases in which two students carry out a degree project together, the contribution of each student is to be specified. The extent of the work is to correspond to the extent of two individual projects. The examiner is to ensure that each student has contributed in a satisfactory manner to the work, and that each student satisfies the requirements for achieving a Pass grade for the degree project.

Degree projects carried out in collaboration between more than two students are not permitted.

### Examiners

The examiner must be employed as a teacher at LiU according to the LiU Regulations for Appointments (https://styrdokument.liu.se/Regelsamling/VisaBeslut/622784). The following teachers can be appointed as examiner: Professor (including Adjunct and Visiting Professor), Associate Professor (including Adjunct), Senior Lecturer (including Adjunct and Visiting Senior Lecturer), Research Fellow, or Postdoc. The examiner must also have the expertise required to examine degree projects (for example through research, supervision or teaching) within the relevant main subject area,

and be appointed by the faculty programme board. The faculty programme board can also appoint emerita/emeritus as examiner for a single thesis work.

The examiner is to:

- ensure before the start of the degree project that the student satisfies the conditions for commencement of the degree project within the relevant main subject area. The study guidance counsellor is to check whether the commencement criteria are satisfied and inform the examiner of this
- check whether special admission requirements (where relevant) are satisfied, for example that the student can demonstrate a certain degree of in-depth knowledge within the field relevant for the degree project
- determine the specialisation and principal work of the degree project, based on an assessment of whether the degree project will result in the learning outcomes of the course syllabus being satisfied
- in conjunction with the planning report, check that the student has registered for the degree project and that the student has a supervisor
- pass/fail the planning report
- pass/fail the mid-way assessment
- be responsible that the supervisor or supervisors carry out their duties
- approve the work for presentation
- before the presentation, check that the proposed opponent satisfies the conditions for commencement of the degree project and has attended three thesis presentations
- pass/fail the presentation and the opposition to it
- approve a concluding reflection document
- ensure that a degree project that has been passed satisfies the learning outcomes of the course syllabus and other requirements, and award a grade to the degree project (either G = Pass, or U = Fail).

In cases in which a degree project is carried out jointly by two students with different main subject areas, one examiner in each main subject area must be appointed, where this is necessary.

### Supervisors

A student working on a degree project is to have access to an internal supervisor at the department at which the degree project has been registered. The internal supervisor is to have a degree that corresponds at least to the level of the degree project to be supervised. The internal supervisor may, in exceptional circumstances, be the same individual as the examiner. A decision of whether to allow this in a particular case is to be made by the relevant faculty programme board before the degree project is started.

The supervisor is to ensure that the student obtains help with:

- expert support in general questions related to methods, specialist knowledge of the subject, and writing the thesis
- problem formulation, and setting the limits of the work
- scheduling and planning work, and selection of appropriate methods.

If the degree project is being carried out outside of LiTH, an external supervisor from the commissioner is to be appointed.

### Planning report

During the first weeks of the degree project, the student is to draw up a planning report that contains:

- a preliminary title of the degree project
- a preliminary statement of the research question, against the background of a literature search
- a preliminary description of the approach to be taken
- planned literature foundation
- a schedule for the execution of the degree project, including suggested dates for the mid-way assessment and presentation.

Formulation of the research question is to be bounded, realistic and viewed from a perspective of societal or commercial benefit. The term “societal” is to be understood here to include universities and university colleges.

### Mid-way assessment

Approximately half-way through the degree project, the student is to describe to the examiner at a mid-way assessment how the work is progressing relative to the planning report. The supervisor should also participate. The form of the mid-way assessment may be anything from an oral presentation to a public seminar. The conclusion of the mid-way assessment may be one of three possibilities:

1. The work has been carried out essentially as planned, and can continue as planned. The mid-way assessment has been passed.
2. The work has been carried out with certain deviations from the planning report. It is, however, believed that it will be possible to complete the work with minor adjustments to the formulation of the research question, approach and/or schedule. The mid-way assessment has been passed.
3. The work has deviated from the planning report in a significant manner, and there is a risk that a Pass grade cannot be given. The mid-way assessment has been failed. A new planning report must be drawn up and a new mid-way assessment carried out.

### Reporting

Both oral and written reports of the degree project are to be made, in Swedish or English. For the international Master's programmes, both the oral and written examination should be made in English. The faculty programme board can allow the reporting to be carried out in another language than Swedish or English.

The oral presentation is to take place in public, unless there are exceptional circumstances that this should not be done. The written report is to be in the form of a professionally produced degree project thesis. The presentation and thesis are to follow the instructions given below.

### Presentation

The oral presentation is to take place when the examiner considers that the work has been completed and is ready to be presented. The presentation is to take place on site at LiU at a time when other students can attend. This means that the presentation can take place on a date that the student has agreed with the examiner, normally between the re-examination period in August and midsummer, and after the student has attended three thesis presentations.

