Division: Technical
Subject Code: ELME Course: 218
Course Title: Process Control and Industrial Instrumentation

Thaddeus Stevens College of Technology

Master Course Form

Catalog Description: This course covers the fundamentals of process control and instrumentation as applied in industry for the control of level, flow, temperature, and pressure. The concept of a control loop is introduced and each of the loop's components- sensor, controller and final element- are examined. Design, documentation, operation, performance tuning and troubleshooting of single loop systems is discussed.

Digital Description:

- Credit Hours: 4
- Lecture Hours: 2
- Lab Hours: 4

Prerequisites: **Minimum Grade Required**

- None

Corequisites:

- ELME 214, ELME 225

Objectives:

Upon successful completion of the course, each student will be able to:

1. Define process control and identify the kinds of variables found in process control.
2. Define a control loop and identify the types of control loops
3. Define a piping and instrumentation diagram and explain its function.
4. List the considerations for using thermocouples in various environments.
5. List and describe flow measurement devices.
6. Describe some of the factors that affect sensor installation
7. Explain the methods of tuning controllers.
8. Apply PLC logic in a process control system.

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Competencies:

Upon successful completion of the course, each student will demonstrate the ability to:

1. Describe proper safety procedures for working with process systems
2. Define process control; controlled and manipulated variables; open and closed loop control; manual control; automatic control; transducer; transmitter; converter; controller; final control element; sensor; specific gravity; sensitivity; accuracy; scaling; on/off control; time-proportional control; proportional control; steady state; transient state; upset; integral control; derivative control; proportional band; gain; reset; reset tune; reset rate; wind-up; resolution; accuracy; repeatability; temperature; internal energy; heat transfer; conduction; convection; radiation; thermal power
3. Describe the operation, function and application of level measurement, sight gages
4. Describe the function and use of ISA block diagrams and instrument tags
5. Identify the common symbols, line types, notations and indexes of a Process and Instrumentation Diagram (P&ID)
6. Use the common symbols, line types, notations and indexes of a Process and Instrumentation Diagram (P&ID)
7. Power up a loop controller
8. Configure a loop controller
9. Calibrate a loop controller
10. Tune a loop controller
11. Operate a loop controller
12. Connect current to pressure (I/P) converters for final control elements
13. Operate current to pressure (I/P) converters for final control elements
14. Calibrate current to pressure (I/P) converters for final control elements
15. Connect a diaphragm actuated proportional valve
16. Operate a diaphragm actuated proportional valve
17. Adjust a diaphragm actuated proportional valve
18. Describe methods of measuring liquid level including a bubbler and a pressure sensor
19. Convert between liquid level units, pressure units, sensor output units and display units
20. Demonstrate the ability to connect, operate, test and display level using a capacitance pressure sensor
21. Describe the function, operation, and application of ultrasonic level measurement
22. Demonstrate the ability to connect ultrasonic level sensors and apply in a closed loop system for level control
23. Demonstrate the ability to configure ultrasonic level sensors and apply in a closed loop system for level control
24. Demonstrate the ability to operate ultrasonic level sensors and apply in a closed loop system for level control
25. Describe the principles and operation of an on/off process control algorithm with alarms
26. Connect electronic controllers to implement tank level control and alarming using an on/off algorithm and discrete inputs and outputs

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27. Configure electronic controllers to implement tank level control and alarming using an on/off algorithm and discrete inputs and outputs
28. Operate electronic controllers to implement tank level control and alarming using an on/off algorithm and discrete inputs and outputs
29. Use an electronic controller to control a process in proportional mode, proportional / integral mode, proportional / derivative mode and proportional / integral / derivative mode
30. Describe methods of measuring flow including turbine sensors and paddlewheel sensors
31. Convert between velocity, volumetric and mass flow rate units
32. Describe how differential pressure is used to measure flow, the types of sensors used, types of orifice plates and the operation and function of a DP transmitter
33. Describe the operation of flow nozzles, venture tubes, and pitot tubes
34. Measure flow using orifice plates, venture tubes and pitot tubes together with a differential pressure flow transmitter
35. Demonstrate the ability to construct and operate a flow control loop using DP
36. Demonstrate the ability to configure and implement a flow control loop using a paddlewheel sensor, a digital flow transmitter, a valve and a controller
37. Describe loop optimization
38. Calculate resolution and accuracy for a loop
39. Tune a loop using the process reaction curve open-loop method, the Ziegler-Nichols closed-loop method and an automatic method
40. Perform thermal energy calculations and conversions between temperature scales, energy units (BTU's Joules) and power units
41. Calculate the energy needed to raise the temperature of a substance and the heat transfer rate to raise the temperature of a flowing fluid
42. Describe the function, operation and application of heating elements, heat exchangers, chillers, thermostats and manual temperature controllers
43. Describe the functions, operation, issues and applications of thermocouples, two and three wire RTDs and two, three and four wire
44. Measure the outputs of thermocouples, RTDs and thermisters.
45. Demonstrate the ability to configure and implement a flow control loop using a paddlewheel sensor, a digital flow transmitter, a valve and a controller
46. Describe the function and operation of temperature transmitters
47. Configure transmitters for thermocouples, RTD's and thermisters
48. Connect transmitters for thermocouples, RTD's and thermisters
49. Demonstrate the ability to configure, connect and operate a controller for manual, on/off, time-proportional and proportional output control
50. Describe a distributed control systems (DCS) and its role in process control
51. Compare a DCS to a PLC and stand-alone instrumentation

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Planned Sequence of Learning Activities:

- Process Control and Instrumentation
- Control Loops
- Level Process Control
- Flow Process Control
- Thermal Process Control

List of Texts, References, Selected Library Resources or other Learning Materials:

1) Process Control Trainer
    a. Temperature Control Manual – Lab-Volt
    b. Pressure, Flow, and Level Processes – Lab-Volt
2) Instrumentation and Process Control, 6th Edition, ATP, Franklyn W. Kirk, Thomas A. Weedon, Philip Kirk, ISBN-978-0-8269-3442-0

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