# Project Course in Applied Physics, CDIO

Programme course

12 credits

Projektkurs i teknisk fysik, CDIO

TFYA92

Valid from: 2020 Spring semester

**Determined by**
Board of Studies for Electrical Engineering, Physics and Mathematics

**Date determined**
2019-09-23

## Main field of study
Applied Physics, Physics

## Course level
Second cycle

## Advancement level
A1X

## Course offered for
- Master's Programme in Materials Science and Nanotechnology
- Biomedical Engineering, M Sc in Engineering
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering

## Specific information
The Entrepreneurship part overlap with other CDIO courses and cannot be included more than once in a degree.

Exchange students may apply for the course after arrival to LiTH but before it starts. The Faculty coordinators for exchange studies must be contacted before applying.

The course is scheduled for the last time HT2020.

The course is replaced by TFYA99 from 2021.

## Entry requirements
Note: Admission requirements for non-programme students usually also include admission requirements for the programme and threshold requirements for progression within the programme, or corresponding.

## Prerequisites
Knowledge in Physics, corresponding to mandatory courses on the programmes Applied Physics and Electrical Engineering, Biomedical Engineering, or Materials Science and Nanotechnology. The course offers various projects, and depending on the project chosen additional prerequisites may be required. For the project "Design, processing, and test of a sensor system", desirable knowledge is on Semiconductor technology, Microchip fabrication, Semiconductor physics, Surface physics, Materials physics, Sensor technology, Bio-analytical methods, Chemical sensor systems. For the project "Computational Physics" it is recommended to have taken a prior course in computational physics and be thoroughly familiar with programming.

# Intended learning outcomes

The goal of the course is to provide an interdisciplinary and integrated education, and bring the students closer to the real engineering world by means of a project work in applied physics, developing a practical product or a simulation software. After the course, the students should be enriched in their professional engineering knowledge and skills related to the project work, and to the understanding of the technical importance and strategic value of their work. Furthermore, the course should also provide the students the infrastructure for the project management (linked with the use of LIPS), such that the students will be able to work as a team in a project in an industry-like environment.

The project work shall be carried through in a professional manner leading to development and solidification of the participants' competence, knowledge, and skills.

After completing the course, the students should be able to:

- analyze and structure problems
- carry out relevant literature search
- write and follow-up technical documentation
- actively contribute to the project through team work
- apply knowledge and methods from previous courses
- independently acquire new knowledge and methods
- take initiatives and find creative solutions, monitoring the feasibility of their choices
- present results in writing and orally

The results of the project work shall:

- maintain high technical standards based on modern knowledge and methods in applied physics
- be documented with a requirement specification, project plan, design specification, test plan, time plan, and a technical report
- be presented orally
- be followed up in a project reflection document

The course also aims at the acquisition of knowledge and abilities within the general area of entrepreneurship, with particular focus on business planning for new ventures.

After the course, the students should be able to:

- account for models that describe what it takes for a new venture to have a stable basis for further development and to assess the level of development of ventures using such models
- account for the information and analyses needed to evaluate a development project from a business point of view and have the ability to collect and analyze relevant information for the purpose.

# Course content

The project course serves as an umbrella for a variety of projects with focus on Applied Physics. Within the course, the students will have the possibility to get

new knowledge and apply prior knowledge for advanced applications of scientific and industrial relevance. All the projects include a common part with lectures on the CDIO initiative, the LIPS model, and an entrepreneurship part. These clarify the expectations and intended learning outcomes of the course.

The following two projects are offered in the course:

(i) Design, Processing and Test of a Sensor System. Chemical sensors with certain requirements and with high technological and commercial value will be provided or partially fabricated, and fully characterized by the students. The ultimate goal of the project is to implement such sensors in a portable sensor system platform for field test measurements. The project will include about 25 h of introductory lectures, during which the students will learn about the background, methods, market needs and demands, some basic knowledge related to the project work and the sensor technology used, device characterization, data acquisition, analysis and evaluation.

The students will:

1. Conceive and realize their own experiments, with support of a supervisor when necessary
2. Design a prototype and the process flow, identifying, evaluating, selecting and motivating their choices
3. Implement the sensor system and take initiative on the experimental activities
4. Operate the sensors, plan and perform measurements, coordinate laboratory activities, and manage the need to book and share equipment and supervision time
5. Compare obtained results with the most recent scientific literature and other sensors commercially available
6. Provide a general discussion about the usefulness of the sensors in a real application related to the fields of environment and health, such as air quality control and sensor technologies for sustainable development

(ii) Computational Physics: implementation and execution of computer simulations within a relevant field in computational physics. The project work aims to give the experience of software development and application of computational physics as a tool in applications in industry and science. The initial lectures present the background of the project, methods, market needs and demands, and knowledge necessary for the project, including extended programming skills for shared development of software in larger projects, theoretical models and approaches to simulation, data collection, analysis, evaluation, and visualization of results. Practical exercises complement the lectures.

The central part of the project consists of work with software that uses a relevant computational physics simulation approach. The students will:

1. Plan out their work in advance using a relevant project model.
2. Develop and test an implementation of new functionality, or a significant extension of existing functionality, in the simulation approach that is used.
3. Use the software that has been developed to apply computational physics to solve a project assignment.
4. Analyze the results on a scientific basis with meaningful visualizations and

interpretations in the context of a relevant application.
5. Present the software that has been developed, the computations, and the analysis in writing and orally.

