Course syllabus

Kontinuerliga system
Applied Mathematics

FMA021, 7.5 credits, A (Second Cycle)

Valid for: 2016/17
Decided by: Education Board B
Date of Decision: 2016-03-29

General Information

Main field: Technology.
Compulsory for: F2, Pi2
Elective for: D4, E4, M4
Language of instruction: The course will be given in Swedish

Aim

Within the engineering sciences the term "continuous system" means a system whose state space is described by a continuous family of parameters. Continuous systems occur frequently in physics and other natural sciences, in mechanics, electricity and other engineering sciences, in economic sciences, etc. To describe a continuous system one is in general led to partial differential equations (pde).

One aim of the course is to provide mathematical tools, and the ability to use them, for the whole chain model building - analysis - interpretation av solutions to pde:s appearing for such systems. Another aim is the converse: to lay a foundation for a general competence in mathematics, useful in further studies as well as in professional activities, by showing how abstract mathematical concepts, such as Hilbert spaces, may be used in concrete applications. A further aim is that the student should become acquainted with the use and usability of software packages for computation and simulation.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

• be able to demonstrate an ability to formulate mathematical models for phenomena in heat conduction, diffusion, wave propagation and electrostatics.
be able to demonstrate an ability to physically interpret mathematical models with
different boundary conditions for the three basic types of pde:s: the heat equation, the
wave equation and the Laplace/Poisson equation, and to understand the characteristics
of their solutions.

be able to demonstrate an ability to use spectral methods (Fourier) and source function
methods (Green) to solve problems for the three basic equations in simple geometries.

be able to demonstrate an ability to interpret functions as abstract vectors in a Hilbert
space, and to use for functions concepts such as norm, distance, scalar product.

be able to demonstrate an ability to decide whether an operator is symmetric, and an
ability to identify Sturm-Liouville operators.

be able to demonstrate an ability to find eigenfunctions and eigenvalues for some types
of Sturm-Liouville operators, in particular those associated with the Laplace operator in
one, two and three dimensions.

be able to demonstrate an ability to explain the projection formula and to use it to solve
least squares problems.

have some experience and understanding of the use of mathematical and numerical
software in order to solve problems related to the course.

**Competences and skills**

For a passing grade the student must

• be able to demonstrate an ability to independently choose appropriate methods to solve
the three basic types of partial differential equations, och to carry out the solution
essentially correctly.

• be able to demonstrate an ability to use theoretical tools from areas such as Hilbert
space theory, special functions, distribution theory, Fourier and Laplace transforms, and
Green functions to solve the three basic pde:s in simple geometries.

• in connection with problem solving, be able to demonstrate an ability to integrate
knowledge from the different parts of the course.

• with proper terminology, in a well structured way and with clear logic be able to explain
the solution of a mathematical problem within the course.

**Contents**

Physical models. Fourier’s method, series expansions and integral transforms. Green
Sturm-Liouville operators and their eigenvalues and eigenfunctions. Special functions,
e.g., Bessel, Legendre, spherical harmonics. Distributions. The Fourier and Laplace
transforms. Something about the numerical solution of partial differential equations.

**Examination details**

**Grading scale:** TH

**Assessment:** Written test comprising theory and problem solving. Computer sessions. A
voluntary test at the middle of the course provides an opportunity to collect credits for
the final exam.
Parts
Credits: 7.5. Grading scale: TH.
Code: 0298. Name: Laboratory work.
Credits: 0. Grading scale: UG.

Admission
Admission requirements:

- FMA420 Linear Algebra and 6 credits from FMA430/FMA435 Calculus in Several Variables

Required prior knowledge: FMAF05 Systems and Transforms.
The number of participants is limited to: No
The course overlaps following course/s: FMAF15, FMA020, FMA022, FMFF15

Reading list


Contact and other information

Director of studies: Studierektor Anders Holst, Studierektor@math.lth.se
Teacher: Pelle Pettersson, pelle@maths.lth.se
Course administrator: Studerandeexpeditionen, expedition@math.lth.se
Course homepage: http://www.maths.lth.se/course/kontsys/
Further information: Any credits acquired by passing the voluntary written test at the middle of the course expire after a year. Thereafter it is possible to participate in the voluntary test the following year in order to try to acquire new credits. The credits may only be used to raise a failing grade to a pass, but not to raise a pass to a higher mark.