Beni Suef Technological University

PLC

Syllabus

Syllabus

Course Title: PLC

Course Code: N/A

Course Followers:

Students of Mechatronics Department in 1st semester of 2nd year

Course Meeting Times

Lectures: 1 session / week, 2 hours / session

Tutorial: 1 session / week, 2 hours / session

Labs: 1 session / week, 3 hours / session

Course Credits: 4

Course Introduction

This course gives Mechatronics department students necessary knowledge and understanding of Siemens or Mitsubishi PLC (Programmable Logic Controller) that are widely used in the industrial field. This course deals with some fundamentals of PLC-based control systems without which Mechatronics technicians‟ field, namely factory automation domain cannot exist. This PLC course is designed to equip the novice with no prior PLC programming experience with the basic tools required to create a complete PLC program using ladder logic common to most current platforms. Using Siemens or Mitsubishi PLC software, we will be covering such topics as general controls, digital and analog IO, ladder logic programming, alarm/notification handling, emulation, best practices and more. The student will write, enter, and execute application programs using the

programmable controllers. The use of the PLC Lab equipment will give the student practical programming and troubleshooting skills used in the maintenance of automated systems.

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Course Objectives

Main objective:

The main objective is learning PLC operation and programming.

Learning objectives:

1. Characteristics of a PLC
2. Know general PLC issues
3. Understanding of PLC programming, ladder logic.
4. Understand and design basic input and output wiring
5. Analysis and classification of the process control
6. Interlocking process control
7. Sequential process control
8. Random process control
9. Understand the operation of a PLC
10. Understanding of Siemens or Mitsubishi PLC hardware units and utilizing them.

Learning Outcomes

By the end of this practice, mechatronics department students will be able to:

1. Describe typical components of a Programmable Logic Controller.
2. Explain the basic concepts of a Programmable Logic Controller.
3. State basic PLC terminology and their meanings.
4. Explain and apply the concept of electrical ladder logic, its history, and its relationship to programmed PLC instruction.
5. Use ladder language programming for real cases.
6. Explain the concept of basic digital electronics and data manipulation.
7. Learn the difference between digital and analog signals and how to bring them into a PLC, process them, and send them back out.

8. Use latch, timer, counter, and other intermediate programming functions.
9. Design and program basic PLC circuits for entry-level PLC applications.
10. Design and program a small, automated industrial production line.
11. Explore basic, standard controls techniques for all process control which classified into Interlock control, Sequential control, and Random control.
12. By the end of this practice, students will be able to create a PLC program from scratch and find some solutions for real-time industrial automation problems.

Prerequisites / Reference Courses

Classic control

Digital signaling

Microprocessor and microcontroller

Sensors in Technology

System Network in Technology

Textbooks

The course textbooks are:

1. Mano, M. Morris. Digital logic and computer design. Pearson Education India, 2017.
2. Kamel, Khaled, and Eman Kamel. Programmable logic controllers: Industrial control. McGraw Hill Professional, 2013.
3. Handbook, P. L. C. "Practical Guide to Programmable Logic Controllers." AutomationDirect. com.
4. Jack, Hugh. Automating manufacturing systems with PLCs. Lulu. com, 2010.
5. CHUNGPA, "User's Manual :Universal PLC Training System CPS-3580U", English ver1, 2020.
6. Egyptian Company for the Development of Technical Education (ECDTE), PLC Kit Manual: ECDTE 1000.1 Laboratory Manual, 2018.

Homework

- Homework will be issued in lectures and collected a week later in recitation.
- Corrected homework with solutions will be returned in labs the week after it is collected. You are welcome and encouraged to discuss the homework among your colleagues. However, the final formulation and write up of your homework answers must be your own.

