# Electromagnetic Field Theory

Programme course

8 credits

Elektromagnetism

TFYA13

Valid from: 2017 Spring semester

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

**Date determined**
2017-01-25

**Offered for the last time**
Spring semester 2023

**Replaced by**
TFYB05 och TFYB09 eller TFYA70 och TFYB10

## Main field of study
Applied Physics, Physics

## Course level
First cycle

## Advancement level
G2X

## Course offered for
- Applied Physics and Electrical Engineering - International, M Sc in Engineering
- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanotechnology

## 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
Calculus with One and Several Variables, Vector Analysis

## Intended learning outcomes
The overall goal is that the student - with the Maxwell equations, MW, as starting point, should be able to define, derive and use basic electromagnetic laws and theorems on problems in physics and electrical engineering. This implies that the student should:

- be familiar with and able to use electromagnetic laws and theorems
- be able to formulate idealized models for electromagnetic problems
- be able to apply electromagnetic theory to solve problems primarily in physics and electrical engineering
- be able to explain in a well structured and logical concise way derivations/relations within electromagnetics as well as between the central concepts of the theory
- be able to formulate, analyze and solve electrostatic problems with the help of a modern numeric computer tool
- be able to use electromagnetic theory to qualitatively explain in a well structured and logical concise way numerically obtained results

## Course content

Electrostatics: Electric Field Intensity, Coulomb's law, Potential, Gauss's law, Poisson's and Laplace's Equations, Capacitance, Dielectrics, Electric Dipole, Polarization, Electrostatic Energy and Forces, Method of Images. Steady Electric Currents: Current Density, Equation of Continuity, Resistance, Joule's law. Magnetostatics: Magnetic Flux Density, Biot-Savart law, Ampere's Circuital law, Vector Magnetic Potential, Magnetic Materials, Magnetic Circuits, Magnetic Dipole, Magnetization, Magnetostatic Energy and Forces, Motion of Charged Particles in Electromagnetic Fields. Time-Varying Electromagnetic Fields: Induction, Faraday's law, Inductance, Electromotive Force, Displacement Current Density, Skin Effect, Electromagnetic Waves, Poynting Vector. Snell's laws of reflection and refraction, and Fresnel's formulas are derived from electromagnetics. Certain applications of electromagnetics on waveguides. The finite-elemet-method in two dimensions will be briefly introduced for electrostatic problems. The different parts of the course are presented as specific applications of Maxwell's equations.

## Teaching and working methods

The course consists of lectures in connection to problem solving sessions and computer simulations.

## Examination

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|---|---|---|---|
| UPG1 | Examination | 0.5 credits | U, G |
| TEN1 | Written examination | 7.5 credits | U, 3, 4, 5 |

Optional course modules can provide points that may be counted on the written exam.

## Grades

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

## Other information

Supplementary courses: Classical Electrodynamics

## Department

Institutionen för fysik, kemi och biologi

## Director of Studies or equivalent

Magnus Johansson

## Examiner

Peter Münger

## Course website and other links

## Education components

Preliminary scheduled hours: 80 h
Recommended self-study hours: 133 h

## Course literature

Cheng, David: Field and Wave Electromagnetics, Addison-Wesley Co.
Exempelsamling i Elektromagnetism. Simuleringar med finita-element-metoden inom Elektromagnetism, IFM.

# Common rules

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.