ITT Technical Institute

ET2750T

Programmable Logic Controllers

Onsite and Online Course

SYLLABUS

Credit hours: 4.5

Contact/Instructional hours: 67 (41 Theory Hours, 26 Lab Hours)

Prerequisite(s) and/or Corequisite(s):

Prerequisites: ET1220T Digital Fundamentals or equivalent, ET1410T Integrated Circuits or equivalent

Course Description:

In this course, students study components, operations, maintenance and troubleshooting of programmable logic controllers (PLC). Topics include I/O addressing, ladder schematics, scan sequence, sensors, actuators, controls, data manipulation methods, timers and counters, sequencers and shift-registers. Students have a PLC project in this course.

COURSE SUMMARY

COURSE DESCRIPTION

In this course, students study components, operations, maintenance and troubleshooting of programmable logic controllers (PLC). Topics include I/O addressing, ladder schematics, scan sequence, sensors, actuators, controls, data manipulation methods, timers and counters, sequencers and shift-registers. Students have a PLC project in this course.

MAJOR INSTRUCTIONAL AREAS

1. PLC hardware components
2. PLC programming
3. Fundamentals of logic
4. Developing fundamental PLC wiring diagrams and ladder logic programs
5. Programming timers and counters
6. Program control instructions
7. Data manipulation and math instructions
8. Sequencer and shift register instructions
9. PLC installation practices, editing, and troubleshooting

COURSE LEARNING OBJECTIVES

By the end of this course, you should be able to:
1. Describe the operation and components of a PLC system.
2. Identify electrical and safety requirements to install and interface a PLC system.
3. Explain I/O addressing and the corresponding file image table.
4. Describe the PLC scan sequence and PLC operating modes.
5. Create correct ladder logic programs.
6. Use PLC timers and counters with associated circuitry to control a system.
7. Interpret relay ladder schematics and convert to ladder logic diagrams.
8. Identify sensors, actuators, and controls used in PLC systems.
9. Explain the methods used for program control in a PLC system.

10. Differentiate between data manipulation methods and explain purposes of data instructions.

11. Use PLC sequencers and shift-registers with associated circuitry to control a system.

COURSE OUTLINE

MODULE 1: FUNDAMENTAL PLC CONCEPTS

COURSE LEARNING OBJECTIVES COVERED

- Describe the operation and components of a PLC system.
- Identify electrical and safety requirements to install and interface a PLC system.

TOPICS COVERED

- PLC Industry Today
- PLC Definitions
- General Characteristics of PLC
- PC/PLC Differences and Similarities
- PLC Block Diagram
- Ladder Logic Programming
- Electrical Shock and Safe Electrical Practices

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 1, Sections 1-2–1-5, pp. 3–21 and Section 1-7, pp. 28–32; Chapter 2, Sections 2-2–2-8, pp. 33–73.	No	6.5 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Discussion: Participate in the discussion titled "Evolution of the Modern-Day PLC Industry."	Yes	NA
Lab: Complete the lab titled "Getting Started with PLCs."	Yes	NA
Project: Read and begin the project.	No	1 hr

Total Out-Of-Class Activities: 9 Hours

MODULE 2: PLC PROGRAMMING WITH TIMERS AND COUNTERS

COURSE LEARNING OBJECTIVES COVERED

- Explain I/O addressing and the corresponding file image table.
- Describe the PLC scan sequence and PLC operating modes.
- Create correct ladder logic programs.
- Use PLC timers and counters with associated circuitry to control a system.

TOPICS COVERED

- PLC Memory
- PLC Ladder Logic Programming
- Input and Output Addressing
- PLC Scan
- Mechanical and Electronic Timers
- PLC Timer Instructions
- Mechanical and Electronic Counters
- Allen Bradley Counters or Up/Down Counters

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 3, Sections 3-5–3-12, pp. 84–140, Chapter 4, Sections 4-2–4-12, pp. 141–177, and Chapter 5, Sections 5-2–5-8, pp. 179–209.	No	12.5 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Exercise 1: Submit the exercise titled "PLC Programming and I/O Logic."	Yes	2 hr
Exercise 2: Submit the exercise titled "Timers and Counters."	Yes	2 hr
Lab 1: Complete the lab titled "Programming Input and Output Logic."	Yes	NA
Lab 2: Complete the lab titled "Timers and Up/Down Counters."	Yes	NA
Project: Continue work on Project Part 1.	No	3 hr

Total Out-Of-Class Activities: 21 Hours

MODULE 3: PLC INSTRUCTIONS

COURSE LEARNING OBJECTIVES COVERED

- Create correct ladder logic programs.

- Interpret relay ladder schematics and convert to ladder logic diagrams.

- Explain the methods used for program control in a PLC system.

