MET-2460: APPLIED PROGRAMMABLE LOGIC CONTROLLERS AND MECHATRONIC SYSTEMS

Cuyahoga Community College

Viewing: MET-2460 : Applied Programmable Logic Controllers and Mechatronic Systems

Board of Trustees:
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Academic Term:
Fall 2021

Subject Code
MET - Mech Eng/Manuf Ind Eng Tech

Course Number:
2460

Title:
Applied Programmable Logic Controllers and Mechatronic Systems

Catalog Description:
Provides the knowledge and skills for the efficient operation and troubleshooting of complex mechatronic systems. Students in this program confront a complete system and learn about its various parts by examining their own role within it. They explore each of the system's individual components and discover how they interrelate. Using their knowledge of the system, students learn how to pinpoint where and why malfunctions might occur within each component.

Credit Hour(s):
5

Lecture Hour(s):
2

Lab Hour(s):
9

Requisites

Prerequisite and Corequisite
MET-1640 Robotics and Programmable Logic Controllers in Process Automation, EET-1220 Circuits and Electronics for Automation, and ISET-2200 Industrial Motor Controls or departmental approval.

Outcomes

Course Outcome(s):
Examine the role of each part within a complete mechatronics system by exploring each of the system's individual components to discover how they interrelate.

Objective(s):

a. Review technical documents, reports and outlines specific to a system and its subsystems.
b. Explain principal operations of mechatronic subsystems in a complex system.
c. Explain and demonstrate how subsystems work together.
d. Examine localized malfunctions and identify their causes/sources such as defective components.
e. Discuss the need for routine preventive maintenance of various components within the system.
f. Recognize safety regulations required for system operation.

Course Outcome(s):
Demonstrate efficient operation and troubleshooting of complex mechatronics systems.

Objective(s):

a. Interpret technical documents, reports and outlines specific to a system and its subsystems.
b. Explain principal operations of mechatronic subsystems in a complex system.
c. Explain how subsystems work together.
d. Recognize impending malfunctions and correct them (or seek expert assistance) in order to keep the production line functioning and prevent production loss.
e. Troubleshoot localized malfunctions or seek expert assistance, identify their causes/sources, correct them by repairing/replacing defective components, or document them for resolution by appropriate experts.
f. Perform routine preventive maintenance.
g. Perform assigned duties effectively as a team member, coordinating activities with upstream/downstream operations.
h. Explain principal operations of mechatronic subsystems in a complex system.

Course Outcome(s):

Recognize efficient operation in a complex mechatronic system, identify problems and be able to troubleshoot.

Objective(s):

a. Explain complex mechatronic system and describe potential components.
b. Demonstrate ability to identify problems and provide solutions.
c. Evaluate the system efficiency and correct the shortfalls or seek expert assistance.

Methods of Evaluation:

a. Quizzes
b. Text assignments
c. Tests
d. Laboratory assignments
e. Participation
f. Instructor observation/evaluation of student lab exercise performance

Course Content Outline:

a. Electrical components
    i. Current, resistance, voltage, measurement (using meters)
    ii. Laws (Ohm's, KVL, KCL)
    iii. Series circuits, parallel circuits, power (Watt's Law)
    iv. Series-parallel circuits, Wheatstone bridge
    v. Voltage dividers, variable resistance, capacitance
    vi. Electromagnetism and electromagnetic induction
    vii. AC generators, DC generators, alternators
    viii. Rectifiers and smoothing
    ix. AC Single Phase Circuits (talk about RMS and power factor)
    x. Signal types
        1. Signal "shapes" (ramp, step, square, sawtooth, sinusoidal, etc.)
        2. Interpreting scope readings/waveforms
        3. Digital vs analog
    xi. AC three phase
    xii. Transformers
    xiii. Power supplies, AC to DC (converter), DC to AC (inverter)
    xiv. Motors (AC and DC)
    xv. Solenoids
b. Mechanical components and electrical drives
    i. Mechanical principles
        1. Work and power
        2. Energy (potential and kinetic) and force
        3. Rotation and speed (and acceleration)

