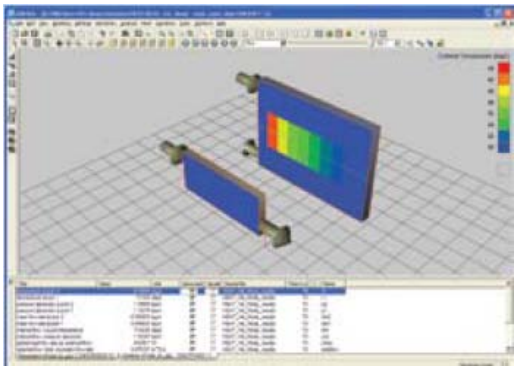
THE CENTER FOR
PROFESSIONAL STUDIES



Design of Hydraulic and Thermal Fluid Systems

Today intelligent system integration is driving improved product performance and delivering innovative designs in a variety of industries. Recent surveys show that approximately 80% of the next-generation systems and products will be derived from so-called intelligent systems.

Using physics-based simulation, engineers can design complete fluids hydraulic and pneumatic systems, from the tank to the actuators up the fluid network. Using standardized libraries of hydraulic and the thermal fluid system components, one can develop products with components actuated by hydraulic and pneumatic fluid power systems. For example, fluid power actuation systems for crane, crawler, earthmoving and mining equipment and machine tools can be developed and analyzed. Also, fuel injection, lubrication, variable valve actuation and timing can be addressed. The solution delivers the required insights to improve product quality, robustness and reliability, reduce power generation and develop new functionality.

- First, the basics of designing fluid systems it is necessary to have a good understanding of the thermal aspects and exchanges that can be added to any fluid system in interaction with the environment and/or any material participating to the different heat transfers.

- Next, participants will focus on every aspect of the hydraulic and thermal fluid system design. The components used and their use in a hydraulic or thermal fluid network will be explained and demonstrated.

- Lastly, participants will be shown how to run the model and interpret output results on LMS software products. A thorough understanding of what these results mean and how to use them to improve the product design will be discussed.

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Course Syllabus

I IDENTIFYING INFORMATION

Course:	Design of Hydraulic and Thermal Fluid Systems
Prerequisite:	Computer Aided Engineering (CAE)
Time Frame:	40 total contact hours
Instructor:	A technical specialist with LMS International BS in Mechanical Engineering 5 years of experience with LMS software 5 years of applicable industrial experience
Phone:	(248) 952-5664
E-mail:	caesupport.us@lmsintl.com

II REFERENCE MATERIALS

1. Faisandier J., "Mécanismes oléo-hydrauliques" 1987
2. Blackburn J.F., Reethof G., Shearer J.L., "Fluid Power Control", 1966
3. Mac Cloy D., Martin H.R., "Control of Fluid Power", 1980
4. Merrit H.E., "Hydraulic Control Systems", 1967

III COURSE GOALS AND OBJECTIVES

1. Introduce important basic hydraulic concepts
2. Global view on hydraulic libraries / components in LMS Imagine.Lab AMESim.
3. Learn how to build hydraulic models
4. Review the modeling of some typical hydraulic systems.
5. Use the hydraulic resistance library to evaluate pressure losses and flow rate distribution in hydraulic networks
6. Understand the important concepts for modeling of hydraulic systems.
7. Understanding of hydraulic components and lines in LMS Imagine.Lab AMESim.
8. Learn to construct hydraulic network models.
9. Hydraulic model simplification.
10. To provide a good understanding of the thermal aspects and exchanges that can be added to any fluid system in interaction with the environment and/or any material participating to the different heat transfers.
11. To understand the dynamic interactions between different subsystems to optimize stability and reduce oscillatory behavior.

IV METHODOLOGY

This course will demonstrate how to design and analyze hydraulic or fluid power systems in LMS Imagine.Lab AMESim. Each module will introduce new material that the student will be allowed to experience for himself with the associate In-class Tutorials.

