Faculty of Science

# FYSC20, Physics: Electromagnetism, 7.5 credits

*Fysik: Elektromagnetism, 7,5 högskolepoäng*

**First Cycle / Grundnivå**

## Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2023-06-13 and was last revised on 2024-10-11 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2024-10-11 and is valid from the autumn semester 2025.

## General information

The course is a compulsory first cycle course for a degree of Bachelor of Science in Physics and 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 study* | *Specialisation* |
|---|---|
| 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 theory for electromagnetic fields 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 the method of images, 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 symmetric charge and current distributions as well as to solve induction problems,
8. at a general level describe the properties of electromagnetic waves in vacuum,
9. analyse problems in electromagnetism and choose a suitable method for solving them,
10. discuss situations in electromagnetism in words using appropriate concepts and terminology.

## 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: electromotive force and induction,
- electromagnetic waves in vacuum,
- scalar and vector potential: method of images, 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.

## Assessment

The examination consists of:

- compulsory written hand-in assignments during the course,
- a written examination at the end of the course.

It is required to pass the hand-in assignments to take part in the exam.

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.

## Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction

For a Pass grade on the whole course, the student must have Pass grades on the written examination and hand-in assignments.

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

The final grade is determined by the 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,
- FYSB21 Mathematical Methods for Vibrations, Waves and Diffusion, 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:

- 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.

Students who have obtained the corresponding knowledge by other means may also be admitted to the course.

## Further information

The course is part of the Bachelor's programme in physics, theoretical physics, and astrophysics. The teaching is based on the assumption that the student follows the program and has assimilated the knowledge in the previous courses, and takes other program courses in parallel. The course is also elective in the Master’s programme in computational science. For those who have acquired equivalent knowledge in other ways, the course can be taken as a stand-alone course.

The course replaces FYTB13 Electromagnetism 7.5 credits.

The course may not be credited towards a degree together with FYTB13 Electromagnetism 7.5 credits nor with FYTA12 Basic theoretical physics 30 credits.

The course is given by the Department of Physics, Lund University.