Aalto University
School of Electrical
Engineering

Syllabus

ELEC-E8405 Electric Drives (5 ECTS)

Marko Hinkkanen

Autumn 2020

Course Description

Course name: ELEC-E8405 Electric Drives

Credits: 5 ECTS

Periods: I–II

Time: Every Wednesday 9.9.–25.11.2020 at 8:15–12:00

Distance teaching platform: Microsoft Teams

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

Prerequisites: Circuit theory, basics of electrical power engineering, analog control

Instructors

- Lectures
  - Marko Hinkkanen
- Exercises and assignments
  - Eemeli Mölsä
  - Jarno Kukkola
  - Lauri Tiitinen
  - Mahafugur Rahman
  - Reza Hosseinzadeh
  - Ville Pirsto

Course Format and Preliminary Schedule

- 12 lectures (8:15–10:00)
- 6 problem-solving exercises (10:15–12:00)
- 4 instruction sessions for assignments (10:15–12:00)
- Exam 9.12.2020 (9:00–12:00)

Date	Lecture	Problem-solving exercise	Classroom instruction for assignments
9.9.2020	1, 2		
16.9.2020	3	1	
23.9.2020	4	2	
30.9.2020	5		1a
7.10.2020	6	3	
14.10.2020	7		1b
Exam week			
28.10.2020	8	4	
4.11.2020	9		2a
11.11.2020	10	5	
18.11.2020	11		2b
25.11.2020	12	6	

Preliminary Lecture Plan

1. Syllabus, introduction
2. DC motor model
3. Mechanics
4. Losses and heat transfer
5. DC motor dynamics
6. DC-DC conversion, PWM
7. Cascade control of a DC motor drive
8. Elementary AC machines, 3-phase systems
9. Space-vector models
10. Field-oriented control of a PMSM drive
11. Other AC motor and converter types, future trends
12. Guest lecture

Course Materials

Materials available at MyCourses

- Lecture slides
- Exercise materials
- Assignments

Readings (selected pages)

- Electric Motors and Drives: Fundamentals, Types, and Applications by A. Hughes and B. Drury (2013) (online: http://app.knovel.com.libproxy.aalto.fi/hotlink/toc/id:kpEMDFTA01/electric-motors-drives/electric-motors-drives)
- Control of Voltage-Source Converters and Variable-Speed Drives by L. Harnefors, M. Hinkkanen, O. Wallmark, and A. G. Yepes (2015) (MyCourses)

Additional recommended textbook (not course material): Electric Machines and Drives: A First Course by N. Mohan (2012)

Grading is Based on Assignments and Exam

- Totally 100 points available
- Assignment 1: Selecting an All-Electric Vehicle Powertrain (10 points)
  - Instruction sessions: 30.9. and 14.10.2020 at 10:15–12:00
  - Deadline 21.10.2020
- Assignment 2: Modelling and Simulation of a DC Motor Drive (20 points)
  - Instruction sessions: 4.11. and 18.11.2020 at 10:15–12:00
  - Deadline 25.11.2020
- Exam 9.12.2020 at 9:00-12:00 (70 points)

- 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!
- Matlab and Simulink software is needed to complete the assignments

Grading: Available Points

	Available points
Assignment 1	10
Assignment 2	20
Exam	70
Total	100

- At least one question in the exam will be (almost) directly from the exercises
- 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)	24	24	48
Exercises (à 2 h)	12	12	24
Assignments (2)	8	24	32
Preparing for the exam		24	24
Taking the exam		3	3
Total	44	87	131

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

After the Course You Will Be Able to...

1. Select a motor and converter for periodic duty
2. Build the simulation model for a cascade-controlled DC motor drive
3. Tune the control system of the DC motor drive
4. Apply space vectors for modelling and analysis of three-phase systems
5. Draw and explain the block diagram of a vector-controlled PMSM drive system