Dnr: 2021/1430-3.1.2.2

Course syllabus

Faculty of Technology
Department of Mathematics and physics

2MA904 Modellering och simulering med partiella differentialekvationer, 7,5 högskolepoäng

Modeling and Simulation with Partial Differential Equations, 7.5 credits

Main field of study
Mathematics

Subject
Mathematics

Level
First cycle

Progression
G2F

Date of Ratification
Approved 2021-04-12.
The course syllabus is valid from autumn semester 2022.

Prerequisites
1MA905/465 Multivariable Calculus and Vector Calculus (7.5 credits)
1MA907 Linear Algebra Advanced Course (5 credits)
2MA901 Fourier Series and Complex Analysis (5 credits)
2MA903 Numerical Methods (5 credits)
or equivalent

Objectives

Knowledge and understanding
After the course the student must be able to:

- explain linear models of physical systems based on physical relationships

- explain a selection of common partial differential equations (PDEs) and its fields of application

- demonstrate basic knowledge and understanding of numerical methods for solving linear partial differential equations. This means understanding the strengths and weaknesses of common numerical methods for discretizing partial differential equations

- demonstrate basic knowledge of mathematical tools used to analyze linear partial differential equations and explain the relevance of basic concepts in PDE theory such as the existence and unambiguity of solutions, as well as continuous dependence on initial and boundary values

- show basic error estimates for finite element methods

Ability and capacity

After the course the student must be able to:

- demonstrate the ability to formulate an adequate mathematical problem for the problem based on a general question, and use and integrate knowledge of models and methods from previous courses and Modeling and simulation with partial differential equations to analyze, structure and solve problems in computational mathematics

- demonstrate the ability to plan and with adequate methods carry out tasks in computational mathematics and construct a computer program for the purpose of simulating a system, and report the results in the form of a report

Judgement and approach

After completing the course, the student is expected to be able to

- demonstrate the ability to interpret, evaluate and assess the plausibility of results with regard to relevant scientific aspects within computational mathematics and PDE theory
- demonstrate insight into the possibilities and limitations of numerical methods

Content

The course provides an introduction to analysis and numerical methods for solving partial differential equations. Common numerical methods for discretizing PDE are introduced and basic numerical analysis is presented for the finite element method. In compulsory assignments, finite element methods, finite difference methods and spectral methods are implemented. In addition, both theory and applications are included in these assignments.

The following items are addressed:

- background and derivation of some common partial differential equations

- PDE-problems in elasticity, heat conduction, and wave propagation

- Fourier's method for solving boundary value problems

- basic understanding of PDE theory as the existence and uniqueness of solutions, as well as continuous dependence on initial and boundary values
- L2-projection och Ritz-projection
- basic knowledge of finite element methods, finite difference methods and spectral methods
- develop program code for discretizing PDE in Matlab or Python

Type of Instruction

Lectures, problem solving sessions, and computer labs.

Examination

The course is assessed with the grades A, B, C, D, E or F.

The grade A is the highest grade, and the remaining grades follow in decreasing order where E is the lowest grade to pass. The grade F means that the student's performance is considered insufficient to pass.

Examination consists of

Exam: Theory and problem solving (grades A-F), 5 credits
Assignment (grade G-U), 2.5 credits

For a passing grade on the course, at least grade E on Exam and grade G on Assignment are required.
The final grade is determined from Exam.

Repeat examination is offered in accordance with Local regulations for courses and examination at the first and second-cycle level at Linnaeus University.

If the university has decided that a student is entitled to special pedagogical support due to a disability, the examiner has the right to give a customised exam or to have the student conduct the exam in an alternative way.

Course Evaluation

During the implementation of the course or in close conjunction with the course, a course evaluation is to be carried out. Results and analysis of the course evaluation are to be promptly presented as feedback to the students who have completed the course. Students who participate during the next course instance receive feedback at the start of the course. The course evaluation is to be carried out anonymously.

Overlap

The course cannot be included in a degree along with the following course/courses of which the content fully, or partly, corresponds to the content of this course:
2MA409 Modeling and simulation with partial differential equations, 7.5 credits

Other Information

Grading criteria for the A-F scale are communicated to the student via a special document. The student is informed about the course's grading criteria no later than in connection with the start of the course.

The course is conducted in such a way that the course participants' experiences and knowledge are made visible and developed. This means, for example, that we have an inclusive approach and strive for no one to feel excluded. This can be expressed in different ways in a course, for example by the teacher using gender-neutral examples.

Required Reading and Additional Study Material

Mats G. Larson, Fredrik Bengzon, The Finite Element Method : Theory, Implementation, and Practice, Springer, latest edition. Pages: approx. 200 out of 385.