## Teaching and working methods

Before the start of the course, the students choose one of the offered projects. Each project has a separate examiner. A number of project specific, introductory lectures and/or laboratory work in the beginning give basic knowledge for the project work. The project group shall consist of at least four students. Each group is assigned a supervisor to support its work. Before the project work is started, the project group shall negotiate a requirement specification with the customer, and write a project plan and a time plan for the project. The course follows the "Conceive Design Implement Operate" (CDIO) program at LiU and the project model "Linköping Interactive Project Steering" (LIPS) is used.

## Examination

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|---|---|---|---|
| UPG1 | Entrepreneurship Assignments | 3 credits | U, G |
| PRA1 | Group Working Report and Conference Presentation followed by | 9 credits | U, G |

The work of the group is presented in written reports, following the LIPS documents, a poster and an oral presentation at a project conference, where the group will also answer questions about the project. Grades are given as ‘Fail’ or ‘Pass’.

## Grades

Two grade scale, older version, U, G

# Other information

The course is conducted in such a way that experience, knowledge, competence and skills of both women and men are equally highlighted and developed. Planning and implementation of the course should be based on the syllabus formulations. The course evaluation included in the course should therefore be implemented with the syllabus as a starting point.

### About teaching and examination language

The teaching language is presented in the Overview tab for each course. The examination language relates to the teaching language as follows:

- If teaching language is Swedish, the course as a whole or in large parts, is taught in Swedish. Please note that although teaching language is Swedish, parts of the course could be given in English. Examination language is Swedish.
- If teaching language is Swedish/English, the course as a whole will be taught in English if students without prior knowledge of the Swedish language participate. Examination language is Swedish or English (depending on teaching language).
- If teaching language is English, the course as a whole is taught in English. Examination language is English.

### Other

The course is conducted in a manner where both men's and women's experience and knowledge are made visible and developed.

The planning and implementation of a course should correspond to the course syllabus. The course evaluation should therefore be conducted with the course syllabus as a starting point.

# Department

Institutionen för fysik, kemi och biologi

# Director of Studies or equivalent

Magnus Boman

# Examiner

Donatella Puglisi, Rickard Armiento

# Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html?selection=all&sort=kk

# Education components

Preliminary scheduled hours: 56 h
Recommended self-study hours: 264 h

# Course literature

### Books

Allen, M. P., Tildesley, D. J., (1989) *Computer simulation of liquids* Oxford : Clarendon, 1989.
ISBN: 0198556454
For the project Computational physics.
Svensson, T., Krysander, C., (2011) *Projektmodellen LIPS* Lund : Studentlitteratur, 2011.
ISBN: 9789144075259
For both projects.

### Articles

D'Amico A., Di Natale C., Sarro P. M., Ingredients for sensors science *Sensors and Actuators B* 207 (2015) s.1060-1068.
For the project Design, processing, and test of a sensor system.

### Websites

*The CDIO Initiative* http://www.cdio.org

### Other

*Övrig rekommenderad läsning för projektet Design, tillverkning och test av ett sensorsystem:*

Other recommended reading for the project Design, processing, and test of a sensor system: Book chapters, articles and other reading materials which will be suggested throughout the project course, reading on constructive feedback.

# Common rules

## 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.

## Interrupting a course

The vice-chancellor's decision concerning regulations for registration, deregistration and reporting results (Dnr LiU-2015-01241) 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 a course is carried out using a web-based form: https://www.lith.liu.se/for-studenter/kurskomplettering?l=en.

## Cancelled courses

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, http://styrdokument.liu.se/Regelsamling/VisaBeslut/917592.

An examiner must be employed as a teacher at LiU according to the LiU Regulations for Appointments (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

### Examination

Written and oral 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 board of studies.

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 October
- 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 board of studies 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 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 board of studies. In all cases above, the examination is also offered one more time during the academic year after the following, unless the board of studies decides otherwise.

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

### Registration for examination

In order to take an examination, a student must register in advance at the Student Portal during the registration period, which opens 30 days before the date of the examination and closes 10 days before it. Candidates are informed of the location of the examination by email, four days in advance. Students who have not

registered for an examination run the risk of being refused admittance to the examination, if space is not available.

Symbols used in the examination registration system:

** denotes that the examination is being given for the penultimate time.

* denotes that the examination is being given for the last time.

### 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 computer-based examinations in an attempt to achieve a higher grade. This is valid for all examination components with code "TEN" 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.

### Retakes of other forms of examination

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

### 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 https://www.student.liu.se/studenttjanster/lagar-regler-rattigheter?l=en.

### Grades

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

1. Grades U, 3, 4, 5 are to be awarded for courses that have written examinations.
2. 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.
3. Grades Fail (U) and Pass (G) are to be used for degree projects and other independent work.

### Examination components

1. Grades U, 3, 4, 5 are to be awarded for written examinations (TEN).
2. 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), oral examination (MUN), computer-based examination (DAT), home assignment (HEM), and assignment (UPG).
3. 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 other examination (ANN), tutorial group (BAS) or examination item (MOM).
4. 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).

For mandatory components, the following applies: 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. (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).

For written examinations, the following applies: 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 instead 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. (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).

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

## 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-_och_avancerad_niva.