The oral presentation is to describe the background to the problem that has been studied, describe the methods used, and present the results and conclusions. The presentation is to be at a level suitable for everyone present, not just for specialists. After the oral presentation, the student is to counter any criticism that the opponent may raise, and allow other participants to pose questions. The presentation and the opposition are to be approved by the examiner. When any required adjustments of the thesis have been made, the reflection document has been approved, and the student has functioned as an opponent for another degree project, the degree project is reported as a passed course and the credits can be used to satisfy the requirements for a qualification.

## Degree project thesis

The written degree project report is to be professionally written and comprehensive, and it is to demonstrate a scientific approach. The report must be prepared in accordance with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc., of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations, such as undergraduate work, project reports, etc. (This is sometimes known as “self-plagiarism”.) A failure to specify such sources may be regarded as attempted deception during examination.

The contents are to be easy to understand, and the way in which material is presented is important. It must describe the background to the project and the formulation of the research question. The choice of approach is to be clearly explained, and the thesis should make clear the coupling between the results and the conclusions. Commonly accepted scientific methods are to be used for processing the results. The discussion is to be comprehensive, and demonstrate that the student masters analytical thought processes. The thesis is to demonstrate good mastery of the literature in the field, and include an abstract. Theses that are principally written in Swedish should contain a summary in English. A publication-ready manuscript and a reflection document covering the work undertaken are to be submitted to the examiner within 10 days after the oral presentation. The examiner may grant an exemption from this requirement. If final versions of the required documents are not submitted as stipulated, the examiner may determine that the presentation is to be rescheduled.

The Faculty of Science and Engineering (Institute of Technology) at Linköping University recommends that degree project theses be published.

## Opposition

An oral opposition is to be carried out in connection with the student’s own

presentation of his or her thesis, i.e. at the end of the own studies, and is to take place on site at LiU. The opposition is made on other degree projects at the same level and of the same extent as the own degree project. The opponent must also have attended three thesis presentations as a member of the audience. In a normal case, the number of opponents will be the same as the number of respondents. In exceptional cases, the examiner may decide that this is not to be the case. Acting as an opponent during the thesis presentation of another student is subject to points-based assessment as described in the course syllabus.

The opponent is to:

- discuss and comment on the selection of methods, results and (where relevant) data processing, conclusions, possible alternative solutions and conclusions, and the management of literature
- comment on the general arrangement of the degree project thesis and related, formal aspects of style, and comment on the oral presentation technique
- illuminate the strengths and weaknesses of the thesis.

The duration of the opposition should be approximately the same as that of the presentation, and it is to include a discussion in which the student presenting the thesis replies to and comments on the criticism raised by the opponent.

Unless otherwise agreed, at least one week before the presentation the opponent is to present in writing to the examiner the important issues that will be discussed, and the structure of the opposition that will be taken. The opponent and the examiner discuss the structure that the opponent has drawn up.

### Attendance at presentations

A student is to attend presentations of degree project theses as described in the course syllabus. The presentations attended must be at the same level or a higher level than the degree project of the student.

It is advantageous that one of the presentations attended is a licenciate degree seminar or a doctoral disputation. The student is responsible for ensuring that a certification of attendance at the presentation is obtained and passed to the departmental administrator for registration in Ladok. Attendance at such presentations is a component of the degree work that is subject to points-based assessment.

The occasions on which a student attends presentations are to be completed before the student presents the degree project thesis. The course syllabus for the degree project describes the scheduling of the attendance at presentations.

The attendance at presentations is to take place on site at LiU. It is not possible to participate remotely.

### Reflection document

A document reflecting on the work that has been carried out is to be submitted to the examiner within 10 working days of the oral presentation. Instructions for

preparing a reflection document can be reached through Reflection document.

### Grades

The degree project is graded as either Pass or Fail. In order for a student to obtain a pass grade for the degree project, all components must be completed and be awarded a pass grade.

### Right to obtain supervision

It is expected that the student complete and pass a degree project within specified time limits. The department is required to provide supervision for a maximum of 18 months after the student has registered the degree project in Ladok. The examiner may grant additional supervision after this period in special cases. If the examiner determines that supervision is to be ended, the degree project is to be awarded a Fail grade. The examiner does not have to fail the degree project if it is considered possible that the student can finish the thesis without further supervision.

If the degree project is awarded a Fail grade for the reason described above or for any other reason, the student is to be directed towards carrying out a further degree project. However, carrying out a new degree project means very limited opportunities for supervision.

### Quality assurance

The relevant faculty programme board has overall responsibility for the quality of study programmes. This responsibility covers also degree projects. Quality assurance is to be carried out as determined by the faculty board.

### Exemptions

If there are exceptional circumstances, an exemption can be granted from the above regulations.

