

Applications of Hydraulic Circuits in Control Systems (An Interactive, Computer-Based, E-Learning and Virtual Lab Course)

Introduction:

Hydraulic systems use special oils to power & control many applications. Hydraulic drive is a transmission system uses pressurized oil to drive hydraulic machineries. Hydrostatic refers to energy transfer from flow and pressure, not from kinetic energy of flow. Hydraulic circuits consist of many parts: Inlet hydraulic power generator (positive displacement pump driven by electric motor/combustion engine); various control valves; filters; piping; circuit outlet actuator (e.g., hydraulic motor, cylinder or semi-rotating motor) to drive machinery and get predefined controlled motion. Examples for hydraulic systems are clamp & drill circuit (as in fig.), hydraulic press and hydraulic cylinders used on excavators.

Hydraulic systems are essential parts of many industrial practical engineering applications. Designing of hydraulic circuits and their components & their operation & maintenance are very important practices of many engineers & technicians. Availability, efficiency and extended reliable performance of power plants, pumping and fluid handling stations & similar facilities are greatly influenced by accurate design, selection, efficient operation and proper maintenance of hydraulic systems & associated components.

Course Objectives:

This is an interactive, computer-based, e-Learning and virtual lab course. It has been designed to give the participant a broad based understanding of the most important hydraulic circuit's concepts. Upon completion of this course, he should understand various basic physics laws as they apply to hydraulics power, as well as essential hydraulic symbols and understanding circuit's schematics and the control system design. The participant will also study the various components found in a typical hydraulics system and how these components function and interact with each other. Each lecture will be followed by a very comprehensive interactive and computer based virtual and multi-media training lab and software. Each lab will also include animations, 3-D models and on-line training quizzes. This Course will give the participants a wide range of knowledge & practical skills to:

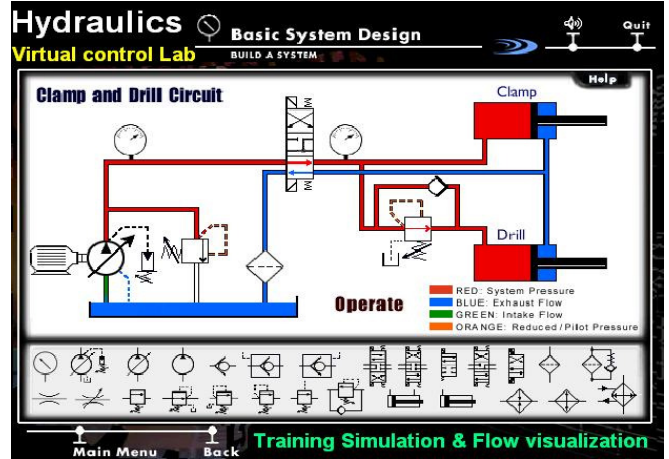
- Understand basic components of hydraulic circuits and hydraulic control system.
- Understand and examine various types of hydraulic positive displacement pumps.
- Understand and examine various types of hydraulic actuators (cylinders, motors and semi-rotating motors).
- Understand various types of hydraulic oils and effects of oil's viscosity on the hydraulic system.
- Understand and examine various types of valves used to control (pressure, direction, flow rate and check valves). This includes functions, materials, sizes, geometry considerations and essential characteristics.
- Understand various types of accessories used in hydraulic circuits (e.g., filters, flow meters, pressure gauges, heat exchangers and pressure switches..etc).
- Understand Symbols & reading hydraulic schematics and identify system components & design function as well.
- Practical training for basic hydraulic system design and how to build, analyze and operate hydraulic circuits.
- Understand and examine International Reference Standards related to Hydraulic Symbols and system/circuit design.
- Understand some maintenance and troubleshooting requirements for hydraulic circuits

The ILO's (Intended Learning Outcomes) of the Course:

a- Knowledge and Understanding:

This course has been designed to give the participants a broad based understanding of the most important hydraulic concepts. Upon completion of this course, they should have the ability to:

- ✓ Understand the use of various types of virtual labs applications for modern automatic control systems.





- ✓ Understand and apply knowledge of basic physics laws and fluid mechanics concepts as they apply to hydraulic power and to solution of automatic control problems using Hydraulic systems.
- ✓ Understand and apply knowledge of thermo-fluid characteristics of hydraulic oils and various types of fluid conducting methods and the proper materials used for each one.
- ✓ Understand and apply knowledge of Principles of Hydraulic System design including types of positive displacement pumps and various types of hydraulic actuators (i.e., linear, rotating and semi-rotating).
- ✓ Understand various types of hydraulic valves to control: pressure, direction, flow rate and check valves.
- ✓ Understand various accessory components found in a typical hydraulic systems and process control design.
- ✓ Understand Symbols & reading hydraulic schematics and identify system components & design function as well.
- ✓ Understand and apply knowledge of Maintenance & Troubleshooting of Hydraulic Control Systems.
- ✓ Understand current engineering technologies related to Hydraulics use in Automatic Control Systems.

