Maha Fluid Power Research Center
Fundamentals in Industrial and Mobile Hydraulics

Contact Information

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Dates: Summer session
June 9th – 13th. Monday – Thursday Full days and Friday morning only.

Target Audience and preferred experience:

This course is designed for industry professionals who have:

- Engineering degrees or equivalent.
- Interest in increasing their fundamental understanding of hydraulic equipment for mobile or industrial applications.
- Beginner level in fluid power (0-3 years of experience)
- Interest in broad concepts in fluid power

Course Description:

This course provides an introduction into modeling and design principles of hydraulic components and systems. This course focuses on modeling techniques based on physical laws and measured performance characteristics. These techniques will be applied to the design, testing and analysis of components and systems used in hydraulic applications in mobile and industrial equipment. The course will begin with fundamental aspects of fluid flow, standardized symbols, common hydraulic circuits, and typical functioning principles for the moving parts inside of the components. The course is paired with hands on laboratory and testing exercises focused on reinforcing the concepts learned in the class with the use of computer simulations as well as tear down of components and real-life circuits on hydraulic trainers.

Learning Objectives:

1. Understand and reflect on the significance of fluid selection and or conditioning on a fluid power system.
2. Estimate, identify and quantify the sources of pressure, flow or power loss in a hydraulic system.
3. Recognize and analyze factors affecting the performance of a fluid power component in operation trough computer simulation.
4. Identify proper standardized test procedures used in industry to assess component and system performance.

5. Recognize and troubleshoot commonly used fluid power systems in mobile applications.
6. Assesses and predict the dynamic performance of a system using computer-based simulations in FluidSim and Matlab Simscape.

Topics and schedule:

Day 1: Lab 1:	- Fluid properties and fundamental laws of hydrostatics and pneumatics • Fluids: function and properties, Focus on fluid properties, density, specific gravity bulk modulus, viscosity and viscosity index • Pascal's law in hydraulic systems. energy and power, force, flow, velocity, pressure. Review of physical units manipulation. • Conservation of energy, continuity equation, hydraulic power. - Symbology and standardization - Filtration & Cavitation **Hands on Lab at 1158 (Motion Control Lab) Component and symbols identification, viscosity measurements, use and application of standards ISO 4413, ISO 4391, 4392, ISO 5598, ISO 1219, Max relief valve pressure and hydraulic power.**
Day 2: Lab 2:	- Pressure, flow and power loss in fluid power systems. • Frictional losses in laminar and turbulent flow - Component physical principles and applications I (General) • Pumps (Gear, Piston, vane, other designs) • Motors • Linear actuators • Hydrostatic transmission (General principles and drivetrain configurations) **Hydraulic simulation (Computer laboratory) of simplified hydrostatic transmissions in FluidSim and Matlab-Simscape (Steady state analysis only) Analysis of the performance and derived displacement of a pump from datasheet.**
Day 3: Lab 3:	- Component principles and applications II (valves and ancillary components) - Valve fundamentals and applications in hydraulic systems. • Pressure control valves, • Flow control valves, • Directional control valves, - Reservoirs - Heat exchangers. - Accumulators **Hands on Lab at 1158 (Motion Control Lab) Regenerative circuit, Meter In-Out and Bleed out circuits Counterbalance valve, Sequence circuit, Open center system.**
Day 4: Lab 4:	- Commonly used fluid power circuits • Mobile applications ▪ Priority valve applications, ▪ Counterbalance valve applications, ▪ Series, Parallel and Power split hybrids • Industrial applications ▪ Automatic circuits ▪ Electro-hydraulics, Basic PLC logic • Pneumatic applications ▪ Pneumatic logic systems, cascade and shift register systems **Day 4: Accumulator simulation, energy storage systems. Modeling of a closed loop control system in Simulink. Modeling a closed loop control system in FluidSim**

Day 5:	- Practical Block diagrams and Laplace Transform - Lumped parameter modeling - Full system simulation fundamentals and dynamic control systems for fluid power engineering. **Last day, No lab**

No Textbook is required for the course (The list below is a list of recommended books for your reference only):

- Vacca, Andrea., Franzoni, Germano. Hydraulic Fluid Power: Fundamentals, Applications, and Circuit Design. United Kingdom: Wiley, 2021.
- Manring, Noah D., and Roger C. Fales. Hydraulic control systems. John Wiley & Sons, 2019.
- El-Din, Mahmoud Galal, and Mohamed Rabi. Fluid power engineering. McGraw-Hill Education, 2009.
- Trostmann, E. (2000). Tap water as a hydraulic pressure medium. CRC Press.

Attendance:
The minicourse will open to in-person participants at Purdue University: max 24 participants

Cost:

Free registration for:

- 1 participant from Maha Fluid Power Research Center Basic Members
- 2 participants from new Maha Fluid Power Research Center Basic Members (joining the center in 2025)
- 3 participants from Maha Fluid Power Research Center Executive Members

$ 1,500 / additional participants from member companies (*)
$3,500 / participant for non-member companies (*)
(*) registration priority goes to members benefitting from free registration as detailed above.

Registration includes all course material (books not included), lunches, and coffee breaks. No dinner/hotel accommodation is provided with course registration.