Course Title: Programmable Logic Controller		**Course Code: 15MC51T**
Mode (L:T:P) : 4:0:0	**Credits:4**	**Core/ Elective: Core**
Type of Course: Lectures & Student Activities		**Total Contact Hours: 52**
CIE :25 Marks		**SEE : 100 Marks**

Pre-requisites: Knowledge of Fundamentals of Digital Electronics Engineering, Basics of Electrical and Electronic Engineering, Fluid Pneumatics and Industrial Electronics.

Course Objectives: to understand Programmable Logic control, Programming and Ladder diagrams to implement in Engineering Applications.

Course Outcome: At the end of the course, the student should be able to,

1. Explain PLC and its Architecture.

2. Build the PLC Programs using Ladder Diagrams.

3. Develop the PLC Applications involving Arithmetic and Timer functions.

4. Develop the PLC Applications involving Counter Functions.

5. Explain the Data handling functions and Shift Register Applications.

6. Explain the Advanced PLC Operations.

	Course Outcome	**Cognitive Level**	**Linked with PO**	**Teaching Hours**
CO1	Explain PLC and its architecture.	U	2	10
CO2	Build the PLC Programs using Ladder Diagrams.	U/A	2	08
CO3	Develop the PLC Applications involving Arithmetic and Timer functions.	U/A	2	10
CO4	Develop the PLC Applications involving Counter Functions.	U/A	2	10
C05	Explain the Data handling functions and Shift Register Applications.	U/A	2	10
C06	Explain the Advanced PLC Operations.	U	2	04
		Total sessions		52

Legend: R; Remember, U: Understand A: Application

Mapping of Course Outcomes with Program Outcomes.

Course	Programme Outcomes									
	1	2	3	4	5	6	7	8	9	10
Programmable Logic controller	-	3	-	-	-	-	-	-	-	-

Course Content and Weightage For SEE

Unit No	Unit Name	CO	Hour	Marks allocated for different Cognitive level Questions			Marks Weightage (%)
				R	U	A	
1	Introduction and Architecture of PLC	1	10		25	-	17.24
2	Basic PLC Programming	2	08	-	10	10	13.80
3	PLC Arithmetic and Timer functions	3	10	-	10	20	20.68
4	PLC Counter Functions	4	10	-	10	20	20.68
5	Data handling functions and Shift Registers	5	10	-	20	10	20.68
6	Advanced PLC Operations.	6	04	-	10	-	6.9
	Total		52	145 Marks			100

Contents

Unit-I

Introduction and Architecture of PLC

Introduction, Block diagram of PLC system, Classification of PLC, Relay Logic Control and PLC Logic Control, PLC advantages and disadvantages, Internal Architecture of PLC, I/O Modules (Interfaces), Memory organization.

10 Hours

Unit-II

Basic PLC Programming

Programming standards, PLC Input Instructions, Outputs: Coils, Indicators and others, Contact and Coil Input/ Output Programming Examples, Relation of Digital Gate Logic to Contact/Coil Logic, Conversion from word description to ladder diagram and vice-versa.

8 Hours

Unit-III

PLC Arithmetic and Timer Functions

PLC arithmetic functions (Addition, Subtraction, Multiplication & Division), Basic comparison function, Comparison functions in application process, Introduction to Timer functions, PLC timer functions, Applications of timing functions in process control -- On Delay Timer Function, Of-delay Timer Function, Limited on time Timer Function , Repeat cycling Timer (Pulsed Timer) Function, one shot Timer operation Function.

10 Hours

Unit-IV

PLC Counter Functions

Introduction, PLC counter functions, Applications of PLC counter function in process control -- Basic PLC Counter Operation , Dual Counter Operation ,Count and Time Program ,delay of the start of the Counting Process, Rate per Time Period Program Sequencer Function.

10 Hours

Unit-V

Data Handling Functions and Shift Registers

Skip function, Master control relay function, Jump with non-return, Jump with return, MOVE function and application, Block MOVE function and applications, FIFO Functions. Bit patters in a register, changing a register big status, Shift Register functions, Shift Register applications -- Flashing Arrow Patterns and Registers, Morse Code SR Patterns.

10 Hours

Unit-VI

Advanced PLC Operations

PID module, PLC and the Internet, SCADA system, Distributed Control System, Selection of PLC and its Maintenance.

4 Hours

References.
1. "Programmable Logic Controllers Principles and Applications" by John W. Webb – Ronald   A. Reis. , 5th Edition, Published by PHI Publication.
2. "Introduction to PLC's" by Gary Dunning, 3rd Edition, Thomson India Edition
3. "PLC's" by W. Bolton, 4th edition.
4. Programmable Logic Controllers by Frank D Petruzella, 4th Edition, McGraw Hill Publications.

