I

Name ________________________

Roll No. ______________ Year 20______ 20______

Exam Seat No. ________________________

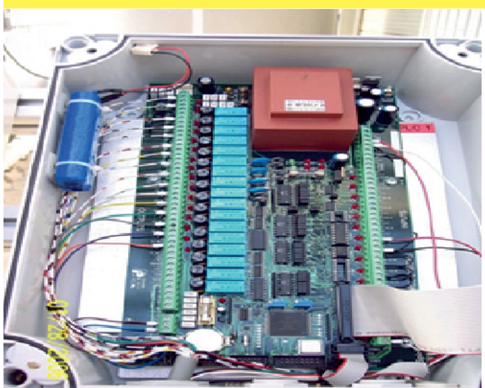
ELECTRONICS GROUP | SEMESTER - V | DIPLOMA IN ENGINEERING AND TECHNOLOGY

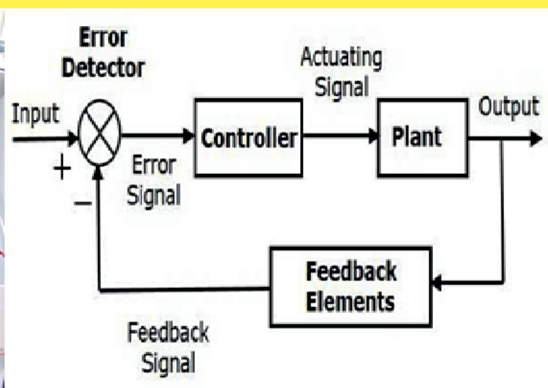
A LABORATORY MANUAL

FOR

CONTROL SYSTEMS AND PLC

(22531)





MAHARASHTRA STATE BOARD OF TECHNICAL EDUCATION, MUMBAI

(Autonomous) (ISO 9001 : 2015) (ISO / IEC 27001 : 2013)

VISION

To ensure that the Diploma level Technical Education constantly matches the latest requirements of technology and industry and includes the all-round personal development of students including social concerns and to become globally competitive, technology led organization.

MISSION

To provide high quality technical and managerial manpower, information and consultancy services to the industry and community to enable the industry and community to face the changing technological and environmental challenges.

QUALITY POLICY

We, at MSBTE are committed to offer the best in class academic services to the students and institutes to enhance the delight of industry and society. This will be achieved through continual improvement in management practices adopted in the process of curriculum design, development, implementation, evaluation and monitoring system along with adequate faculty development programmes.

CORE VALUES

MSBTE believes in the followings:

- Education industry produces live products.
- Market requirements do not wait for curriculum changes.
- Question paper is the reflector of academic standards of educational organization.
- Well designed curriculum needs effective implementation too.
- Competency based curriculum is the backbone of need based program.
- Technical skills do need support of life skills.
- Best teachers are the national assets.
- Effective teaching learning process is impossible without learning resources.

A Laboratory Manual

For

Control Systems and PLC

(22531)

Semester-V

(DE/EJ /ET/EN/EX/EQ)

Maharashtra State
Board of Technical Education, Mumbai

(Autonomous) (ISO:9001:2015) (ISO/IEC 27001:2013)

Maharashtra State Board of Technical Education,
(Autonomous) (ISO:9001: 2015) (ISO/IEC 27001 : 2013)
4th Floor, Government Polytechnic Building, 49, Kherwadi,
Bandra (East), Mumbai - 400051.
(Printed on May,2019)

Maharashtra State
Board of Technical Education

Certificate

This is to certify that Mr. / Ms ……………………………………

Roll No……………………….of ……….. Semester of Diploma in ……………………………………………………………. of Institute………………………………………………. (Code………………..) has attained pre-defined practical outcomes(PROs) satisfactorily in course **Control Systems and PLCs (22531)** for the academic year 20…….to 20…..... as prescribed in the curriculum.

Place ………………. Enrollment No…………………..

Date:…..................... Exam Seat No. …………………....

Course Teacher **Head of the Department** **Principal**

Seal of the Institute

Preface

The primary focus of any engineering laboratory/ field work in the technical education system is to develop the much needed industry relevant competencies and skills. With this in view, MSBTE embarked on this innovative 'I' Scheme curricula for engineering diploma programmes with outcome-base education as the focus and accordingly, relatively large amount of time is allotted for the practical work. This displays the great importance of laboratory work making each teacher; instructor and student to realize that every minute of the laboratory time need to be effectively utilized to develop these outcomes, rather than doing other mundane activities. Therefore, for the successful implementation of this outcome-based curriculum, every practical has been designed to serve as a ***'vehicle'*** to develop this industry identified competency in every student. The practical skills are difficult to develop through 'chalk and duster' activity in the classroom situation. Accordingly, the 'I' scheme laboratory manual development team designed the practicals to ***focus*** on the ***outcomes***, rather than the traditional age old practice of conducting practicals to 'verify the theory' (which may become a byproduct along the way).

This laboratory manual is designed to help all stakeholders, especially the students, teachers and instructors to develop in the student the pre-determined outcomes. It is expected from each student that at least a day in advance, they have to thoroughly read through the concerned practical procedure that they will do the next day and understand the minimum theoretical background associated with the practical. Every practical in this manual begins by identifying the competency, industry relevant skills, course outcomes and practical outcomes which serve as a key focal point for doing the practical. The students will then become aware about the skills they will achieve through procedure shown there and necessary precautions to be taken, which will help them to apply in solving real-world problems in their professional life.

This manual also provides guidelines to teachers and instructors to effectively facilitate student-centered lab activities through each practical exercise by arranging and managing necessary resources in order that the students follow the procedures and precautions systematically ensuring the achievement of outcomes in the students.

A control system is a discipline that applies automatic control theory to design systems in such a way as to achieve a desired control of operation of the system. Control engineering has an essential role in a wide range of control systems. It seeks to understand physical systems, using mathematical modelling, in terms of inputs, outputs and various components with different behaviours. This course will facilitate students to use the different control systems used in various range of applications from simple home heating controller using a thermostat to a large Industrial control systems which are used for controlling processes or machines. The course introduces Control system and PLC which is adapted for the control of manufacturing processes.

Although all care has been taken to check for mistakes in this laboratory manual, yet it is impossible to claim perfection especially as this is the first edition. Any such errors and suggestions for improvement can be brought to our notice and are highly welcome.

Programme Outcomes (POs) to be achieved through Practical of this Course:

Following programme outcomes are expected to be achieved through the practical of the course

PO1. **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.

PO2. **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.

PO3. **Experiments and practice:** Experiments and practice: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.

PO4. **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

PO5. **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics and Telecommunication engineering.

PO6. **Environment and sustainability:** Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in societal and environmental contexts.

PO7. **Ethics:** Apply ethical principles for commitment to professional ethics, responsibilities and norms of the practice also in the field of Electronics and Telecommunication engineering.

PO8. **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

PO9. **Communication:** Communicate effectively in oral and written form.

PO10. **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

Program Specific Outcomes (PSO) (What s/he will be able to do in the Electronics and Telecommunication engineering specific industry soon after the diploma programme).

PSO1. Electronics and Telecommunication Systems: Maintain various types of Electronics and Telecommunication systems.

PSO2. EDA Tools Usage: Use EDA tools to develop simple Electronics and Telecommunication engineering related circuits.

List of Industry Relevant Skills

- The following industry relevant skills of the competency '**Maintain electronic automated systems in process and manufacturing industries**.' are expected to be developed in students by undertaking the practical of this laboratory manual.

1. Identify the control system components for given process.
2. Identify the appropriate control action for given industrial process.
3. Compare performance of different control system.
4. Selection of appropriate PLC for given application.
5. Develop ladder logic for given industrial process control system.
6. Troubleshoot ladder logic for given system.
7. Interpret the ladder logic for given system.

Practical- Course Outcome matrix

Course Outcomes (COs)

a. Identify different types of control systems.
b. Determine the stability of the control system.
c. Test the performance of various types of controllers.
d. Maintain various components of PLC based process control system.
e. Maintain PLC based process control systems.

