

# Course PM

## 1TD056: Applied finite element methods, 5.0 hp

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### Course description

In this course you will learn the basic knowledge of the theory, practice and implementation of finite element methods to the partial differential equations of physics and engineering sciences. The main purpose is to give a balanced combination of theoretical and practical skills. The theory part gives you knowledge on the derivation of finite element formulations, a priori and a posteriori error estimates, methods and algorithms of adaptive mesh refinements, computer implementations of the finite element discretizations: element matrices, assembly process, numerical integration, local mesh refinement, etc. The practical part of the course helps you to learn to program finite element discretizations in Matlab in 1D and 2D. You will also learn to solve realistic partial differential equations in the open sources computational science software FEniCS.

### Instructor

**Lecturer:** Murtazo Nazarov

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Office hours: Fridays 10:15-11:00, or by appointments

### Teaching plan

There will be 10 lectures, 3 exercise sessions and 3 labs.

### Course homepage

<http://www.it.uu.se/edu/course/homepage/fem/ht17>

## Course literature

Larson, M.G., Bengzon, F. The Finite Element Method: Theory, Implementation, and Practice. Department of Mathematics, Umea University 2009.

K. Eriksson, D. Estep, P. Hansbo, C. Johnson. Computational Differential Equations. Studentlitteratur, ISBN ISBN 91-44-49311-8.

C. Johnson. Numerical Solution of Partial Differential Equations by the Finite Element Method.

Alexandre Ern, Jean-Luc Guermond. Theory and Practice of Finite Elements. ISBN 978-0-387-20574-8.

**Note:** we will be using mainly the first book.

## Prerequisites

Basic courses in scientific computing, some knowledge in programming and differential equations.

## Homework

There will be a set of home exercises assigned after every lectures. Solving the homework problems in time helps you to understand the subject, get more learning experience and get prepared to the mandatory assignments and the final exam. The homeworks are not graded but it is highly recommended to solve them in time.

## Programming assignments

There will be one mandatory programming project which consists of three parts. **The project is individual: you will submit your own code and write a report.** The report must contain the title page including your name and contact info, introduction, problems statement, problems solution including theory and result, summary. Include the complete code at the end of your report as an attachment. The report should be submitted through the student portal, where all works are checked for plagiarism. There will be three deadlines for each three part of the project. **Always submit your work before the deadline, if you miss the deadline without any reason (especially if you miss the last deadline) you will have to wait until the next course period, i.e. October 2018.**

## Examinations

The course is graded with respect to your final examination. However, the course is completed only if you pass all your programming assignments and the exam.

**Programming assignments:** 2 points

**Final:** 3 points

## **Weekly plan**

**Week 1:** Piecewise polynomial approximation in 1D

**Week 2:** Finite element methods in 1D

**Week 3:** Piecewise polynomial approximations in 2D

**Week 4:** Finite element methods in 2D

**Week 5:** Finite element methods for time-dependent problems

**Week 6:** Course review and repetition

**Week 7:** Final exam

## **Scholastic Dishonesty**

Students may work together and discuss the homework problems with each other. Copying work done by others is an act of scholastic dishonesty and will be prosecuted to the full extent allowed by University policy. For more information on university policies regarding scholastic dishonesty, see the University of Uppsala's policy at <http://www.it.uu.se/edu/fusk>.

## **Students with Disabilities**

According to the University regulation all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you need help or want to get more information about it please contact the University of Uppsala's services for students with disabilities.