E-References/ Urls

1) http://www.automazione.ingre.unimore.it/pages/corsi/materialedidattico/CMA1213meccatronica/IEC61131_1.pdf.
2) http://www.slideshare.net/indira_kundu/basics-of-automation-plc-and-scada.
3) http://applicationofscada.blogspot.in/2012/05/introduction-of-power-plant.html

Student Activity

Activity No.	Description of the Student Activity
1	Carry out a Survey and Prepare a hand written report on the different PLC's available in market.
2	Students can make simulations of PLC applications beyond the curriculum.
3	Prepare a hand written report on the various Sensors and Actuators used in the PLC Implementations.

Note:
1. Group of max four students should do any one of the above activity or any other similar activity related to the course COs and get it approved from concerned Teacher and HOD.
2. No group should have activity repeated or similar
3. Teacher should ensure activities by different groups must cover all COs
4. Teacher should asses every student by using suitable **Rubrics** approved by HOD

Sample Rubrics

Dimension	Exemplary	Accomplished	Developing	Beginning	Roll No. of the Student				
	5/4	3	2	1	1	2	3	4	5
Organization	Information presented in logical, interesting sequence	Information in logical sequence	Difficult to follow presentation-- student jumps around	Cannot understand presentation-- no sequence of information	Ex: 2				
Subject Knowledge	Demonstrates full knowledge by answering all class questions with explanations and elaborations	At ease with expected answers to questions but does not elaborate	Uncomfortable with information and is able to answer only rudimentary questions	Does not have a grasp of the information. Cannot answer questions about subject	3				
Graphics	Explain and reinforce screen text and presentation	Relate to text and presentation	Occasionally uses graphics that rarely support text and presentation	Uses superfluous graphics or no graphics	4				
Oral Presentation	Maintains eye contact and pronounces all terms precisely. All audience members can hear	Maintains eye contact most of the time and pronounces most words correctly. Most audience members can hear presentation	Occasionally uses eye contact, mostly reading presentation, and incorrectly pronounces terms. Audience members have difficulty hearing	Reads with no eye contact and incorrectly pronounces terms. Speaks too quietly	5				
Total Score=2+3+4+5=14/4=3.5=4									

Institutional Activity

Activity No	Description of the Institutional Activity

1	Organize Seminar, workshop, Lecture, from an experts in the following domain:
	  1. Modern trends in Industrial Electrical and Electronics, PLC.
	  2. Modern trends in Motor controls.

2	Organize an industrial visit.
3	Motivate student to take case study on Applications of PLC's to inculcate self and continuous learning.

Course Assessment Pattern

Particulars			Max Marks	Evidence	Course outcomes
Direct Assessment	**CIE**	Three tests (Average of three tests)	20	Blue books	1,2,3,4,5,6
		Student Activity	05	Student Activity Sheets	1,2,3,4,5,6
	SEE	End of the course	100	Answer scripts at BTE	1,2,3,4,5,6
Indirect Assessment	**Student Feedback on course**	Middle of the course		Feedback forms	1, 2 and 3
		End of the course		Feedback forms	1,2,3, 4, 5and6

Note: I.A. test shall be conducted for 20 marks. Average marks of three tests shall be rounded off to the next higher digit.

Note to IA verifier: The following documents to be verified by CIE verifier at the end of semester
1. Blue books (20 marks)
2. Student suggested activities report for 5 marks and should be assessed on RUBRICS
3. Student feedback on course regarding Effectiveness of Delivery of instructions & Assessment Methods.

Date and Time	Semester		Course		Max Marks
1Test (6 th week of sem) 10-11 Am	V SEM		Programmable Logic Controller		20
	Year: 2017-18		Course code:15MC51T		

Name of Course coordinator :   **Units:1,2 CO: 1,2**
All questions carries equal marks

Question No	Question	CL	CO	PO
1	Explain the Block diagram of PLC system. **OR** Classify between Relay logic control and programmable logic control..	U	1	2
2	Explain any two i) Discrete I/P modules, ii) Analog I/P modules that can be interfaced with PLC. **OR** Explain any two i) Discrete O/P modules, ii) Analog O/P modules that can be interfaced with PLC.	U	1	2
3	Explain the different Programming standards used in PLC. **OR** Construct the PLC logic using ladder diagram for the following logic gates AND, EX-OR, NAND.	U/A	2	2
4	Construct the PLC diagram for Forward-reverse-stop process control application with mutual interlocks using contacts and coils. **OR** Develop the following Boolean expression $P = \bar{A}BC + A\bar{B}C + AB\bar{C} + ABC$ in logic diagram using gates and PLC ladder diagram.	U/A	2	2

Model Question Paper
V Semester Diploma in Mechatronics Engineering
Programmable Logical control Instructions

Answer any six questions from part-A and Seven full questions from part-B

PART-A

Answer any six questions.   **5X6=30 marks**

1 Explain PLC and Summarize major advantages of using a PLC.
2 Explain the working principle of PLC.
3 Compare between Relay logic control and programmable logic control.
4 Explain different PLC programming standards.
5 Construct the PLC Ladder diagram for Forward-reverse-stop with mutual interlocks circuit..
6 Explain the Addition Arithmetic function with example.
7 Explain the PLC sequencer function.
8 Explain i) block format ii) Up-Down Combination Counter, of PLC counter function.
9 Explain the Block MOVE functions.

