

## Electrohydraulic Feedback Systems

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### I. Program Description

This course is intended to be an introductory course in electrohydraulic feedback control systems. Both position and speed control systems are covered in both the lecture and lab. Additionally, servo valves and proportional valves are studied and their performances are compared.

#### A. Aims/Objectives

The objective of the course is to expose the student to practical experiences with feedback systems to control position and speed. At the completion, the student should understand the elements of closed loop control, and should be able to set up basic position and speed servomechanisms. An additional aim is to provide methods for sizing a servo or proportional valve for a given application and how performance differences between the two affect the decision on which type to use.

#### B. Major Topics Covered

Servo mechanisms, servo valves, proportional valves, feedback, valve sizing, speed loops, positioning loops, valve testing, valve characteristics, frequency response, bandwidth, servo loop gain, servo stability/oscillation, servo loop errors, interpretation of catalog data.

### II. Who Should Participate

Sales and application engineers at both the distributor and manufacturer levels who need to apply motion control to industrial machinery. Electronics is reviewed; however, some exposure and knowledge of industrial electronics is helpful. No prior knowledge of closed loop servo systems is assumed. .

### III. Session Information

Classes are conducted several times per year. For scheduled dates, contact our offices.

**SNO-Motion Solutions**  
41 West Guest Avenue  
Salt Lake City, UT 84115  
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**To Apply for Training Class on Line:**  
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and choose the appropriate class title.

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## Course Outline

### I. First Day of Class

- A. Analysis of Cylinder Circuits
  1. Cylinders
  2. Flow in cylinder
  3. Effects of throttling orifices
  4. Power
  5. Metering methods
  6. Three-way control
- B. Valve Control of Cylinder Motion (VCCM)
  1. Generalized equation (VCCM)
  2. Operating envelope
  3. Design equations
  4. Optimal control
  5. Cavitation and overrunning loads
  6. Design strategies
  7. Sizing the pump

### II. Second Day of Class

- A. Stopping the Cylinder
  1. Conditions/force balance
  2. Load force effects
  3. Tank pressure effectsLab #1 - Positional Servo - Servo Valve
- B. Fluid Compressibility
  1. Capacitance
  2. Analytical schematics
  3. Effective capacitance of cylinder
  4. Line expansion

### III. Third Day of Class

- A. Analysis of the Cylinder Circuit
  1. Analytical schematic
  2. Equations
  3. Resonant frequency
  4. Damping ratio

### IV. Fourth Day of Class

- A. Closure of the Position Loop
  1. Control system block diagrams
  2. Errors
  3. EH positional servo
  4. Disturbances
  5. Calculation of error contributors
  6. Bandwidth criteria
  7. Profile requirements
  8. Dead band correctionLab #2 - Positional Servo - Proportional Valve

### V. Fifth Day of Class

- A. Profile Synthesis
  1. Meeting cycle time
  2. Physics of profiles
  3. Motion controlLab #3 - Profile Control Demonstration