



**Please upload a picture of yourself to Bilda!**

## Course description

### EJ2201 Electrical Machines and Drives (6 ECTS)

#### Period 1, 2014

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The course covers the basics of electrical machines and electrical drive systems. The operating principles are thoroughly described as well as the design and control of the drive systems.

#### Objectives

After the course, participants are expected to be able to

- Describe the fundamental parts of electrical drives including converter, electrical machine and load.
- Explain the operating principles of induction machines, synchronous machines and dc machines
- Identify parameters in models of electrical machines
- Use equivalent circuits to analyze electrical machines in steady state
- Construct phasor diagrams for different loads and use the vector method for analysis of AC machines
- Describe the design of a simple three-phase ac winding and explain the concepts of pole number and winding factor
- Explain the background to voltage harmonics and estimate their influence on e.g. losses in electrical machines
- Use dynamic simulation software to analyze vector control of induction motors.

#### Course responsible and Examiner

Associate professor *Juliette Soulard*, Teknikringen 33, Tel: 08 - 790 77 36, juliette.soulard@ee.kth.se

#### Course registration

It is up to the course participants themselves to do the course registration using “My Pages” as soon as possible.

#### Student office

STEX, Osquidas väg 10

#### Lectures

Assoc. Prof *Juliette Soulard*

TeknL *Mats Leksell*, mats.leksell@ee.kth.se

Prof. *Lennart Harnefors*, lhar@kth.se

## Tutorials

Instructors: *Naveed ur Rehman Malik*, Teknikringen 33, Tel: 08 790 78 65, nurmalik@kth.se

*Rúdi Soares*, Teknikringen 33, Tel: 08 790 77 75, rhoares@kth.se

*Naveed* and *Rúdi* conduct standard tutorials in which they guide the students through the solutions using the whiteboard. Active participation is highly recommended.

## “Open doors” concept

Students are encouraged to interact with the teachers as much as possible. Please feel free to visit us at Teknikringen 33. You can use the phone at the entrance door.

## Student room with computers

Participants in the course are entitled to have access to the Student room, 1 floor up Teknikringen 33. The room contains computers and a small kitchen. Many students already have access to the room and the computers via other courses and it is only new students that have to register to get access! Register by sending an e-mail to peter.lonn@ee.kth.se, and give your name (James Bond), your KTH-ID (“bond@kth.se”), the course number (EJ2201) and the 4 digits on your entrance card (0007).

## Internet resources

Registered students have access to all documentation in BILDA, [www.bilda.kth.se](http://www.bilda.kth.se). Bilda will be use late news announcements, so keep personal contact information up-to-date. Course participants are encouraged to **upload a photo** to Bilda!

A useful animation programme for electrical machines and power electronics is found at: <http://webfiles.portal.chalmers.se/et/Files/elkraft/> (Includes a glossary!)

## Course material

- Electrical Machines and Drives EJ2200, Text book KTH 2012 (Sold at STEX for 200:-)
- 2 laboratory hand-outs (see BILDA)
- 1 project assignment (see BILDA)
- Formula sheet for EJ2201 Electrical Machines and Drives (see BILDA)

## Examination

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In order to pass the course, the following items have to be completed:

- LAB1 (0.5 credits): Two laboratory exercises (P/ F)
- PRO1 (1.5 credits): Project work (P/ F)
- TENA (4 credits): Written examination (A-E)

The grading of the course (A/F) is given by the grading at the written examination (TEN1).

At the written examination it is allowed to use a standard mathematical handbook, "Formulas in EJ2201 Electrical Machines and Drives" and a calculator. The exam gives a maximum of 30 points. A total score of 15 is required to pass.

KTH has a centralized administration of exams for students with any kind of handicap, who have the right to any individualized situation for examination. If you have any questions concerning this service, or your exam, please contact: Towe Breidenstein, FUNKA. Brinellvägen 8, [tow@kth.se](mailto:tow@kth.se), 08-7906178

- Ordinary exam: Saturday, 17<sup>th</sup> January
- Re-sit: To be decided, week 15 2015

***Registration for an exam has to be done via "My pages",  
no later than 2 weeks in advance!***

## **Complementary exams**

Students that are close to pass the exam will be given a second opportunity to pass the exam. At the complementary exam, three problems that give three points each will be given. To pass the exam (i.e. to obtain grade E), 7 out of 9 points are required. The complementary exam lasts for one hour.

Students that are offered a complementary exam will be notified when the result of the ordinary exam is presented.

