

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

COURSE CURRICULUM COURSE TITLE: PROGRAMMABLE LOGIC CONTROLLERS (COURSE CODE: 3352003)

Diploma Programme in which this course is offered	Semester in which offered
Mechatronics Engineering	5 th Semester

1. RATIONALE

In previous semesters students have learnt the fundamentals of electronics, digital circuits, Visual Basic practice and control devices, they are capable to understand and develop a basic circuit. To use this knowledge and programming skill in the field of automation it is also necessary to learn about Programmable Logic Controller. Programmable Logic Controller works as brain of automation system, which can be programmed for desired functions for controlling different machines. The Industries therefore demand for persons having automation knowledge with skill of P.L.C. programming. To cater to the need of Industries and to convert their basic skill in to some advance level, this course is being introduced in their 5th semester.

2. LIST OF COMPETENCY

The course should be taught and implemented with the aim to develop required skills in students so that they are able to acquire following competency:

- **Programme PLC to execute various machine cycles.**

3. COURSE OUTCOMES

The theory should be taught and practical should be carried out in such a manner that students are able to acquire different learning out comes in cognitive, psychomotor and affective domain to demonstrate following course outcomes.

- i. Operate PLC.
- ii. Use PLC memory.
- iii. Use Boolean algebra to simplify designs.
- iv. Use Ladder Logic Function and advance function for PLC programming.
- v. Select PLCs for relevant applications.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				Total Marks
				Theory Marks		Practical Marks		
L	T	P	C	ESE	PA	ESE	PA	200
3	0	4	7	70	30	40	60	

Legends: L-Lecture; T – Tutorial/Teacher Guided Theory Practice; P - Practical; C – Credit, ESE - End Semester Examination; PA - Progressive Assessment

5. COURSE CONTENT DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I. PLC Overview	1a. Describe principle of operation of PLC 1b. Differentiate between PLC and computer controlled systems 1c. Describe hardware components of PLC. 1d. Explain the block diagram of PLC.	1.1 Principles of operation of PLC 1.2 PLC verses computer 1.3 PLC hardware components 1.4 Scan time of a cycle. 1.5 Industrial PLC. 1.6 Application of PLCs.
Unit– II PLC Memory and Logical Sensor	2a. Explain different types of memories available for PLC. 2b. Distinguish between various data files: User Bits Memory, Timer Counter Memory, PLC Status Bits, User Function Control Memory, Integer Memory, Floating Point Memory 2c. Use addresses for locations in memory. 2d. Distinguish between Switches, TTL, Sinking and sourcing, Connection of switch 2e. Distinguish the various types of human/ product presence detection sensors 2f. Select sensors for a given application.	2.1 Memory Address. 2.2 Program Files. 2.3 Data files: User Bits Memory, Timer Counter Memory, PLC Status Bits, User Function Control Memory, Integer Memory, Floating Point Memory 2.4 Sensor wiring: Switches, TTL, Sinking and sourcing, Connection of switch 2.5 Human/ product Presence Detection Sensors: Reed Switch, Optical Sensor, Capacitive Sensor, Inductive Sensor
Unit– III Boolean Logic Design and Timers, Counter , Latch Concept	3a. Explain logic design for a given application 3b. Simplify designs with Boolean algebra. 3c. Use timers, latch and counters in various designs 3d. Use counter as per requirement Apply latch in ladder logic	3.1 Boolean algebra: Rules of Boolean Algebra, Logic Design for a given application 3.2 Common Logic Forms: Complex gate forms, Multiplexer. 3.3 Timers: On-delay timer, Off-delay timer, Retentive timer. 3.4 Counters: Up-Counters, Down-Counter, Up-Down Counter. 3.5 Master Control Relay.
Unit– IV Ladder Logic Function and Advance Function	4a. Explain various programme control instructions 4b. Manipulate the data for various applications 4c. Develop ladder logics for a particular design 4d. Develop programmes for given applications.	4.1 Data handling Function: Move Function, Mathematical Function, Conversion Function 4.2 Logic Function: Comparison of Value, Boolean Function 4.3 List Function: Shift registers, Stacks, Sequencer 4.4 Program Control: Branching and

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
		looping.
Unit-V Selecting PLC	5a. State the criteria for selection of PLC 5b. Select right PLC for a given application. 5c. Prepare the specifications of a PLC	5.1 Analog Input – Output Module. 5.2 Discrete Input – Output Module. 5.3 PLC selection criteria. 5.4 PLC specifications

6. SUGGESTED SPECIFICATION TABLE WITH HOURS AND MARKS (THEORY)

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	PLC Overview	3	03	04	00	07
II	PLC Memory Logic Sensor	10	06	06	06	18
III	Boolean Logic Design and Timers, Counter, Latch Concept.	13	08	08	08	24
IV	Ladder logic function and Advance Function	11	05	05	04	14
V	Selecting PLC	5	02	02	03	07
	Total	42	24	25	21	70

Legends: R = Remember U = Understand; A = Apply and above levels (Bloom's revised taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.

