

Hydraulic Servo Systems

- 1. Course number and name:** 020SSHES5 Hydraulic Servo Systems
- 2. Credits and contact hours:** 4 ECTS credits, 2x1:15 contact hours per week
- 3. Name(s) of instructor(s) or course coordinator(s):** TBD (To Be Determined)
- 4. Instructional Materials:** PowerPoint slides

Textbooks/References:

- Hydraulic Servo Systems: Modeling, Identification and Control, Jelali Mohieddine and Kroll Andreas, London: Springer, 2004. ISBN 978-1-4471-1123-8.
- Hydraulic Control Systems, Noah D. Manning and Roger C. Fales, 2nd edition, John Wiley & Sons. ISBN 9781119416470.

5. Specific course information

a. Catalog description:

This course covers the fundamentals of modeling and control of hydraulic servo-systems. It provides theoretical background and practical techniques for the modeling, identification and control of hydraulic servo-systems. Classical and advanced control algorithms are discussed. The use of MATLAB/Simulink and other programming languages will be an integral part in this course.

b. Prerequisites:

Linear Control (020AULES2) and Fluid Mechanics (020MEFES1) or Fluid Mechanics 1 (020MF1ES1).

c. Selected Elective for ME students.

6. Educational objectives for the course

a. Specific outcomes of instruction:

A student who successfully fulfills the course requirements will have demonstrated an ability to:

- Identify the components of a hydraulic servo drive.
- Recognize physical modeling of hydraulic servo drives and to simulate them using simulation software.
- Apply different model identification techniques hydraulic drives in theory and simulation.
- Recognize classical and advanced control techniques to apply for control problems of hydraulic servo-drives.

b. PI addressed by the course:

PI	1.1	1.2	1.3	7.1	7.2
Covered	x	x	x	x	x
Assessed					

7. Brief list of topics to be covered

- **Introduction.**
- **General description of hydraulic servo systems.**
 - Basic structure of hydraulic servo-systems.
 - Description of the components.
 - Classification of hydraulic servo-systems.
 - Measurement and control devices.
 - Application/Examples.
- **Physical fundamentals of hydraulics.**
 - Physical properties of fluids.
 - General equations of fluid motion.
 - Flow through passages.
 - Spool port forces.
 - Electro-hydraulic analogy.
- **Physically based modeling.**
 - Introduction.
 - Elementary models.
 - Typical non-linear state-space models.
 - Structured and simplified models of valve-controlled systems.
 - Determination of specific model parameters.
 - Implementation and software tools.
- **Experimental modeling (Identification).**
 - Introduction.
 - Pre-identification process.
 - Overview of model structure.
 - Description of selected non-linear model structures.
 - Parameter estimation methods.
 - Optimization algorithms.
 - Grey-box identification of non-linear hydraulic servo-system models.
 - Fuzzy Identification.
 - Implementation and software tools.
- **Hydraulic control systems design.**
 - Introduction.
 - Classical feedback control design.
 - Estimator-based state feedback control.
 - Extensions to linear feedback control
 - Feedback linearizing control
 - Approaches similar to feedback linearization.
- **Case Studies.**