Exemption to replace the oral opposition with a detailed written opposition can be granted after approval by the faculty programme board when all other elements for the degree have been fulfilled, the degree project has been submitted and there are exceptional circumstances. It is the examiner who applies to the faculty programme board for an exemption for written opposition.

Written opposition can be carried out in any of the following ways:

- The student makes a written opposition to a work done by another student, whose examiner then examines the opposition
- The student's examiner instructs the person in question to make a written opposition to a degree project that has already been examined by the examiner.

In the case of a written opposition, there is no need for an initial account of the structure of the opposition.

Exemption from conducting the oral opposition on site at LiU (and instead

conducting it remotely) with reference to exceptional circumstances is given by the examiner. Examples of exceptional circumstances are the lack of a visa to come to Sweden.

Exemption from carrying out presentation on site at LiU (and instead conducting it remotely) can be granted by the respective faculty programme board if there are exceptional circumstances. Examples of exceptional circumstances are the lack of a visa to come to Sweden.

## Course syllabus

A syllabus must be established for each course. The syllabus specifies the aim and contents of the course, and the prior knowledge that a student must have in order to be able to benefit from the course.

## Timetabling

Courses are timetabled after a decision has been made for this course concerning its assignment to a timetable module.

## Interruption in and deregistration from a course

The LiU decision, Guidelines concerning confirmation of participation in education (Dnr LiU-2020-02256), states that interruptions in study are to be recorded in Ladok. Thus, all students who do not participate in a course for which they have registered must record the interruption, such that the registration on the course can be removed. Deregistration from or interrupting a course is carried out using a web-based form Forms

## Cancelled courses and changes to the course syllabus

Courses with few participants (fewer than 10) may be cancelled or organised in a manner that differs from that stated in the course syllabus. The Dean is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

## Guidelines relating to examinations and examiners

For details, see Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, Dnr LiU-2020-04501 (http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592).

An examiner must be employed as a teacher at LiU according to the LiU Regulations for Appointments, Dnr LiU-2021-01204 (https://styrdokument.liu.se/Regelsamling/VisaBeslut/622784). For courses in second-cycle, the following teachers can be appointed as examiner: Professor (including Adjunct and Visiting Professor), Associate Professor (including Adjunct), Senior Lecturer (including Adjunct and Visiting Senior Lecturer), Research Fellow, or Postdoc. For courses in first-cycle, Assistant

Lecturer (including Adjunct and Visiting Assistant Lecturer) can also be appointed as examiner in addition to those listed for second-cycle courses. In exceptional cases, a Part-time Lecturer can also be appointed as an examiner at both first- and second cycle, see Delegation of authority for the Board of Faculty of Science and Engineering.

## Forms of examination

### Principles for examination

Written and oral examinations and digital and computer-based examinations are held at least three times a year: once immediately after the end of the course, once in August, and once (usually) in one of the re-examination periods. Examinations held at other times are to follow a decision of the faculty programme board.

Principles for examination scheduling for courses that follow the study periods:

- courses given in VT1 are examined for the first time in March, with re-examination in June and August
- courses given in VT2 are examined for the first time in May, with re-examination in August and January
- courses given in HT1 are examined for the first time in October, with re-examination in January and August
- courses given in HT2 are examined for the first time in January, with re-examination in March and in August.

The examination schedule is based on the structure of timetable modules, but there may be deviations from this, mainly in the case of courses that are studied and examined for several programmes and in lower grades (i.e. 1 and 2).

Examinations for courses that the faculty programme board has decided are to be held in alternate years are held three times during the school year in which the course is given according to the principles stated above.

Examinations for courses that are cancelled or rescheduled such that they are not given in one or several years are held three times during the year that immediately follows the course, with examination scheduling that corresponds to the scheduling that was in force before the course was cancelled or rescheduled.

When a course, or a written examination (TEN, DIT, DAT), is given for the last time, the regular examination and two re-examinations will be offered. Thereafter, examinations are phased out by offering three examinations during the following academic year at the same times as the examinations in any substitute course. If there is no substitute course, three examinations will be offered during re-examination periods during the following academic year. Other examination times are decided by the faculty programme board. In all cases above, the examination is also offered one more time during the academic year after the following, unless the faculty programme board decides otherwise. In total, 6 re-examinations are offered, of which 2 are regular re-examinations. In the examination registration system, the examinations given for the penultimate time and the last time are denoted.

If a course is given during several periods of the year (for programmes, or on different occasions for different programmes) the faculty programme board or boards determine together the scheduling and frequency of re-examination occasions.

### Retakes of other forms of examination

Regulations concerning retakes of other forms of examination than written examinations and digital and computer-based examinations are given in the LiU guidelines for examinations and examiners, http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592.

