KTH Electrical Engineering

COURSE PM EI2440 Electrotechnical Design, 7.5p. Per. 3, 2017.

Welcome to the course in Electrotechnical Design!

PREREQUIREMENTS

Basic electric network theory, electromagnetic field theory and linear system theory like Fourier- and Laplace transforms and convolutions.

COURSE RESPONSIBLE

Lecturer and examiner:Professor Hans Edin, Teknikringen 33,
phone 08 - 790 7639, e-mail: hans.edin@ee.kth.se

OBJECTIVES

The course is a basic course in electrotechnical design including electrical, mechanical and thermal design.
The course will give knowledge of basic principles, physical relations and mechanisms that are important in electrotechnical design. It also will develop the ability to solve problems related to design of electrotechnical equipment by use of computer based tools.

The overall aim is to

-supply knowledge of how electrical, magnetic, mechanical, and thermal aspects are treated in design of electrotechnical apparatus

-train the ability to by means of models and computer based aids independently solve electrotechnical design problems

After completion of the course the student will be able to

-describe the function of some electrotechnical components and function and properties of involved magnetic, dielectric and conductor materials

-describe and explain how electrical and magnetic fields influence on the function of electrotechnical equipment

-use analytical, dynamic simulation and the finite element method for dimensioning of electrotechnical equipment

-identify functional properties of electrotechnical components by means of analytical methods, dynamic simulation and the finite element method

-modify electrotechnical components by use of analytical methods, dynamic simulation and the finite element method such that properties and performance better meet given demands

-summarise and value a proposed design regarding properties and performance in a technical report

COURSE ORGANISATION AND EXAMINATION

The course is oriented towards four project tasks. Interleaved with these a number of lectures and exercises will be given. The aim of those is to create a deeper understanding of the topics that are treated in the project tasks. The course participants are advised to study the appropriate course material before the lectures and the introductions of the project tasks.

The detailed schedule of the projects is evident from the tables below.

Lectures

The lectures intend to give an overview of the subject and a generalized treatment of Electrotechnical Design with a special focus on the design of electric power equipment. The lectures will be mixed with theory and problem solving. The intention is that the lectures should be performed in an active dialogue between the course participants and the lecturer. Lecture notes will be handed out. The lecture notes will also contain detailed derivations whereas the lectures more focus on the ideas and basic principles behind the theories.
The course participants are advised to prepare questions related to the course material that they want to be further illuminated by the lecturer.

A detailed schedule of the lectures with time, place and preferential subject is given in Appendix 1.

Project tasks

A significant part of the projects will be done in form of project tasks. Each project task comprises about 20 hours of independent work except for the project introduction. General rules regarding the written documentation are given in Appendix 2.

Each project task should be performed by normally 2 persons, but three persons can be accepted from case-to-case. For each project task a written documentation according to the assignments in the instruction should be worked out.

Each project is evaluated and a grade is given (E-A).

Dates for introduction of the project tasks are evident from the enclosures 1.

The four compulsory projects in the course are:
1. High Voltage Bushing **Deadline: 160213, 17:00**
2. Transformer **Deadline: 160226, 17:00**
3. Cable Design **Deadline: 160311, 17:00**
4. Loudspeaker **Deadline: 160318, 17:00**

Reports should be uploaded in Canvas, the exact place will be informed later.

Laboratory experiments

The course has two laboratory exercises:

- Lab 1: Measurements on insulation materials, Responsible: Patrick Janus
- Lab 2: Soft magnetic materials, Responsible: Hans Edin

Bookings for the laboratory exercises are done on the web-based booking system that is found on a link that will be e-mailed later.

Final examination

The final examination consists of 6 problems. Each problem can give 5 points, totally 30 points.

The final examination is a closed book examination. Allowed aids are mathematical and physical tables, e.g. Beta Mathematics Handbook, Physics Handbook, TEFYMA and any calculator. 6 pages (3 papers), of a size not larger than A4, with own notes are allowed to be brought to the examination.

Scheduled times for final examination:

Ordinary examination: Friday March 17 2017, 8.00 - 13.00 in B23-B24
Re-examination: June 2016

Table of grades on the final examination are given below. Final course grade is the average of projects and written examination.

Points on exam.	Grade
Points ≤13	F
13,5≤ Points ≤ 14,5	Fx
15≤ Points ≤ 18	E
18,5≤ Points ≤ 20,5	D
21 ≤ Points ≤ 23,5	C
24≤ Points ≤ 27,5	B
28≤ Points ≤ 30	A

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LITERATURE

The course literature consists of:

Compendium “Electrotechnical modeling and design”
Power Transformer Design Fundamentals
4 Project task descriptions
Some examination problems with solutions
2 Laboratory exercise instructions

All materials will be made available on Bilda.

COMPUTER SOFTWARE

In this course we intend to use the FEM based software Comsol Multiphysics ver. 5.2. More about that in the beginning of the course.

PARTICIPATING TEACHERS

Teacher	Abbr.	Phone 08-790####	Part
Hans Edin hans.edin@ee.kth.se	HE	7639	Lectures, lessons, Projects. Lab.
Patrick Janus patrick.janus@ee.kth.se	PJ	8276	Lab. 1.

HOMEPAGE

The course homepage is on KTH Social.

COURSE EVALUATION

A course evaluation meeting will be set-up directly after the final examination is completed.