Pro. No.	Practical Outcomes (PrO)	CO a.	CO b.	CO c.	CO d.	CO e.
1.	Use potentiometer as error detector.	√	-	-	-	-
2.	Determine error of angular position of DC servo system.	√	-	-	-	-
3.	Test the Step response of R-C (first order) circuit.	-	√	-	-	-
4.	Test the Step response of R-L-C (second order) circuit.	-	√	-	-	-
5.	Test the functionality of temperature control with on-off controller.	-	-	√	-	-
6.	Use PI controller to control temperature of the given process.	-	-	√	-	-
7.	Use PD controller to control temperature of the given process.	-	-	√	-	-
8.	Use PID controller to control temperature of the given process.	-	-	√	-	-
9.	Identify and test different parts of PLC .	-	-	-	√	-
10.	Develop ladder diagram to test the functionality of the logic gates.	-	-	-	-	√
11.	Develop ladder diagram to test Demorgan's theorem.	-	-	-	-	√
12.	Develop the ladder diagram for Adder and Subtractor by using PLC.	-	-	-	-	√
13.	Develop ladder diagram for ON and OFF control of lamp using timer and counter.	-	-	-	-	√

14.	Develop ladder diagram for traffic light Control system.	-	-	-	-	√
15.	Develop ladder diagram for stepper motor control.	-	-	-	-	√
16.	Develop ladder diagram for temperature controller.	-	-	-	-	√

Guidelines to Teachers

1. Teacher is expected to refer complete curriculum document and follow guidelines for implementation
2. Teacher should provide the guideline with demonstration of practical to the students with all features.
3. Teacher shall explain prior concepts to the students before starting of each practical
4. Involve students in performance of each practical.
5. Teacher should ensure that the respective skills and competencies are developed in the students after the completion of the practical exercise.
6. Teachers should give opportunity to students for hands on experience after the demonstration.
7. Teacher is expected to share the skills and competencies to be developed in the students.
8. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected the students by the industry.
9. Give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions.
10. Assess the skill achievement of the students and COs of each unit.
11. At the beginning Teacher should make the students acquainted with any of the simulation software environment as few practical are based on simulation.
12. It is desirable to paste the photo of actual practical setup or draw block diagram of practical setup.
13. During industrial visit show use of various controllers in industries

Instructions for Students

1. Listen carefully the lecture given by teacher about course, curriculum, learning structure, skills to be developed.
2. Before performing the practical student shall read lab manual of related practical to be conducted.
3. For incidental writing on the day of each practical session every student should maintain a ***dated log book*** for the whole semester, apart from this laboratory manual which s/he has to ***submit for assessment to the teacher***.
4. Organize the work in the group and make record of all observations.
5. Students shall develop maintenance skill as expected by industries.
6. Student shall attempt to develop related hand-on skills and gain confidence.
7. Student shall develop the habits of evolving more ideas, innovations, skills etc. those included in scope of manual
8. Student shall refer technical magazines, IS codes and data books.
9. Student should develop habit to submit the practical on date and time.
10. Student should well prepare while submitting write-up of exercise.

Content Page

List of Practicals and Progressive Assessment Sheet

Sr No	Title of the practical	Page No.	Date of performance	Date of submission	Assessment marks(25)	Dated sign. of teacher	Remarks (if any)
1*	Use potentiometer as error detector.	1					
2	Determine error of angular position of DC servo system.	7					
3*	Test the Step response of R-C (first order) circuit.	14					
4	Test the Step response of R-L-C (second order) circuit.	20					
5*	Test the functionality of temperature control with on-off controller.	27					
6	Use PI controller to control temperature of the given process.	34					
7	Use PD controller to control temperature of the given process.	41					
8*	Use PID controller to control temperature of the given process.	49					
9*	Identify and test different parts of PLC .	57					
10	Develop ladder diagram to test the functionality of the logic gates.	65					
11*	Develop ladder diagram to test Demorgan's theorem.	75					
12	Develop the ladder diagram for Adder and Subtractor by using PLC.	83					
13	Develop ladder diagram for ON and OFF control of lamp using timer and counter.	95					
14	Develop ladder diagram for traffic light Control system.	104					
15*	Develop ladder diagram for stepper motor control.	113					
16*	Develop ladder diagram for temperature controller.	122					
Total Marks							

- *The practical marked as '*' are compulsory,*
- Column 6^{th} marks to be transferred to Performa of CIAAN-2017.

Practical No. 1: Use potentiometer as error detector.

I Practical Significance

Potentiometer is basic control system component used by industry for error detection. The potentiometer has been in use for determining error of angular position. This system is extremely flexible system for error measurement. This practical will help student to analyse characteristics of potentiometer and to determine error.

II Relevant Program Outcomes (POs)

- **Discipline knowledge**: Apply Electronics and Telecommunication engineering knowledge to solve broad based Electronics and Telecommunication engineering related problems.
- **Experiments and practice**: Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools**: Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency '**Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select the component as per required applications.

IV Relevant Course Outcome(s)

Identify different types of control systems.

V Practical Outcome

Use potentiometer to determine error in process control system.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

All feedback control systems operate from the error signal which is generated by a comparison of the reference and the output. Error detectors perform the crucial task of comparing the reference 'and output signals. In a purely electrical system where the reference and output are voltages, the error detector is a simple comparator. A position control system, with both input and output variables as mechanical positions (linear or angular), may however consist of two potentiometers -reference and output, which function as an error detector.

VIII Practical set-up / Circuit diagram

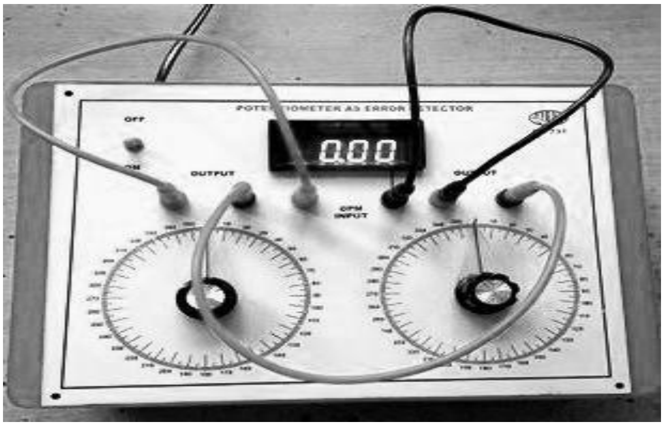


Figure 1.1 Potentiometer setup

[Note: Available and Relevent setup can be used]

IX Resources Required

Sr. No.	Name of Resource	Suggested Broad Specification	Quantity
1	DIGITAL Multimeter	0-600V,0-10A, 0-10MΩ	1 No.
2	Potentiometer system kit		1 No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in ‘off’ condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure [Following procedure for setup shown figure 1.1]

1 Connect set up as shown in figure 1.1.
2 Keep the input pot on 0 degree position.
3 Observe position of output pot.
4 Change the input potentiometer with angle of 30^{o}.
5 Measure error voltage for each change in degree with voltmeter.
6 Observe the voltage and angular position of output pot.
7 Tabulate the observation in Table 1.1.
8 Plot the graph error vs. output voltage.

XII Resources Used

Sr. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table No: 1.1

Sr. No	Input angle	Error voltage in volt	Output voltage at initial position	Final voltage
1				
2				
3				
4				
5				

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

1. State testing method for linearity of potentiometer.
2. State initial calibration process of potentiometer.
3. State Voltage of input potentiometer for different angle.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2 Process control User Guide, 2016
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Calculate theoretical values of given meter	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Member

1 ………………………

2 ………………………

3 ………………………

4 ………………………

Marks Obtained			Dated signature of Teacher
Process Related (15)	Product Related (10)	Total (25)	

Scale

X-axis -

Y-axis -

Practical No.2: Determine error of angular position of DC servo system.

I Practical Significance

DC servo system is one of important instrument used by industry. DC servo system have been in use for determining error of angular position. This servo system is extremely flexible system for error measurement. This practical will help student to analyze characteristics of dc servo system and to determine error.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select the component as per required applications.

IV Relevant Course Outcome(s)

Identify different types of control systems.

V Practical Outcome

Determine Error of Angular Position of DC Servo System

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

DC position control system is required to keep the position of the load constant. The output position is sensed and feedback to the potentiometer used as an error detector. For any change in the output position θ_L, the potentiometer generates an error signal proportional to the difference θr and θ_L. The θr is the reference position corresponding to the ideal output position. The error signal is given to the amplifier and the output of the amplifier is given to the armature of a DC motor. The DC motor maintains the output shaft position constant.

