MJ2444 Theory and Practice of Computational Methods in Energy Technology 7.5 credits

Teori och praktik av numeriska beräkningsmetoder inom energiteknik

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

Establishment

On 22/04/2022, the Dean of the ITM school has decided to establish this official course syllabus to apply from spring term 2022 (registration number M-2022-0618).

Grading scale

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

Education cycle

Second cycle

Main field of study

Mechanical Engineering

Specific prerequisites

- MJ1401 "Heat Transfer" 6cr, or equivalent
- SG1220 "Fluid Mechanics for Engineers" 6hp, or equivalent

Language of instruction

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

Intended learning outcomes

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

1. Describe numerical methods for treating partial differential equations, derive specific expressions for programming, and analyze sources of error
2. Define governing equations for relevant physical processes and construct representative numerical simulations
3. Account for current developments in computational fluid dynamics methods and software, contrasting selected approaches in analysis
4. Conduct numerical simulations with commercial computational fluid dynamics software and analyze results in terms of validity and accuracy, including comparisons to real processes

Course contents

The following topics on computational methods for heat conduction and fluid flow are covered in the course:

1. How computers store numbers (single and double precision)

2. Numerical differentiation (central and forward differencing)

3 .Errors in numerical methods (truncation, round-off, etc)

4. Heat conduction in solids: governing equations

5. Divergence Theorem

6. Compressible inviscid flow equations: conservation of mass, momentum and energy.

7. Finite difference method for steady 1D and 2D for heat conduction

8. Euler method for solving unsteady heat conduction equations (explicit time marching)

9. Higher order time-stepping (Predictor-Corrector Scheme and Runge-Kutta method

10. Stability limits for explicit time-marching

11. Crank-Nicolson Method (implicit time-marching)

12. Meshing

13. Advection equation and upwind schemes

14. Lax-Wendroff scheme

15. Introduction to solving inviscid flow equations

16. Introduction to Navier-stokes equations and turbulence

Examination

- TEN1 - Written exam, 3.0 credits, grading scale: A, B, C, D, E, FX, F
- INLA - Home assignment, 0.5 credits, grading scale: P, F
- INLB - Home assignment, 0.5 credits, grading scale: P, F
- LABA - Computer laboratory, 3.5 credits, grading scale: P, 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.

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

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.