SF1668 Mathematical and Numerical Analysis I 10.0 credits

Matematisk och numerisk analys I

This is a translation of the Swedish, legally binding, course syllabus.

If the course is discontinued, students may request to be examined during the following two academic years

Establishment

Course syllabus for SF1668 valid from Autumn 2018

Grading scale

A, B, C, D, E, FX, F

Education cycle

First cycle

Main field of study

Technology

Specific prerequisites

Basic and specific requirements for engineering program.

Language of instruction

The language of instruction is specified in the course offering information in the course catalogue.

Intended learning outcomes

An overall goal of the course is that students should develop a good understanding of basic mathematical concepts in one-variable calculus and be able to use these for mathematical modelling of engineering and scientific problems.

The student will develop skills to illustrate key concepts and solve applied problems, by using the computer and using standard functions from the programming language library. In addition, students should be able to visualize and present results in a clear manner.

After completing the course a student with a passing grade should be able to

- Use, explain and apply the terminology and the main basic concepts and problem-solving methods, in particular:
  • explain the concept of a function of one variable and what is meant by such a function being one-to-one and in that case determine the inverse
  • using the derivative to examine the properties of a function, e.g. sketch the graph of a function, solve extreme value problems and inequalities
  • approximate the derivative numerically using finite differences as well as be familiar with the error of the approximation
  • use Taylor's formula to approximate functions with polynomials to a preprescribed accuracy
  • solve nonlinear equations numerically and have knowledge of criteria for convergence and rate of convergence
  • interpolate and be familiar with interpolation error
  • explain the definition of Riemann integrals and applications of integrals, as well as calculate integrals with primitive functions, integration by parts, substitution and partial fractions
  • calculate integrals numerically and be familiar with the error of the approximation
  • explain what is meant by a Riemann sum and use it to approximate integrals as well as derive integrals in applications
  • explain what is meant by improper integrals and determine whether certain improper integrals converge or diverge with the help of comparison criteria and calculation
  • explain the concept of series and determine whether certain series converge or diverge with the help of comparison criteria
  • solve some linear ordinary differential equations with constant coefficients and explain how they arise in applications
  • solve linear ordinary differential equations approximately using basic numerical methods and be familiar with the error of approximation
  • calculate simple limits and use them to study the behaviour of functions locally or asymptotically
- Set up simple mathematical models of phenomena and processes that can be described by means of functions of one variable, discuss the relevance of such models, plausibility and accuracy, and know how mathematical software can be used, for example, to sketch graphs and solving equations.
- Select the appropriate numerical method for the analysis of a given mathematical model and motivate the choice of method, describe the advantages and limitations.
- Make reliability assessment of numerical results: parameter sensitivity, experimental perturbation, precision, and present the results in a clear manner.

- Read and understand mathematical texts about functions of one variable and their applications, communicate mathematical reasoning and calculations in this subject verbally and in writing in such a way that they are easy to follow

For higher grades, a student should be able to:

- Derive some particularly important theorems and formulas and algorithms
- Generalize and adapt methods to fit in partly new situations
- Solve problems that require complex calculations in several steps
- Explain the theory behind the concepts of limit, continuity, series.

Course contents

Function, graph of a function. Elementary functions, the unit circle, trigonometric formulas and equations, exponential and logarithms, power laws, logarithms. Limits, standard limits, continuity. Derivative, rules of differentiation and applications: extreme value problems, graphing, inequalities. Finite differences. Taylor's formula with error estimation. Interpolation and interpolation error. Numerical solutions of nonlinear equations with the fixed point method and Newton's method. Linear differential equations with constant coefficients and their applications. Numerical solution of linear differential equations using Euler's method as well as existing functions in Matlab. Riemann integral, primitive function, substitution, integration by parts, partial fractions, geometric and other applications, generalized integrals. Numerical computation of integrals with trapezoidal rule and existing functions in Matlab. Something about series. Problem solving by breaking down a problem into parts. The use of mathematical software to solve engineering and mathematical problems, numerical experimentation and presenting solutions. Basic concepts and ideas in numerical methods: algorithms, computational cost, local linearization, iteration, extrapolation, discretization, convergence, stability. Reliability: parameter sensitivity, experimental perturbation.

Course literature

Calculus (9th edition) by Robert A. Adams and Christopher Essex, 2013, ISBN 978-0-13-415436-7

Exempelsamling i numeriska metoder by Edsberg et al

Examination

- LAB1 - Lab Assignments, 2.0 credits, grading scale: P, F
- LAB2 - Lab Assignments, 2.0 credits, grading scale: P, F
- TEN1 - Examination, 6.0 credits, grading scale: A, B, C, D, E, FX, F

Based on recommendation from KTH’s coordinator for disabilities, the examiner will decide how to adapt an examination for students with documented disability.

The examiner may apply another examination format when re-examining individual students.

Other requirements for final grade

Written exam (TEN1; 6 cr). Computer assignments with oral and written presentation (LAB1 and LAB2; 4 cr)

Ethical approach

- All members of a group are responsible for the group's work.
- In any assessment, every student shall honestly disclose any help received and sources used.
- In an oral assessment, every student shall be able to present and answer questions about the entire assignment and solution.