VIII Practical set-up / Circuit diagram / Work Situation

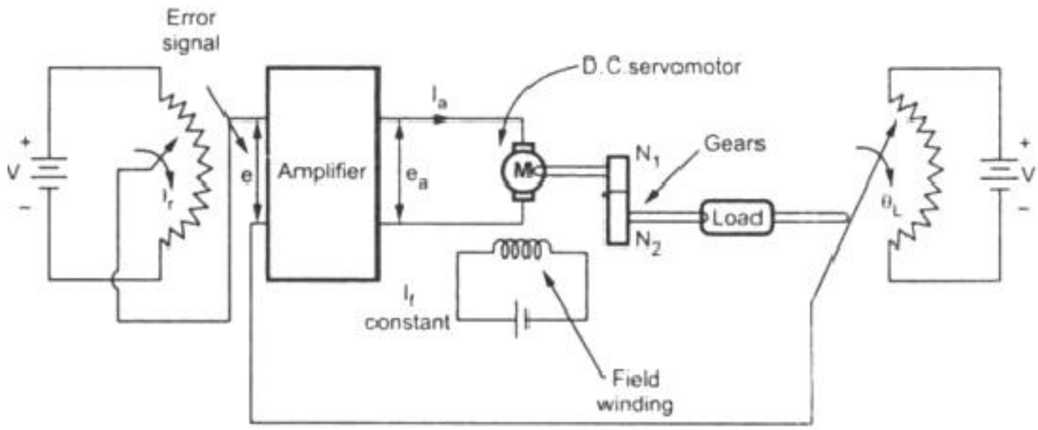

Figure 2.1 DC Position Control Schematic

Figure2.2 Front Panel of DC Position Control System (Ref: visuallightbox.com)

[**Note***:* Available and Relevent setup can be used]

Actual Setup:

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	DIGITAL Multimeter	0-600V,0-10A, 0-10MΩ	1 No.
2	DC Position control system Experimental setup /Kit	DC Servomotor of 12V or 24V or 230V Speed with 10 RPM to 50 RPM	1No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in 'off' condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure [Following procedure is for given setup in Figure 2.1and Figure 2.2**]**

1 Before switching ON the mains, check that the switches SW3, SW4 are in down ward position i.e. ON position.(Figure 2.2)
2 Keep the input pot P_1in 10 degree position.
3 Adjust the pot P_2 (amplifier gain adjustment) in mid position(Figure 2.2)
4 Change the input potentiometer (P_1) with angle of 30^o. (Figure 2.2)
5 Measure error voltage with voltmeter at Tp1(Figure2.2)
6 Measure the output voltage at initial and final position at Tp3(Figure2.2)
7 Tabulate the observation in Table No: 2.1.
8 Plot the graph error vs. output voltage.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution followed

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XV Observations and Calculations

Table No: 2.1 Observation

Sr. No	Reference Position(θ)	Actual position (θ)	Error (θ)	Error voltage
1				
2				
3				
4				
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XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions.

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XIX Practical Related Questions

1 Explain the calibration process followed by you used in this experimental setup.
2 State the value of supply voltage required for 12V Dc motor,24V Dc motor and 220V Dc motor
3 State the condition of motor and pot when the switches SW3 and SW4 in off position.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments,Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN:9780852265543
2 Process control User Guide,2016
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN:978087909222
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related:15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related:10 Marks		**40%**
5	Calculate theoretical values of given meter	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of Student Team Member

1 ………………………

2 ………………………

3 ………………………

4 ………………………

Marks Obtained			**Dated signature of Teacher**
Process Related(15)	**Product Related(10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No. 3: Test the Step response of R-C (first order) circuit.

I Practical Significance

The step signal is one of the important test signal used in control system and RC network represent first order system. By testing the RC circuit response using step signal student will be able to understand the behaviour of first order system for transient and steady state response in this practical.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based Electronics and Telecommunication engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select the component as per required applications.

IV Relevant Course Outcome(s)

Determine the stability of the control system.

V Practical Outcome

Test the Step response of R-C (first order) circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

Step Response is understood to be zero state response of the circuit when unit step input is applied to RC (first order) circuit. Hence the initial voltage across the capacitor is zero. It takes an impulse current flow through a capacitor to change its voltage by a non-zero finite amount instantaneously. The total response of a control system or element of a system can be considered to be made up of two aspects the steady state response and the transient response.

$$\mathbf{RC}\frac{dv}{dt} + \mathbf{v} = \mathbf{V}$$

$$\mathbf{V_{c(t)}} = \int (1/RC)e^{-1/t}\,dt = (1 - e^{-1/t})V$$

VIII Practical set-up / Circuit diagram

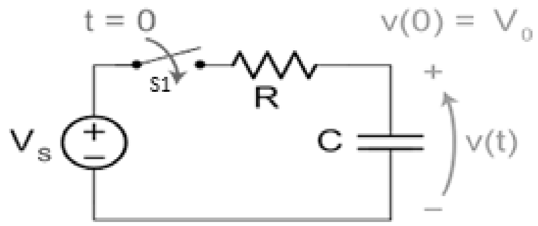

Figure 3.1 RC Circuit

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	DSO	70Mhz, Dual channel	1 No.
2	DC Regulated power supply	0-30 V, 2A, Ripple free	1 No.

X Precautions to be followed

1. Ensure proper earthing to the equipment.
2. Ensure the power switch is in 'off' condition initially.
3. Ensure that the Power Supply switch is in off condition.

XI Procedure

1 Connect resistance and capacitor in series on the breadboard.
2 Connect 5V DC supply to RC circuit through switch S1.
3 Connect DSO across capacitor.
4 On the switch S1 and check the response on DSO across the capacitor.
5 Measure the output voltage at 10% , 90% and at final position (where response will be steady state).
6 Measure the time at10% , 90% and at final position (where response will be steady state) .
7 Repeat the Procedure for different of R and C values for given table1.
8 Plot the response.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1.					
2.					
3.					

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution followed

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XV Observations and Calculations (use blank sheet provided if space not sufficient)

Table 3.1 Observations

Sr. No	Resistance and Capacitance Value		At 10% of its maximum Voltage		At 90% of its maximum		Final	
	R in Ω	C	Voltage	Time	Voltage	Time	Voltage	Time
1	1K	220uF						
2	10K	220uf						
3	100	1000uf						
4	100K	.47uf						
5	1000	100uf						

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions

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XIX Practical Related Questions

1. State the significance RC circuit in control system.
2. State significance of step input.
3. State meaning of order of system and its practical significance.
4. State physical equivalence of RC circuit

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2 Process control User Guide, 2016
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related:10 Marks		**40%**
5	Calculate theoretical values of given time constant	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No. 4: Test the Step response of R-L-C (second order) circuit

I Practical Significance

The step signal is one of the important test signal used in control system and RLC network represent second order system. By testing the RLC circuit response using step signal student able to understand the behaviour of second order system for transient and steady state this practical achieve the same.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select the component as per required applications.

IV Relevant Course Outcome(s)

Determine the stability of the control system.

V Practical Outcome

Test the Step response of RLC (Second Order) circuit.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

The RLC series circuit is consider second order system. The response of this system contains two part that is natural response and force response. The natural response is transient response while force response is steady state response. Response of second order system is given by following equation

$$\frac{\omega_n^2}{S^2 + 2\xi\omega_n S + \omega_n^2}$$

Where 1) ω_n is natural angular frequency
2) ξ is damping factor

The damping factor decides whether the system is over damped, un-damped or under damped.

VIII Practical set-up / Circuit diagram

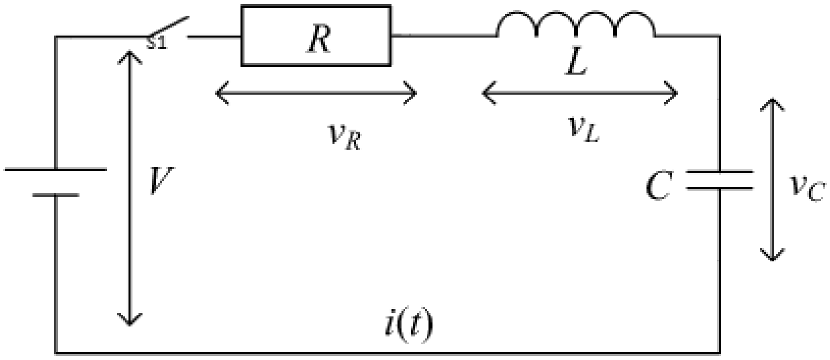

Figure: 4.1 RLC circuit

[***Note***: *Available and Relevent setup can beused*]

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	DSO	70Mhz, Dual Channel	1 No.
2	DC Regulated power supply.	0-30 V, 2A, Ripple Free	1 No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in ‘off’ condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure

1 Connect 5V DC supply to RLC circuit through switch S1.
2 Connect DSO across capacitor.
3 On the switch S1 and check the response on DSO across the capacitor.
4 Note down the values of Mp, Td (time at amplitude reach 10% of input voltage), Tr (time at amplitude reach 90% of input voltage), Ts(time at amplitude reach 90% to final Value of input voltage).
5 Compare with theoretical values.
6 Repeat the Procedure for different values of R, L and C values for given table 4.1
7 Tabulate the result in Table 4.1
8 Plot the response on graph paper.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Qty	Remarks (If any)
		Make	Details		
1					
2					
3					
4					

XIII Actual Procedure Followed

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XIV Precaution followed

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XV Observations and Calculations

Table 4.1 Observations

Sr. No	Resistance, Inductance, Capacitance, Value			Mp Peak overshoot in volt		Td Delay time		Ts Settling time		Tr Rise time	
	R Ω	C μf	L mH	TH	PR	TH	PR	TH	PR	TH	PR
1	100	1	100								
2	1k	1	100								
3	10k	.1	100								
4	10k	.1	47								
5	100k	.01	100								

Calculation: Mp(peak Overshoot)

Ts (Settling time):

T_d (Delay time):

Tr (Rise Time):

ξ (damping factor):

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1 State the significance RLC circuit in control system.
2 State different component of step response.
3 Compare of order of system and its practical significance.
4 State physical equivalence of RLC circuit.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2 Process control User Guide, 2016
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related:10 Marks		**40%**
5	Calculate theoretical values of given time constant	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		100 %

Names of student Team Member

1 …………………………………..