Stockholm 2017-01-16

Hans Edin

APPENDIX 1 - Course schedule Electrotechnical Design, EI2440, Per. 3 2017

Type	Preferential subject	Day	Hour	Place	Teacher
Lec. 1	Course introduction. From Modelling to Design	Tue 17/1	10 – 12	B22	HE
Lec. 2	Electromagnetism recapitulation	Wen 18/1	10 – 12	B24	HE
Lec. 3	The Finite Element Method, pt1	Thu 19/1	10 – 12	B22	HE
Lec. 4	The Finite Element Method, pt 2	Mon 23/1	10 – 12	B22	HE
Lec. 5	The Finite Element Method, pt 3 and Comsol Multiphysics introduction	Tue 24/1	10 – 12	B21	HE
Lec. 7	Electrical Insulation Materials pt. 1	Wen 25/1	10 – 12	B24	HE
Lec. 8	Electrical Insulation Materials pt. 2. Project 1 Introduction High Voltage Bushing	Thu 26/1	10 – 12	B23	HE
Exc 1	Exercise 1	Mon 30/1	10 - 12	B22	HE
WS 1	Workshop 1	Wen 1/2	10 – 12	A822	HE
Lec. 9	Magnetic materials pt. 1	Thu 2/2	10 - 12	B23	HE
Lec. 10	Magnetic materials pt. 2	Mon 6/2	10 – 12	B23	HE
Lec. 11	Conducting materials	Tue 7/2	10 – 12	B22	HE
Lec. 12	Project 2 Transformer - Introduction	Wen 8/2	10 – 12	B21	HE
Lec. 13	Superconducting systems	Thu 9/2	10 - 12	K53	HE
Exc. 2	Exercise 2	Mon 13/2	10 - 12	B22	HE
Lec. 14	Thermal Design	Mon 13/2	10 – 12	B22	HE
WS 2	Workshop 2	Tue 14/2	10 - 12	A822	HE
Lec. 15	Thermal properties	Wen 15/2	10 - 12	B21	HE
Lec. 16	Electromechanical Design Pt. 1	Thu 16/2	10 - 12	L43	HE
Lec. 17	Electromechanical Design Pt. 2. Project 3 Power cable - Introduction	Mon 20/2	10 – 12	B22	HE
Exc. 3	Exercise 3	Tue 21/2	10 - 12	B22	HE
Lec. 18	Non-linear field grading systems	Wen 22/2	10 - 12	B23	HE
WS 3	Workshop 3	Thu 23/2	10 - 12	A822	HE
Lec. 19	Project 4 Loud speaker - Introduction	Mon 27/2	10 - 12	B22	HE

Exc. 4	Exercise 4	Tue 28/2	10 – 12	B22	HE
	Reserve time	Wen 1/3	10 - 12	B22	HE
WS 4	Workshop 4	Mon 5/3	8 - 10	A822	HE
Lec. 20	Course summing up	Mon 6/3	10 - 12	B22	HE
Exam. 1	Final examination	Fri 17/3	8 - 13	B23-B24	HE

Appendix 2 General instructions for reporting of the project tasks within EI2440 Electrotechnical Design

1. Written report

For each project task a written report should be worked out. Handwriting is acceptable, but it is highly recommended that you type it on a computer in order to simplify any updates and changes. The report must be written in english.

Even though a project task is small and comprises rather guided exercises the aim is that the written report is worked out as a normal (brief). The project task then will give training in structuring and writing a technical report. A more extensive training on report writing will be obtained during the master thesis work.

Each project task has its own characteristic and will demand its special disposition of the corresponding report. However, there are a number of general basic features that can give guidance regarding the shape of the report. Some simple rules are:

- Concentrate the report on the result and omit irrelevant information.
- Do not repeat what is already written in publications. Refer instead.
- Express things rather in the active than the passive voice.
- Avoid I and we in the text.

A standard disposition can look like below, but should of course be adapted to the task.

Summary

1 Introduction

The introduction comprises normally three parts.

- Background, where the task is put into its context.
- Aim. What is the aim of the work performed?
- A summary of how the work and the report is presented in the report.

2 Problem definition

Presentation of the problem/question. In this section all possible presentations regarding geometrical measures, structures, materials, physical properties, other properties, etc. are included.

3 Method

Presentation of methods / approaches that are used in the treatment of the problem / question. Here one can present relevant background theories, theory exercises, choices of boundary conditions, preliminary calculations etc. Here also the experimental set up can be described.

4 Results

Presentations of analysis / calculations / measurements carried out and presentation / compilation of accomplished results.

Here one also can present different intermediate results and analyse them. Use for example sub-headings as FE calculations, simulations, measuring results, verifications, etc.

Figures:
Make clear figures. If several figures are used to compare for example the influence of a parameter on a certain quantity, try to plot several curves in the same figure, this usually simply the comparison. Clearly indicate the quantity and the unit on the axis. Use a figure caption that explains what kind of information that is shown in the figure.
In the text, explain the information in the figure rather than repeating what already could be seen in the figure.

Equations:
Number the equations. Do not include equations that you don't make use of. Check the dimensions.

Useful MATLAB commands: *plot, loglog, semilogx, semilogy, legend, xlabel, ylabel, axes, title*

5 Conclusions

State the main results and the conclusions drawn from these results. Suggestions regarding further work and development may also be included here.

References

How the references have been used should be commented on in the text.

Enclosures

Here you put e.g. lengthy derivations, figures that not can be incorporated in the text, etc.