TOPICS COVERED

- Arithmetic Instructions

- Move Instructions

- Comparison Instructions

- Program Control Instructions

- Immediate Input and Output Instructions

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 6, Sections 6-4-6-6, pp. 215-223 and Section 6-8, p. 235, Chapter 7, Sections 7-4-7-6, pp. 250-267, and Chapter 8, Sections 8-2-8-4, pp. 273-298.	No	6 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Exercise: Submit the exercise titled "PLC Instructions."	Yes	4 hr
Lab 1: Complete the lab titled "Math, Move, and Compare Instruction Ladder Logic."	Yes	NA
Lab 2: Complete the lab titled "Programming Control and Addressing Instructions."	Yes	NA
Project: Submit Project Part 1.	Yes	3 hr

Total Out-Of-Class Activities: 14.5 Hours

MODULE 4: ADDRESSING, DATA HANDLING, AND SEQUENCER INSTRUCTIONS

COURSE LEARNING OBJECTIVES COVERED

- Explain I/O addressing and the corresponding file image table.
- Create correct ladder logic programs.
- Differentiate between data manipulation methods and explain purposes of data instructions.
- Use PLC sequencers and shift-registers with associated circuitry to control a system.

TOPICS COVERED

- Addressing Modes
- Data Handling
- Logical Bitwise Instructions
- File-Arithmetic-Logic Instruction
- Bit-Shifting and Word-Shifting Instructions
- Sequencers

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 9, Section 9-2, pp. 303–309, Chapter 10, Sections 10-2–10-3, pp. 317–340, and Chapter 11, Sections 11-3–11-4, pp. 349–369.	No	6 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Discussion: Participate in the discussion titled "Addressing Modes and Shift Operations."	Yes	NA
Exercise 1: Submit the exercise titled "Allen Bradley Addressing Modes."	Yes	1 hr
Exercise 2: Submit the exercise titled "Data Handling and Sequencer Instructions."	Yes	4 hr
Lab: Complete the lab titled "Ladder Logic Problems Using Data Handling and Sequencer Instructions."	Yes	NA
Project: Continue work on Project Part 2.	No	3 hr

Total Out-Of-Class Activities: 15.5 Hours

MODULE 5: SENSORS, PROCESS CONTROL, AND DISTRIBUTIVE CONTROL

COURSE LEARNING OBJECTIVES COVERED

- Identify sensors, actuators, and controls used in PLC systems.
- Explain the methods used for program control in a PLC system.

TOPICS COVERED

- Analog Sensors
- Closed Loop Control Systems
- Intermittent and Continuous Control
- Sequential Function Chart
- Network Standards
- Network Interfaces and Applications
- Distributed Networks
- Network Design

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 12, Sections 12-2-12-5, pp. 373-420, Chapter 14, Sections 14-2-14-4, pp. 449-469, and Chapter 17, Sections 17-2-17-11, pp. 511-528.	No	9 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Discussion: Participate in the discussion titled "Process Control."	Yes	NA
Exercise: Submit the exercise titled "Closed Loop Systems and Networking PLCs."	Yes	4 hr
Lab: Complete the lab titled "PLC Installation, Control System, Network, and Protocols."	Yes	NA
Project: Submit Project Part 2.	Yes	3 hr

Total Out-Of-Class Activities: 17.5 Hours

MODULE 6: PLC STANDARD IEC 61131-3 LANGUAGES

COURSE LEARNING OBJECTIVES COVERED

- Describe the operation and components of a PLC system.

- Identify electrical and safety requirements to install and interface a PLC system.

- Explain I/O addressing and the corresponding file image table.

- Describe the PLC scan sequence and PLC operating modes.

- Create correct ladder logic programs.

- Use PLC timers and counters with associated circuitry to control a system.

- Interpret relay ladder schematics and convert to ladder logic diagrams.

- Identify sensors, actuators, and controls used in PLC systems.

- Explain the methods used for program control in a PLC system.

- Differentiate between data manipulation methods and explain purposes of data instructions.

- Use PLC sequencers and shift-registers with associated circuitry to control a system.

TOPICS COVERED

- Functional Block Diagram

- Structured Text Language

- Sequential Function Chart

MODULE LEARNING ACTIVITIES	GRADED	OUT-OF-CLASS TIME
Reading: Rehg & Sartori, Chapter 13, Sections 13-2–13-5, pp. 423–448, Chapter 15, Sections 15-2–15-4, pp. 477–486, and Chapter 16, Sections 16-2–16-3, pp. 495–508.	No	4 hr
Lesson: Study the lesson for this module.	No	1.5 hr
Lab: Complete the lab titled "ITT Tech Virtual Library Research on PLCs."	Yes	NA
Final Exam: Prepare for the final exam.	No	5 hr
Final Exam: Take the final exam.	Yes	NA

