Course syllabus

Kontinuerliga system
Applied Mathematics

FMAN55, 7,5 credits, A (Second Cycle)

Valid for: 2020/21
Decided by: PLED F/Pi
Date of Decision: 2020-04-01

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 of solutions to pdes 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 pdes: 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 pdes 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, in particular the
Laplace operator with simple boundary conditions on simple domains. 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 - (U,3,4,5) - (Fail, Three, Four, Five)
**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.

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.

Parts
Credits: 7.5. Grading scale: TH.
Code: 0217. Name: Laboratory Work.
Credits: 0. Grading scale: UG.

Admission
Admission requirements:

- FMA420 Linear Algebra or FMAA20 Linear Algebra with Introduction to Computer Tools or FMAB20 Linear Algebra or FMAF01 Mathematics - Analytic Functions or FMAF05 Mathematics - Systems and Transforms
- FMA430 Calculus in Several Variables or FMA435 Calculus in Several Variables or FMAB30 Calculus in Several Variables or FMAB35 Calculus in Several Variables or FMAF01 Mathematics - Analytic Functions or FMAF05 Mathematics - Systems and Transforms

Assumed prior knowledge: FMAF01 Analytic Functions and FMAF05 Systems and Transforms.
The number of participants is limited to: No
The course overlaps following course/s: FMAF15, FMA020, FMA022, FMFF15, FMA021

Reading list
- Matematikcentrum: Laborationshandledningar. Distributed by the department.

Contact and other information
Director of studies: Studierektor Anders Holst, Studierektor@math.lth.se
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Teacher: Mikael Persson Sundqvist, mikael.persson_sundqvist@math.lth.se
Course homepage: http://www.maths.lth.se/course/kontsysnykod/
Further information: Any credits acquired by passing the voluntary written test at the middle of the course is valid at the examination and at the two resit exams that immediately follow. 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.