2 …………………………………..

3 …………………………………..

4 …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No. 5: Test the functionality of temperature control with ON-OFF controller.

I Practical Significance

The on-off controller is basic controller used in control system. This type controller should work with precision without any offset at given time. Temperature control system is one of the fundamental physical controls in industry for various applications like boiler. This practical will help the students to develop skills to test the Functionality of Temperature Control with On-Off Controller.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select Controller as per required applications.

IV Relevant Course Outcome

Test the performance of various types of controllers.

V Practical Outcome

Test the functionality of Temperature control with on-off controller.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

As the name implies, a temperature controller is an instrument used to control temperatures, mainly without extensive operator involvement. A controller in a temperature control system will accept a temperature sensor such as a thermocouple or RTD as input and compare the actual temperature to the desired control temperature, or set point. It will then provide an output to a control element. On-off control is usually used where a precise control is not necessary, in systems which cannot handle having the energy turned on and off frequently

VIII Practical set-up / Circuit diagram

a) Sample

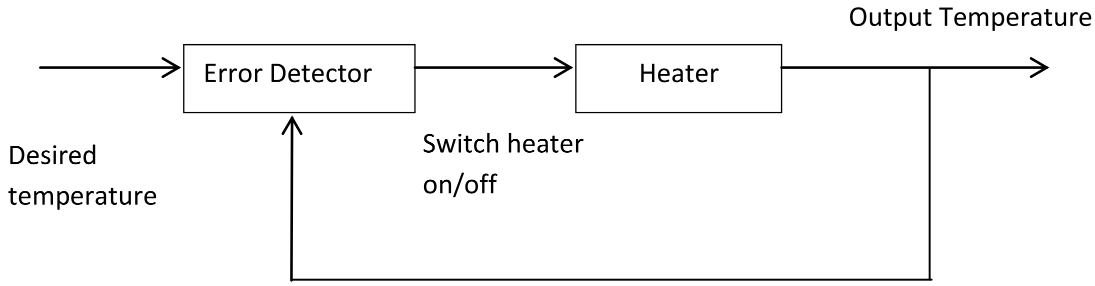

Figure 5.1:On off controller.

[***Note***: *Available and Relevent setup can beused*]

b) Actual setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	ON-OFF control kit, Temperature sensor	Sensor(Thermocouple OR RTD Pt 100) relay ,comparator , heater (230v supply)	1 No.
2	Digital Multimeter	3 ½ digit	1 No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in ‘off’ condition initially.
3 Ensure that the Power Supply switch is in off condition.

Procedure

1 Connect given kit to supply.
2 Connect thermometer to kit.
3 Set the reference temperature.
4 Connect temperature sensor to kit.
5 Switch on the heater.
6 Measure the change in temperature and on off condition of heater.
7 Tabulate result in given Table No: 5.1.
8 Plot the response on graph paper.
9 Determine neutral zone.

XI Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIII Precaution followed

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XV Observations and Calculations

Table No: 5.1 Observations

Sr. No	Set temperature	Measure temperature at heater	
		On	Off
1			
2			
3			
4			

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions:

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XIX Practical Related Questions

1 Write the initial output of sensor used in practical. (Resistance / Current)
2 Write effect on measurement if RTD is replaced by thermistor.
3 Write use of on off controller in Air conditioned system.
4 Write different component used in on-off controller.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543

2 Process control User Guide, 2016

3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222

4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Using appropriate sensor	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No. 6: Use PI controller to control temperature of the given process.

I Practical Significance

The PI controller is one of the closed loop controller use in control system. This type controller is work to minimize offset at given time. Basically it is a low pass filter. To provide linearity in temperature control process PI controller is used like boiler in industry. This practical will help student to understand PI controller behavior in temperature control in given process.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select Controller as per required applications.

IV Relevant Course Outcome

Test the performance of various types of controllers.

V Practical Outcome

Use PI controller to control temperature of the given process.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

P-I controller is mainly used to eliminate the steady state error resulting from P controller. However, in terms of the speed of the response and overall stability of the system, it has a negative impact. This controller is mostly used in areas where speed of the system is not an issue. Since P-I controller has no ability to predict the future errors of the system it cannot decrease the rise time and eliminate the oscillations. If applied, any amount of I guarantees set point overshoot.

$$\boldsymbol{P(t) = K_p e(t) + K_i \int e(t)\, dt}$$

Where P(t) is output with proportional and integral
e(t) is error signal.

Kp is proportional constant.
Ki is integral constant.

VIII Practical set-up / Circuit diagram

a) Sample

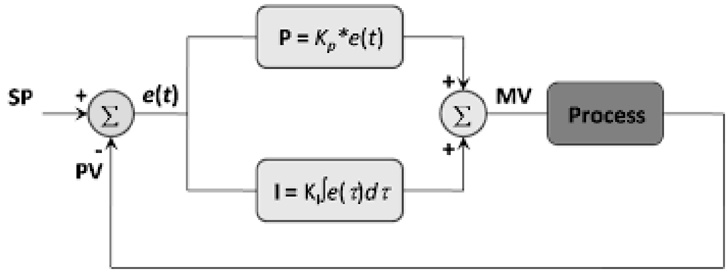

Figure 6.1 PI controller Schematic

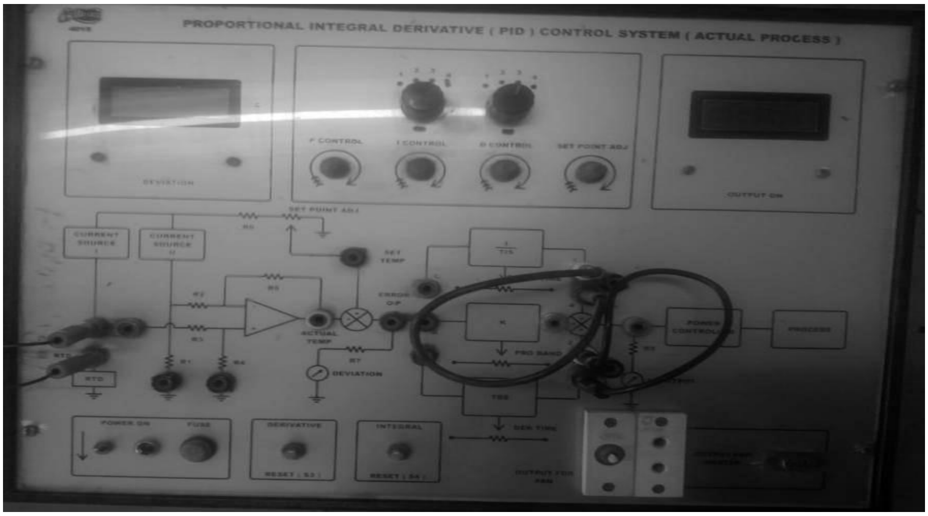

Figure 6.2 PI controller[***Note***: *Available and Relevent setup can beused*]

b) Actual setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	PI controller kit, Temperature sensor	Sensor(Thermocouple OR RTD Pt100) relay ,comparator , heater (230v supply)	1 No.
2	Digital Multimeter	3 ½ digit	No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in 'off' condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure

1 Connect given setup to supply. (Figure 6.2)
2 Connect RTD to Setup.
3 Set the reference temperature.
4 Set the error input.
5 Switch on the heater.
6 Calibrate PI controller as per manual.
7 Measure the change in temperature and corresponding voltage for each 1 second delay.
8 Tabulate the reading in given table
9 Plot the response.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed :

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XIV Precaution followed

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XV Observations and Calculations

Set point Temperature=………..

Proportional constant=**………..**

Integral constant=…………..

Table 5.1: **Proportional constant**

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

Table 5.2: Proportional + integral constant

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions:

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XIX Practical Related Questions

1 State use of PI controller in fridge.
2 Write different component used in PI controller.
3 State calibration process of PI controller.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2 Process control User Guide, 2016
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Using appropriate sensor	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of student Team Member

1 ……………………………………..

2 ……………………………………..

3 ……………………………………..

4 ……………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No.7: Use PD controller to control temperature of the given process.

I Practical Significance

PD controller improves transient response of system without affecting steady state. PD controllers are used in process control applications. At initial condition to bear the system process should be delayed by few seconds for that PD control has significant role. This practical will help the students to develop skills to Use PD controller to control temperature of the given process.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using an control system component.
- Select Controller as per required applications.

IV Relevant Course Outcome(s)

Test the performance of various types of controllers.

V Practical Outcome

Use PD controller to control temperature of the given process.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

The controller in the forward path, which changes the controller input to the proportional plus derivative of error signal is called PD controller.

$$\boldsymbol{P(t) = K\, e(t) + T_d \frac{de(t)}{dt}}$$

Where P(t) is output with Proportional and Derivative
e(t) is error signal.
Kp is proportional constant.
Kd is Derivative constant.