Total Out-Of-Class Activities: 10.5 Hours

EVALUATION AND GRADING

EVALUATION CRITERIA

The graded assignments will be evaluated using the following weighted categories:

CATEGORY	WEIGHT
Exercise	20%
Lab	30%
Project	25%
Discussion	10%
Final Exam	15%
TOTAL	100%

GRADE CONVERSION

The final grades will be calculated from the percentages earned in the course, as follows:

GRADE		PERCENTAGE
A	(4.0)	90–100%
B+	(3.5)	85–89%
B	(3.0)	80–84%
C+	(2.5)	75–79%
C	(2.0)	70–74%
D+	(1.5)	65–69%
D	(1.0)	60–64%
F	(0.0)	<60%

LEARNING MATERIALS AND   REFERENCES

REQUIRED RESOURCES

COMPLETE TEXTBOOK PACKAGE

- Rehg, J. A., & Sartori, G. J. (2009). *Programmable logic controllers (2nd ed.). Upper Saddle River, NJ: Prentice Hall.*
- Textbook Supplements:
  - Online Instructor's Resource Manual with PowerPoints
  - Online TestGen
  - Laboratory Exercises

OTHER ITEMS

If you're taking this course on-campus, you will be provided with:

- Electronics Student Kit: RSLogix 500 software

If you're taking this course off-campus, you will be provided with:

- Electronics Student Kit: LogixPro PLC Simulator with ProSim-II Simulations

  Refer to the [LogixPro PLC Simulator Installation Guide](#) for download instructions.

RECOMMENDED RESOURCES

- Books and Professional Journals
  - Hooper, J. F. (2004). *Introduction to PLCs. Durham., NC: Carolina Academic Press.*
  - Stenerson, J. (2003). *Programming PLCs using Rockwell automation controller. Upper Saddle River, NJ: Pearson Publication.*
- Professional Associations
  - IEEE–International Electrical and Electronic Engineers
  - ISCET–International Society of Certified Electronic Technicians

- <u>ITT Tech Virtual Library</u> (accessed via Student Portal | <u>https://studentportal.itt-tech.edu</u>)
    - o   Basic Search> Browse> Browse by Format> Books> eBooks on EbscoHost>
        - ▪ Bolton, W. (2009). *Programmable logic controllers. Amsterdam: Newnes.*
        - ▪ Wang, L., & Tan, K. C. (2006). *Modern industrial automation software design: Principles and real-world applications. Piscataway, NJ: IEEE Press.*
    - ▪ <u>Other References</u>
        - o   Allen-Bradley

<u>http://www.ab.com</u>

    - o   Free PLC Books Download | Ebooks online

<u>http://www.freeengineeringbooks.com/Electrical/Plc-Ebooks-Download.php</u>

    - o   The PLCMAN

<u>http://www.plcman.co.uk/</u>

<u>NOTE:</u> All links are subject to change without prior notice.

INSTRUCTIONAL METHODS AND TEACHING STRATEGIES

The curriculum employs a variety of instructional methods that support the course objectives while fostering higher cognitive skills. These methods are designed to encourage and engage you in the learning process in order to maximize learning opportunities. The instructional methods include but are not limited to lectures, collaborative learning options, use of technology, and hands-on activities.

To implement the above-mentioned instructional methods, this course uses several teaching strategies, such as online lessons and hands-on labs. Your progress will be regularly assessed through a variety of assessment tools including labs, discussions, exercises, project, and final exam.

OUT-OF-CLASS WORK

For purposes of defining an academic credit hour for Title IV funding purposes, ITT Technical Institute considers a quarter credit hour to be the equivalent of: (a) at least 10 clock hours of classroom activities and at least 20 clock hours of outside preparation; (b) at least 20 clock hours of laboratory activities; or (c) at least 30 clock hours of externship, practicum or clinical activities. ITT Technical Institute utilizes a "time-based option" for establishing out-of-class activities which would equate to two hours of out-of-class activities for every one hour of classroom time. The procedure for determining credit hours for Title IV funding purposes is to divide the total number of classroom, laboratory, externship, practicum and clinical hours by the conversion ratios specified above. A clock hour is 50 minutes.

A credit hour is an artificial measurement of the amount of learning that can occur in a program course based on a specified amount of time spent on class activities and student preparation during the program course. In conformity with commonly accepted practice in higher education, ITT Technical Institute has institutionally established and determined that credit hours awarded for coursework in this program course (including out-of-class assignments and learning activities described in the "Course Outline" section of this syllabus) are in accordance with the time-based option for awarding academic credit described in the immediately preceding paragraph.

ACADEMIC INTEGRITY

All students must comply with the policies that regulate all forms of academic dishonesty or academic misconduct. For more information on the academic honesty policies, refer to the Student Handbook and the School Catalog.

INSTRUCTOR DETAILS

Instructor Name	
Office Hours	
Contact Details	

(End of Syllabus)