ELEC A131: AUTOMATION 1- INDUSTRIAL CONTROL SYSTEMS

Item	Value
Curriculum Committee Approval Date	10/30/2024
Top Code	093400 - Electronics and Electric Technology
Units	4 Total Units
Hours	108 Total Hours (Lecture Hours 54; Lab Hours 54)
Total Outside of Class Hours	0
Course Credit Status	Credit: Degree Applicable (D)
Material Fee	No
Basic Skills	Not Basic Skills (N)
Repeatable	No
Open Entry/Open Exit	No
Grading Policy	Standard Letter (S)

Course Description

This course is a hands-on study of the basics of industrial control systems. Students will learn how to control various processes without the use of PLCs such as temperature control, liquid level control and conveyor motor control. Students will gain proficiency drafting schematics and wiring diagrams and experience wiring control systems using terminal blocks. This course will focus on relays, motor drives (VFDs), motor contactors, photo eyes, thermocouples, and contact limit switches. Students will learn how to implement emergency stop circuitry and add safety components. ADVISORY: ELEC A111 and ELEC A112. Transfer Credit: CSU.

Course Level Student Learning Outcome(s)

1. Students will be able to use the knowledge gained in this course to identify components in an industrial control system and deduce how the system is intended to function.
2. Students will be able to employ diagnostic equipment and techniques to troubleshoot industrial control systems and identify faults.
3. Students will be able to use specialized tools to safely perform maintenance and repair operations on an industrial control system.

Course Objectives

- 1. Perform basic mathematical calculations using Ohm?s Law and Kirchhoff?s Laws.
- 2. Identify various types of motors and determine their operating characteristics.
- 3. Identify different types of motor starters and understand their operating characteristics.
- 4. Identify signal relays and determine their function based on how they are connected to the system.
- 5. Identify different types of motor drives and determine their specifications.
- 6. Demonstrate understanding of how various sensors are used to automate an industrial process.
- 7. Demonstrate the operation of electronically controlled valves.
- 8. Demonstrate the ability to use a multimeter to measure current using a clamp.
- 9. Demonstrate the ability to use a multimeter to measure voltage using contact.
- 10. Demonstrate the ability to use a multimeter to measure resistance of motor windings.
- 11. Demonstrate the ability to read and understand self diagnostic indications on a drive or PLC.

Lecture Content

A. Fundamental Concepts Review1. Ohm's Law2. Series and Parallel Resistors3. Voltage Dividers4. Kirchhoff s Laws B. Motors1. AC Induction Motors2. Motor Phases3. DC Motors4. Servo Motors C. Relays, Contactors, and Starters1. Signal Relays2. Power Switching Relays3. Contactors- 3 Phase and Single Phase4. Reversing Contactors5. Soft Motor Starters D. Motor Drives1. Inverters2. DC Drives3. AC Drives E. Solenoids and Pneumatic and Hydraulic Valves1. Solenoid Operation2. Positional Valves3. Pneumatic Control F. Sensors and Inputs1. Operator Controls2. Limit Switches3. Photo Eyes4. Temperature Sensors5. Pressure Sensors G. Using Test Equipment to Analyze System Performance1. Multimeters a. Voltage Measurements b. Current Clamp Measurements c. Resistance Measurements d. Ranges, Fuses,and Safety2. Oscilloscopes a. Measuring Signals b. Analyzing Noise3. Self Diagnostic Tools a. Reading Error Codes b. Interpreting Status LEDs

Lab Content

Component Familiarization and Installation Buttons Relays Lamps Alarms Potentiometers Wiring Reading and Drafting Wiring Diagrams Color Coding and Identifying Wires Wire Stripping, Crimping, and Using Terminal Blocks Wire management Motor Start/Stop (Latching) with E-Stop Students will build a circuit to start and stop a motor. Students will implement an Emergency Stop Button. Students will create a wiring diagram and ladder logic diagram describing the operation of the system. Motor Stop/Start with Directional Control Students will add directional control via a switch. All the complexities of the previous project are still required. Students will create a wiring diagram and ladder logic diagram describing the operation of the system. Motor Stop/Start with Directional Control using a Variable Frequency Drive or Inverter Students will utilize a motor drive instead of a contactor to control current to the motor. Students will set the drive to ramp up and ramp down speed (soft start) as well as run at a specified RPM. Students will use a potentiometer to control motor speed. Diagnosing System Problems Students will be presented with a relay based control system. The instructor will provide a system diagram, or simply explain how the system is intended to function. The instructor may even demonstrate proper function. The instructor will induce a fault somewhere in the system. Possible faults include- Faulty switches Faulty relays Faulty contactors Faulty connections (most common) The student will use knowledge of control systems, electronics, and a multimeter to diagnose the problem. This exercise should be repeated across a few systems and can be run several times with varying degrees of difficulty throughout the course. Final Project- Converter with Automatic Stop Students will design an industrial control system that advances a conveyor until an object breaks a photo eye beam. The project will contain all the complexity of prior projects. Additionally, students will implement an appropriate safety interlock system. Students will fully document their system to include: Process Flow Chart Narrative Description of the Process Control system summary

in bullet point form Wiring Diagram Ladder Logic Diagram Operators SOP Manual

Method(s) of Instruction

- Lecture (02)
- DE Live Online Lecture (02S)
- DE Online Lecture (02X)
- Lab (04)
- DE Live Online Lab (04S)
- DE Online Lab (04X)

Instructional Techniques

Lecture Detailed whiteboard lectures with opportunity for student engagement. Discussion of media provided and assigned via Canvas. Demonstration Lab Students build and test electronic circuits individually and as groups. Lab projects reinforce lecture topics and are paced to coincide or lag the lecture content. Lab projects generate content that students use to generate reports and documentation, enhancing writing and critical thinking skills.

Reading Assignments

Students will spend approximately 2 hours per week on reading instructor created handouts provided via the LMS

Writing Assignments

Exams Technical reports Engineering journals Approximately 2 hours per week.

Out-of-class Assignments

Students will spend approximately 2-3 hours per week on out-of-class assignments such as the following, in addition to reading/writing assignments: Daily review of student Engineering Journal Technical reports for each project assigned.

Demonstration of Critical Thinking

Students will design, build, program and analyze industrial control systems. Students will demonstrate the ability to diagnose circuit faults using fundamental theory and math to predict proper behavior and determine abnormal behavior.

Required Writing, Problem Solving, Skills Demonstration

The students are required to keep a portfolio of lab projects. Each lab project requires a technical report consisting of a wiring diagram and ladder logic diagram. The final project requires the following documentation: Process Flow Chart Narrative Description of the Process Control system summary in bullet point form Wiring Diagram Ladder Logic Diagram Operators SOP Manual

Eligible Disciplines

Electricity (electrical power distribution): Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience. Electromechanical technology (industrial mechanical technology): Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience. Electronic technology (radio, television, computer repair, avionics): Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience. Electronics: Any bachelor's degree and two years of professional experience, or any associate degree and six years of professional experience.

Other Resources

1. Material Provided via Canvas.