

# MET-2140: MANUFACTURING AUTOMATION AND CONTROL

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## Cuyahoga Community College

**Viewing: MET-2140 : Manufacturing Automation and Control**

**Board of Trustees:**

May 2023

**Academic Term:**

Fall 2023

**Subject Code**

MET - Mech Eng/Manuf Ind Eng Tech

**Course Number:**

2140

**Title:**

Manufacturing Automation and Control

**Catalog Description:**

Automation and control of manufacturing machines and their auxiliary equipment to enable manufacturing systems integration, applying fundamental concepts of Programmable Logic Controllers (PLC's) with emphasis on ControlLogix-LOGIX5000 System. Basic programming and interface of robots to facilitate materials transfer in an integrated manufacturing environment.

**Credit Hour(s):**

3

**Lecture Hour(s):**

2

**Lab Hour(s):**

3

## Requisites

**Prerequisite and Corequisite**

MET-1120 Computer Applications and Programming or concurrent enrollment.

## Outcomes

**Course Outcome(s):**

Apply fundamentals of PLC Programming to analyze, edit, and troubleshoot PLC programs.

**Objective(s):**

- a. Explain a Programmable Logic Controller (PLC).
- b. Distinguish the main components of a PLC.
- c. Rate the general classifications of PLCs.
- d. Examine hardware components for PLCs.
- e. Explain the different memory storage devices.
- f. Analyze PLC architecture.
- g. Evaluate the different PLC peripheral support devices.
- h. Assess I/O modules.
  - i. Differentiate between I/O modules applications.
  - j. List the different I/O modules.
- k. Determine typical Input Devices used in a Manufacturing Environment.
  - l. Identify typical Output Devices used in a Manufacturing Environment.
- m. Demonstrate and apply the fundamentals of PLC programming.
- n. Identify PLC programming languages.
- o. Compare different PLC programming languages.
- p. Explain and apply component addresses.

- q. Examine the different instructions for PLC language.
- r. Demonstrate entering ladder diagram into program.
- s. Execute PLC program.
- t. Explain PLC Scan Time.
- u. Discuss time and event applications controlling assembly lines.
- v. Discuss analog to digital conversion.
- w. Apply analog to digital conversion to industrial applications.
- x. Employ a personal computer (PC) to program PLCs.
- y. Demonstrate using a PC to enter and edit a PLC program.
- z. Experiment with a PC to monitor a running PLC program.
- aa. List troubleshooting procedures for PLC programs.
- bb. Identify and categorize production problems.
- cc. Employ the PLC program to troubleshoot a system.
- dd. Troubleshoot PLC codes to identify particular problems and locations.

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**Course Outcome(s):**

Determine appropriate applications of PLC program.

**Objective(s):**

1. Discuss the basics of PLC numbering systems.
2. Assess the different numbering systems for PLCs (binary, octal, and hexadecimal).
3. Explain the terms that apply to binary system applications (bit, byte, and word).
4. Create a truth table.
5. Explain the function of binary logic gates.
6. Apply Boolean Algebra to logic gates.
7. Construct basic circuits using Boolean equations.
8. Sketch a basic program using gates and Boolean Algebra.
9. Analyze ladder logic.
10. Sketch a basic PLC program in a ladder logic diagram.
11. Create ladder logic diagrams from relay logic diagrams.
12. Read basic hydraulic and pneumatic circuits.

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**Course Outcome(s):**

Describe the application and distinguish among robots used in different environments.

**Objective(s):**

1. Describe motion controls of robots.
2. Select appropriate end-effectors and tooling for different robotic applications.
3. Program robots to achieve desired motions.
4. Describe and explain the applications of basic fluid power devices.
5. Identify and describe different actuators used automation.

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**Course Outcome(s):**

Perform ControlLogix™ Programming.

**Objective(s):**

- a. Create and Organize a Logix Designer Project.
- b. Create a Periodic Task in a Logix Designer Project.
- c. Configure Local I/O Modules in a Studio 5000.
- d. Program Timer Instructions in a Logix Designer Project.
- e. Program Counter Instructions in a Logix Designer Project.
- f. Program Compare Instructions in a Logix Designer Project.
- g. Program Move Instructions in a Logix Designer Project.
- h. Program Math Instructions in a Logix Designer Project.
- i. Handle Expressions in a Logix Designer Project.
- j. Create a "User Defined" Data Type in a Logix Designer Project.