The aim of using P-D controller is to increase the stability of the system by improving control since it has an ability to predict the future error of the system response. In order to avoid effects of the sudden change in the value of the error signal, the derivative is taken from the output response of the system variable instead of the error signal. Therefore, D mode is designed to be proportional to the change of the output variable to prevent the sudden changes

VIII Practical set-up / Circuit diagram

a) Sample

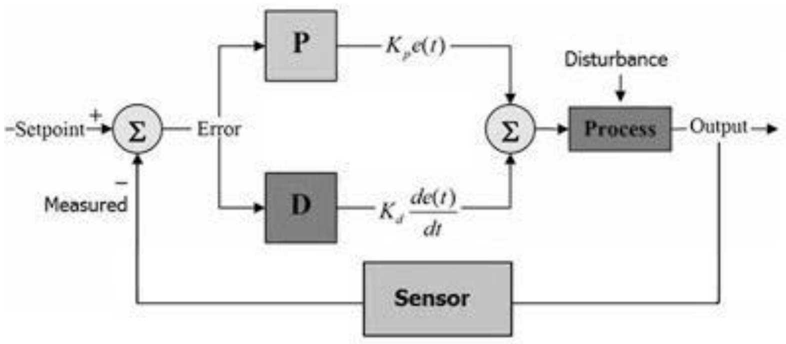

Figure7.1 Schematic PD controller

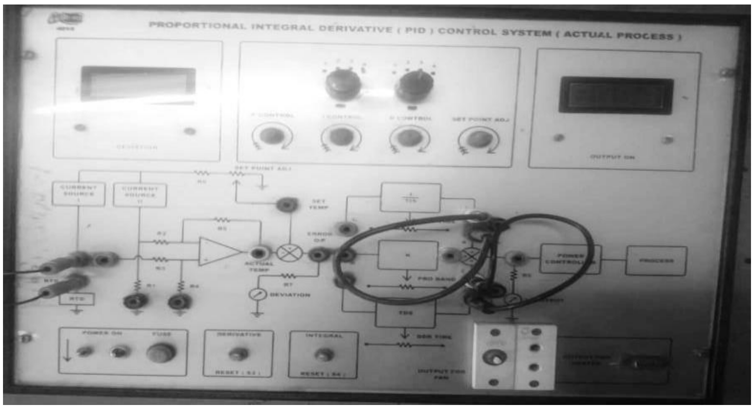

Figure 7.2 PD controller[***Note***: *Available and Relevent setup can be used*]

b) Actual setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	PDcontrollerSETUP, Temperature sensor	Sensor(Thermocouple OR RTD Pt 100) relay ,comparator , heater (230v supply)	1 No.
2	Digital Multimeter	3 ½ digit	No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in 'off' condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure

1 Connect given set up to supply as shown.(figure 7.2)
2 Connect RTD to setup. (figure 7.2)
3 Set the reference temperature.
4 Set the error input.
5 Set Derivative control pot minimum position.
6 Calibrate the PD controller as given in manual.
7 Switch on the heater.
8 Measure the change in temperature and corresponding voltage for each 1 second delay only with proportional and then proportional with derivative.
9 Tabulate the reading in given table
10 Plot the response.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed :

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XIV Precaution followed

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XV Observations and Calculations

Set point Temperature=………..
Proportional constant=………..
Derivative constant=…………..

Table 7.1: Proportional constant

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

Table 7.2: Proportional + Derivative constant

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions:

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XIX Practical Related Questions

1. State initial condition of component use for derivative action.
2. State effect on measurement RTD is replaced by thermocouple
3. State use of PD controller in Air conditioned system component.
4. Write different component used in PD controller.
5. Write calibration process of PD controller for given setup.

[Space for Answers]

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XX References / Suggestions for further reading

1 Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2 Process control User Guide, 2016.
3 Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222.
4 https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Using appropriate sensor	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No.8: Use PID controller to control temperature of the given process.

I Practical Significance

PID controller improves transient response as well as offset of system without affecting steady state. PID controllers are used in process control applications. At initial condition to bear the system process should be delayed by few seconds for that PID control has significant role. This practical will help the students to develop skills to Use PID controller to control temperature of the given process.

II Relevant Program Outcomes (POs)

- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad based control engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunication technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated system in process and manufacturing industries'**:

- Use of control system component.
- Measure error in position accurately using control system component.
- Select Controller as per required applications.

IV Relevant Course Outcome(s)

Test the performance of various types of controllers.

V Practical Outcome

Use PID controller to control temperature of the given process.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Demonstrate working as a leader/a team member.
- Maintain tools and equipment.

VII Minimum Theoretical Background

The controller in the forward path, which changes the controller input to the proportional plus derivative of error signal is called PD controller.

$$\boldsymbol{P(t) = K\, e(t) + K_i \int e(t)\, dt + T_d \frac{de(t)}{dt}}$$

Where P(t) is output with Proportional and Derivative
e(t) is error signal.
Kp is proportional constant.
Kd is Derivative constant.
Ki is integral constant

The aim of using PID controller is to increase the stability of the system by improving control since it has an ability to predict the future error of the system response. In order to avoid effects of the sudden change in the value of the error signal, the derivative is taken from the output response of the system variable instead of the error signal. Therefore, D mode is designed to be proportional to the change of the output variable to prevent the sudden changes I control is used for remove the offset.

VIII Practical set-up / Circuit diagram

a) Sample

b)

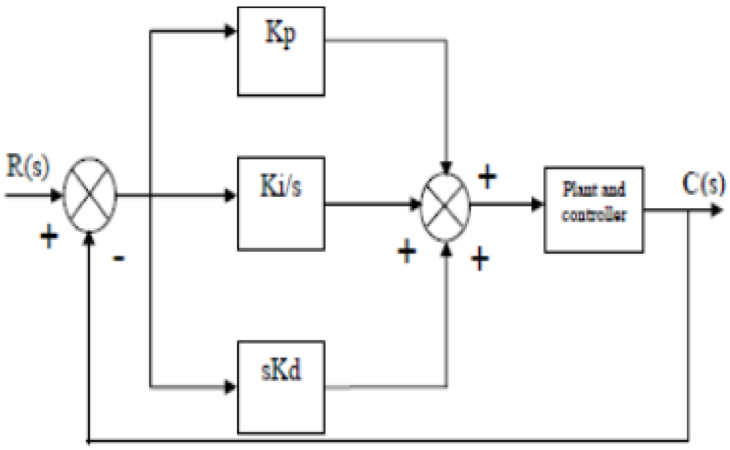

Figure 8.1 Schematic PID controller

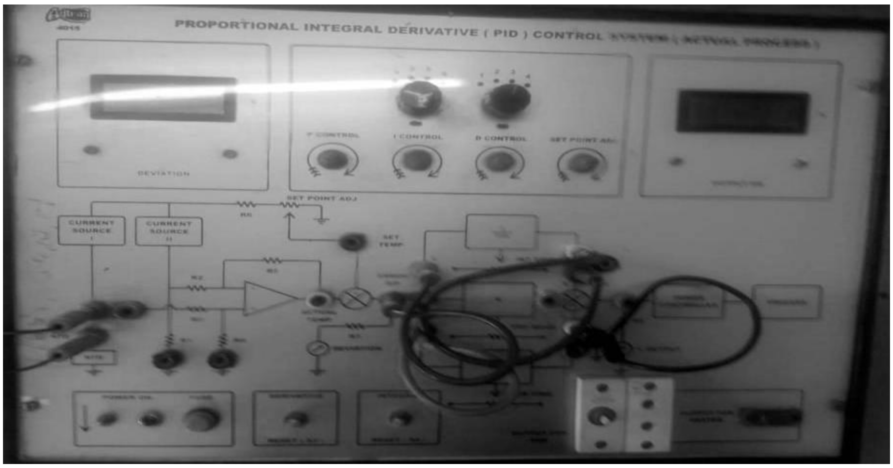

Figure 8.2 PID controller[***Note***: *Available and Relevent setup can be used*]

c) Actual setup

IX Resources Required

S. No.	Name of Resource	Suggested Broad Specification	Quantity
1	PID controller SETUP, Temperature sensor	Sensor(Thermocouple OR RTD Pt 100) relay ,comparator , heater (230v supply)	1 No.
2	Digital Multimeter	3 ½ digit	2 No.

X Precautions to be Followed

1 Ensure proper earthing to the equipment.
2 Ensure the power switch is in 'off' condition initially.
3 Ensure that the Power Supply switch is in off condition.

XI Procedure

1 Connect given PID set up to supply as shown.(figure 8.2)
2 Connect RTD to given PID setup. (figure 8.2)
3 Set the reference temperature as per available setup**.**
4 Set the error input value as per available set up**.**
5 Set Derivative control pot to the minimum position.
6 Set Integral control pot to the maximum position.
7 Calibrate the PID controller as given in manual of given setup.
8 Switch on the heater on the board.
9 Measure the change in temperature and corresponding voltage for each 1 second delay only with proportional and then proportional with integral.
10 Measure the change in temperature and corresponding voltage for each 1 second delay only with proportional and Derivative with integral controller.
11 Tabulate the reading in given table
12 Plot the response.

