MJ1401 Heat Transfer 6.0 credits

Värmeöverföring

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 MJ1401 valid from Autumn 2014

Grading scale

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

Education cycle

First cycle

Main field of study

Mechanical Engineering,Technology

Specific prerequisites

The course MJ1112 Applied thermodynamics or the equivalent

Language of instruction

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

Intended learning outcomes

After the course, the students should be able to:

- Identify, formulate and solve problems for different heat transports
- Analyse, model heat conduction in one-dimensional cases and describe two- and three-dimensional heat conduction and be able to apply them for simple heat conduction problems
- Analyse and apply empirical correlations in connection with the heat transfer at convection, boiling and condensation
- Identify, model and calculate the heat transfer at radiation and irradiated surfaces
- Design heat exchangers of different types

Course contents

One-dimensional cases at stationary conditions.

Differential equations for heat conduction in solid materials.

Solutions for different special cases. Fin efficiency for different fin designs

Two and three-dimensional cases at stationary conditions.

Laplace's equation. The form factor. Numerical solution methods and analogy methods.

Non-stationary cases. Solutions for flat surfaces and cylinders

Superposition of elementary cases. The "Lumped heat capacity" method.

Numerical solution methods.

Convection, radiation, boiling, condensation and heat exchangers

Velocity and temperature boundary layers.

Theoretical treatment of flow over a flat plate at laminar and turbulent flow.

Reynold's analogy between heat transfer and pressure drop.

Empirical relationships for heat transfer at induced flow

Laminar and turbulent flow in pipes and ducts. Flow around bodies

Velocity profiles and entrance regions Hydraulic diameter

Heat transfer at natural (free) convection, Grashof's number. Boundary layer equations in integral form with solutions for natural convection for vertical plates.

Empirical relationships for laminar and turbulent boundary layers at vertical and horizontal plates, cylinders and slots

Heat transfer at radiation

The "black body" concept. Emission and absorption numbers. Radiant efficiency, angular factor.

Heat transfer at irradiated surfaces

Heat transfer at condensation

Nusselt's theory, condensation on and in horizontal pipes

Heat transfer at boiling

Various types of boiling, the boiling curve

Pool boiling, cooking in pipes and slots

Heat exchangers

Different types, logarithmic mean temperature difference, temperature effectiveness, NTU

Disposition

The course is given during fall semester, 2nd quarter. The course includes lectures (32 h), exercises (32 h) and four laboratory sessions and three quizzes and an examination. The lectures present the general ideas and theoretical explanations behind heat transfer. In the exercises the theory is applied for different heat transfer problems.

Course literature

Yunus A. Cengel; Afshin J. Ghajar; Heat and Mass Transfer, Fundamentals and applications; Fourth Edition; Mc Graw Hill companies.

Examination

- LABB - Lab, 0.5 credits, grading scale: P, F
- TENB - Exam 1, 5.5 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.

Examination consists of a short answer section (part A) with ten arithmetical problems that give a total of ten points (one credit point per assignment) and a part B with four more comprehensive arithmetical problems that give 12 points. During the course, three quizzes that give a total of nine points for part A of the examination (each quiz gives three credit points). Each quiz consists of three assignments of 3 points. A pass result for each quiz is given, if the student obtains six points. Quiz (KS) 1 correspond to problems 1-3 and KS 2 and 3, correspondingly, to problems 4-6 and 7-9 respectively. Eight of ten points suffice to pass

the course (grade E). For a higher grade, points from part B are required. Points received for quizzes during one academic year are valid throughout that academic year (regular and re-examination). Part B consists of four assignments of a more problem-based character, and requires deeper understanding of the subject, and is intended for higher grade.

Language of instruction: Swedish and English

Lectures: Swedish

Exercises: English or Swedish (dependent on the assigned teacher)

Reading list: English

Lab exercise instructions and lab exercises: English

Quizzes and written examination: English

Other requirements for final grade

Passed written examination (5.5 credits) and passed four lab exercises (0.5 credits)

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.