Partial Differential Equations, TMA371/MMG800

Credit allocation ?ECTS credits (7.5 Swedish credits)

Description This is the first course on partial differential equations (PDE) with applications i scinces and engineering. The objective is two-fold:
(i) To cover an up-to-date basic theory and
(ii) to introduce some modern approximation tools.

In the theoretical part we study existence, uniqueness and stability concepts for the basic PDEs (Poisson, heat, wave and convection-diffusion equations) in the form of Dirichlet, Neumann and Robin (initial) boundary value problems. We also study population dynamics and dynamical systems.

As for the approximation we focus on constructing and analysing Galerkin methods (both continuous and discontinuous) from two point of views. On one hand we consider the numerical analysis aspects of the approximation proceedure: such as, variational principel, minimization problem and (Lax-Milgram and Riesz) representation theorems, on the other hand we deal with the important implementation aspects of *a priori* (solution dependent) and *a posteriori* (residual dependent) error estimates, and construction of numerical algorithms deriving, e.g., stiffness-, mass- and convection matrices.

The course is for advanced undergraduate students, as well as graduate (PhD) students in Chalmers and GU. Of course students who are not following these programs are also welcome. The course consists of 35 lecture hourse, 21 exercise hours and and gives 7.5 points.

Prerequisites
The participant is presumed to have
(i) a solid background in calculus of one and several variables,
(ii) knowledge of linear algebra/geometry such as vector and matrix algebra and linear spaces,
(iii) knowledge of the elementary theory of linear ordinary differential equations,
(iv) an acquantaince with the complex number system and the complex exponential function,
(v) a solid background in Fourier analysis (especially method of separation of variables for solving PDEs, orthogonal bases as well as Fourier and Laplace transform techniques to solve PDEs).

Aims and objectives
This course gives an introduction to the modern theory of partial differential equations (PDEs) with applications in science and engineering. It also presernts an introduction to the finite element method as a general tool for numerical solution of PDEs. Iteration procedures and interpolation techniques are also employed to derive *a priori* and *a posteriori* error estimates.

Language
English (in breaks and office hourse students may pose questions in both Swedish and English).

Bibliography
• An Introduction to the Finite Element Methods (FEM) for Differential Equations, M. Asadzadeh (Lecture Notes).
• Computational Differential Equations, K. Eriksson, D. Estep, P. Hansbo, and C. Johnson, Studentlitteratur 1996.

Teaching staff
Examiner and lecturer: Mohammad Asadzadeh, E-mail: mohammad@chalmers.se
TA and Tutor: Announced annually.

Semester: Currently, Spring.

Assessment: Home and computer assignments combined with written exam.