SH2774 Numerical Methods in Nuclear Engineering 6.0 credits

Numeriska metoder inom kärnkraftsteknik

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

The course syllabus is valid from Spring 2022 according to the school principal's decision: S-2022-0529 Decision date: 2022-02-24

Grading scale

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

Education cycle

Second cycle

Main field of study

Specific prerequisites

English B / English 6

Language of instruction

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

Intended learning outcomes

Modern engineering work requires a variety of simulation codes. However, computer simulation has become a frequently used and misused tool. Too often the numerical simulation is used as a black box with little insight into the underlying assumptions. The traditional engineering education provides no or little background in simulation techniques, their capabilities and limitations. This course is intended to provide a systematic introduction into the methods, capabilities and limitations of computer simulation.

The course focus is on computational methods for problems arising in nuclear reactor system analysis. Topics include numerical methods for solving large, sparse systems of linear equations that result from the discretization of partial differential equations, numerical solution of nonlinear algebraic equations, eigenvalue problems, ordinary differential equations (ODE's) and partial differential equations (PDE's). Applications include heat conduction, fluid mechanics, neutron diffusion and neutron kinetics.

Within the context of nuclear engineering, after the course the student should be able to:

- Solve system of linear equations
- Solve system of non-linear equations
- Solve eivenvalue/eigenvector problem
- Use Taylor expansion to derive finite difference approximation
- Derive truncation error of discretized equations
- Analyze consistency, stability and convergence of numerical method
- Solve system of linear ODE's
- Solve system of linear PDE's arising in nuclear engineering applications

Course contents

The course addresses fundamentals of numerical analysis and numerical solution of ODE's and PDE's arising in nuclear engineering. Topics covered include

- Solution of linear equations using direct, stationary and non-stationary iterative methods
- Solution of system of non-linear equations using iterative methods
- Solution of eigenvalue problems
- Numerical integration and differentiation
- Consistency, stability and convergence of discretized equations
- Truncation error analysis
- Von Neumann stability analysis
- Lax-Richtmyer equivalence theorem
- Finite difference discretization of ODE's
- Numerical solution of initial value and boundary value ODE's
- Finite difference and finite volume discretization of PDE's

- Numerical solution of PDE’s arising in nuclear engineering

Examination

- INL1 - Assignment, 1.0 credits, grading scale: P, F
- INL2 - Assignment, 1.0 credits, grading scale: P, F
- INL3 - Assignment, 1.0 credits, grading scale: P, F
- INL4 - Assignment, 1.0 credits, grading scale: P, F
- TEN1 - Examination, 1.0 credits, grading scale: A, B, C, D, E, FX, F
- TEN2 - Examination, 1.0 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.

Homework assignments (INL1-4, 4 ECTS).
Two written exams (TEN1-2, 2 ECTS).

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.