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. Manring 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.**