PART- B

Answer any seven full questions.   **10x7=70 Marks**

1) Explain the different i) Discrete I/P module ii) Analog I/P module that can be interfaced with PLC.   (5+5)M

2) a) Develop the following Boolean Expression Z= [(P+$\overline{Q}$+R). (U+V).$\overline{W}$ .X] +(S+T).Y in Logic diagram using gates and PLC Ladder diagram.

   b)   The Process Fan is to run only when all of the following conditions are met,

   i)   Input 1 is OFF.

   ii)   Input 2 is ON or Input 3 is ON, or both 2 and 3 are ON.

   iii)   Inputs 5 and 6 are both ON.

   iv)   One or more of the inputs 7,8 or 9 is ON.

   Develop the above conditions in the Boolean expression and write the Logic diagram using gates and PLC Ladder diagram.   (5+5)M.

3) Construct the PLC Ladder diagram and timing diagram to illustrate the one shot Timer operation Function for process control application. 10M

4) Construct the PLC Ladder diagram and timing diagram to illustrate the Of-delay Timer Function for process control application. 10M

5) The Counter has to keep track of net number or parts on a conveyor. The number of parts going on the conveyor is counted by one proximity device's count. The number leaving the conveyor is counted by a second proximity devices count. Each Proximity device feeds information into its own counter function. Construct a PLC diagram using Counters Used for a Net Count. 10M

6) An output Indicator is to go on when six of Part C and eight of Part D are on a conveyor. This Circuit should monitor the proper counts.IN002 and IN003 are proximity devices that pulse on when a part goes by them. Note that the circuit should not indicate more than six or eight parts; it would only indicate when there are enough parts. Construct a PLC Ladder diagram to illustrate the above scenario (Dual Counter Operation). 10M

7) a. Explain the operation of skip function.
   b. Explain how a jump with return instruction work (5+5)M

8) Explain the Flashing Arrow Patterns and Registers, application of shift register. 10M

9). a. Explain how to Modify the status of Register bit using all the 3 Instructions.
    b. Explain i) Rotate Left ii) Rotate Right Register functions with Examples. (5+5)M

10). a) Illustrate PID Module.
     b) Explain the factors to be considered to select a PLC for a process control application. (5+5)M

Model Question Bank
V Semester Diploma in Mechatronics Engineering
Programmable Logic Controller

Unit-I
Introduction and Architecture of PLC
Cognitive level- Understand

1. Explain PLC.
2. Explain the various types of solid state memory used in a PLC CPU.
3. Summarize the advantages of using a PLC.
4. Summarize the disadvantages of using a PLC.
5. Explain the different Discrete I/P module input modules that can be interfaced with PLC.
6. Explain the different Analog I/P module input modules that can be interfaced with PLC.
7. Explain the different Discrete O/P module input modules that can be interfaced with PLC
8. Explain the different Analog O/P module input modules that can be interfaced with PLC.
9. Explain the Block diagram of PLC system layout.
10. Explain the working principle of PLC.
11. Explain the classification of PLC and explain.

12. Compare between Relay logic control and programmable logic control.
13. Compare data processing and a process control computer.
14. Explain the internal architecture of PLC.

Unit-II
Basic PLC Programming

Cognitive level - Understanding

1   Explain different PLC programming standards.
2   Explain the PLC Input Instructions.
3   Explain the different types of Outputs used in PLC.

Cognitive level - Application.

1   Construct the PLC Ladder diagram for Simple one –contact, one-coil circuit.
2   Construct the PLC Ladder diagram for Standard start-stop-seal circuit circuit.
3   Construct the PLC Ladder diagram for Forward-reverse-stop with mutual interlocks circuit.
4   Construct the PLC Ladder diagram for Forward-reverse-stop with direct reversal circuit.
5   Construct the PLC Ladder diagram for Start-stop-jog circuit.
6   Construct the PLC logic using ladder diagram for AND, OR, NOT logic gates.

7. Output is to be ON only when either inputs 7 and 8 are ON or if Inputs 17 and 18 are ON. Output can be ON when all the four Inputs are ON. **Construct** the above conditions in the Boolean expression and write the Logic diagram using gates and PLC Ladder diagram.