- Submitting homework copied from someone else is a breach of ethics, and will be handled by the Committee on Discipline. More importantly, although homework counts for only 5 percent of the grade, they are critical to learning the material and to doing well on the quizzes and final exam. **One homework problem will appear in each of the tests**, and homework performance will be taken into account during grade assignment for cases that are on letter-grade boundaries.
- **Late homework will not be accepted for grading**. However, total homework grades will be based on the best nine out of eleven individual homework grades. Thus, with one exception, two homework assignments may be missed without a grading penalty.
- All homework will be graded on a coarse scale of 0 to 3 points. 3 points if all or nearly all problems are correct, 2 points if homework is approximately half correct, 1 point if mostly incorrect, and 0 points if late or not submitted.

Labs (or Tutorials/Exercise, Workshop)

- Labs will be conducted during the weeks shown in the schedule. Each lab assignment involves one or more accomplishments which must be checked off by an instructor in the lab. The instructor will be available for help and lab check-off during those weeks in which a lab is in progress.
- No written work will be due for the last lab.
- You are welcome and encouraged to discuss the labs among your colleagues. You are also welcome to team up in pairs to execute a lab. However, the write up of your lab must be done on your own. Skipping the lab and submitting work copied from someone else is a serious breach of ethics and will be handled by the Committee on Discipline.
- Lab assignments will be graded on a scale of 0 to 3 (3: lab complete, works, good job on pre- and post-lab; 2: lab mostly complete, reasonable job on pre and post lab; 1: lab partially done, marginal to poor job on pre- and post-lab; 0: lab not done, poor job on pre- and post-lab).

Lab Books

- You must obtain the contents of a few pages for every lab (from Lab #1 to lab #15) for recording measurements, observations and graphs of data taken during the in-lab exercises.
- Written pre-lab and post-lab exercises are also to be completed in your own papers.

Midterm Exam

- One closed-book midterm exam will be given in this term. The exam will take place few days after Lab #7 for a two-hour duration.
- There will be no lecture or lab on the day. **You may bring <u>one two-sided sheet of notes</u> written by your own hands to the exam**. You may also bring a calculator, eraser, pencil or ball pens.

Final Exam

- A three-hour final exam will be given during the end-of-term exam week. Timing and room assignments will be announced later. **You may bring three two-sided sheets of notes written by your own hands to the exam**.

Calendar

The calendar provides information on the course's lecture class (L), lab (Lab #), and exam (E) sessions.

SES #	TOPICS	KEY DATES
L1	Introduction to Logic Circuit: Logic Gates, Numbering System.	Homework #1 in
Lab #1	Introduction to PLC lab	Lab report #1 in
L2	Interfacing Peripheral Chips: F.F., Registers, Tristate Buffers, Latches, Decoders, Memory.	Homework #1 out Homework #2 in
Lab #2	Configuration and Software Install	Lab report #1 out Lab report #2 in
L3	Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC.	Homework #2 out Homework #3 in
Lab #3	Monitoring and Simulation	Lab report #2 out Lab report #3 in
L4	PLC Construction: What is a PLC, Why preferring PLC, PLC Memories, PLC I/O, PLC Programming, introduction to PLC Ladder, PLC Special I/O, PLC Types.	Homework #3 out Homework #4 in
Lab #4	Ladder Logic	Lab report #3 out Lab report #4 in
L5	PLC Basic Instructions: PLC Ladder Language, Ladder/Instruction List, PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung).	Homework #4 out Homework #5 in
Lab #5	Logic Design with Siemens (TIA Portal)	Lab report #4 out Lab report #5 in
L6	Process Control Problems Classification: Types of Process Control, Interlock control definition, Sequential control definition, Random control	Homework #5 out Homework #6 in