The complementary exam will be given on:

- 9<sup>th</sup> February, 10:00-11:00 in the Seminar room, Teknikringen 33
- Around 3 weeks after the re-sit exam

## **Short tests (not compulsory)**

Two short tests will be given in order to encourage continuous studying. Each short test lasts for 45 minutes and consists of three problems, worth each 1 point when correctly solved. The results of short tests 1 and 2 (ST1 and ST2), are combined with the results of problems 1 and 2 (E1 and E2) at the exam taken before June 2015. ST1 is replacing E1 if higher, in the sum of the points obtained at the exam. The same applies for ST2 and E2.

- Short test 1: 15<sup>th</sup> of October, DC machines and induction machines
- Short test 2: 9<sup>th</sup> of December, synchronous machines

***Registration for a short test has to be done via "My pages",  
no later than 2 weeks in advance!***

## **Laboratory class**

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Lab 1: *Induction machines – time and space harmonics*

Instructors: *Mojgan Nikouie Harnefors*, Teknikringen 33, [nikouie@ee.kth.se](mailto:nikouie@ee.kth.se)  
*Simon Nee*

Lab 2: *Induction machines – equivalent circuit and rated operation*

Instructors: *Erik Velander*, Teknikringen 33, [erikvel@kth.se](mailto:erikvel@kth.se)  
*Simon Nee*

Venue: Electrical machines laboratory, Teknikringen 33, 1 floor down.

Two laboratory exercises are included in the course. The exercises are done in groups of 3 students (lab 1) or 2 students (lab 2). Registration for the laboratory class is done on an individual basis. Registration is made via the registration system of the EE School: <https://www.ee.kth.se/lab>. Registration for the laboratory exercises will be open from **10th September** until **22nd September**.

The preparatory work included in the laboratory hand-out, has to be **submitted no later than two working days in advance** of the laboratory exercise. Please use the mailbox at the notice board, Teknikringen 33. It is allowed to submit one document per registered group of students (3 students during lab 1, 2 students during lab 2) but all students must have participated in the preparation of the document. Write on the document the names of the students that have participated.

There is a short **individual diagnostical test** at the beginning of each exercise. The requirement is to give correct answers to 3 out of 5 questions in order to be allowed to do the exercise; else the instructor will re-schedule the student to a new time! Examples of test questions are published in BILDA.

An **individual oral test** is carried out at the end of each laboratory exercise. Those students who fail in the oral test must repeat the test at a later time.

## Project assignment

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### **Vector control of the induction motor– a simulation study**

Instructor: *Juan Colmenares Herrera*, Teknikringen 33, juanco@kth.se

The assignment is done in groups of 2 students, same group as lab 2 in principle.

A more detailed presentation of the assignment (including an introduction to Simulink) will be given on **14th October, 15-17, Room Q2**.

In order to pass the assignment, the following is required:

- ✓ Team up in groups of two. Once you have found your group member, you have to log-in to Bilda and “join” one of the available groups under the menu *Project groups*. Deadline for registration is **18th November**
- ✓ Development of simulation models for the different tasks and analysis of the results.
- ✓ Submission of first draft report via BILDA no later than **28<sup>th</sup> November** (including a minimum of a complete report of tasks 3.1 to 3.4 included). This working material is checked for plagiarism to detect possible issues to be corrected. Feedback will also be given on contents and report quality.
- ✓ Submission of a technical report. The report is to be submitted via BILDA, whereby an automatic plagiarism check is performed as well. Deadline for submission of the report is **19th December**. Do not forget that the models you have developed must be included in an appendix to the report.  
If corrections to the report are required, they must be submitted **within 3 weeks of notification**.
- ✓ A special introduction to Matlab/Simulink is offered on the 14<sup>th</sup> of October for the students who need one (try to form a group with somebody who has already used Simulink in that case).
- ✓ Three time slots in the Student room for questions to the course instructor are scheduled on: **19th November, 10-12, 20th November, 15-17 and 11<sup>th</sup> December 15-17**.

