

GUJARAT TECHNOLOGICAL UNIVERSITY, AHMEDABAD, GUJARAT

**COURSE CURRICULUM
COURSE TITLE: PLC PROGRAMMING
(COURSE CODE: 3351704)**

Diploma Programmers in which this course is offered	Semester in which offered
Instrumentation and Control Engineering	5 th semester

1. RATIONALE

Different logical process automation is used for optimum controlling of the process parameters and hence Diploma Engineers should be able to maintain these instrumentation systems. This requires that they should know very well about logical control action fundamentals. Hence this curriculum has been designed so that the students will be able to develop, program and troubleshoot applications of various PLC based logical control strategies for automation.

2. LIST OF COMPETENCY

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

- **Maintain different types of PLC based process instrumentation systems.**

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.

- Identify logical process control in automation
- Connect the PLC peripherals with the PLC for logical functioning.
- Develop advance PLC programs.
- Able to develop PLC based automation system.
- Troubleshoot PLC.

4. TEACHING AND EXAMINATION SCHEME

Teaching Scheme (In Hours)			Total Credits (L+T+P)	Examination Scheme				
				Theory Marks		Practical Marks		Total Marks
L	T	P	C	ESE	PA	ESE	PA	
3	0	2	5	70	30	20	30	150

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

5. COURSE DETAILS

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
Unit – I Basic PLC system	1a Explain block diagram for PLC based automation system with sketch. 1b Draw block diagram various PLC modules and explain them in brief. 1c State steps to install PLC. 1d Describe PLC networking (master slave mode) with sketch.	PLC system 1.1.Over view of PLC system 1.2. PLC module 1.2.1.Intelligent module 1.2.2.PID module 1.2.3.Communication module 1.3.PLC Installation 1.4.PLC networking
Unit – II Basic PLC function	2a Describe the function of five common types of registers used in PLC. 2b Describe use of PLC registers in PLC operation. 2c Develop ladder logic for flip flops (R-S, ONE SHOT, D, T, and J-K) in PLC. 2d Describe module addressing for PLC. 2e Describe PLC retentive and delay timer functions 2f State types and instructions of timing functions used in PLC. 2g Draw ladder diagram and wiring diagram for each timer functions for PLC. 2h State types and instructions of PLC counter functions. 2i Draw ladder diagram for each counter functions for PLC. 2j Develop ladder logic for ON-OFF temperature control using timer, counter and limit switches.	2.1.PLC Registers and I/O addressing. 2.1.1.Register and flip-flop Characteristic. 2.1.2.Types of register(Holding, Input, Output register) 2.1.3.Module addressing 2.2. PLC timer function 2.2.1.Types and instructions of timer On Delay, Off Delay, Retentive ,Non Retentive timer 2.3.PLC counter function 2.3.1.Types and instructions of counter UP,DOWN,UP/DOWN counter
Unit – III Arithmetic and logical function	3a Describe arithmetic, comparison, square root, PLC functions. 3b Use PLC arithmetic functions to Add, subtract, multiply and divide numbers. 3c Derive square root by using PLC square root functions. 3d Describe each PLC Advanced comparison functions. 3e Describe each PLC logical functions. 3f Describe operation of the	Arithmetic and logical function used in PLC 3.1.PLC arithmetic function : Addition, Subtraction Multiplication, Division, Square root Negative, Average 3.2.PLC comparison function Basic comparison functions Equal, Not equal Greater than, Less than, Greater than equal to, Less than equal to 3.3.Advanced comparison functions LIMIT TEST, MASKED COMPARE, COMPARE EXPRESSION(CMP)

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	SKIP, MASTER CONTROL RELAY, JUMP, MOVE, FIFO, FAL, ONE SHOT (ONS), CLR, SWEEP functions. 3g Describe the PLC digital bit control functions. 3h Explain BIT SET, BIT CLEAR & BIT FOLLOW functions showing bit pattern in the registers. 3i Use shift register to move digital bits within registers. 3j Use shift register to move digital bits through registers.	3.4.PLC logical function 3.5.SKIP,MASTER CONTROL RELAY,JUMP with non return, JUMP with return 3.6.Data transfer function MOVE, BLOCK MOVE,TABLE AND REGISTER MOVE 3.7.FIFO, FAL, ONE SHOT, CLR and SWEEP functions 3.8.PLC Digital bit function 3.8.1 Bit patterns in registers 3.8.2 Changing register bit status 3.8.3 Shift register functions
Unit – IV Advanced PLC functions	4a Describe PLC sequencer. 4b Describe Sequencer output, input and load functions. 4c Develop ladder logic program using Sequencer output, input and load functions. 4d Differentiate between discrete and analog operation of PLC. 4e Convert input signals suitable to input module of PLC. 4f Convert output module signal to suitable values for output devices of PLC. 4g Describe the internal PLC operation for analog I/O systems. 4h List the different types of PID Tuning methods. 4i Discuss PID PLC function. 4j Describe PLC auxiliary functions.	4.1.Sequencer function 4.1.1. Sequencer output, input and load instruction. 4.2. PLC analog operation 4.2.1.analog signal processing 4.2.2. BCD or multibit data processing 4.3. PID function for continuous process 4.3.1.PID tuning (open loop transient system, ultimate cycle, frequency response) 4.3.2.PID function 4.4. PLC Auxiliary functions 4.4.1. Monitor mode function 4.4.2. Force mode function
Unit – V PLC Application and Troubleshooting	5a Draw neat sketches of PLC process applications for the given parameters of processes(5.1.1 to 5.1.4) 5b Identify Input and Output devices used for PLC process applications and assign proper addresses to each of them for the given parameters of processes. 5c Prepare sequence of events	5.1. PLC process Applications : 5.1.1.bottle filling plant 5.1.2.material handling elevator 5.1.3. 2-axis robot with PLC sequencer control 5.1.4. Process level control 5.2.Troubleshooting

Unit	Major Learning Outcomes (in cognitive domain)	Topics and Sub-topics
	for PLC process applications for the given parameters of processes 5d Develop Ladder Logic diagram for PLC process applications for the given parameters of processes 5e State the trouble shooting procedure for PLC system.	

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

Unit No.	Unit Title	Teaching Hours	Distribution of Theory Marks			
			R Level	U Level	A Level	Total Marks
I	Basic PLC system	04	2	4	1	07
II	Basic PLC function	10	4	8	2	14
III	Arithmetic and logical function	12	7	7	7	21
IV	Advanced PLC functions	10	4	8	2	14
V	PLC Application and Troubleshooting	06	0	4	10	14
	Total	42	17	31	22	70

Legends: R = Remembrance; U = Understanding; A = Application 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.

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)	Hrs. required
1	I	Install hardware and software components of Given PLC system. Check it's working by running a sample program	02
2	I	Identify intelligent, PID , Input , Output , Communication module	02

3	I	Wire Inputs , Outputs via PLC input output modules	02
4	I	Wire intelligent, PID , Communication module with PLC	02
5	I	Connect master PLC with two slave PLCs	02
6	I	Study networking of PLC by means of simulation or appropriate video.	02
7	II	Develop ladder logic to realize D flipflop	02
8	II	Develop ladder logic to realize RS flipflop	02
9	II	Develop ladder logic to realize JK flipflop	02
10	II	Develop ladder logic to realize T flipflop	02
11	II	Simulate Industrial application of PLC On Delay Timer.	02
12	II	Verify On Delay timer operation using actual PLC	02
13	II	Simulate Industrial application of PLC Off Delay Timer.	02
14	II	Verify Off Delay timer operation using actual PLC	02
15	II	Simulate Industrial application of PLC Retentive Timer.	02
16	II	Verify Retentive timer operation using PLC	02
17	II	Simulate Industrial application of PLC UP COUNTER.	02
18	II	Verify UP COUNTER operation using actual PLC	02
19	II	Simulate Industrial application of PLC UP/DOWN COUNTER.	02
20	II	Verify UP/DOWN COUNTER operation using actual PLC	02
21	II	Simulate Industrial application of PLC ADDITION Function.	02
22	III	Verify ADDITION Function using actual PLC	02
23	III	Simulate Industrial application of PLC SUBTRACTION Function.	02
24	III	Verify SUBTRACTION Function using actual PLC	02
25	III	Simulate Industrial application of PLC EQUAL TO Comparison Function.	02
26	III	Verify EQUAL TO Comparison Function using actual PLC	02
27	III	Simulate Industrial application of PLC LESS THAN and GREATER THAN Comparison Functions.	02
28	III	Verify LESS THAN and GREATER THAN Comparison Functions using actual PLC	02
29	III	Simulate Industrial application of PLC Advance Comparison Functions.	04
30	III	Verify the operation of Advance Comparison Functions using actual PLC	04
31	III	Simulate Industrial application of PLC SKIP and MCR Functions. Verify the same functions using actual PLC	02
32	III	Simulate Industrial application of PLC JUMP Functions. Verify the same functions using actual PLC	02
33	III	Simulate Industrial application of PLC Data Transfer Functions. Verify the same functions using actual PLC	02
34	III	Simulate Industrial application of PLC Data Transfer Functions. Verify the same functions using actual PLC	04
35	III	Simulate Industrial application of PLC SHIFT REGISTER Functions. Verify the same functions using actual PLC.	02
36	IV	Simulate Industrial/Domestic application of PLC SEQUENCER Function. Verify the same function using actual PLC.	04
37	IV	Control the level in a given level control loop using PID function of PLC. Obtain the response curves of PV, SP and Controller O/P. Tune the loop properly to obtain close control.	04
38	IV	Control the temperature in a given temperature control loop using PID function of PLC. Obtain the response curves of PV, SP and	04

		Controller O/P. Tune the loop properly to obtain close control.	
39	IV	Control the Pressure in a given pressure control loop using PID function of PLC. Obtain the response curves of PV, SP and Controller O/P. Tune the loop properly to obtain close control.	04
40	IV	Control the flow in a given flow control loop using PID function of PLC. Obtain the response curves of PV, SP and Controller O/P. Tune the loop properly to obtain close control.	04
41	V	Simulate Bottle filling process on PLC simulator. Verify operation of the same process using actual PLC. Draw connection details for the same process	04
42	V	Simulate material handling elevator operation on PLC simulator. Verify operation of the same process operation using actual PLC. Draw connection details for the same process.	04
Total Hours (practical for 28 hours from above representing each unit may be selected)			102

8. SUGGESTED LIST OF STUDENT ACTIVITIES

Following is the list of proposed student activities like:

- i. Assemble PLC power supply PLC, Input / Output and other module on mounting rack.
- ii. Wire automatic level control system using various components.
- iii. Wire automatic temperature control system using various components.
- iv. Wire automatic flow control system using various components.
- v. Connect personal computer using star topology.
- vi. Connect personal computer using ring topology.

9. SPECIAL INSTRUCTIONAL STRATEGIES (if any)

I. Visits to Industries.

- ii. Use free simulators for PLC programming in the class when teaching.
- iii. Video films/animation films on working of different type automatic system such as bottle filling plant, material handling elevator, 2-axis robot with PLC sequencer control, Process level control, Process temperature control Troubleshooting of PLC from YouTube and other resources.
- iv. Mini project based on 2 axis ROBOT, Designing of process control loop, PLC Industrial Application which is not covered in above Experiment list

10. SUGGESTED LEARNING RESOURCES

A) List of Books

S. No.	Title of Book	Author	Publication
1	Programmable logic Controllers Principles and applications	John w. Webb Ronald A Reis	PHI Learning,
2	Programmable logic Controllers Programming methods and applications	John R Hackworth Frederick D. Hackworth Jr.	Pearson
3	Process Control Principles and applications	Surekha Bhanot	Oxford University press
4	Instrumentation engineer's handbook	B.G Liptak	Chilton Book Co., Philadelphia
5	Process control Instrumentation technology	Curtis D Johnson	PHI pvt. Ltd.

6.	Programmable Logic Control: Principles And Applications	NIIT	PHI EEE edition
7	Programmable Controllers	Thomas A. Hughes	ISA

B) List of Major Equipment/ Instrument with Broad Specifications

- i. Electrical tool kit 3sets
- ii. Multi-meter 3 No.
- iii. Master PLC with Power supply and Hand held PLC programmer (touch screen teach pendant). 1 NO
- iv. Slave PLC with Power supply and Hand held PLC programmer. 3 NO
- v. 24 analog input module (8 analog input module 3NO.)
- vi. 24 analog output module (8 analog input module 3NO.)
- vii. 24 digital input module (8 digital input module 3 NO.)
- viii. 24 digital output module (8 digital input module 3 NO.)
- ix. PID module (3 NO.)
- x. Communication module (3 NO.)
- xi. Thermocouple module (3 NO.)
- xii. 3 level switch
- xiii. DP Transmitter (2 NO.)
- xiv. Capacitive level transmitter
- xv. 3NO Temperature switch
- xvi. J and K thermocouple (5 NO each)
- xvii. RTD (3 NO)
- xviii. 3 NO flow switch
- xix. 3" conveyor system operated 12V DC motor with digital shaft encoder
- xx. 12 proximity switch(Inductive,Optical, motion , light)
- xxi. 12 V DC motor with digital shaft encoder
- xxii. PLC based Automatic bottle filling plant
- xxiii. Flow, temperature, level control setup for PLC based automation using Flow, temperature, level switches.

B) List of Software

To run PLC compatible software should be purchased from the PLC supplier such as WINCC/ RS logix etc.

Learning Websites

- i. www.control.com
- ii. www.plcs.net
- iii. www.pacontrol.com
- iv. En.wikipedia.org
- v. www.seimens.com
- vi. www.ab.rockwellautomation.com › *Allen-Bradley*
- vii. www.abb.co.in
- viii. www.triplc.com
- ix. <http://plc-training-rslogix-simulator.soft32.com/free-download/>
- x. www.youtube.com
- xi. www.ourinstrumentationgroup.com
- xii. for PLC networking in master-slave :
<http://www.automationdirect.com/static/manuals/dadnet/appxa.pdf>
- xiii. books.google.com

11. COURSE CURRICULUM DEVELOPMENT COMMITTEE
Faculty Members from Polytechnics

- **Prof R. P. Merchant**, HOD IC Engineering, Govt. Polytechnic, Gandhinagar
- **Prof A. K. Bilakhia**, Lecturer IC Engineering, Govt. Polytechnic, Gandhinagar
- **Prof N. B. Mehta**, Lecturer IC Engineering, Govt. Polytechnic, Ahmedabad
- **Prof Manan Modi**, Lecturer IC Engineering, Govt. Polytechnic, Palanpur

Coordinator and Faculty Members from NITTTR Bhopal

- **Prof. (Mrs.) C. S. Rajeshwari**, Professor, and Head, Department of Electrical and Electronics Engineering
- **Prof. Joshua Earnest**, Professor, Department of Electrical and Electronics Engineering