### Course closure

For Decision on Routines for Administration of the Discontinuation of Educational Programs, Freestanding Courses and Courses in Programs, see DNR LiU-2021-04782. After a decision on closure and after the end of the discontinuation period, the students are referred to a replacement course (or similar) according to information in the course syllabus or programme syllabus. If a student has passed some part/parts of a closed program course but not all, and there is an at least partially replacing course, an assessment of crediting can be made. Any crediting of course components is made by the examiner.

### Registration for examination

In order to take an written, digital or computer-based examination, registration in advance is mandatory, see decision in the university's rule book https://styrdokument.liu.se/Regelsamling/VisaBeslut/622682. An unregistered student can thus not be offered a place. The registration is done at the Student Portal or in the LiU-app during the registration period. The registration period opens 30 days before the date of the examination and closes 10 days before the date of the examination. Candidates are informed of the location of the examination by email, four days in advance.

### Code of conduct for students during examinations

Details are given in a decision in the university's rule book: http://styrdokument.liu.se/Regelsamling/VisaBeslut/622682.

### Retakes for higher grade

Students at the Institute of Technology at LiU have the right to retake written examinations and digital and computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN", "DIT" and "DAT". The same right may not be exercised for other examination components, unless otherwise specified in the course syllabus.

A retake is not possible on courses that are included in an issued degree diploma.

### Grades

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5).

- Grades U, 3, 4, 5 are to be awarded for courses that have written or digital examinations.
- Grades Fail (U) and Pass (G) may be awarded for courses with a large degree of practical components such as laboratory work, project work and group work.
- Grades Fail (U) and Pass (G) are to be used for degree projects and other independent work.

### Examination components

The following examination components and associated module codes are used at the Faculty of Science and Engineering:

- Grades U, 3, 4, 5 are to be awarded for written examinations (TEN) and digital examinations (DIT).
- Examination components for which the grades Fail (U) and Pass (G) may be awarded are laboratory work (LAB), project work (PRA), preparatory written examination (KTR), digital preparatory written examination (DIK), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).
- Students receive grades either Fail (U) or Pass (G) for other examination components in which the examination criteria are satisfied principally through active attendance such as tutorial group (BAS) or examination item (MOM).
- Grades Fail (U) and Pass (G) are to be used for the examination components Opposition (OPPO) and Attendance at thesis presentation (AUSK) (i.e. part of the degree project).

In general, the following applies:

- Mandatory course components must be scored and given a module code.
- Examination components that are not scored, cannot be mandatory. Hence, it is voluntary to participate in these examinations, and the voluntariness must be clearly stated. Additionally, if there are any associated conditions to the examination component, these must be clearly stated as well.
- For courses with more than one examination component with grades U,3,4,5, it shall be clearly stated how the final grade is weighted.

For mandatory components, the following applies (in accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592):

- If special circumstances prevail, and if it is possible with consideration of the nature of the compulsory component, the examiner may decide to replace the compulsory component with another equivalent component.

For possibilities to alternative forms of examinations, the following applies (in accordance with the LiU Guidelines for education and examination for first-cycle and second-cycle education at Linköping University, http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592):

- If the LiU coordinator for students with disabilities has granted a student the right to an adapted examination for a written examination in an examination hall, the student has the right to it.
- If the coordinator has recommended for the student an adapted examination or alternative form of examination, the examiner may grant this if the examiner assesses that it is possible, based on consideration of the course objectives.
- An examiner may also decide that an adapted examination or alternative form of examination if the examiner assessed that special circumstances prevail, and the examiner assesses that it is possible while maintaing the objectives of the course.

### Reporting of examination results

The examination results for a student are reported at the relevant department.

### Plagiarism

For examinations that involve the writing of reports, in cases in which it can be assumed that the student has had access to other sources (such as during project work, writing essays, etc.), the material submitted must be prepared in accordance with principles for acceptable practice when referring to sources (references or quotations for which the source is specified) when the text, images, ideas, data, etc. of other people are used. It is also to be made clear whether the author has reused his or her own text, images, ideas, data, etc. from previous examinations, such as degree projects, project reports, etc. (this is sometimes known as “self-plagiarism”).

A failure to specify such sources may be regarded as attempted deception during examination.

### Attempts to cheat

In the event of a suspected attempt by a student to cheat during an examination, or when study performance is to be assessed as specified in Chapter 10 of the Higher Education Ordinance, the examiner is to report this to the disciplinary board of the university. Possible consequences for the student are suspension from study and a formal warning. More information is available at Cheating, deception and plagiarism

## Regulations (apply to LiU in its entirety)

The university is a government agency whose operations are regulated by legislation and ordinances, which include the Higher Education Act and the Higher Education Ordinance. In addition to legislation and ordinances, operations are subject to several policy documents. The Linköping University rule book collects currently valid decisions of a regulatory nature taken by the university board, the vice-chancellor and faculty/department boards.

LiU’s rule book for education at first-cycle and second-cycle levels is available at http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-

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