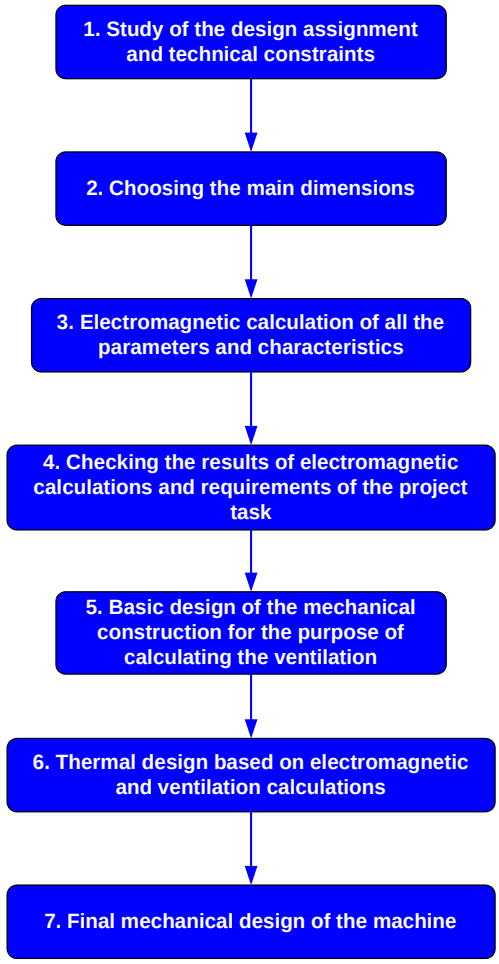
Lehrveranstaltungsankündigung

LV 431.313 Ausgewählte Themen der elektrischen Antriebstechnik 1

Permanent Magnet Machine Design

(2SWS/3ECTS)

Content:
This course explains the engineering approach to design and sizing of synchronous permanent magnet machines. It focuses on theoretical and practical aspects of design considering the constraints imposed by physical properties of materials, manufacturing tolerances and conformity with international standards. The course introduces basic design tools in the form of analytic and finite element based models of PM machines. In addition, the classical manual approach to motor sizing is supplemented with more elaborate approach based on mathematical optimization.



Typical workflow scheme for electric motor design.

Lecturer:
Prof. **Damir Žarko** is an associate professor at the University of Zagreb Faculty of Electrical Engineering and Computing, Croatia. He is the head of the Laboratory for Electric Machines, Power Electronics and Drives. His research activities are related to design, modeling, analysis, optimization and testing of electrical machines and power transformers.

Prerequisites:
Undergraduate electric machines and drives course.

Meeting Times and Location:
Monday, 21st November 2016 - Friday, 25th November 2016, 9:30h – 15:00h, including coffee and lunch breaks,
Library of the Electric Drives and Machines Institute, Inffeldgasse 18, 8010 Graz

Assessment:
Two hour exam (50%) (Friday, 2nd December 2016), project with written final report (50%) (due Friday, 9th December 2016).

Course overview

Title: Permanent magnet machine design

Instructor: Prof. Damir Žarko
E-mail: damir.zarko@fer.hr

Course description

This course explains the engineering approach to design and sizing of synchronous permanent magnet machines. It focuses on theoretical and practical aspects of design considering the constraints imposed by physical properties of materials, manufacturing tolerances and conformity with international standards. The course introduces basic design tools in the form of analytic and finite element based models of PM machines. In addition, the classical manual approach to motor sizing is supplemented with more elaborate approach based on mathematical optimization.

Learning outcomes

1. Identify the types of cooling, mechanical protection and construction of PM machines.
2. Explain the principles of PM machine design.
3. Derive an analytical model of a surface PM machine.
4. Extract PM machine parameters and characteristic from finite-element models.
5. Calculate the main dimensions of PM machines.
6. Analyze the impact of PM machine parameters on its output characteristics.
7. Relate characteristics of the magnetic circuit with parameters of an electric machine model.

General Competencies

1. Knowledge of electric machine design based on technical specifications and demands.
2. Basic knowledge of thermal and mechanical limitations in construction and exploitation of PM machines.
3. Ability to utilize standards in machine design.
4. Capability of creating a PM machine design.

Course Topics

1. Definition of the machine design problem. Conditions and limitations in the design considering the properties of materials, types of cooling, level of mechanical protection and utilization of international standards.
2. Working principle of synchronous permanent magnet motors, phasor diagram, back EMF, inductances, control strategies for achieving maximum torque per amp or maximum efficiency, characteristic current, torque-speed characteristic, constant torque and field weakening regime.
3. Physical properties of materials used in PM machines.
4. Initial sizing of a machine.
5. Design of surface PM machines. Analytic modeling of magnetic circuit. Calculation of winding inductance and resistance. Calculation of power losses.
6. Design of interior PM machines. Finite element modeling. Methods for calculation of motor parameters, torque-speed characteristic and power losses from magneto-static simulations.
7. Design issues with development of permanent magnet motor series. Size variation using axial and radial scaling. Parameters of scaled PM machines.
8. Torque pulsations and methods for their suppression
9. Basic thermal modeling of PM machines.
10. PM machine design using mathematical optimization. Definition and solution of the constrained optimization problem.

Textbook references

1. T.A. Lipo, *Introduction to AC Machine Design*, WisPERC, University of Wisconsin -Madison, USA, 2004
2. J. Hendershot, T. Miller, *Design Of Brushless Permanent-MagnetMachines*, Venice: Motor Design Books Llc, 2010
3. J. Pyrhönen, T. Jokinen, V. Hrabovcová, *Design of Rotating Electrical Machines*, John Wiley & Sons Ltd, 2008
4. M. Ramamoorty, *Computer - Aided Design of Electrical Equipment*, Halsted Press New York, NY, USA, 1998
5. S.J. Salon, *Finite Element Analysis of Electrical Machines*, Kluwer Academic Publishers, USA, 1995