

MECH 0054 - MECHATRONICS SYSTEM

Catalog Description

Formerly known as CIE 54

Prerequisite: Completion of MECH 4 with grade of "C" or better

Hours: 108 (54 lecture, 54 laboratory)

Description: Full integration of mechatronic principles into complete closed-loop systems such as automated production equipment and industrial robots. Topics include sensors, optical encoders, analog-to-digital and digital-to-analog conversion, closed-loop AC and DC motor control, hydraulic power concepts, hydraulic motors, pneumatic and hydraulic valves and actuators and fluid power computer simulation tools. (CSU)

Course Student Learning Outcomes

- CSLO #1: Diagnose and develop solutions for issues with complete mechatronic control systems.
- CSLO #2: Analyze and construct pneumatic and hydraulic actuated systems.
- CSLO #3: Design and create closed loop industrial control systems.

Effective Term

Fall 2022

Course Type

Credit - Degree-applicable

Contact Hours

108

Outside of Class Hours

108

Total Student Learning Hours

216

Course Objectives

Lecture Objectives:

1. Explain the essential components and concepts for a closed-loop system.
2. Investigate the key parameters of an analog-to-digital interface to a PLC.
3. Investigate the key parameters of a digital-to-analog interface to a PLC.
4. Differentiate the characteristics of voltage signaling and current signaling systems.
5. Investigate PLC code for a closed-loop temperature control system.
6. Explain the concept of PWM motors speed control and the application of optical encoding.
7. Investigate the key parameters of PID loop control.
8. Analyze a PLC-based controlled-closed loop AC Motor control system using a VFD and PID loop control.
9. Appraise the advantages and disadvantages of Functional Block PLC programming.

10. Identify and select the schematic symbology used for fluid power control.
 11. Critique the advantages and disadvantages of hydraulic systems.
 12. Analyze the components and operation of a small-scale industrial processing station.
 13. Instruct the class on the operation of a small-scale industrial processing station.
 14. Analyze a full control program for a small-scale industrial processing station.
 15. Investigate the technology for PLC-based control of multi-station industrial control systems.
- Laboratory Objectives:
1. Construct, evaluate and document an analog-to-digital interface to a PLC.
 2. Construct, evaluate and document a digital-to-analog interface to a PLC.
 3. Construct, evaluate and document a PLC controlled-closed loop temperature control system.
 4. Construct, evaluate and document a closed-loop DC Motor control system using PWM and optical encoders.
 5. Construct, evaluate and document a closed-loop AC motor control system implementing PID loop control.
 6. Develop and interpret Functional Block programming for a PLC.
 7. Design and simulate a fluid power system.
 8. Construct, evaluate and demonstrate a pneumatic logic circuit.
 9. Investigate and demonstrate a hydraulic fluid-power system.
 10. Design and implement a simple control program for a small-scale industrial processing station.
 11. Evaluate, modify and document a full control program for a small-scale industrial processing station.
 12. Design and implement a PLC-based control system for a multi-station industrial control system.

General Education Information

- Approved College Associate Degree GE Applicability
- CSU GE Applicability (Recommended-requires CSU approval)
- Cal-GETC Applicability (Recommended - Requires External Approval)
- IGETC Applicability (Recommended-requires CSU/UC approval)

Articulation Information

- CSU Transferable

Methods of Evaluation

- Essay Examinations
 - Example: Students must write an essay describing the implementation of a PLC program utilizing timers and counters, including any problems they encountered and how they resolved them.
- Objective Examinations
 - Example: Students must complete a quiz on fluid power fundamentals. Standard Grading. Example: What are the fluid power fundamentals?
- Problem Solving Examinations
 - Example: Students must analyze the behavior of a small-scale industrial processing station and implement fixes for any improper operation discovered. Grading based on industry standard.
- Projects

- Example: Students must develop a PLC program that demonstrates the functionality of all input and output devices of a small-scale industrial process station. Grading based on industry standard.
- Reports
 - Example: Students must write an extensive report on the hardware and software functionality of a small-scale industrial control station.
- Skill Demonstrations
 - Example: Students must accurately build a pneumatic logic circuit, based on their design and simulation. Grading based on industry standard.

Repeatable

No

Methods of Instruction

- Laboratory
- Lecture/Discussion
- Distance Learning

Lab:

1. Students are required to write PLC code to implement analog-to-digital conversion and demonstrate proper functionality on a mechatronics trainer. Instructor will monitor the students work to ensure that equipment is not damaged due to miswiring and will guide student through methodical troubleshooting if the results are not correct.

Lecture:

1. Instruction is given by the instructor on key parameters of analog-to-digital conversion such as range and resolution. Students are to actively engage by identifying the key parameters.

Distance Learning

1. The instructor will post a video demonstrating how to write Functional Block PLC code and will provide sample code via the LMS. Students will write simulate, verify and critique PLC code in the Functional Block format, using software downloaded from the internet. Instructor will review results and student analysis of the advantages and disadvantages of this method of programming.

Typical Out of Class Assignments

Reading Assignments

1. Read PLC manual sections pertaining to analog-to-digital conversion. Students should prepare to discuss the topic during the next class session.
2. Review fluid power symbology and learn the proper method for implementing various valve, metering and actuator systems. Students should prepare to discuss the topic during the next class session.

Writing, Problem Solving or Performance

1. Analyze existing PLC code for a small-scale industrial processing station. Evaluate various alternate methods for implementing similar system behavior.
2. Write a technical report documenting the hardware and software for optimized control of a small-scale industrial processing station.

Other (Term projects, research papers, portfolios, etc.)

1. Organize and maintain a course portfolio incorporating all pertinent documentation related to fully integrated mechatronic systems.

Required Materials

- Automated Manufacturing Systems with PLCs
 - Author: Hugh Jack
 - Publisher: GVSU.edu (GNU Free License)
 - Publication Date: 2010
 - Text Edition: 7th
 - Classic Textbook?:
 - OER Link:
 - OER:
- Industrial Process Automation System
 - Author: B.R Mehta
 - Publisher: Butterworth-Heinemann
 - Publication Date: 2014
 - Text Edition: 1st
 - Classic Textbook?:
 - OER Link:
 - OER:
- Fundamentals of Industrial Instrumentation and Process Control
 - Author: Dunn, William
 - Publisher: McGraw-Hill
 - Publication Date: 2018
 - Text Edition: 2nd
 - Classic Textbook?:
 - OER Link:
 - OER:

Other materials and-or supplies required of students that contribute to the cost of the course.

Scientific calculator Computer data storage media