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
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
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
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