ISET-3100: ELECTRICAL AND MECHANICAL SYSTEMS FOR SMART MANUFACTURING

Cuyahoga Community College

Viewing: ISET-3100 : Electrical and Mechanical Systems for Smart Manufacturing

Board of Trustees:
December 2023

Academic Term:
Fall 2024

Subject Code
ISET - Integrated Systems Engineering

Course Number:
3100

Title:
Electrical and Mechanical Systems for Smart Manufacturing

Catalog Description:
Covers the commissioning and setup of process control equipment and VFDs. Includes networking a totally integrated automation system, networking a variety of industrial control equipment across a mix of vendor platforms and connecting those with other industrial IT networks. Also prepares students to understand a variety of motor control techniques, physics principles and manufacturing processes. Provides students with the knowledge and skills necessary to take the Siemens Level 2 Mechatronics Systems Associate Exam.

Credit Hour(s):
3

Lecture Hour(s):
2

Lab Hour(s):
2

Requisites

Prerequisite and Corequisite
MET-2460 Applied Programmable Logic Controllers and Mechatronic Systems.

Outcomes

Course Outcome(s):
Evaluate how temperature, pressure, level, and flow process control technologies are used in closed loop control system.

Objective(s):
1. Evaluate types of temperature, pressure, level, and flow sensing equipment.
2. Evaluate types of temperature, pressure, level, and flow control equipment.
3. Evaluate how temperature, pressure, level, and flow sensing and control equipment work together in a closed loop system.
4. Evaluate benefits of different types of temperature, pressure, level, and flow sensing and control equipment.

Course Outcome(s):
Setup and utilize temperature, pressure, level, and flow process control technologies are used in closed loop control system.

Objective(s):
1. Setup and utilize different types of temperature, pressure, level, and flow sensing equipment.
2. Setup and utilize different types of temperature, pressure, level, and flow control equipment.

3. Setup and utilize different temperature, pressure, level, and flow sensing and control equipment and make them work together in a closed loop system.
4. Select the appropriate type of temperature, pressure, level, and flow sensing and control equipment based on specific real world example conditions and desired control.

Course Outcome(s):

Compare different motor control starting and stopping techniques.

Objective(s):

1. Compare different motor starting techniques including, full voltage, reduced voltage, wye-delta, soft starting, variable voltage and variable frequency.
2. Compare different motor stopping techniques including, electrical breaking, regenerative braking, variable voltage and variable frequency.

Course Outcome(s):

Identify single-phase, 3-phase, and DC motor wiring configurations and applications.

Objective(s):

1. Identify single-phase motor wiring configurations and applications.
2. Identify 3-phase motor wiring configurations and applications.
3. Identify DC motor wiring configurations and applications.

Course Outcome(s):

Set up, configure, and network Variable Frequency Drives (VFDs) with an industrial PLC to control a motor for given applications.

Objective(s):

1. Set up Variable Frequency Drives(VFDs) with an industrial PLC to control a motor for given applications.
2. Configure Variable Frequency Drives (VFDs) with an industrial PLC to control a motor for given applications.
3. Network Variable Frequency Drives (VFDs) with an industrial PLC to control a motor for given applications.

Course Outcome(s):

Network multiple manufacture's industrial components to communicate with each other to include two brands of PLCs and multiple drives in a variety of network topologies.

Objective(s):

1. Network multiple manufacture's industrial components to communicate with each other to include two brands of PLCs and multiple drives in a ring network.
2. Network multiple manufacture's industrial components to communicate with each other to include two brands of PLCs and multiple drives in a star network.
3. Network multiple manufacture's industrial components to communicate with each other to include two brands of PLCs and multiple drives in a bus network

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Course Outcome(s):

Construct advanced-level programming arithmetic and analog data manipulation on RSLogix 5000 and Siemens Step 7 platforms.

Objective(s):

1. Construct advanced-level programming arithmetic and analog data manipulation on RSLogix 5000 platform.
2. Construct advanced-level programming arithmetic and analog data manipulation on Siemens Step 7 platform.

Course Outcome(s):

Identify networking protocol and demonstrate networking PLCs of the same manufacturer.

Objective(s):

1. Identify networking protocol of Allen Bradley PLC's Ethernet IP.
2. Identify networking protocol Siemens MPI and PROFIBUS
3. Demonstrate networking of multiple Control Logix or Compact Logix PLCs.
4. Demonstrate networking multiple Siemens PLCs.

Course Outcome(s):

Demonstrate the set-up of a new Control Logix controller and configuration of several different I/O cards.

Objective(s):

1. Demonstrate the set-up of a new Control Logix controller.
2. Demonstrate the configuration of several different Control Logix I/O cards.

Methods of Evaluation:

1. Completion of homework assignments
2. Written and/or verbal quizzes covering homework and in-class demonstrations
3. Demonstration of application of procedures and methods
4. Final Project

Course Content Outline:

1. **Instrumentation**
   a. Instrumentation Overview
   b. Fundamentals of Process Control
   c. Piping and Instrumentation Diagrams
   d. Temperature, Heat, and Energy
   e. Thermal Expansion Thermometers
   f. Electrical Thermometers
   g. Infrared Radiation Thermometers
   h. Practical Temperature Measurement and Calibration
   i. Pressure
   j. Mechanical Pressure Instruments
   k. Electrical Pressure Instruments
   l. Practical Pressure Measurement and Calibration
   m. Mechanical Level Instruments
   n. Electrical Level Instruments
   o. Ultrasonic, Radar, and Laser Level Instruments
   p. Nuclear Level Instruments and Weigh Systems
   q. Practical Level Measurement and Calibration
   r. Fluid Flow
   s. Differential Pressure Flowmeters
   t. Mechanical Flowmeters
   u. Magnetic, Ultrasonic, and Mass Flowmeters
   v. Practical Flow Measurement
   w. Gas Analyzers
   x. Humidity and Solids Moisture Analyzers
   y. Liquid Analyzers
   z. Electrochemical and Composition Analyzer
   aa. Mechanical and Proximity Switches
   bb. Practical Position Measurement
2. **Process Control**
   a. Transmission Signals
   b. Digital Numbering Systems and Codes
   c. Digital Communications

d. Industrial Networks
e. Wireless Systems
f. Practical Transmission and Communication
g. Automatic Control and Process Dynamics
h. Control Strategies
i. Controller Tuning
j. Digital and Electric Controllers
k. Hydraulic Analysis
l. Control Valves
m. Selection and Sizing of Control Valves
n. Regulators and Dampers
o. Actuators and Positioners
p. Variable-Speed Drives and Electric Power Controllers
q. Safety Devices and Equipment
r. Electrical Safety Standards
s. Safety Instrumented Systems
t. General Control Techniques
u. Temperature Control
v. Pressure and Level Control
w. Flow Control
x. Analysis and Multivariable Control

Resources

Thomas A. Weedon, Philip Kirk, Franklyn W. Kirk. *Instrumentation and Process Control*. 7th. Orlando Il: American Technical Publishers, 2019.

Wade Wittmus. *PLC and HMI Programming Using Studio 5000 and FactoryTalk View*. Orlando IL: American Technical Publishers, 2023.

David Deeg, Jon Stenerson. *Siemens Step 7 (TIA PORTAL) Programming, a Practical Approach*. 2nd . London, UK: Book Depository International, 2019.

Glen A. Mazur. *Electrical Motor Controls for Integrated Systems*. 5th. Orlando, IL: American Technical Publishers, 2020.

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