

Digital and Servo Drives

Code: MK5DIGSR06RX17-EN

ECTS Credit Points: 6

Evaluation: mid-semester grade

Year, Semester: 1st fall semester

Its prerequisite(s): -

Further courses are built on it: Yes/No

Number of teaching hours/week (lecture + practice): 0+4

Topics:

Fundamentals of drive systems, operation modes. Kinematics equations for different applications. Summary of electrical machines: DC, AC (induction motors, synchronous motor), stepper motor, special motors: EC and BLDC. Electronic drive of electric motors: power electronics, and PWM method. Summary of mechanical components: drives, drive types, bearings, linear movements and guides. Sensor summary: measurement of linear and angular displacement with optical or induction sensors. Digital measurements and control circuits: microcontrollers and FPGAs.

Drive control: acceleration, speed and position control loops. Modelling of mechanical components, electrical machines and sensors in time and frequency domain. Description of open and closed loop control with transfer function and state space method. Performance analysis of control loops: step response and disturbance rejection.

Digital drive control: digital filtering, coordinate transform. Implementation of digital PID control law and parameter tuning. Implementation of digital state observer.

Literature:

Compulsory:

- Asif Sabanovics, and Kouhei Ohnishi, "Motion Control Systems", 2011 John Wiley & Sons, ISBN: 978-0-470-82573-0
- Robert Bishop, "Modern Control Systems with LabView", 2012, NTS Press, ISBN: 978-1-934891-18-6
- Robert Bishop, "Mechatronics Handbook", CRC Press, ISBN: 0-8493-0066-5

Schedule

1st week Registration week

2nd week:

Lecture: Servo Drives theory and applications.

Practice: Position, speed, and acceleration curves for different applications.

4th week:

Lecture: Sensor summary for servo drives: displacement, angular displacement measurement with optical, induction sensors.

Practice: Sensor application examples. Sensor calibration practice.

6th week:

Lecture: Power electronics for electrical machines: controlled rectifiers and PWM method.

3rd week:

Lecture: Mechanical parts for servo drives summary: gearboxes, and gears, drives, linear drives, bearings.

Practice: Mechanical parts practice.

5th week:

Lecture: Electrical machines summary for servo drives: DC, AC (synchronous and induction) motors, stepping motor, special motors: EC, BLDC.

Practice: Electrical machines applications.

7th week:

Lecture: Digital measurement and control: microcontrollers and FPGA-s.

Practice: Electrical drive of electrical machines practice.

8th week: 1st drawing week

Practice: Digital control practice: microcontrollers and FPGA-s.

9th week:

Lecture: Drive control: acceleration, speed, and position control loops.

Practice: Control loop practice.

11th week:

Lecture: Modelling of open and closed loop controls with transfer functions and state space method.

Practice: Motion control loop practice.

13th week:

Lecture: Servo drive control digital implementation: digital filtering of measurement signals, coordinate transformations.

Practice: Implementation and tuning of discrete PID control loop.

10th week:

Lecture: Modelling of mechanical parts, electrical machines and sensors in frequency and time domain.

Practice: Servo drive modelling practice.

12th week:

Lecture: Control loop performance analysis: step response, disturbance rejection property.

Practice: Control loop performance analysis practice.

14th week:

Lecture: Disturbance observers in motion control applications.

Practice: Digital implementation of state observer.

15th week: 2nd drawing week

Requirements

A, for a signature:

Attendance at **lectures** is recommended, but not compulsory.

Participation at **practice** is compulsory. Students must attend the practice classes and may not miss more than three times during the semester. In case a student does so, the subject will not be signed and the student must repeat the course. Students can't make up a practice class with another group. Attendance at practice classes will be recorded by the practice leader. Being late is counted as an absence. In case of further absences, a medical certificate needs to be presented. Missed practices should be made up for at a later date, being discussed with the tutor. Students are required to bring the drawing tasks and drawing instruments to the course with them to each practice class. Active participation is evaluated by the teacher in every class. If a student's behaviour or conduct doesn't meet the requirements of active participation, the teacher may evaluate his/her participation as an absence because of the lack of active participation in class.

During the semester there are two tests: the 1st test in the 7th week and the 2nd test in the 15th week. Students have to sit for the tests.

B, for grade:

The course ends in a **mid-semester grade** based on the test results.

The minimum requirement for both mid-term and end-term tests is 50%. Based on the score of the tests separately, the grade for the tests is given according to the following (score/grade): 0-39 = fail; 40-52 = pass (2); 53-63 = satisfactory (3); 64-71 = good (4); 72-80 = excellent (5).

If the score of the sum of the two tests is below 40, the student once can take a retake test of the whole semester material.