

# Modern Physics

Programme course

6 credits

Modern fysik

TNE041

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

First cycle

## Advancement level

G2X

## Course offered for

- Electronics Design Engineering, M Sc in Engineering

## 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

Multivariable calculus, Mechanics and Wave physics or similar courses

## Intended learning outcomes

The course shall give an introduction to and an overview of modern physics, especially areas in statistical physics, quantum mechanics and solid state physics that are important in semiconductor technology. After completing this course students should be able to do the following:

- Apply basic relations in relativistic dynamics
- Describe basic phenomena that motivated the transition from classical physics to quantum physics and the formulation of the Bohr model
- Describe the uncertainty relations and the different ways of interaction between electromagnetic radiation and matter, and apply these in problem solving
- Solve the Schrödinger equation in some special cases; be able to interpret and describe the solutions (wave functions) physically, and to calculate physically measurable quantities using wave functions.
- Describe non-classical concepts like tunnel effect and spin and their applications, and apply these concepts in simple model calculations
- Describe the Pauli principle and explain how it determines the electron configuration in atoms, and its importance for the principles of the buildup of the periodic system
- Apply basic statistical mechanics, especially being able to calculate physical quantities starting from distribution functions
- Give an account for the main steps in the derivation of the Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions, and give examples of applications.
- Describe different types of crystal structures and chemical bonds in solid materials
- Give an account for what characterizes conductors, semiconductors and insulators, especially with respect to the electrical conductivity, and the meaning and importance of energy bands.
- Describe central concepts in semiconductor physics like doping, acceptor, donor, effective mass, and make simple model calculations using them
- Explain and evaluate results obtained from assignments in computer simulation and communicate by presenting written accounts of these

## Course content

Relativistic dynamics, Quantum mechanics: interaction between electromagnetic radiation and matter, wave-particle dualism, the uncertainty principle. The Schrödinger equation with applications on simple systems. The Pauli principle and the periodic system. Statistical physics: Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein distributions with applications.

Solid state physics: Crystal structures, lattices, electrical conductivity of semiconductors, band theory.

## Teaching and working methods

Lectures, tutorials and computer laboratory sessions.

## Examination

UPG1	Optional hand-in assignments	0 credits	U, G
LAB1	Laboratory work	1.5 credits	U, G
TEN1	Written examination	4.5 credits	U, 3, 4, 5

Optional homework problems are given that may give a bonus on the written examination, the bonus is valid until the examination in August immediately after the course is finished.

## Grades

Four-grade scale, LiU, U, 3, 4, 5

## Course literature

Randy Harris: Modern Physics.  
Nordling, Österman: Physics Handbook

## Other information

Supplementary courses: Semiconductor technology, organic electronics

## Department

Institutionen för teknik och naturvetenskap

## Director of Studies or equivalent

Adriana Serban

## Examiner

Ulf Sannemo

## Course website and other links

<http://www2.itn.liu.se/utbildning/kurs/>

## Education components

Preliminary scheduled hours: 46 h  
Recommended self-study hours: 114 h

## Course literature

### **Books**

Randy Harris, *Modern Physics* Second Ed Pearson

### **Other**

*Nordling, Österman: Physics Handbook, Studentlitteratur*

## 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](http://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://stydokument.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 with 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](http://styrdokument.liu.se/Regelsamling/Innehall/Utbildning_pa_grund-_och_avancerad_niva).