Mathematical Methods of Physics

Programme course

6 credits

Fysikens matematiska metoder

TFYA18

Valid from: 2017 Spring semester

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

Date determined
2017-01-25

Main field of study

Mathematics, Applied Mathematics, Applied Physics, Physics

Course level

Second cycle

Advancement level

A1X

Course offered for

- Applied Physics and Electrical Engineering, M Sc in Engineering
- Physics and Nanoscience, Master's programme
- Applied Physics and Electrical Engineering - International, 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

Analysis, Linear algebra, Vector analysis, Complex analysis, Fourier analysis.

Intended learning outcomes

The course is aimed at making the students familiar with the basic equations of the mathematical physics and the methods of their solutions. The emphasis will be done on the special functions involved in the solution of these equations. It will be given much attention to the visualization of the solutions for a number of typical physical problems of current interest. To achieve this goal students have to

- model physical systems in mechanics, hydrodynamics, electrodynamics and quantum mechanics by the wave and heat transfer equations, Poisson, Laplace and Schrödinger equations;

- explore the methods of the solutions of these equations in rectangular, cylindrical and spherical coordinates with corresponding boundary and initial conditions;
- know the properties and how to use in practice the Bessel functions, Legendre polynomials, associative Legendre polymomials, Lagerre and Hermitian polynomials;
- analyze and visualize the solutions in terms of special functions;
- get knowledge of the methods of the random processes theory from the description of correlations in mesoscopic systems.

Course content

Basic equations of mathematical physics and methods of their solutions: separation of variables, orthogonal set expansion, Fourier- and Laplace integral transforms, Green's functions. Sturm-Liouville problem. Bessel functions. Fourier-Bessel series. Boundary value problems in potential theory. Legendre and associative Legendre polynomials. Application of Legendre polynomials in potential theory. Spherical harmonics. Temperature and potential problems in spherical symmetry. Schrödinger equation in cylindrical and spherical symmetry. Theory of Brownian motion. Langevin equation. Fokker-Planck equation. Long-lived correlations in mesoscopic systems. Visualization of the solutions of wave and heat transform equations, vibration of a circular membrane, potential problems in cylindrical and spherical symmetry, hydrogen atom and free particle in central force problem, temperature distribution in a cylindrical bar and a sphere.

Teaching and working methods

Seminars including theory and problem solving following a special plan presented at the beginning of the course. Labs including numerical solutions of partial differential equations.

Examination

TEN1	A written examination containing theory problems	U, 3, 4, 5	6 credits

Grades

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

Department

Institutionen för fysik, kemi och biologi

Director of Studies or equivalent

Magnus Johansson

Examiner

Iryna Yakymenko

Course website and other links

http://www.ifm.liu.se/undergrad/fysikgtu/coursepage.html?selection=all&sort=kk

Education components

Preliminary scheduled hours: 48 h
Recommended self-study hours: 112 h

Course literature

I.I. Yakymenko. Lecture Notes in Mathematical Methods in Physics. I.I. Yakymenko. Set of Problems in Mathematical Methods in Physics.

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.