



LUNDS UNIVERSITET  
Lunds Tekniska Högskola

*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 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 functions. Wave propagation. Function spaces and function norms. Hilbert spaces. 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

**Code:** 0117. **Name:** Applied Mathematics.

**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

- Sparr, G & Sparr, A: Kontinuerliga system. Studentlitteratur, 2000, ISBN: 91-44-01355-8.
- Sparr, G & Sparr, A: Kontinuerliga system., Övningsbok. Studentlitteratur, 2000, ISBN: 91-44-01234-9. Preferably the printing from 2006.
- Matematikcentrum: Laborationshandledningar. Distributed by the department.

## Contact and other information

**Director of studies:** Studierektor Anders Holst, [Studierektor@math.lth.se](mailto:Studierektor@math.lth.se)

**Course administrator:** Studerandeexpeditionen, [expedition@math.lth.se](mailto:expedition@math.lth.se)

**Teacher:** Mikael Persson Sundqvist, [mikael.persson\\_sundqvist@math.lth.se](mailto: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.