

Course Objectives/Course Outline
Spokane Community College

Course Title: Introduction to Programmable Controllers

Prefix and Course Number: ELMT 243

Course Learning Outcomes:

By the end of this course, a student should be able to:

- be familiar with the applications of programmable logic controllers (PLC).
- identify the components and functions of PLC's.
- be familiar with input and output interfacing to a PLC.
- be able to convert hard-wired ladder logic to PLC logic.

Course Outline:

- I. Programmable Logic Controllers
 - A. Definition
 - B. History and Evolution of the PLC
 - C. Requirements
 1. electrician friendly
 - a. programming languages
 - (1) IEEE 1131
 2. construction
 3. maintenance
 4. interface abilities
 - a. definition
 - b. industry standard electrical control signals
- II. PLC to PC Comparisons
 - A. Environment
 - B. Memory Size
 1. units
 - a. computer
 - b. PLC
 - C. Speed
 - D. Memory Storage
- III. PLC to "Hard-Wired" Control Comparisons
 - A. Physical Wiring
 - B. Speed
 - C. Special Functions
 - D. Quick Changes in Logic
- IV. PLC Selection and Sizing
 - A. I/O Capability
 - B. Memory Size
 - C. Scan Time
 - D. Special Functions
- V. PLC Components
 - A. Processor (CPU)
 - B. Power Supply
 - C. Input/Output Section (I/O)
 - D. Programmer
- VI. I/O Section

- A. Purpose
 - B. One of the Main Reasons for the PLC Versatility
 - C. Each Device Has a Distinct Address
 - VII. Modular I/O Racks or Chassis
 - A. Hardware is Used in the Modular I/O Section
 - 1. I/O racks
 - a. dip switches
 - (1) fault parameters
 - (2) addressing
 - (a) ½ slot
 - (b) one slot
 - (c) two slot
 - 2. modules
 - 3. power supplies
 - B. Local Racks
 - 1. advantages
 - 2. disadvantages
 - C. Remote Racks
 - 1. advantages
 - 2. disadvantages
 - 3. communications hardware
 - a. serial
 - (1) advantages
 - (2) disadvantages
 - b. parallel
 - (3) advantages
 - (4) disadvantages
 - c. baud rate
 - d. parity
 - e. remote I/O
 - f. controlnet
 - g. Ethernet
- VIII. Module Construction
 - A. Common Sizes
 - B. Common Voltages and Currents
 - C. Wiring Connections
 - D. Optical Isolation
 - E. Status LED
 - F. Keying
 - 1. hardware
 - 2. software
 - G. Inserting or Removing Modules Under Power
 - 1. manufacturers' guidelines
 - 2. faulting the system
 - H. Input Modules
 - 1. purpose
 - 2. response time (input filter)
 - a. AC modules
 - b. DC modules
 - 3. typical input module wiring
 - a. AC
 - b. DC

- (1) sinking
- (1) sourcing
- 4. basic AC and DC module circuitry
- I. Output Modules
 - 1. purpose
 - 2. response time
 - a. AC modules
 - b. DC modules

- 3. AC modules
 - a. zero crossing
- 4. DC modules
 - a. sinking
 - b. sourcing
- 2. typical output module wiring
- J. Basic AC and DC Module Circuitry
 - 1. triacs
 - 2. transistors
- K. Fusing Options
 - 1. factory
 - 2. field
- L. Current Ratings
 - 1. per point
 - 2. per module
 - 3. derating
- M. Surge Suppression with Inductive Devices

- N. Interposing Relays
 - 1. voltage
 - 2. current
 - 3. system interfacing
- O. Analog Input and Output Modules
 - 1. types
 - 2. applications
- P. Electrical Noise
 - 1. causes
 - 2. solutions
- Q. I/O Shielding
- IX. NEMA Safety Guidelines
 - A. NEMA Recommendations
 - B. Emergency Stop Circuit Wired to a PLC
 - 1. purpose
 - 2. options
- X. Troubleshooting PLC Systems
 - A. Status Lights
 - 1. processor
 - 2. power supply
 - 3. I/O modules
 - B. Testing Inputs and Outputs for Voltage
 - 1. characteristics of meters
- XI. Special I/O Modules
 - A. Bar Code
 - B. Co-Processors
 - C. Vision
 - D. Ethernet
- XII. Power Supply
 - A. Purpose
 - B. Sizing Procedure
 - C. System Voltages
- XIII. Processor Unit
 - A. The Processor

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B. How Does the Processor Perform or Complete Its Function

