Faculty of Science

FYTB13, Theoretical Physics: Electromagnetism, 7.5 credits

Teoretisk fysik: Elektromagnetism, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2016-05-15 and was last revised on 2022-12-08. The revised syllabus applies from 2022-12-08, autumn semester 2023.

General Information

The course is an compulsory first cycle course for a degree of Bachelor of Science in Physics and is an alternative-compulsory course for a degree of Master of Science in Computational Science with specialisation in Physics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Physics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The overall aim of the course is that the students should learn the basics of the electromagnetic field theory based on Maxwell's equations and the Lorentz force.

Knowledge and understanding

On completion of the course, the students shall be able to:

1. state and justify which of Maxwell's equations that are relevant in different physical situations
2. describe the potential formulation of Maxwell's equations
3. explain the phenomena of polarisation and magnetisation
4. at a general level explain the meaning of gauge, gauge choice and gauge transformations.

Competence and skills

On completion of the course, the students shall be able to:

5. apply the tools of vector calculus and use fundamental integral relations to solve problems in electromagnetism,
6. apply general methods of solution such as separation of variables and multipole expansion to solve electromagnetic problems,
7. use Maxwell's equations in both microscopic and macroscopic form to derive the fields around simple symmetric stationary charge and current distributions as well as boundary conditions for the fields at boundaries between vacuum and linear media,
8. analyse energy content and energy transport for electromagnetic fields in vacuum and linear media
9. calculate propagation, reflection and transmission of electromagnetic waves
10. describe a modern application of electromagnetic theory in writing.

Judgement and approach

On completion of the course, the students shall be able to:

11. in writing review and assess the factual content in written reports.

Course content

The course contains basic electromagnetic field theory as well as related vector calculus. In particular it includes:

- vector calculus: derivatives of vector fields and related integral theorems as well as Dirac's delta function,
- Maxwell's equations on differential and integral form in both microscopic and macroscopic formulation,
- stationary electric and magnetic fields in vacuum and matter,
- electrodynamics: Lorentz force and induction,
- conservation laws and energy transport,
- electromagnetic waves: reflection and transmission in linear media,
- scalar and vector potential: separation of variables, multipole expansion, the gauge principle and gauge choices.

Course design

The teaching consists of lectures and problem solving sessions as well as compulsory written hand-in assignments. Furthermore, a compulsory project is included.

Assessment

The examination consists of:

- compulsory written assignments during the course - examines a selection of the intended learning outcomes
- written project report and written feedback on other students' reports- examines in particular intended learning outcomes 10 and 11
- a written examination at the end of the course - examines all the intended learning outcomes. Under special circumstances the written exam can be replaced by an oral one.

Students who do not pass the regular exam are offered a new possibility shortly after the regular exam.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a Pass grade on the whole course, the student must have Pass grades on the written examination, project report, written feedback on other student's report and hand-in assignments.

The grading scale for hand-in assignments and project is Fail, Pass, whereas the written examination is graded according to the scale Fail, Pass, Pass with Distinction.

The final grade is determined by grade on the written examination.

Entry requirements

The prerequisites required for admission to the course are, general entry requirements as well as 30 credits in physics and 45 credits in mathematics, including knowledge corresponding to:

- FYSA12 Introduction to University Physics, with Mechanics and Electricity, 15 credits,
- NUMA01 Computational Programming with Python, 7.5 credits,
- MATB21 Analysis in Several Variables 1, 7.5 credits
- MATB22 Linear algebra 2, 7.5 credits,

alternatively 75 credits in mathematics, including knowledge corresponding to:

- NUMA01 Computational Programming with Python, 7.5 credits,
- MATB21 Analysis in Several Variables 1, 7.5 credits,
- MATB22 Linear algebra 2, 7.5 credits,
- MATB23 Analysis in Several Variables 2, 7.5 credits
- MATB24 Linear Analysis, 7.5 credits.

English 6/English B.

Further information

The course may not be credited towards a degree together with FYTA12 Basic theoretical physics 30 credits.

Subcourses in FYTB13, Theoretical Physics: Electromagnetism

Applies from H23

2301 Hand-in Assignments and Project, 1,5 hp
Grading scale: Fail, Pass
2302 Written Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction

Applies from V17

1601 Hand-in Assignments and Project, 1,5 hp
Grading scale: Fail, Pass
1602 Written Examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction