GUJARAT TECHNOLOGICAL UNIVERSITY

INSTRUMENTATION & CONTROL ENGINEERING (17)
PROGRAMMABLE LOGIC CONTROLLER
SUBJECT CODE: 2161709
B.E. 6th SEMESTER

Type of course: Core Engineering

Prerequisite: Digital Logic Design, Concept of Micro Processor and Micro Controller, Relay Logic, Control System, Knowledge of programming and flow charts

Rationale: Students of Instrumentation & Control engineering should have detailed skill of controlling any system. Programmable Logic Controller (PLC) is a very important device to control any system and is widely used in industries now a day. Therefore the person who wants to work in control and automation industries must have enhance knowledge of PLC. This course gives a detailed knowledge and practice of PLC programming

Teaching and Examination Scheme:

TeachingScheme			Credits	Examination Marks						Total Marks
L	T	P	C	TheoryMarks			PracticalMarks			
				ESE (E)	PA(M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
4	0	2	6	70	20	10	20	10	20	150

Content:

S. N.	Content	Total Hrs	% Weight age
1	PLC BASICS Programmable Logic Controllers (PLCs): Introduction; definition & history of the PLC; Principles of Operation; Various Parts of a PLC: CPU & programmer/ monitors; PLC input & output modules; Solid state memory; the processor; I/O modules; power supplies. PLC advantage & disadvantage; PLC versus Computers, PLC Application. Programming equipment; proper construction of PLC ladder diagrams; process scanning consideration; PLC operational faults.	2	4
2	PLC Hardware Components The I/O section, Discrete I/O Modules, Analog I/O Modules, Special I/O Modules, I/O specifications, The CPU, Memory design, Memory Types, Programming Devices, Selection of wire types and size.	2	4
3	Fundamentals of Logic The Binary Concept, AND, OR and NOT functions, Boolean Algebra, Developing circuits from Boolean Expression expressions, Producing the Boolean equation from given circuit, Hardwired logic versus programmed logic, Programming word level logic instructions. Converting Relay schematics and Boolean equation into PLC Ladder Programs, Writing a ladder logic program directly from a narrative description.	2	4
4	Various INPUT /OUTPUT Devices and its interfacing with PLC. Different types of Input devices : Switches: Push button Switches, Toggle Switches, Proximity switches, Photo	4	8

	switches, Temperature Switch, Pressure Switch, and Level Switch,Flow Switches, manually operated switches,Motor starters, Transducers and sensors, Transmitters etc. Their working, specification and interfacing with PLC. Different types of Output devices : Electromagnetic Control Relays, Latching relays, Contactors, Motors, Pumps, Solenoid Valves etc. Their working, specification and interfacing with PLC.		
5	Basics of PLC Programming Processor Memory Organization, Program Scan, PLC Programming languages, Relay type instructions, Instruction addressing, Branch Instructions, Internal Relay Instructions, Programming Examine if Closed and examine If Open instructions, Entering the ladder diagram, Modes of operation. Creating Ladder Diagrams from Process Control Descriptions. Ladder diagram & sequence listing; large process ladder diagram construction, flow charting as programming method, Industrial Examples	6	12
6	PLC INSTRUCTIONS Bit Logic Instructions: NO, NC, Set, Reset, rising edge Pulse, Falling Edge Pulse, RS, SR, NOP, OUTPUT etc. Clock: READ RTC, SET_RTC. Different Logical operation Instructions: INVERT BIT, BYTE, WORD DOUBLE WORD. OR: BIT, BYTE, WORD DOUBLE WORD. AND: BIT, BYTE, WORD DOUBLE WORD. X-OR: BIT, BYTE, WORD DOUBLE WORD.	3	6
7	Different Integer Math Instructions: Addition, Subtraction, Multiplication, Division, Increment, Decrement- Integer, Byte, Double Word. Different Floating-Point Math Instructions: Addition, Subtraction, Multiplication, Division, Square Root, Sin, Cosine, Tan, LN, Exponential, PID.	4	8
8	Programming Timers Mechanical Timing relay, Timer instructions, ON delay timer instruction, Off-Delay timer instruction, Retentive Timer, Cascading Timers, examples of timer function industrial application; industrial process timing application.	2	4
9	Programming Counters Counter Instructions, Up-counter, down counter, Up- Down counter, Cascading counters, Incremental encoder counter applications, Combining counter and timer functions, High Speed counter instruction, HSC, PLS, examples of counter function industrial application.	2	4
10	Different Conversion Instructions : Byte – Integer, Integer To Byte, Integer To Double Integer, Double Integer To Integer, Real To Integer, Real To Integer, Integer To String, String To Integer, Integer To ASCII , ASCII To Integer, Real To ASCII , ASCII To Real, ASCII To Hexadecimal, Hexa- Decimal To ASCII , Decode,, encode, segment. Truncate.	2	4
11	Different Comparison Instructions Data manipulation, data transfer operations, Data compare instructions, Data manipulation Programs, Numerical Data I/O interfaces, Set-point control.	2	4
12	Program Control Instructions The PLC SKIP and MASTER CONTROL RELAY Functions. Introduction; the SKIP function & application; the MASTER CNTROL RELAY function & application. Introduction: Jump with non-return; jump with return.	3	6
13	DATA HANDLING FUNCTIONS PLC Data Move Systems. Introduction; PLC MOVE function & application; moving large blocks of PLC data; PLC table & registers moves; other PLC MOVE functions. Other PLC Data Handling Functions.	2	4