    4. Mechanical efficiency
    5. Load types
  ii. Belts and belt drives
    1. Pulley ratios, speed, torque
    2. Belt types
    3. Simple alignment of belt drives
    4. Belt tensioning
  iii. Chains and chain drives
    1. Sprocket ratios, speed, torque
    2. Chain types
    3. Simple alignment of chain drives
    4. Chain tensioning
  iv. Gears and gear trains
    1. Gear ratios, speed, torque
    2. Gear types
    3. Simple alignment of gear drives
    4. Transmissions
  v. Bearings types and failure modes
    1. Loading
    2. Types
    3. Failure modes
  vi. Shafts, keys, pins and retaining rings
  vii. Basic alignment terms
  viii. Couplings
  ix. Clutches and brakes
  x. Linear actuators (ball screws, ACME power threads, rack and pinion)
  xi. Elastic (mechanical) springs
  xii. Fasteners, nuts and washers
  xiii. Lubrication and friction
  xiv. Sealing and gasketing
  xv. Precision measurements
  xvi. Technical drawings (tolerances, fits, standards)
  xvii. Material basics
  xviii. Failure modes (cover brittle vs ductile)
c. (Electro) pneumatic and hydraulic control circuits
  i. What is a fluid
  ii. Advantages and disadvantages of hydraulic and pneumatic systems
  iii. Pressure and force and volume (SI units)
  iv. Vacuum
  v. Pascal’s law, work and power
  vi. Hydraulic fluid types, contamination
  vii. Fluid conditioning components
  viii. Laminar and turbulent flow
  ix. Viscosity
  x. Fluid conductors (piping)
  xi. Fluid storage/reservoirs
  xii. Hydraulic pumps, pressure and flow regulation
  xiii. Actuators, seals
  xiv. Fluid-driven motors.
  xv. Directional control valves
  xvi. Cylinder stroke and speed regulation, cushioning
  xvii. Symbols
  xviii. Pneumatic pumps (air compressors), pneumatic pressure control
  xix. Pneumatic actuators
  xx. Vacuum generators, pneumatic system conditioning
  xxi. Pneumatic actuator stroke control,
  xxii. Actuation methods (solenoid, manual, piloted, etc.)

xxiii. Electro-pneumatic/hydraulic control schematics (EPH)
xxiv. Relay schematics (european style)
xxv. Charting a mechatronic system, the Siemens way

d. Digital fundamentals and PLCs Factory of Future
   i. PLC hardware
   ii. Basic internal operation (flow of information) of a PLC
      1. I/O data tables
      2. Scan
      3. Memory calculations (bytes and bits)
   iii. Signal types
   iv. Analog vs. digital signals (input and output)
   v. Wiring inputs and outputs
   vi. Memory organization
   vii. Memory addressing
   viii. Basic ladder logic programming
      1. Branches, rungs, I/O
      2. XIO
      3. XIC
      4. Seal-in
   ix. Latching/unlatching relays
   x. Boolean logic and truth tables
   xi. Number systems
      1. Decimal
      2. Binary
      3. Floating-point binary
      4. Hex
      5. BCD (“8-4-2-1”)
      6. Conversion between all
      7. Thumbwheel switches and 7-segment displays
   xii. Timers, counters
   xiii. Program control
   xiv. Data transfer, data compare, data conversion
   xv. Mathematical manipulation
   xvi. Sequencers
   xvii. Word shifting, bit shifting, multiplexing
   xviii. RSLogix 500 vs RSLogix 5000

Resources

Shawn A. Ballee and Gary R. Shearer. *Industrial Maintenance and Mechatronics*. 1st. G-W, 2020.

James R. Daines and Martha J. Daines. *Hydraulics and Pneumatics*. 3rd. G-W, 2020.

Larry T. (Tim) Ross, Stephen W. (Steve) Fardo, and Michael F. Walach . *Industrial Robotics Fundamentals: Theory and Applications*. 3rd. G-W, 2020.

Top of page
Key: 4995