Project Course in Applied Physics, CDIO

Programme course

12 credits

Projektkurs i teknisk fysik, CDIO

TFYA92

Valid from: 2019 Spring semester

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

Date determined
2018-08-31

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.

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, knowledge is desirable, but not compulsory, in Semiconductor technology, Microchip fabrication, Semiconductor physics, Surface physics, Materials physics, Sensor technology, Bio-analytical methods, Chemical sensor systems. For the project Computational Physics, knowledge is desirable in Statistical Mechanics, Solid State Physics, Condensed Matter Physics, Quantum Mechanics, Materials Science, and solid programming. The emphasis is on general algorithms, so no specific programming language is required.

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 an industrial professional manner leading to development and solidification of the participants' competence. After completing the course, the student should be able to:

- analyse and structure problems
- seek out and assimilate supplementary knowledge
- write and follow-up of project plans and time plans
- actively contribute to the function of the project group
- apply knowledge from previous courses
- take initiatives and find creative solutions
- present results in writing and orally.

The result of the project work shall:

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

Another purpose for the course is for the students to acquire knowledge and abilities within the general area of entrepreneurship, with particular focus on business planning for new ventures. After the course, 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 asess the level of development of ventures using such models; and
- 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 analyse relevant information for the purpose.

Course content

The project course serves as an umbrella for a variety of projects with an Applied Physics focus. These will give the student opportunities to apply knowledge in Applied Physics for advanced applications of industrial relevance. At present, the following two projects are offered in the course:

(i) Design, Processing and Test of a Sensor System. The sensors in this project will be of high technological and commercial value with applications for example for monitoring of emissions in car exhausts or in flue gases from boilers. In 10 hr of lectures, students will learn about the background, methods, and some basic knowledge required for the project work, including
1. wide bandgap semiconductor physics,
2. device physics and processing technology,
3. thin film technology,
4. sensor physics, detection mechanisms including surface catalytic reactions, etc.
The project work starts with a general investigation to understand the R & D background, technological and social demands, and required new innovations of the sensor devices to be used in the dedicated sensor system:
1. The students design the device layout and the process flow, and perform a proper choice of the sensing materials
2. They take part in material characterization, processing of components, and the mounting of the sensors
3. They characterize the sensors through measurements and evaluation of sensor functions and characteristics.
4. Finally, the students should provide a general discussion about the usefulness of the sensors in a real application like control of the combustion in car exhausts or in the flue gases of domestic boilers.

(ii) Computational Physics. The project is concerned with the theory and application of computer simulations of many-body systems, as applied in materials science studies, with emphasis on Molecular Dynamics. The project starts with 16h of lectures in which the statistical mechanics principles underlying computer simulations, the Monte Carlo (MC) and Molecular Dynamics (MD) techniques, are introduced. Topics discussed include Monte Carlo integration, the Metropolis method, integration of equations of motion for many-body systems in MD, Verlet algorithms and force calculations, simulations in various statistical ensembles. Lectures are complemented by practical tutorials, in which students learn to use the MD technique based on a hands-on approach. Specific analysis and visualization techniques are introduced and used throughout the course, with emphasis on their application to practical solutions of materials related problems. The actual project consists of students writing and operating their own MD software tools. Following the assembly, compilation and testing of the MD code, students are required to calculate with their program a number of specific bulk and surface properties of a chosen material, such as cohesive energy, lattice constant, specific heat, surface formation energies etc. Students present their results, i.e. a description of the MD code and analysis of the material properties calculated, in written and oral form.

Teaching and working methods

Before the start of the course the student 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

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, which follow 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

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Boman

Examiner

Valeriu Chirita (Beräkningsfysik), Donatella Puglisi

Course website and other links

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

Education components

Preliminary scheduled hours: 42 h
Recommended self-study hours: 278 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 has been 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. A central timetable is not drawn up for courses with fewer than five participants. Most project courses do not have a central timetable.

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: www.lith.liu.se/for-studenter/kurskomplettering?l=sv.

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 board of studies is to deliberate and decide whether a course is to be cancelled or changed from the course syllabus.

Regulations relating to examinations and examiners

Details are given in a decision in the university's rule book: http://styrdokument.liu.se/Regelsamling/VisaBeslut/622678.

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 at Easter 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 only three times during the year in which the course is given.
- 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.
- If teaching is no longer given for a course, three examination occurrences are held during the immediately subsequent year, while examinations are at the same time held for any replacement course that is given, or alternatively in association with other re-examination opportunities. Furthermore, an examination is held on one further occasion during the next subsequent year, unless the board of studies determines 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.

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 regulations for examinations and examiners, http://styrdokument.liu.se/Regelsamling/VisaBeslut/622678.

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.

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=sv.

Grades

The grades that are preferably to be used are Fail (U), Pass (3), Pass not without distinction (4) and Pass with distinction (5). Courses under the auspices of the faculty board of the Faculty of Science and Engineering (Institute of Technology) are to be given special attention in this regard.

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.

Examination components

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

3. 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).
4. 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).

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.