# Preliminary schedule

*Suggested problems are given in brackets.*

Week 36, 2014					
Mon 1 sep	15:00- - 17:00	Lecture 1	H1	Introduction to electrical machines and drives, course information and study tips	Juliette
Fri 05 sep	13:00- 15:00	Lecture 2	B1	Operating principle of DC machines, equivalent circuit (comp. chpt 8-8-4)	Mats
Week 37, 2014					
Tues 09 sep	15:00- 17:00	Lecture 3	D3	DC machines, equivalent circuit, steady-state operation (comp. chpt 8.5-8.7)	Mats
Wed. 10 sep	08:00- 10:00	Tutorial 1	M31, M32	Problems 8.4, 8.3, 8.7, 8.12, 8.11	Naveed, Rúdi
Week 38, 2014					
Thur 18 sep	15:00- 17:00	Lecture 4	Q2	Induced voltage and winding factor, air gap mmf and three-phase mmf, multiple pole pairs (comp. chpt 3)	Juliette
Fri 19 sep	08:00- 10:00	Tutorial 2	E32, E36	Problems 3.6, 3.1, 3.7, 3.4	Naveed, Rúdi
Week 39, 2014					
Thur 25 sep	14:00- 16:00	Lecture 5	B1	Operating principle of the induction machine, magnetisation and torque production in induction machines, equivalent circuit (comp. 2-2.4)	Juliette
Thur 25 sep	16:00- 18:00	Tutorial 3	Q17, Q26	Problems 2.1, 2.4, 2.11, 2.10	Naveed, Rúdi
Week 40, 2014					
		Lab 1		Mon 29 sept to Friday 03 oct 8 groups of 6 students (3+3)	Mojgan Simon
Mon 29 sep	15:00- 17:00	Lecture 6	D3	Leakage inductance, starting, reversing, generator operation (comp. 2-.5-2.8)	Juliette
Thur 02 oct	15:00- 17:00	Tutorial 4	Q15, Q17	Problems 2.5, 2.12, 2.18, 2.19	Naveed, Rúdi
Week 41, 2014					
Mon 06 oct		Lab 1		4 groups of 6 students (3+3)	Mojgan Simon
Thur 09 oct	13:00- 15:00	Lecture 7	M3	Variable speed control, Operation at unbalanced voltages. Single-phase induction motors (comp. 2.9-2.11)	Juliette
Thur 09 oct	15:00- 17:00	Tutorial 5	M36, V11	Problems 2.8, 2.14, 2.16 <b>One group in M3?</b>	Naveed, X?
Week 42, 2014					
Tues 14 oct	15:00- 17:00	Project	Q2	Presentation of project (student room for Simulink introduction)	Juan, Rúdi
Wed 15 oct	09:00- 10:00	Short test 1	E31, E32, E33, E35	DC machines and induction machines	Juliette
Week 45, 2014					
Mon 03 nov	13:00- 15:00	Lecture 8	Q2	Vector representation of induction machines, dynamics	Juliette
Thur 06 nov	15:00- 17:00	Lecture 9	Q2	Vector representation of induction machines, dynamics Problems 4.3, 4.5	Juliette

<b>Week 46, 2014</b>					
		Lab 2		Mon 10- Thur 13, 7 groups of 8 students (groups of 2)	Erik Simon
Wednesday 12	13:00-15:00	Lecture 10	Q2	Vector control of induction machines	Juliette
Friday 14 nov	10:00-12:00	Lecture 11	B3	Vector control of induction machines	Lennart
<b>Week 47, 2014</b>					
		Lab 2		Mon 17- Tues 18, 3 groups of 8 students (groups of 2)	Erik Simon
Wednesday 19 nov	10:00-12:00	Project		Student room, Teknikringen 33	Juan, Rúdi
Thursday 20 nov	15:00-17:00	Project		Student room, Teknikringen 33	Juan, Rúdi
<b>Week 48, 2014</b>					
Monday 24 nov	13:00-15:00	Lecture 12	Q2	Operating principle of synchronous machines, Salient poles (comp. chpt 6)	Juliette
Tuesday 25 nov	15:00-17:00	Tutorial 6	E32, E36	Phasor diagrams 4 cases problems 6.1. 6.6	Naveed, Rúdi
<b>Week 49, 2014</b>					
Monday 01 dec	13:00-15:00	Lecture 13	Q2	Short-circuit of synchronous machine (Comp. chpt 6.3)	Juliette
Tuesday 02 dec	08:00-10:00	Tutorial 7	M32, M35	Problems 6.2, 6.7, 6.8	Naveed, Rúdi
<b>Week 50, 2014</b>					
Tuesday 09 dec	09:00-10:00	Short test 2	E31, E32, E33, E35	Synchronous machines	Juliette
Thursday 11 dec	15:00-17:00	Project		Student room, Teknikringen 33	Rúdi
<b>Week 51, 2014</b>					
Tues 16 dec	10:00-12:00	Lecture 14	M2	Time and space harmonics (comp. chpt 7)	Juliette
Wed 17 dec	15:00-17:00	Tutorial 8	B2	Problems 7.6, 7.1, 7.11 Only one group	Juliette
<b>Week 3, 2015</b>					
Saturday 17 jan	14:00-19:00	Examination	E32, E33, E35, E36	Everything :-)	Juliette