- k. Document and Search Ladder Logic Using the Logix Designer Application.
- l. Configure Logix5000 Controllers to Share Data over an EtherNet/IP Network.
- m. Retrieve and Set Controller Status Values with GSV and SSV Instructions.
- n. Configure a Logix5000 message.
- o. Create Tags and Monitor Data in a Studio 5000 Logix Designer™ Project.
- p. Organize Arrays in a Logix Designer™ Project.
- q. Enter Ladder Logic Components in a Studio 5000 Logix Designer™ Routine.

**Course Outcome(s):**

Demonstrate ControlLogix™ Fundamentals and Troubleshooting.

**Objective(s):**

- a. Understand Control Systems.
- b. Locate ControlLogix® SystemComponents.
- c. Connect a Computer to a Communications Network in a Logix5000™ System.
- d. Download and Go Online to a Logix5000™ Controller.
- e. Update Logix5000™ Firmware.
- f. Locate I/O Tags and Devices in a ControlLogix® System.
- g. Interpret Logix Designer™ Project Organization and Execution.
- h. Interpret Ladder Logic Structure in a Logix Designer Routine.
  - i. Locate and Editing Tag Values in a Logix Designer™ Project.
  - j. Interpret Bit Instructions in a Logix Designer Routine.
- k. Force I/O and Toggle Bits in the Logix Designer™ Application.
  - l. Troubleshoot 1756 Digital I/O Module Problems.
- m. Troubleshoot 1756 Analog I/O Module Problems.
- n. Troubleshoot ControlLogix® Controller Problems.
- o. Navigate Through the Logix Designer Application.

**Methods of Evaluation:**

- a. Completion of assigned homework
- b. Periodic quizzes
- c. Exams
- d. Tests
- e. Simulations and Applied Demonstrations

**Course Content Outline:**

- a. CONCEPTS
  - i. Overview of Industrial Automation.
  - ii. Safety
  - iii. Programmable Logic Controllers
  - iv. Fundamentals of Programming.
    - v. Rockwell Automation Addressing and Instructions.
  - vi. Timers and Counters.
  - vii. Input/Output Modules and Wiring.
  - viii. Math and Advanced Instructions.
    - ix. Industrial Sensors.
    - x. Introduction to Robotics.
    - xi. Introduction to Fluid Power Actuation.
  - xii. Fundamentals of Process Control
  - xiii. Process Control Systems.
  - xiv. Overview of Plant Floor Communication.
    - xv. Ladder Logic
    - xvi. Programming (Rslogix, Control Logix)

- xvii. Input / output modules and devices
  - xviii. Function of binary logic gate
  - xix. Truth Tables
    - xx. Binary system application terms
  - xxi. Boolean Algebra
  - xxii. Boolean equations
  - xxiii. PLC numbering system
  - xxiv. PLC troubleshooting techniques
  - xxv. Relay logic diagrams
  - xxvi. Motion controls of robots
  - xxvii. Robotic programming techniques
- b. SKILLS
- i. Create a truth table
  - ii. Design, write, and edit PLC programs
  - iii. Set up PLC units to communicate and exchange data
  - iv. Install and troubleshoot control and monitoring devices
  - v. Comply with all appropriate safety rules and regulations
  - vi. Provide quality customer service
  - vii. Interpreting schematics and drawings
  - viii. Locating additional resources for materials & troubleshooting
  - ix. Interpreting drawings & schematics that are dimensions in U.S customary & metric units.
    - x. Sketch ladder and relay logic diagrams
  - xi. Classify and differentiate robots
  - xii. Select and setup tooling for robots
  - xiii. Program robots to orchestrate the motions required to accomplish materials transfers
  - xiv. Read basic hydraulic and pneumatic circuits
  - xv. Select different actuators and devices needed to construct simple circuits
  - xvi. Design simple fluids power circuits
- c. Issues
- i. Safety
  - ii. Troubleshooting PLC programs

## Resources

Anderson, Gary D. (2015) *PLC Programming. Using RSLOGIX 500 Advanced Programming Concepts*, Create Space.

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Anderson, Gary D. (2020) *Program Flow Instructions Using Rslogix 500*, CreateSpace Independent.

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Groover, Mikell. *Automation Production Systems, and Computer Integrated Manufacturing*. 5th ed. Harlow, England, 2021.

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Stenerson, Jon. (2010) *Programmable Logic Controllers with ControlLogix*, Cengage.

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Stenerson, Jon. (2012) *Quick Start to Programming Alternative ControlLogiz Languages*, Cengage.

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*Journal of Manufacturing Science and Engineering*. The American Society of Mechanical Engineers, 2018. <http://asmedigitalcollection.asme.org/ss/help.aspx>

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Marco, Gottardo. (2019) *Advanced PLC programming*, Lulu.com.

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**Resources Other**

- a. Amatrol and Rslogix Software

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