1. program scan
 - a. three typical steps
 - b. housekeeping step
 - (1) watchdog timer

- C. Scan Time
- D. I/O Capabilities
- E. Memory Size
 - 1. bit
 - 2. byte
 - 3. words
 - 4. elements (Allen-Bradley PLCs)
- F. Memory Types
 - 1. volatile
 - a. RAM
 - b. battery backup
 - (1) maintenance
 - (2) status light
 - (3) disposal
 - 2. non-volatile
 - a. ROM
 - b. EEPROM
 - (1) flashram
 - 3. working with memory
- G. Memory Groups
 - 1. data files
 - 2. programming files
- H. Communications
 - 1. peer to peer
 - 2. master/slave
 - 3. ethernet
- XIV. Programming Memory Structure
 - A. Programming Files
 - B. Main Control Programs (MCP)
 - C. Subroutines
- XV. Data Memory Structure
 - A. File Type
 - B. Allen-Bradley's PLC-5 and SLC-500 Data Table Memory
 - 1. output image table
 - 2. input image table
 - 3. processor status
 - 4. internal relays
 - 5. timers
 - 6. counters
 - 7. control
 - 8. integers-internal storage for whole numbers
 - 9. floating point-internal storage for decimal numbers
 - a. SLC-500
 - C. Allen Bradley I/O Addressing
 - 1. AB PLC-5
 - a. numbering system used
 - 2. AB SLC-500
 - a. numbering system used I/O addressing
 - 3. micro-logix
- XVI. Numbering Systems
 - A. Why Numbering Systems Were Developed
 - B. Numbering Systems Used with PLCs

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1. decimal
 2. binary
 3. hexadecimal
 4. octal
 5. binary coded decimal
- C. Least Significant Digit – Most Significant Digit

- XVII. Understanding and Using Electrical Control Diagrams
 - A. Wiring Diagrams
 - B. Ladder Logic Diagrams
 - 1. rules
 - C. Converting Hard-Wired Ladder Logic Diagrams to PLC Programs
- XVIII. Allen Bradley PLC Instructions Explained and Applied
 - A. XIC
 - 1. define an examine on instruction
 - B. XIO
 - 1. define an examine off instruction
 - C. OTE
 - D. OTL
 - E. OUT
 - F. TON
 - G. TOF
 - H. RTO
 - I. RES
 - J. CTU
 - K. CTD
- XIX. PLC Ladder Logic Programming
 - A. Rung Limitations in a PLC
 - 1. matrix size
 - B. How to Program "Around" PLC Limitations
 - 1. horizontal limits
 - 2. vertical limits
 - 3. combination horizontal and vertical limits
 - C. Machines in the Class
 - D. Programming Restrictions
 - 1. logic flow in a PLC
 - 2. outputs per rung
 - E. Branching
 - 1. limitations
 - a. number of branches per rung
 - b. nesting
 - (1) Definition: All portions of a branch do not begin at a common point, or all portions of a branch do not end at a common point.
 - c. machines that deal with nesting
 - d. programming not to "nest"
 - F. Stop Pushbuttons Wired Normally Closed in a PLC
 - 1. safety considerations
 - G. Start Pushbuttons Wired Normally Open in a PLC
 - 1. safety considerations
 - H. Logical Holding Paths Versus Discrete Holding Paths
 - I. Forcing I/O
 - 1. force on
 - 2. force off
 - J. Online or Programming Changes
 - K. Searching Functions
- XX. PLC Software
 - A. Soft PLC

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B. Programming

1. DOS
2. Windows

- XXI. Programming Devices (Programmers)
 - A. Purpose of a Programmer
 - B. Types
 - 1. dedicated desk-top programmers
 - 2. personal computers
 - 3. hand-held programmers
 - C. Programming a PLC - Define the Terms
 - 1. offline programming
 - 2. online programming
 - D. Programmer Not Required for the PLC to Operate
 - E. Monitoring the Program in a PLC While in the RUN Mode
 - 1. **True**, logically true, logic continuity, passing logic, closed
 - 2. **False**, logically false, no logic continuity, blocking logic, open
- XXII. Peripherals
 - A. Definition
 - B. Common Examples
 - 1. printers
 - 2. modems
 - a. function
- XXIII. Small Programmable Controllers
 - A. Cost
 - B. Applications
 - C. Types
 - 1. modular I/O
 - 2. fixed I/O
 - 3. block I/O
- XXIV. Recording Programs to Save for Future Use
 - A. EEPROM Chips
 - 1. flash RAM
 - B. Floppy Disk
 - C. Tape Recorders
 - D. Printout