SES #	TOPICS	KEY DATES
	definition, Interlock control examples.	
Lab #6	Logic Design with Mitsubishi (GX-Works2)	Lab report #5 out Lab report #6 in
L7	Timers and Counters: Timers, Counters, Examples.	Homework #6 out Homework #7 in
Lab #7	Timers and Counters	Lab report #6 out Lab report #7 in
E1	**Midterm Exam**	
L8	Word and Branching Instruction: Data Handling Instruction, Arithmetic Instruction, PLC Internal Facilities, Logic Instruction, I/O Instruction, Program Control Instruction.	Homework #7 out Homework #8 in
Lab #8	Experiments Classification and Simple Programming Exercises	Lab report #7 out Lab report #8 in
L9	Sensors, Switches, Solid State Relays.	Homework #8 out Homework #9 in
Lab #9	Solving Interlock Problems	Lab report #8 out Lab report #9 in
L10	Sequential Process Control: Sequential control, Sequential control examples.	Homework #9 out Homework #10 in
Lab #10	Solving Basic Sequential Problems	Lab report #9 out Lab report #10 in
L11	Application Examples of Sequential Industrial Problem	Homework #10 out Homework #11 in
Lab #11	Traffic Control	Lab report #10 out Lab report #11 in
L12	Application Examples of Production Lines	Homework #11 out Homework #12 in
Lab #12	Conveyor Control	Lab report #11 out Lab report #12 in

SES #	TOPICS	KEY DATES
L13	Application Examples	Homework #12 out Homework #13 in
Lab #13	Stepper Motor Control	Lab report #12 out Lab report #13 in
L14	Random Process Control: Random control, Random control examples.	Homework #13 out Homework #14 in
Lab #14	CNC Machine Control	Lab report #13 out Lab report #14 in
L15	Application Examples	Homework #14 out Homework #15 in
Lab #15	Random Experiment: Elevator Control	Lab report #14 out Lab report #15 in
E2	**Final Exam**	

Grading (or Assessment) Policy

Initial grading will be based on the following weighting:

ACTIVITIES	PERCENTAGES
Homework	5%
Labs (performance & reports)	35%
Midterm	30%
Final exam	30%

- Lab assignments will be graded on a scale of 0 to 3
  - i) 3: lab complete, works, good job on pre- and post-lab;
  - ii) 2: lab mostly complete, reasonable job on pre and post lab;
  - iii) 1: lab partially done, marginal to poor job on pre- and post-lab;

iv) 0: lab not done, poor job on pre- and post-lab.

- All homework will be graded on a coarse scale of 0 to 3 points,
  - i) 3 points if all or nearly all problems are correct,
  - ii) 2 points if homework is approximately half correct,
  - iii) 1 point if mostly incorrect, and
  - iv) 0 points if late or not submitted.

· This will be followed by considerable discussion among the entire teaching staff to factor in your diligence on the homework and labs, and your participation in class and labs. This discussion can affect your letter grade for the course, particularly if your initial grade is on a letter-grade boundary.

· Furthermore, failure to complete the labs in this subject will result in an overall grade that is one letter grade lower (not an Incomplete).

· This subject has been designed so that lectures, homework and labs are integral and essential parts of the learning process. Although there is no specific reward for participation, there is a clearly defined penalty for not participating. Students who consistently miss lectures, homework and labs will not be included in the grading discussions.

Lecture notes

This section contains lecture notes from some chapters of the following books,

I) Mano, M. Morris. Digital logic and computer design. Pearson Education India, 2017.
II) Kamel, Khaled, and Eman Kamel. Programmable logic controllers: Industrial control. McGraw Hill Professional, 2013.
III) Handbook, P. L. C. "Practical Guide to Programmable Logic Controllers." AutomationDirect. com.
IV) Jack, Hugh. Automating manufacturing systems with PLCs. Lulu. com, 2010.
V) CHUNGPA, "User's Manual :Universal PLC Training System CPS-3580U", English ver1, 2020.
VI) Egyptian Company for the Development of Technical Education (ECDTE), PLC Kit Manual: ECDTE 1000.1 Laboratory Manual, 2018.