	Different Move Instructions: BIT, BYTE, WORD DOUBLE WORD, REAL, SWAP Byte, Move Byte Immediate Read, Move Byte Immediate Write. Different Shift/Rotate Instructions		
14	Sequencer and shift register instructions PLC Sequencer Functions. Introduction; electromechanical sequencing; the basic PLC sequencerfunction; a basic PLC sequencer application with timing; other PLCsequencer function; cascading sequencer. Controlling a Robot with a PLC. Introduction; basic two axis ROBOT with PLC sequencer control; industrial three axis ROBOT with PLC control.	3	6
15	Different Interrupt Instructions- ENI, DSI, RETI, ATCH, DTCH, CLR_EVNT.	1	2
16	PLC Networking Introduction, Levels of Industrial Control, Types of Networking, Network communications.	2	4
17	Analog PLC Operation Introduction, Types of PLC Analog Modules and Systems, PLC Analog Signal Processing, PLC Analog Application Examples, PID Modules, PID Tuning, Typical PID Functions.	2	4
18	PLC Installation practices, Editing and Troubleshooting PLC Enclosures, Electrical Noise, Leaky Inputs and Outputs, Grounding, Voltage variations and Surges, Program Editing, Programming and Monitoring, Preventive Maintenance, Troubleshooting, Connecting PC with PLC.	2	4
19	Alternative Programming Languages Structured Text, Function block diagram, Instruction list, sequential function chart – Introduction and of few instructions with LD.	3	6
20	Various Brands of PLCs and their revolution. Overview, Siemens PLC, Allen Bradley PLC, Schneider electric PLC, Omron PLC, Mitsubishi PLC. Their comparison of various instructions.	1	2

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**14**	**21**	**14**	**14**	**0**

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's 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.

Reference Books:

1. Programmable logic controller by Frank D. Petrusella, Tata McGraw-Hill publication
2. Introduction to programmable logic controller by Gary dunning, Thomson Asia Pte Ltd. Publication, Singapore
3. Programmable Logic Controllers: Principles and Applications by John W. Webb and Ronald A. Reis, Prentice – Hall India publication, 5th edition
4. Programmable Logic Controllers by W. Bolton, Elsevier Newnes publication, 4th edition
5. Programmable Controllers An engineer's guide by E.A.Parr, Elsevier Newnes publication 3rd edition

6. S7-200, PLC Manual of Siemens for Instructions
7. S7-300, PLC Manual of Siemens for Instructions
8. Programmable Controller by T. A. Huges, ISA publication, 2nd edition
9. Programmable Logic Controllers: Programming methods and applications by
10. John R. Hackworth and Frederick D. Hackworth Jr., Pearson publication

Course Outcome:

After learning the course the students should be able to:

CO 1 compare conventional sequential control with programmable logic control system
CO 2 develop programs using different PLC programming languages for sequential and continuous process
CO 3 interface analog and digital input/ output devices with PLC using different communication protocol
CO 4 test the PLC based system and troubleshoot the errors associated with it.

List of Experiments:

1. Introduction to ladder programming& to implement basic logic gates.
2. Develop, Simulate and Test Ladder diagram for
    a. A Door Bell Operation   b. A Combination Lock.
3. Develop, Simulate and Test Ladder diagram for Bottle Filling system.
4. Develop, Simulate and Test Ladder diagram for Traffic Light Control System.
5. Develop, Simulate and Test Ladder diagram for Car Parking system.
6. Develop Simulate and Test Ladder diagram for an alarm annunciator system.
7. Develop, Simulate and Test Ladder diagram for Batch Mixer.
8. Develop, Simulate and Test Ladder diagram for Drink Dispenser system.
9. Develop and test PLC program for three phase motor in both direction.
10. Develop, Simulate andTest Ladder diagram for stepper motor control in forward and reverse direction.
11. Develop and test PLC program for two axis Robotic arm for pick and place application
12. Develop, Simulate and Test Ladder diagram for Packing line system.
13. Develop, Simulate andTest Ladder diagram for an Elevator system.
14. Develop and test PLC program for PID Controller for Temperature control Application.
15. Develop and test PLC program in FBD, SFC, IL, ST, and Ladder Logic Language for Motor starter application.
16. Detail study of PLC Hardware and its interfacing.

Design based Problems (DP)/Open Ended Problem:

➔ Speed measurement using counter
➔ DC motor control in both direction
➔ Level controller of underground and overhand tank.
➔ Servo motor control
➔ Automatic Stamping machine
➔ Automatic Drilling machine
➔ Automatic painting machine
➔ Four-way traffic light control
➔ Control of robotic arm

Major Equipment:

Computers, simulation software, PLCs, Input/ Output devices.

List of Open Source Software/learning website:

http://coep.vlab.co.in/?sub=33&brch=97

http://www.plcdev.com/book/export/html/9

http://www.plcmanual.com/

http://literature.rockwellautomation.com/

http://www.automation.siemens.com/

http://nptel.ac.in/video.php

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.