DEPARTMENT OF PHYSICS

FYP202 Electromagnetic field theory, 7.5 credits

Elektromagnetisk fältteori, 7,5 högskolepoäng

First Cycle

Confirmation

This course syllabus was confirmed by Department of Physics on 2011-10-17 and was last revised on 2020-05-04 to be valid from 2020-07-01, autumn semester of 2020.

Field of education: Science 100%
Department: Department of Physics

Position in the educational system

The course is included in the Bachelor of Science in Physics and the Medical Physicist Programme. It is also given as a freestanding course.

The course can be part of the following programmes: 1) Bachelor of Science in Physics (N1FYS) and 2) Medical Physicist Programme (N1SJU)

Main field of studies	*Specialization*
Physics	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Entry requirements

For admission to the course, completed courses are required from the first two semesters of the Bachelor of Science in Physics programme as well as having completed the course FYP201 Mathematical Physics A, or that the equivalent knowledge has been acquired in some other way.

Learning outcomes

After completion of the course Electromagnetic field theory, the student should be able to:

Knowledge and understanding

- discuss and show understanding of the physical concepts of classical electromagnetic field theory listed in the course content below;
- discuss the fundamental laws for electromagnetic fields and potentials in electrostatics, magnetostatics, and electrodynamics, in algebraic, differential, and integral form, and derive the different formulations from each other;
- discuss the different methods to calculate electromagnetic fields and potentials from electric charge and current distributions and vice versa, as well as have an understanding of which method is preferable under different conditions;
- understand electromagnetic phenomena, such as attraction and repulsion between charges and current-carrying conductors, Faraday cages, electromagnetic induction, and describe these phenomena with tools from vector calculus;
- discuss and show understanding of the experiments that contradicted classical mechanics and led to special relativity;
- discuss the physical concepts of special relativity listed in the course content below;
- describe, explain, and predict electromagnetic phenomena as well as relativistic effects in nature, everyday life, and society;

Competence and skills

- perform calculations related to classical electromagnetism, such as determining electromagnetic fields and potentials from collections of point charges and from charge and current distributions in simpler geometries in vacuum and materials;
- use mathematical methods to solve Maxwell's equations in various forms, such as integration, the method of images, multipole expansion, and the relaxation method;
- describe electromagnetic waves with different frequencies, polarizations, energies and wave forms as solutions to the wave equation;
- perform simpler calculations related to special relativity, such as calculating lengths and time intervals in different inertial systems and calculating the energies and linear momenta of relativistic objects;
- present scientific results orally and in writing;
- analyze data from experiments and/or computer simulations of electromagnetic systems;

Judgement and approach

- be familiar with how electromagnetic fields have affected our world view and our modern society;
- evaluate results from scientific studies in electromagnetism.

Course content

Classical electromagnetism including the following concepts: electric charge, electric fields, Coulomb's law, superposition principle, charge density, Gauss' law, electrostatic potential, Poisson's and Laplace's equations, general electrostatic field problems and solution methods, capacitance, electrostatic energy, electric dipoles, polarization, electric and magnetic fields in matter, polarization and displacement fields, electric current, Lorentz force, magnetic fields, Biot-Savart's law, Ampère's law, vector potential, magnetostatic energy, motion of charged particles in homogeneous electric and magnetic fields, self-inductance and mutual inductance, magnetic dipoles, magnetization, Ohm's law, electromotive force, Faraday's law, RLC circuits, Maxwell's equations, electromagnetic waves and optics, group velocity, scalar and vector potentials for time-dependent fields, energy in electromagnetic fields, Poynting's theorem, radiation from moving point charges.

Basic principles of special relativity including the following concepts: relativistic velocity addition, time dilation, length contraction, Lorentz transformations, Minkowski space, and relativistic mechanics.

The course consists of two sub-courses. In sub-course 2, the student focuses on a specific experiment, which is then presented in writing and orally.

Sub-courses

1. **Electromagnetic field theory** *(Elektromagnetisk fältteori),* 7 credits
   Grading scale: Pass with Distinction (VG), Pass (G) and Fail (U)

2. **Demonstrations** *(Demonstrationer),* 0.5 credits
   Grading scale: Pass (G) and Fail (U)

Form of teaching

Sub-course 1: lectures, guest lectures, tutorials and hand-in assignments.
Sub-course 2: demonstrations and presentations.

Compulsory components with requirement to be present: guest lectures (sub-course 1) as well as demonstrations and presentations (sub-course 2).

Language of instruction: Swedish

Assessment

Subcourse 1: oral exam and hand-in assignments, 7.0 credits
Sub-course 2: presentation and written report, 0.5 credits

Grades

The grading scale comprises: Pass with Distinction (VG), Pass (G) and Fail (U).
Pass (G) on the entire course requires Pass grades on both sub-course 1 and sub-course 2. Pass with Distinction (VG) on the entire course requires Pass with distinction on sub-course 1 and Pass on sub-course 2.

Course evaluation

A course evaluation should be arranged after the course has ended where all participating students are given the possibility to provide anonymous feedback via a course survey. The course responsible should, together with student representatives, discuss and assess the completed survey. Meeting notes should afterwards be made available via the university learning platform.