ELEC A232: AUTOMATION 2 - PROGRAMMABLE LOGIC CONTROLLER

Item	Value
Curriculum Committee Approval Date	12/02/2020
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
Grading Policy	Standard Letter (S)

Course Description

Students will learn how to connect to PLCs, upload and backup programs, and obtain diagnostic data from operational PLCs. This course is a hands-on course that uses both Allen-Bradley and Siemens control systems. Students will become proficient at interpreting and drafting ladder logic diagrams. This course will cover connecting various process sensors to PLC inputs as well as connecting relays to outputs to drive motor contactors, indications, and handshaking. Students will learn to describe a control process in documentation and then implement the process using ladder logic programming on the PLC. ADVISORY: ELEC A111. Transfer Credit: CSU.

Course Level Student Learning Outcome(s)

1. Students will be able to Identify common components of a PLC based industrial control system.
2. Students will be able to design, build, calibrate, and evaluate PLC based control systems to automate industrial processes.
3. Students will be able to use test equipment and diagnostic tools to analyze PLC systems and troubleshoot problems.
4. Students will be able to explain the function and operation of PLC based systems in a professional manner using industry standard diagrams, schematics, charts, and documentation.

Course Objectives

- I PLC Architecture
- I. 1. Analyze, construct and explain a system diagram of PLC Architecture
- I. 2. Analyze and produce documentation for hardware, software, preventive maintenance, Engineering journal, and technical reports
- I. 3. Explain the Automation cycle of a typical Open Loop PLC system
- I. 4. Explain the Automation cycle of a typical Closed Loop PLC system
- II PLC Motor control
- II. 1. Connect the PLC system to a PC for programming and diagnostics.
- II. 2. Analyze and operate a simple motor control program
- II. 3. Design and diagnose a program of an open loop system
- II. 4. Design and diagnose a program of an closed loop system
- II. 5. Demonstrate the ability to use a variety of hardware and software diagnostic instruments.
- III Devices
- III. 1. Differentiate between analog and digital devices
- III. 2. Differentiate between similar input devices
- III. 3. Differentiate between similar output devices.
- III. 4. Appropriately test and calibrate input/output devices
- IV System Design
- IV. 1. Construct an open and closed loop PLC system
- IV. 2. Explain the operation of the system
- IV. 3. Properly implement safety interlocks and emergency stop devices.
- V Diagnostics
- V. 1. Perform diagnostics (Test, calibrate, analyze, troubleshoot, repair) on open and closed loop systems
- V. 2. Evaluate design parameters for: Life cycle, Preventive maintenance and, intrinsically safe systems
- V. 3. Perform and design calibration tuning procedures for Open loop and Closed loop systems.

Lecture Content

Review of Industrial Automation Systems and Basic Electronics DC Circuits AC Circuits Control devices Switches Relays Transistors Review of Industrial Control Start Stop Emergency Stop Jog Reverse PLC Architecture System Architecture Components Input devices and sensors Output devices Controller Input Ports Output Ports Programming Port Interface Modules Process I/O Analog Digital Networking and Communication Power Supplies

Lab Content

Motor Stop/Start with E-Stop Students will use a PLC to implement a simple motor stop/start controller. The system will implement an E-Stop feature independent of the PLC. The system will utilize a contactor to switch current to the motor. The PLC will use lights/lamps to indicate the status of the system. Motor Stop/Start with Directional Control Students will use a PLC to implement a simple motor stop/start with a FWD/REV selector switch. The system will implement an E-Stop feature independent of the PLC. The system will utilize a contactor to switch current to the motor. The PLC will use lights/lamps to indicate the status of the system. The PLC will stop the motor and pause prior to reversing direction. The PLC will indicate a direction change by actuating an audible alarm for a period of time. Motor Stop/Start with Directional Control using a Variable Frequency Drive or Inverter Students will use a PLC to implement all of the previous project requirements. Students will utilize a motor drive instead of a contactor to control current to the motor. Students will use a potentiometer to control motor speed. Diagnosing System Problems Students will be presented with a PLC 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 PLC systems and a multimeter to diagnose the problem. This exercise should be repeated across a few systems can

can be run several times with varying degrees of difficulty throughout the course. Motor Speed Control Based on Sensor Input Students will select one of the following sensors: Temperature Light Level Photoeye or Light Based Proximity or Distance Sensor Hall Effect Sensor Students will build a PLC based control system that controls the speed of the motor based on sensor inputs in a closed-loop fashion. The instructor will validate whether the architecture provides a sufficient challenge for this exercise. The control system will feature an E-Stop, Start/Stop process buttons, and indicator lamps. Final Project Students will design a PLC controller based on a process provided by the instructor. 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 relay logic and PLC 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 bachelors degree and two years of professional experience, or any associate degree and six years of professional experience. Electromechanical technology (industrial mechanical technology): Any bachelors 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 bachelors degree and two years of professional experience, or any associate degree and six years of professional experience.

Textbooks Resources

1. Required Cumming, A. PLC Manufacturers Programming Handbook, Latest ed. Chicago: Direct Logic, 1999 Rationale: - 2. Required Petruzella, F.. Programmable Logic Controllers., latest ed. McGraw-Hill Education, 2016

Other Resources

1. Material provided via Canvas.