b- Intellectual Skills:

This course helps the participants to acquire the ability to:

- ✓ Identify, select, describe, and draw the main various components in typical hydraulics schematics and to recognize and comprehend how these components function and interact with each other.
- ✓ Follow and participate in a comprehensive interactive & computer-based virtual and multi-media training labs which include system animations, 3-D models and on-line multiple choices quizzes.
- ✓ Identify, formulate and solve main basic automatic control problems using hydraulic power.
- ✓ Design hydraulic circuit, component & schematics to meet required needs within realistic constraints.
- ✓ Select appropriate components for modeling and analyzing typical Hydraulic Control problems.
- ✓ Select appropriate solutions for various multiple choices quiz problems based on analytical thinking.
- ✓ Assess and evaluate the characteristics and performance of pumps, hydraulic actuators, various control valves and accessory components in a typical hydraulic system and process control design.
- ✓ Use virtual lab tools & software packages pertaining to hydraulic systems & process control design.

c- Practical and Professional Skills:

This course helps the students to acquire the ability to:

- ✓ Integrate knowledge of basic physics laws, fluid mechanics concepts, information technology, design, and engineering practice to solve engineering problems of Hydraulic Control Systems.
- ✓ Employ drawing and professional skills to design and analyse standard schematics of hydraulic systems and process control circuits.
- ✓ Identify and use a wide range of computer applications, technical tools, and techniques including pertinent virtual labs software.
- ✓ Implement comprehensive knowledge, understanding, and intellectual skills in solving on-line virtual training labs, exercises, and MCQ problems.
- ✓ Prepare and present technical reports and schematics of hydraulic circuits and control systems.

d-General and Transferable Skills:

This course helps the students to acquire the ability to:

- ✓ Collaborate & Communicate effectively within a lab group/team.
- ✓ Work in stressful class and lab environment and within time constraints.
- ✓ Demonstrate efficient IT capabilities.
- ✓ Manage tasks and lab resources efficiently.
- ✓ Search for information and adopt self learning and Refer to relevant literature effectively.

Who Should Attend:

Engineers and Field Personnel involved with design, maintenance, operation, selection installation and maintenance as well as plant reliability, condition monitoring and for the day to day servicing and operational efficiency. Also plant and maintenance engineers, process engineers and maintenance managers. It is also be invaluable to supervisors who are involved in pump and compressor maintenance activities.



The Instructor:

Dr. Mohsen Soliman is an Associate professor of fluid mechanics group in Mechanical Power Engineering Department – Cairo university. He has a Ph.D. degree, 1987 from university of California, Irvine and has a long teaching and research experience in the area of fluid flow, turbo machines, and gas dynamics and has many research papers published at international conferences and journals. Dr. Soliman has had many years' experience in organizing and lecturing training courses for engineers inside and outside Egypt. The courses cover design pipe lines, valve technology, water hammer and fire fighting systems. Currently, Dr. Soliman is the manager of the Automatic Control Lab, ACC, and the administrator of the Automatic Control Post Graduate Diploma at Mech. Power Engineering Dept. FECU. See the ACC site: www.acc-vlab.cu.edu.eg

Daily Course Program

Day one:

9:00 – 9:30	Registration	
9:30 – 11:00	Lecture 1	Introduction & ILO's of the course
11:00 – 11:30	Coffee break	
11:30 – 13:00	Lecture 2	Overview for Using Virtual Labs for Automatic Control Systems+ movie.
13:00 – 13:30	Lunch break	
13:30 – 15:00	Lecture 3	Fluid Power Physics: basic physics laws and thermo-fluid mechanics concepts.

Day Two:

9:00 – 10:30	Lecture 4	Positive Displacement Pumps used in hydraulic circuits.
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 5	Hydraulic Actuators (cylinders, motors and semi-rotating motors).
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 6	Pressure Control Valves.

Day Three:

9:00 – 10:30	Lecture 7	Directional Control Valves.
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 8	Flow Control Valves.
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 9	Fluid Conditioning (filters, heat exchangers and oil tanks).

Day Four:

9:00 – 10:30	Lecture 10	Check Valves and Accessory Components.
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 11	Fluid Conductors and Piping System.
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 12	Understanding Symbols and Reading Hydraulic Circuits Schematics.

Day Five:

9:00 – 10:30	Lecture 13	Practices for Basic System Design. Build, Analyze & Operate Hydraulic Circuits
10:30 – 11:00	Coffee break	
11:00 – 12:30	Lecture 14	International Reference Standards related to Hydraulic Symbols & Systems.
12:30 – 13:00	Lunch break	
13:00 – 14:30	Lecture 15	Maintenance and Troubleshooting. Course Review and Course Evaluation.

أ.م/ محسن سيد سليمان
مدير معمل التحكم ACC ومسئول إدارة دبلوم التحكم الأوتوماتيكي
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