7. SUGGESTED LIST OF EXERCISES/PRACTICALS

The practical/exercises should be properly designed and implemented with an attempt to develop different types of skills (**outcomes in psychomotor and affective domain**) so that students are able to acquire the competencies/programme outcomes. Following is the list of practical exercises for guidance.

Note: Here only outcomes in psychomotor domain are listed as practical/exercises. However, if these practical/exercises are completed appropriately, they would also lead to development of certain outcomes in affective domain which would in turn lead to development of **Course Outcomes** related to affective domain. Thus over all development of **Programme Outcomes** (as given in a common list at the beginning of curriculum document for this programme) would be assured.

Faculty should refer to that common list and should ensure that students also acquire outcomes in affective domain which are required for overall achievement of Programme Outcomes/Course Outcomes.

S. No.	Unit No.	Practical Exercises (outcomes in Psychomotor Domain)	Approx Hours. required
1	I	Demonstrate Step 7- Micro/Win 32 and the S7-200 PLC	2
2	V	Exposure to programming examines the function of Bit Logic Instructions.	4
3	V	Exposure to programming examines the function of SEQUENCER.	4
4	IV	Test and Identify different types of TIMER.	4
5	IV	Test and Identify different types COUNTER.	4
6	V	Explore programming examines of the Program Control Instructions.	2
7	V	Explore programming examines the function of Math Instructions.	4
8	III	Identify Different types of LADDER LOGIC.	4
9	IV	Develop ladder programming for a given statement - To on the bulb1 after 5sec of switch1 on. Turn the bulb2 on after the 5 sec of bulb1 on and test.	2
10	IV	Develop ladder programming for a given statement -To on the bulb after 5sec of switch off. Turn the bulb2 off after the 5 sec of bulb1 on and test.	2
11	IV	Develop ladder programming for a given statement - To watch the on time of switch if total time excludes the limit, turn the bulb off and test.(Retentive Timer)	4
12	IV	Develop ladder programming for a given statement -To count a car and give signal for empty space and test.	4
13	V	Develop ladder programming for a given statement - To on or off the motor via one switch and test.	4
14	IV	Develop ladder programming for a given statement -To operate four bulbs in series and test.	4
15	IV	Develop ladder programming for a given statement - To operate three floor elevators and test.	4
16	IV	Design a ladder to operate bottler filling plan and test	4
Total Hours			56

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities such as:

- Prepare journals based on practical performed in laboratory.
- Assignments on solving Boolean algebra.
- Prepare/Download a dynamic animation to illustrate the following:
 - Working principle of Timer
 - Working principle of Counter
 - Working of different types Ladder logic.
- Carry out a market survey of local dealers for PLC and compare them on mentioned points: (a) Rating (b) Memory (c) Cost (d) Programming language and (e) Performance

- v. Download the catalogue of PLC from websites of reputed manufacturers such as SIEMENS, FATEK, DELTA, ABB, and OMRON etc. to learn the latest developments.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

- i. Show video/animation films to explain functioning of PLC and their accessories.

10. SUGGESTED LEARNING RESOURCES

A. List of Books

S. No.	Title of Book	Author	Publication
1.	Programmable Logic Controller, 5 th Edition	John W. Webb and Ronald A. Reis	PHI Learning, New Delhi
2.	Programming Language Concept	Peter sestoft	Springer
3.	Automating Manufacturing System	Hugh Jack	Mc. Graw Hill, New Delhi
4.	A practical Handbook to PLC	Alireza H. Fassih	New Generation publication
5.	Programmable Logic Controllers, 5th Edition	W. Bolton	Newnes

B. List of Major Equipment/ Instrument with Broad Specifications

- i. PLC Trainer 24VDC , minimum 12 I/O ,TTL OR RELAY TYPE
2PTO-100KHZ min. (optional (Inbuilt)),
Minimum 10-timer and counter.
4 Analog I/O.
- ii. Sensor Proximity (Inductive , Capacitive ,Photoelectric)
Limit Switch.
- iii. PID P.I.D.
Trainer Pulse Train Output.

C. List of Software/Learning Websites

- i. www.plcs.net
- ii. www.automation.siemens.com
- iii. www.abb.co.in
- iv. www.ia.omron.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE

Faculty Members from Polytechnics

- **Prof. P. A. Solanki**, Sr. Lecturer in Mechatronics Engineering, B. S. Patel Polytechnic, Mahesana.
- **Prof. V.K.Patel**, In-Charge H.O.D. in Mechatronics Engineering, B. S. Patel Polytechnic, Mahesana.

Coordinator and Faculty Members from NITTTR Bhopal

- **Dr Vandana Somkuwar**, Associate Professor, Department of Mechanical Engineering
- **Dr. C. K. Chugh**, Professor, Department of Mechanical Engineering