EJ2222 Design of Electrical Machines 7.5 credits

Konstruktion av elektriska maskiner

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 autumn 2024 according to the faculty board decision: J-2024-3121.Decision date: 2024-12-10

Decision to discontinue this course

The course will be discontinued at the end of spring 2026 according to the faculty board decision: J-2024-3121.Decision date: 2024-12-10The course was last given in spring 2024. The last opportunity for examination in the course will be given in spring 2026.Contact the examiner to be examined during the discontinuation period.

Grading scale

P, F

Education cycle

Second cycle

Main field of study

Electrical Engineering

Specific prerequisites

Knowledge in electromagnetic field theory corresponding to EI1200. An introduction to electric machinery corresponding to EJ2201 is recommended but is not a formal requirement. 120 hp and English B or equivalent.

Language of instruction

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

Intended learning outcomes

The overall goal of the course is that the participant, after a completed course, should have a deep understanding of how Maxwell's equations and fundamental principles within heat transfer can be applied to analyze and design electric machines.

After the course, the participants should be able to:

· Apply the theory of MMF-waves to estimate air-gap flux densities, magnetic flux, inductances, and to derive the steady-state equivalent circuit of the induction machine (IM)

· Apply the theory of MMF-waves to analyze and understand limits of permanent-magnet synchronous machines (PMSMs)

· Implement a finite-element (FEM) based solver in a Matlab environment to solve static and quasi static, two-dimensional magnetic problems

· Use FEM-based computations to estimate different performance parameters of IMs and PMSMs

· Estimate stator and rotor resistances, magnetizing inductances and leakage-inductance components for IMs and corresponding parameters for PMSMs using analytical and numerical methods

· Carry out a preliminary electromagnetic sizing of an IM given a defined torque request and thermal limitations

· Carry out FEM-based computations on PMSMs to extract data to implement transient PMSM models including magnetic saturation, magnetic cross saturation and the impact of harmonics

· Carry out FEM-based computations to estimate the resulting temperature distribution in an electric machine of IM or PMSM type

Course contents

The course covers the following topics:

· The theory related to MMF waves (including harmonics) and how this theory is applied to electric machinery

· The steady-state equivalent circuit of the induction machine derived using the MMF theory

· Analytical models to estimate corresponding circuit parameters for IMs and PMSMs

· Magnetic and thermal sizing of IMs

· The finite element method and how it can be applied to solve static and quasi static two-dimensional magnetic problems

· Transient models of PMSMs

· Thermal modeling of electric machinery using the finite-element method

Examination

- PRO1 - Project Work, 2.5 credits, grading scale: P, F
- PRO2 - Project Work, 1.5 credits, grading scale: P, F
- PRO3 - Project Work, 1.5 credits, grading scale: P, F
- PRO4 - Project Work, 2.0 credits, grading scale: P, F
- PRO5 - Project Work, 1.5 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.

Four out of five project works shall be completed where PRO1, PRO2, an PRO4 are mandatory.

PRO1: Analysis of an industrial induction machine using FEM (2.5 hp, mandatory)

PRO2: Electromagnetic sizing of an industrial induction machine (1.5 hp, mandatory)

PRO3: Transient modeling of permanent-magnet synchronous machinery (1,5hp)

PRO4: Thermal modeling of permanent-magnet synchronous machines using the finite-element method (2 hp, mandatory)

PRO5: Implementation of a finite-element based solver in Matlab (1,5 hp)

Other requirements for final grade

Four handed in project reports that are judged passed.

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.