Lectures

Each detailed subject will be presented in a lecture format outlining the theory and standardized accepted methodology. A printed copy of the lecture material will be provided for the student's personal in-class use and as a reference material.

Specific Industry Examples

Real life examples will be covered that explain the application of the theory to various industries such as automotive, aerospace and off-highway. This will give the students a clear understanding of how and why these techniques are utilized in different industries and the value they add to hydraulic and thermal performance.

In-Class Assignments

The student will conduct several hands-on tutorials to reinforce the theoretical concepts. These tutorials will increase in complexity as the students further develop their skills.

V COURSE OUTLINE & ASSIGNMENTS

Module 1 – Presentation of the Hydraulic (HYD) and Hydraulic Resistance (HR)

Fluid Properties
Sources (Pressure and Flow Rate)
Sensors
Orifices (resistance)
Volumes (capacitance)
Pumps, Motors, Jacks, Control Valves (transformers)
Lines
Bond Graph Theory
In-class Tutorial – Flow Distribution
In-class Tutorial – Hydrostatic Transmission
In-class Tutorial – Hydraulic Actuator
In-class – Tutorial – Anti-pulsating System

Module 2 – Applications / Hydraulic Demonstrations

Injections Systems
Mobile Hydraulics: An Excavator
Pump Modeling
In-class – Tutorial – Hydraulic Resistance: Bushing, Nikuradse, Venturi

Module 3 – Fluid Properties

What are Fluid Properties?
Aeration / Cavitation
Fluid properties modeling
In-class – Tutorial – Cavitation
In-class – Tutorial – Hydraulic Stiffness

Module 4 – Pressure Drop in the Hydraulic Library

Orifices
Hydraulic Resistive Elements – the HR Library
Flow Equations (Bernoulli)
Activity Index
Activity Index Examples
In-class – Tutorial – Lubrication Network
In-class – Tutorial – Importing CAD Geometry
In-class – Tutorial – Venturi Tube

Module 5 – Hydraulic Global Components

- Pumps and Motors
- Jacks
- Flow Control Valves
- Pressure Valves and Regulators
- Accumulators
- In-class Tutorial – Hydraulic Wheatstone Bridge
- In-class Tutorial – Designing a Pressure Regulator

Module 6 – Hydraulic System with Control

- Control Library
- Simulink® Interface
- Co-simulation
- In-class Tutorial – Hydraulic System with Control Loop – Power Station

Module 7 – Other Hydraulic Systems

- Constant Power Pump
- Mobile Hydraulic Example
- Loader Crane Example
- In-class Tutorial – Constant Power Pump
- In-class Tutorial – Load Sensing Unit
- In-class Tutorial – Loader Crane

Module 8 – Hydraulic Lines

- Theoretical Introduction
- Modeling of Hydraulic Lines
- Tools for Studying Hydraulic Lines
- In-class Tutorial – Injector Modeling

Module 9 – The Thermal Library

- Introduction
- Thermal Library Components
- Thermal Properties
- Thermal Capacity
- Heat Transfer by Conduction
- Heat Transfer by Convection
- Heat Transfer by Radiation

Module 10 – Thermal Hydraulic Libraries Fundamentals

- Thermo-hydraulic Fluid Properties
- Thermo-hydraulic Capacitive Components
- Thermo-hydraulic Resistive Components
- Thermo-hydraulic Capacitive – Resistive Components
- In-class Tutorial – Aircraft Flight Controls Demonstration
- In-class Tutorial – Swash Plate Pump Demonstration

Module 11 – The Thermal Hydraulic Component Design (THCD) Library

- Introduction
- THCD Components

Module 12 – The Thermal Pneumatic Library

- Introduction
- Main Components
- Heat Exchange Models

Module 13 – The Cooling System Library

- Introduction
- Main Components
- Full Cooling System
- In-class Tutorial – Oil Coolant Heat Exchanger