



Aalto University
School of Electrical
Engineering

Syllabus

ELEC-E8402 Control of Electric Drives and Power Converters

Marko Hinkkanen

Spring 2023

Course Description

Course name ELEC-E8402 Control of Electric Drives and Power Converters D

Credits 5 ECTS

Period IV–V

Time 1.3.–31.5.2023 (Wed 8:15–12:00)

Location Simulointilaboratorio A113, Open Innovation House, Maarintie 6

Teacher in charge Prof. Marko Hinkkanen (marko.hinkkanen@aalto.fi)

Prerequisites ELEC-E8405 Electric Drives

Teachers

- ▶ Lectures
 - ▶ Marko Hinkkanen
- ▶ Exercises and assignments
 - ▶ Rayane Mourouvin
 - ▶ Firdausa Ahmed
 - ▶ Lauri Tiitinen
 - ▶ Reza Hosseinzadeh
 - ▶ Tuure Nurminen
 - ▶ Hannu Hartikainen

Schedule

- ▶ Lectures (8:15–10:00)
- ▶ 5 problem-solving exercises (10:15–12:00)
- ▶ 4 instruction sessions for assignments (10:15–12:00)
- ▶ Demo session (Otakaari 5 L)
- ▶ Two half-course exams or final exam

Date	Lecture	Problem-solving exercise	Classroom instruction for assignments
1.3.	1, 2		
8.3.	3	1	
15.3.	4		1a
22.3.	5	2	
29.3.	6		1b
5.4.	7	3	
12.4.	Half-course exam 1 (9:00-11:00)		
19.4.	No teaching		
26.4.	8		2a
3.5.	9	4	
10.5.	10		2b
17.5.	11	5	
24.5.	Demos (Otakaari 5 L)		
31.5.	Half-course exam 2 (9:00-11:00) or final exam (9:00-12:00)		

Preliminary Lecture Plan

1. Introduction, induction motor (IM)
2. V/Hz-controlled IM drive
3. Vector-controlled IM drive
4. Pulse-width modulation (PWM) and current control
5. Sensorless IM drive, direct torque control (DTC)
6. Grid-connected converter (grid-following, grid-forming)
7. LCL filter
8. Grid faults and disturbances
9. Lossless magnetic field, elementary synchronous machine
10. Interior permanent-magnet synchronous motor (IPMSM) drive
11. Sensorless IPMSM drive
12. Recap, demo

Course Materials

Materials available at MyCourses

- ▶ Lecture slides
- ▶ Exercise materials
- ▶ Homework assignments
- ▶ Selected pages of
Control of Voltage-Source Converters and Variable-Speed Drives
by L. Harnefors, M. Hinkkanen, O. Wallmark, and A. G. Yepes (2015)

Grading is Based on Assignments and Exam

- ▶ Totally 100 points available
- ▶ Assignment 1: Induction motor drive (**15 points**)
 - ▶ Instruction sessions: 15.3. and 29.3. at 10:15–12:00
 - ▶ Deadline 5.4.
- ▶ Assignment 2: Grid-connected converter (**15 points**)
 - ▶ Instruction sessions: 19.4. and 3.5. at 10:15–12:00
 - ▶ Deadline 10.5.
- ▶ Exam 31.5. at 9:00-12:00 (**70 points**)

- ▶ You need MATLAB and Simulink software
- ▶ Assignments are to be completed **in groups of two** (or alone)
- ▶ You are encouraged to discuss the assignments in general terms with others
- ▶ Copying solutions from other groups is not allowed!

Grading: Available Points

	Available points
Assignment 1	15
Assignment 2	15
Exam	70
Total	100

- ▶ At least one question in the exam will be (almost) directly from the exercises
- ▶ Homework assignments will also prepare you for the exam

Grading: Course Grade

Grade	Total points
1	50–59
2	60–69
3	70–79
4	80–89
5	90–100

Estimated Student Workload

	Contact (h)	Individual (h)	Total (h)
Lectures (à 2 h)	22	22	44
Exercises (à 2 h)	10	10	20
Assignments (2)	8	24	32
Demo	2	2	4
Preparing for the exam		24	24
Taking the exam		3	3
Total	42	85	127

- ▶ Weekly individual working is necessary for learning!
- ▶ Reading assignments
- ▶ Reviewing lecture slides and exercises
- ▶ Completing homework assignments

After the Course You Will Be Able to...

1. Draw and explain block diagrams of typical vector-controlled and DTC-controlled drive systems
2. Design 3-phase current controllers
3. Select current references for various AC motors
4. Build simulation models for drive systems and power-converter systems
5. Explain the most essential relationships between control of AC motor drives and control of grid converters