LEC #	TOPICS	LECTURE NOTES
L1	Introduction to Logic Circuit: Logic Gates, Numbering System.	BOOK I Chapter 1: Binary Systems Chapter 2: Boolean Algebra

LEC #	TOPICS	LECTURE NOTES
		and Logic Gates
L2	Interfacing Peripheral Chips: F.F., Registers, Tristate Buffers, Latches, Decoders, Memory.	BOOK I Chapter 6: Synchronous Sequential Logic Chapter 7: Registers, Counters and the Memory Unit
L3	Introduction to PLC: Microprocessor, I/O Ports, Isolation, Filters, Drivers, Microcontrollers/DSP, PLC/DDC.	BOOK II Chapter 1: Introduction to PLC Control Systems and Automation Chapter 2: Fundamentals of PLC Logic Programming
L4	PLC Construction: What is a PLC, Why preferring PLC, PLC Memories, PLC I/O,	BOOK II Chapter 1: Introduction to PLC Control Systems and Automation BOOK III Chapter 1: What is a PLC Chapter 5: PLC Software
L5	PLC Basic Instructions: PLC Ladder Language, Ladder/Instruction List, PLC Basic Instructions, Basic Examples (Start Stop Rung, Entry/Reset Rung).	BOOK IV Chapter 1: Introduction Chapter 14: Ladder Logic Functions
L6	Process Control Problems Classification: Types of Process Control, Interlock control definition, Sequential control definition, Random control definition, Interlock control examples.	BOOK VI Chapter 4: Experiments
L7	Timers and Counters: Timers, Counters, Examples.	BOOK IV Chapter 8: Latches, Timers, Counters and more.
L8	Word and Branching Instruction: Data Handling Instruction, Arithmetic Instruction, PLC Internal Facilities, Logic Instruction, I/O Instruction, Program Control Instruction.	BOOK IV Chapter 14: Ladder Logic Functions
L9	Sensors, Switches, Solid State Relays.	BOOK IV

LEC #	TOPICS	LECTURE NOTES
		Chapter 3: Logical Sensors
L10	Sequential Process Control: Sequential control, Sequential control examples.	BOOK VI Chapter 4: Experiments
L11	Application Examples of Sequential Industrial Problem	BOOK VI Chapter 4: Experiments
L12	Application Examples of Production Lines	BOOK VI Chapter 4: Experiments
L13	Application Examples	BOOK VI Chapter 4: Experiments
L14	Random Process Control	BOOK VI Chapter 4: Experiments
L15	Application Examples	BOOK VI Chapter 4: Experiments

Lab notes (or Practice Manual)

This section contains lab notes from every chapter of the practice manual, "M. Kang and Amir Yassin, PLC, (Practice Manual), 2020."

LAB #	TOPICS	LAB NOTES (PRACTICE MANUAL CHAPTER)
Lab #1	Introduction to PLC lab	Module 1: Chapter 1
Lab #2	Configuration and Software Install	Module 1: Chapter 2
Lab #3	Monitoring and Simulation	Module 1: Chapter 3
Lab #4	Ladder Logic	Module 2: Chapter 4
Lab #5	Logic Design with Siemens (TIA Portal)	Module 2: Chapter 5

LAB #	TOPICS	LAB NOTES (PRACTICE MANUAL CHAPTER)
Lab #6	Logic Design with Mitsubishi (GX-Works2)	Module 2: Chapter 6
Lab #7	Timers and Counters	Module 3: Chapter 7
Lab #8	Experiments Classification and Simple Programming Exercises	Module 4: Chapter 8
Lab #9	Solving Interlock Problems	Module 4: Chapter 9
Lab #10	Solving Basic Sequential Problems	Module 5: Chapter 10
Lab #11	Traffic Control	Module 5: Chapter 11
Lab #12	Conveyor Control	Module 5: Chapter 12
Lab #13	Stepper Motor Control	Module 5: Chapter 13
Lab #14	CNC Machine Control	Module 5: Chapter 14
Lab #15	Random Experiment: Elevator Control	Module 6: Chapter 15