



## Munich Summer School of Applied Sciences 2024

### Course Description

**Course title:** Hydraulic and Pneumatic Systems

Hours per week: 22h/week, 2 weeks

Number of credits allocated/ workload:

- a) 44 contact hours
- b) 3 US quarter credits
- c) 4 ECTS credits

### **Course Description**

Hydraulic and pneumatic systems are currently used in many applications. For example, pneumatic systems are essential for automated mass production or vehicle suspension and braking systems. Injection systems for engines, control devices for aircraft or power transmission in construction machinery are examples for the importance of hydraulics. There is no similar technology available to transfer such large amounts of power (especially force or torque) to an actuator. There doesn't exist a linear operating actuator in any different transmission technology comparable to the simple, lightweight, powerful and sturdy hydraulic cylinder. Knowledge and experience in hydraulic and pneumatic systems are essential elements for engineering designers yet not typically covered in most undergraduate curriculums. This course will give engineering undergraduates a basic understanding of these systems and the theory of their operation along with some "hands-on" experience in a laboratory system with real components.

The design of systems that use air or liquid fluid to transmit power requires special skills and a particular concern for safety, controllability and efficiency. The lecture portion of the course will introduce the basics of modern fluid power systems which will include an overview of common hydraulic and pneumatic applications. The design and analysis of various fluid power elements such as pumps, motors, cylinders and valves will be explored. Design of fluid power systems capable of matching or exceeding design requirements through the correct sizing of components will be emphasized using appropriate analysis. A short design project involving the design and layout of hydraulic system will be undertaken.

The laboratory portion of the course focuses on practical "hands-on" experience with pneumatic and hydraulic components. It will include the design and assembling of a pneumatic circuit based on a schematic, the measurement of hydraulic oil properties, the testing of hydraulic component, the design and testing of simple circuits such as pump, pressure relief valve, flow control valve and a hydraulic cylinder, the design of a two-actuator hydraulic circuit, the comparison of lifting a load with and without a load control valve and the speed and position control of a hydraulic cylinder.

**Prerequisites:**

- ***Good knowledge in fluid mechanics required***
- Prior Matlab/Simulink experience will be helpful but is not required

**Lecture Content**

- Overview of Hydraulic and Pneumatic Systems and various applications
- Properties of Hydraulic Fluids
- Review of Fluid Flow Fundamentals and applications to Hydraulic Systems
- Hydraulic Pump/Motors sizing and selection
- Hydraulic Cylinder construction, sizing and selection
- Valve types and functions and relation to system goals
- Analysis of hydraulic schematics
- Design of a hydraulic system including component selection.

**Laboratory Content**

Laboratory exercises include:

- Design and assembling of pneumatic schematics including pneumatic logic control
- Measurement of oil viscosity and testing of hydraulic filter using an Ubbelohde viscometer.
- Oil contamination/filtering is investigated by a fluid control unit.
- Testing of hydraulic components including a hydraulic pump, a pressure relief valve, a restrictor valve, a flow control valve and a hydraulic cylinder
- Design and assembling of hydraulic circuits using two actuators for the investigation of controllability and energy consumption.
- The setup of load control valves and the comparison of lifting loads with and without these valves.

**Recommended reading:**

Course material will be provided by the teachers.

**Teaching methods:**

Lecture presentations, group assignments and experimental work in the laboratory for hydraulic and pneumatic systems

**Assessment methods:**

Oral exams, written exams and successful laboratory work

**Language of instruction:**

The course is offered in English

**Names of lecturers:**

Prof. Ulrich Westenthanner (Munich University of Applied Sciences)

Prof. Jacques Belanger (California Polytechnic State University, San Luis Obispo)