XII Resources Used

S. No.	Name of Resource	Broad Specifications		Quantity	Remarks (If any)
		Make	Details		
1					
2					
3					

XIII Actual Procedure Followed :

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XIV Precaution followed

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XV Observations and Calculations

- Set point Temperature=……….
- Proportional constant=………..
- Derivative constant=…………..
- Integral constant=………..

Table 8.1: **Proportional constant**

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

Table 8.2: Proportional + Integral constant

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

Table 8.3: Proportional+ Integral + Derivative

Sr. No.	Time in second	Temperature
1		
2		
3		
4		
5		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions:

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XIX Practical Related Questions

1. State initial condition of heater temperature.
2. Write the output of PID if the RTD is replaced by thermistor.
3. PID controller is used in Air conditioned system component justify.
4. State different component used in PID controller.
5. State calibration process of integral controller.
6. State calibration process of PID controller.

[Space for Answers]

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XX References / Suggestions for further reading

1. Laboratory Manual for Introductory Electronics Experiments, Maheshwari, L.K.; Anand, M.M.S., New Age International Pvt. Ltd. New Delhi; ISBN: 9780852265543
2. Process control User Guide, 2016
3. Electronics Component Handbook; Jones, Thomas H., Reston Publishing, Resto, Virginia, USA, ISBN: 978087909222
4. https://youtube/WmIgusHZyPc?t=42

XXI Suggested Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1	Handling of the instruments.	10 %
2	Making connection of instrument.	20 %
3	Measuring value using suitable instrument	20 %
4	Working in team	10 %
Product related: 10 Marks		**40%**
5	Using appropriate sensor	10 %
6	Interpretation of result	05 %
7	Conclusions	05 %
8	Practical related questions	15 %
9	Submitting the journal in time	05%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Scale

X-axis -

Y-axis -

Practical No. 9: Identify and test different parts of PLC.

I Practical Significance

Programmable Logic controller (PLC) is an industrial computer based control system which continuously monitors the state of input devices and other values, make decisions based on the stored programs to control the state of output devices. PLC is used to control machines and processes. This practical will enable the students to identify and test different parts of PLC.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Identify different parts of PLC.
- Test different parts of PLC.

IV Relevant Course Outcome(s)

Maintain various components of PLC based process control system.

V Practical Outcome

Develop ladder diagram to test the functionality of the logic gates.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping
- Practice energy conservation.

VII Minimum Theoretical Background

Parts of PLC

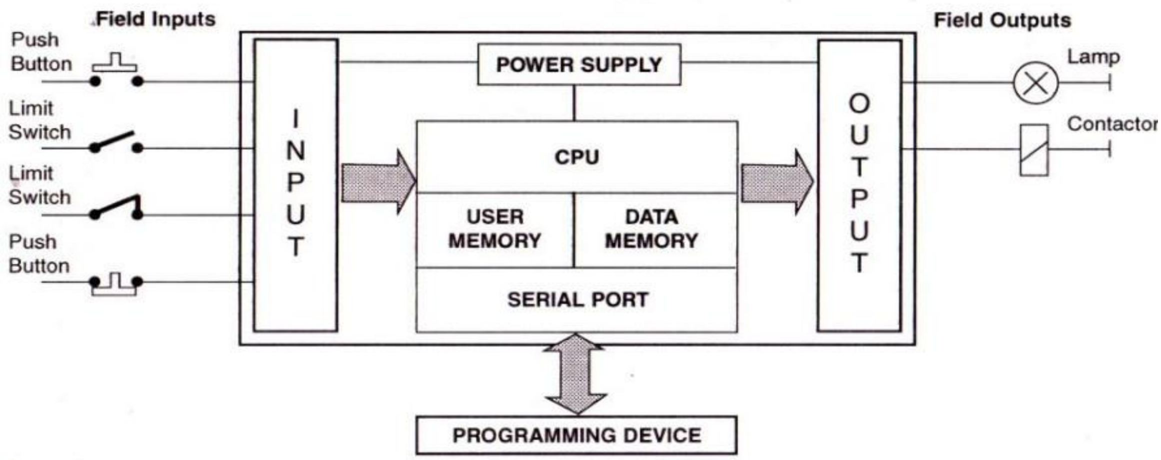

Figure 9.1 Elements of PLC

***Courtesy**: https://belajarplconline.wordpress.com/2010/04/13/komponen-komponen-pada-plc/block-diagram-plc-3/*

A discrete input is an input that is either in an ON or OFF condition. Pushbuttons, toggle switches, limit switches, proximity switches, and contact closures are examples of discrete sensors which are connected to the PLC discrete or digital inputs.

An analog input is a continuous, variable signal. Typical analog inputs may vary from 0 to 20 milliamps, 4 to 20 milliamps, or 0 to 10 volts.

Outputs: There are three common categories of outputs: Discrete, Register, and Analog. Discrete outputs can be pilot lights, solenoid valves. Register output can drive panel meters or displays; analog outputs can drive signals to variable speed drives or to I/P (current to air) converters and thus to control valves.

Control Processor Unit (Real Time): The central processor unit (CPU) performs the tasks necessary to fulfil the PLC function. Among these tasks are scanning, I/O bus traffic control, program execution, peripheral and external device communications, special function or data handling execution (enhancements) and self-diagnostics.

Memory Unit: It is the library where the application program is stored. It is also where the PLC's executive is stored. An executive program functions as the operating system of the PLC. It is the program that interprets, manages, and executes the user's application program.

Programmer Units: The programmer unit provides an interface between the PLC and the user During Program development, start-up, and troubleshooting. The instruction to be performed during each scan are coded and inserted into memory with the programmer. Programmers vary from small hand-held units the size of a large calculator to desktop stand-alone intelligent CRT-based units.

Input Module: It senses input signals ,isolates it and converts it to DC level

Output Module: It receives control signal from CPU and then convert it into analog or digital values.

Power Supply: It provides the supply voltage needed to run the primary PLC components.

VIII Practical Ladder diagram :

a) Sample PLC parts identification diagram

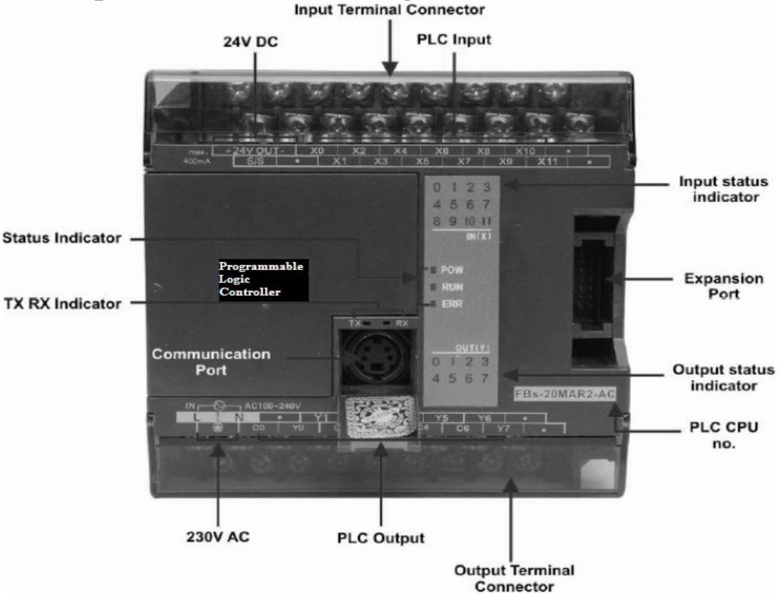

Figure 9.2 Identification of parts of PLC

b) Actual PLC parts identification diagram

c) Sample Experimental set up

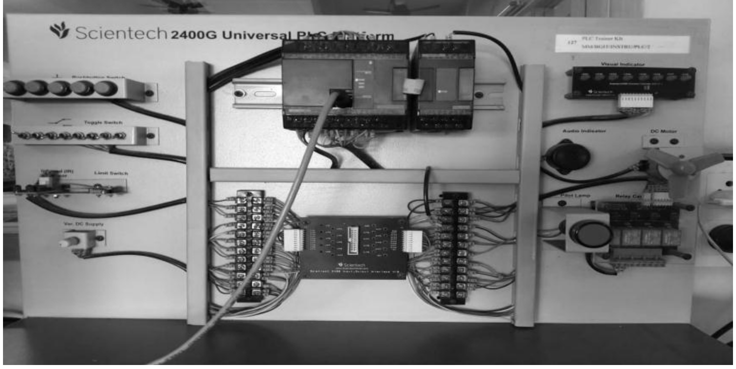

Figure 9.3 PLC Experimental Setup

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Identify the various parts of PLC available in the laboratory.
2. Observe the status of input, output and communication port on PLC front panel.
3. Write down specification of PLC (Refer PLC user manual available in laboratory)

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1.			
2.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations

Table No: 9.1 Specifications of PLC Observation

Trainer Kit	Make and Model No.	Specifications
PLC Trainer		Rated DC output Voltage _____
		Analog inputs______
		Digital inputs______
		Expansion Module- Yes/NO ______
		Program size______
		Analog outputs______
		Digital outputs______

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Name types of field devices are suitable for use with discrete input module.
2. List the different programming devices used with PLC? Which programming device is available in the laboratory.
3. Ladder diagrams called as ladder diagrams, Justify?