8. The Process Fan is to run only when all of the following conditions are met,

    a. Input 1 is OFF.
    b. Input 2 is ON or Input 3 is ON, or both 2 and 3 are ON.
    c. Inputs 5 and 6 are both ON.
    d. One or more of the inputs 7,8 or 9 is ON.

Develop the above conditions in the Boolean expression and write the Logic diagram using gates and PLC Ladder diagram.

9. **Construct** the following Boolean Expression $Z=[(P+\overline{Q}+R).(U+V).\overline{W}.X]+(S+T).Y$ in Logic diagram using gates and PLC Ladder diagram.

Unit-III
PLC Arithmetic and Timer functions
Cognitive level - Understand.

1   Explain the Addition Arithmetic function with example.
2   Explain the Subtraction Arithmetic function with example.
3   Explain the Multiplication Arithmetic function with example.

4   Explain the Division Arithmetic function with example.
5   Explain basic compare functions.
6   Explain the PLC sequencer function.
7   Explain PLC retentive functions.

Cognitive level-- Application

1. We are banding dowels into bundles of 40. Counter function keeps track of the count of number of dowels in the bundle as they are added .The dowel counter's count number is kept in HR0005. Running Count is compared to 40. When the counter reaches 40, the output CR0019 goes ON. Output CR0019 is connected to a bander that operates when 40 is reached. Construct a ladder diagram using Equal - to Compare Function.

4   Output is to be ON except when an input count is exactly 87. Input count is tracked in   IR0062. Operand 2 can be programmed as the number 0087. Develop the ladder diagram using
    i. Not- Equal - to Function,
    ii. Equal - to Function.

5   Construct the PLC Ladder diagram and timing diagram to illustrate the On –Delay Timer Function for process control application.

6   Construct the PLC Ladder diagram and timing diagram to illustrate the Of-delay Timer Function for process control application.

7   Construct the PLC Ladder diagram and timing diagram to illustrate the Limited on time Timer Function for process control application.

8   Construct the PLC Ladder diagram and timing diagram to illustrate the repeat cycling Timer (Pulsed Timer) Function for process control application.

9   Construct the PLC Ladder diagram and timing diagram to illustrate the one shot Timer operation Function for process control application.

Unit-IV
PLC Counter functions.
Cognitive level- Understand

1. Explain i) block format ii) Up-Down Combination Counter, of PLC counter function.
2. Explain i) High Speed Counter ii) Counter with Separate Enable and Reset, of PLC counter function.

Cognitive level - Application

1. Develop a PLC Ladder diagram to illustrate the Basic PLC Counter Operation.

2. An output Indicator is to go on when six of Part C and eight of Part D are on a conveyor. This Circuit should monitor the proper counts.IN002 and IN003 are proximity devices that pulse on when a part goes by them. Note that the circuit should not indicate more than six or eight parts,it would only indicate when there are enough parts. **Construct** a PLC Ladder diagram to illustrate the above scenario (Dual Counter Operation).

3. The Counter has to keep track of net number or parts on a conveyor. The number of parts going on the conveyor is counted by one proximity device's count. The number leaving the conveyor is counted by a second proximity devices count. Each Proximity device feeds information into its own counter function. **Construct** a PLC diagram using Counters Used for a Net Count.

4. Construct a PLC Ladder diagram to illustrate the combination of Count and Time Program.
5. Construct a PLC Ladder diagram to illustrate the delay of the start of the Counting Process.
6. Construct a PLC Ladder diagram to illustrate the Rate –per-Time –Period Program.

Unit-V
Data handling functions and Shift Registers
Cognitive level -- Understand

1 Explain the operation of skip function.
2 Explain the operation of master control relay function.
3 Explain how a jump with non-return instruction works.
4 Explain how a jump with return instruction works.
5 Explain how jump differs from the skip and MCR functions.
6 Explain MOVE functions and its applications.
7 Explain the Block MOVE functions.
8 Explain FIFO and other stacking functions.
9 Explain how to modify the status of Register bit using all the 3 Instructions.
10 Explain i) Shift Left ii) Shift Right Register functions with Examples.
11 Explain i) Rotate Left ii) Rotate Right Register functions with Examples.

Cognitive level - Application

1. Applying the Concept of shift Registers, Explain Flashing Arrow Pattern and Registers.
2. Applying the Concept of Shift Registers, Explain Morse code SR Patterns.

Unit-VI
Advanced PLC Functions
Cognitive level -- Understand.

1 Explain PID Module.
2 Explain SCADA system.
3 Explain the Distributed control system.
4 Explain the concept of PLC and the Internet.
5 Explain the steps involved in maintaining a PLC system.
6 Explain the factors to be considered to select a PLC for a process control application.