LUND UNIVERSITY

LTH
FACULTY OF ENGINEERING

*Course syllabus*

# Finita elementmetoden - flödesberäkningar
# The Finite Element Method - Flow Analysis

## VSMN25, 7,5 credits, A (Second Cycle)

**Valid for:** 2023/24
**Faculty:** Faculty of Engineering, LTH
**Decided by:** PLED V
**Date of Decision:** 2023-03-21

## General Information

**Elective for:** MWLU2, V5-vr, V4-at, V4-ko, W5-vr
**Language of instruction:** The course will be given in English on demand

## Aim

The aim of the course is to give detailed theoretical and practical knowledge on the basic steps in the finite element method and to be able to model and analyse general flow problems described from a physical context. Common problems within the field of engineering will be studeied, such as, heat flow, pipe network flow, ground water flow and diffusion for both stationary and transient conditions.

## Learning outcomes

*Knowledge and understanding*
For a passing grade the student must

- be able to define linear stationary and transient flow problems in 1d-3d and interpret their physical terms.
- from physical relations be able to formulate a mathematical model for the problem.
- be able to transfer a mathematical model, through the weak formulation, to a finite element formulation.
- be able to explain convergence, completeness and compatibility requirements for approximating functions.

- be able to define and utilise various types of boundary conditions and loadings.

*Competences and skills*
For a passing grade the student must

- be able to create finite element models of real flow problems from a physical described context.
- be able to perform finite element analyses of various types of engineering problems.

*Judgement and approach*
For a passing grade the student must

- be able to analyse and interpret results from a finite element simulation.
- be able to estimate the reliability of a finite element analysis.

## Contents

The course consists of lectures, exercise sessions and compulsory design assignments. In the first part of the course a detailed derivation of all the steps in the finite element formulation are given for a one-dimensional heat flow problem: direct approach, strong and weak formulations, approximating functions and weighted residual methods. More advanced problems are gradually added to this basic knowledge, such as, 2- and 3-dimensional field problems. Flow problems that are studied: heat flow, pipe network flow, groundwater flow and diffusion. At the end of the course the theory is extended to the study of transient field-problems. The design assignments illustrate the procedure of transferring a design problem into a model suitable for finite element analysis.

## Examination details

**Grading scale:** TH - (U,3,4,5) - (Fail, Three, Four, Five)
**Assessment:** Approved written examination and approved compulsory design assignments.

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:** 0119. **Name:** Written Examination.
**Credits:** 5. **Grading scale:** TH. **Assessment:** Written examination. **Contents:** The entire course content.
**Code:** 0219. **Name:** Design Assignments.
**Credits:** 2,5. **Grading scale:** UG. **Assessment:** Approved design assignments.

## Admission

**Admission requirements:**

- FMA430 Calculus in Several Variables or FMAB30 Calculus in Several Variables

**The number of participants is limited to:** No
**The course overlaps following course/s:** FHL064, VSM040, VSMN05, FHLF20

## Reading list

- Ottosen, N., Petersson, H.: Introduction to the Finite Element Method. Pearson Education, 1992, ISBN: 9780134738772.

- Olsson, K.-G and Heyden, S.: Introduction to the Finite Element Method, Problems. Studentlitteratur AB, 2007, ISBN: 9789144051260.
- Austrell, P-E., et. al.: CALFEM - A finite element toolbox Version 3.4. Studentlitteratur AB, 2004, ISBN: 9789188558237.

## Contact and other information

**Course coordinator:** Professor Kent Persson, kent.persson@construction.lth.se
**Course homepage:** http://www.byggmek.lth.se