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://sail.co.in/sites/default/files/ipss/about/2-07-015-15.pdf
3. http://www.fatek.com/en/data%2Fftp%2FPLC%2FFBs_Manual%2FManual_1%2Fhardware%2FChapter_1.pdf

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Identification of parts of PLC.	20 %
3.	Observing status	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 10: Develop ladder diagram to test the functionality of the logic gates.

I Practical Significance

Logic is the ability to make decisions when one or more different factors must be taken into account before an action is taken. This is the basis for the operation of PLC, where it is required for the device to operate when certain conditions are met. This practical will enable the students to use basic logic gates for the efficient hardware implementation using PLC.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Built up digital circuits using PLC.
- Develop ladder logic programs for various logic gates.
- Test ladder logic programs for various logic gates.
- Troubleshoot ladder logic programs for various logic gates.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram to test the functionality of the logic gates.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping

VII Minimum Theoretical Background

Basic logic Gates:

1. NOT Gate: Output of NOT gate is the inversion of the input.

Table No: 10.1 Truth table for NOT Logic Gate

Input A	Output $Y = \bar{A}$
0	1
1	0

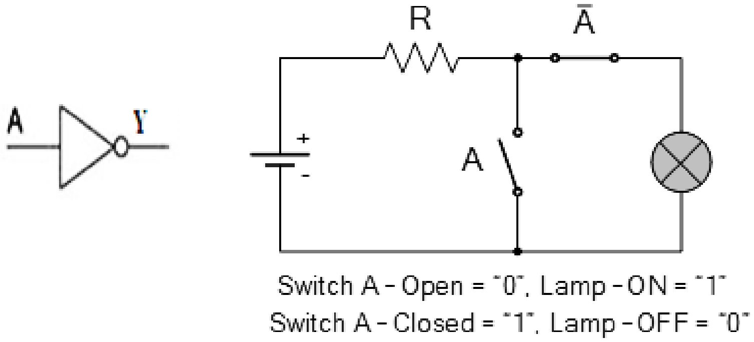

Figure 10.1 NOT Gate electric circuits

NOT Logic Gate can be implemented by using just one normally closed contact. Inverted state of input is obtained as an output.

2. AND Gate

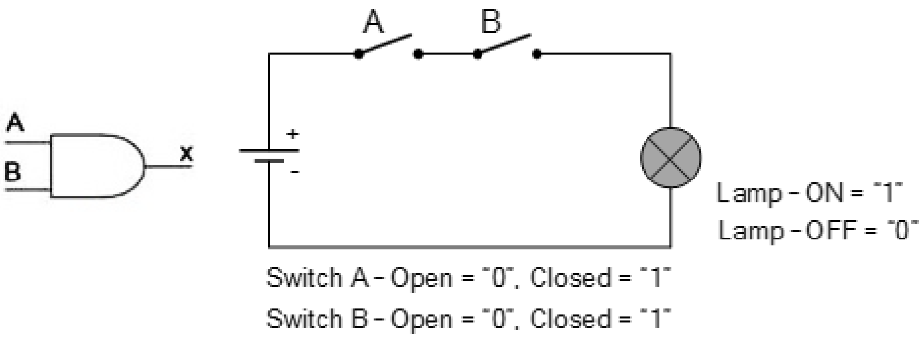

Figure 10.2 AND Gate electric circuits

AND gate can be implemented. by connecting normally open contacts in series, when both inputs are set to 1, then and then only output goes high.

1 OR Gate

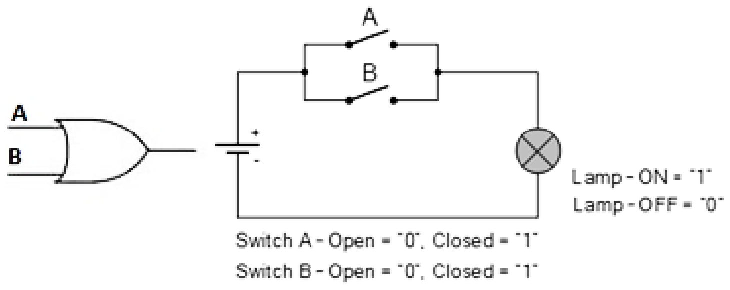

Figure 10.3 OR Gate electric circuits

OR Gate can be implemented by connecting Normally Open contacts in parallel, when either input is set to high, output goes high.

4. NOR Gate

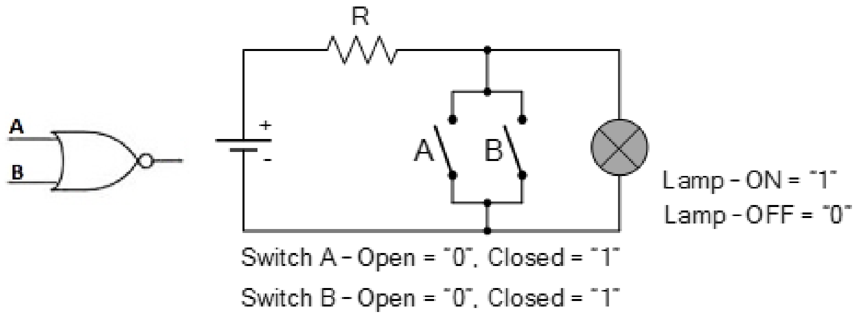

Figure 10.4 NOR Gate electric circuits

NOR Logic Gate can be implemented by connecting normally closed contacts in series, If both inputs are Reset to 0, output goes High otherwise remains in Low state. Or by inverting output of a OR Gate, that is by using output of OR Gate as an input of NOT Gate, NOR Gate can be implemented.

5. NAND Gate

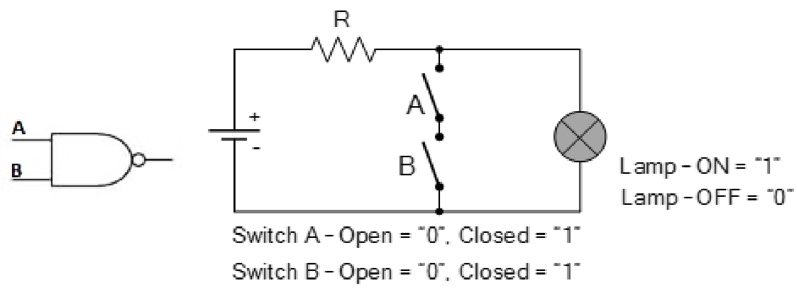

Figure 10.5 NAND Gate electric circuits

By connecting Normally Closed contacts in parallel to each other, NAND Gate can be implemented. Or by simply inverting output of AND gate, NAND Gate can be implemented.

Table No: 10.2 Truth table for Various Logic Gates

Input A	Input B	AND	OR	NOR	NAND
0	0	0	0	1	1
0	1	0	1	0	1
1	0	0	1	0	1
1	1	1	1	0	0

VIII Practical Ladder diagram :

a) Sample Ladder diagram

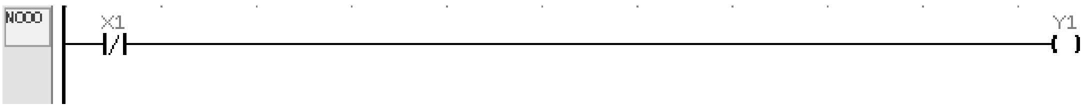

Figure 10.6 Ladder diagram for NOT Gate

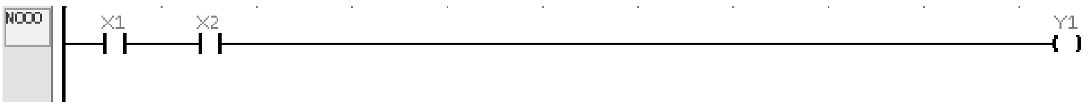

Figure 10.7 Ladder diagram for AND Gate

Figure 10.8 Ladder diagram for OR Gate

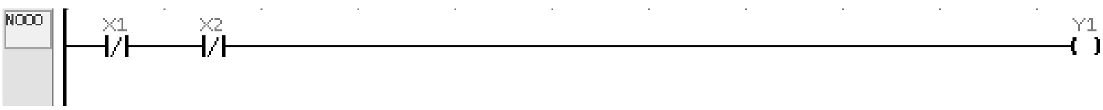

Figure 10.9 Ladder diagram for NOR Gate

Figure 10.10 Ladder diagram for NAND Gate

b) Actual Ladder diagrams

c) Sample Experimental set up

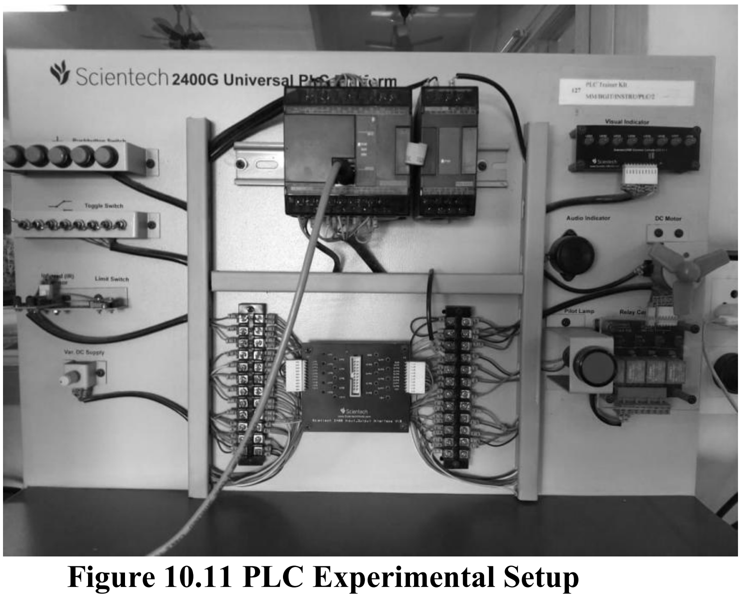

Figure 10.11 PLC Experimental Setup

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Create new project by clicking on the File from the toolbar.
2. Draw ladder diagram for NOT gate
3. Save the project by clicking on Save option.
4. Run the ladder diagram with Run option available on toolbar.

5. Observe the result.
6. Repeat step 1 to 5 for AND,OR, NOR and NAND Gates.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1.			
2.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations

Table No: 10.3 NOT Gate Observation

Input-X_1	Output-Y_1
0	1
1	0

Table No: 10.4 AND,OR,NOR and NAND Gate Observation

Input-X_1	Input-X_2	AND-Y_1	OR-Y_1	NOR-Y_1	NAND-Y_1
0	0				
0	1				
1	0				
1	1				

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Repeat and draw the ladder diagram with the above procedure for X-OR and X-NOR gates
2. Draw and verify ladder logic program for three input AND Gate.
3. State the meaning of XIO and XIC.

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.youtube.com/watch?v=ouN3Kp4a8Z4

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 11: Develop ladder diagram to test Demorgan's theorem.

I Practical Significance

De Morgan's Theorems are used to simplify the complex Boolean/Logic functions. This practical will enable the students to use De Morgan's theorem to simplify for the efficient hardware implementation using PLC.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Built up digital circuits using PLC.
- Develop ladder logic programs for De Morgan's theorem.
- Test ladder logic programs for De Morgan's theorem.
- Troubleshoot ladder logic programs for De Morgan's theorem.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram to test De Morgan's theorem.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping.

VII Minimum Theoretical Background

De Morgan's Theorems are used to simplify the Boolean expressions and Logic functions.

De Morgan's first Theorem: It states that for any two elements A and B in a Boolean algebra, the complement of the sum is equal to product of complements.

De Morgan's first Theorem can be expressed by logic circuits as

$$\overline{A+B} = \bar{A}.\bar{B}$$

NOR Gate = Bubbled AND Gate

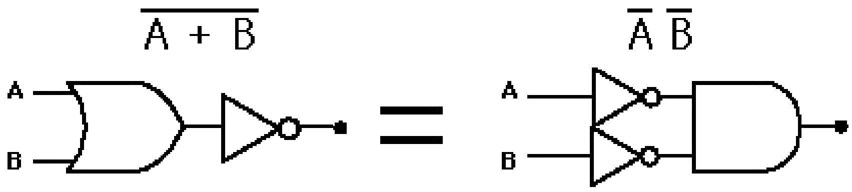

Figure 11.1 De Morgan's first Theorem

De Morgan's second Theorem: It states that for any two elements A and B in a Boolean algebra, the complement of a product is equal to the sum of the complements.

De Morgan's second Theorem can be expressed by logic circuits as

$$\overline{A.B} = \bar{A} + \bar{B}$$

NAND Gate = Bubbled OR Gate

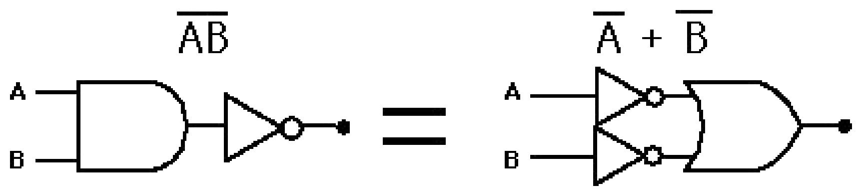

Figure 11.2 De Morgan's second Theorem

VIII Practical Circuit diagram :

a) Sample Ladder diagram

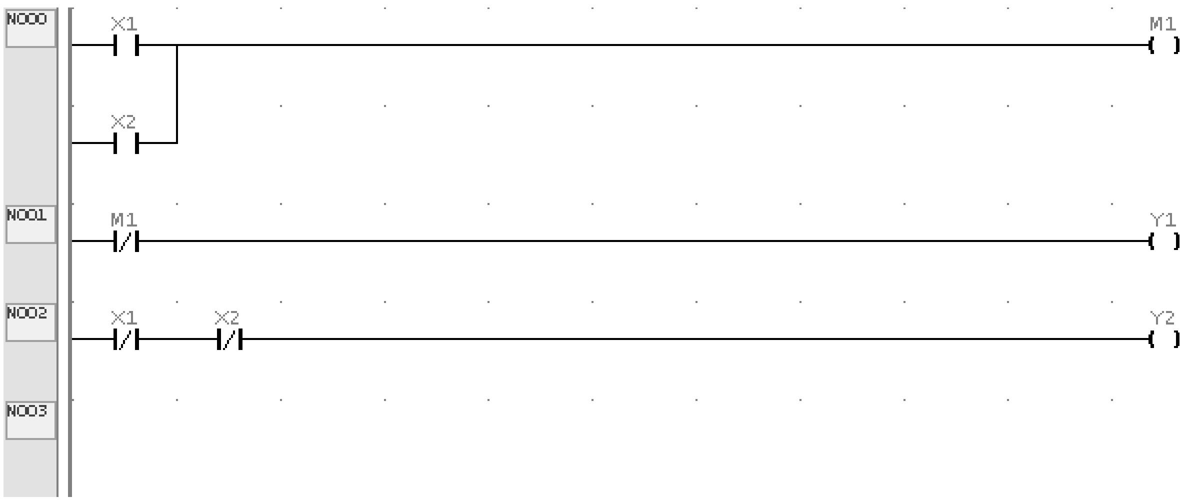

Figure 11.3 Ladder diagram for De Morgan's first Theorem

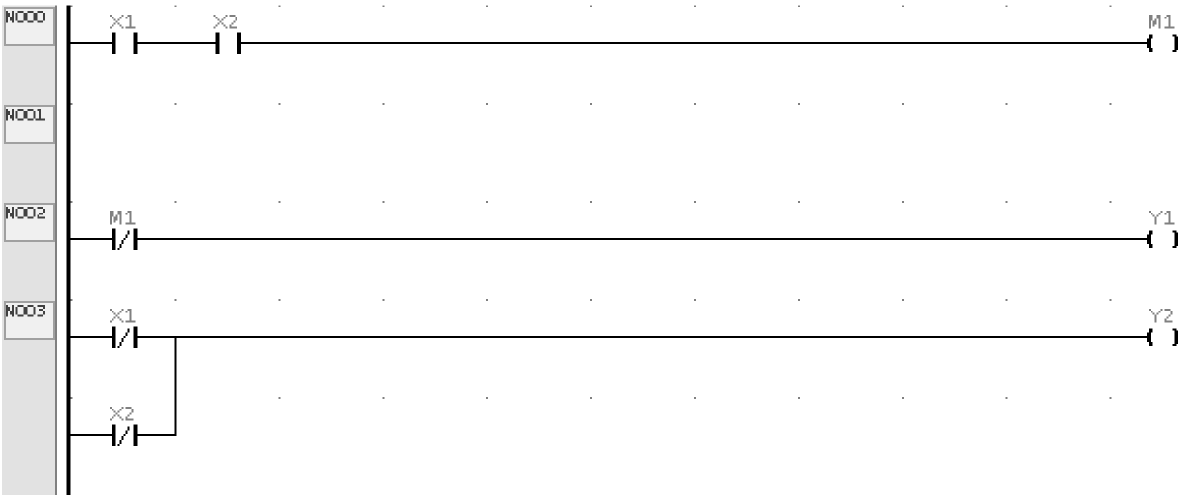

Figure 11.4 Ladder diagram for De Morgan's Second Theorem

b) Actual Ladder diagram

c) Sample Experimental set up

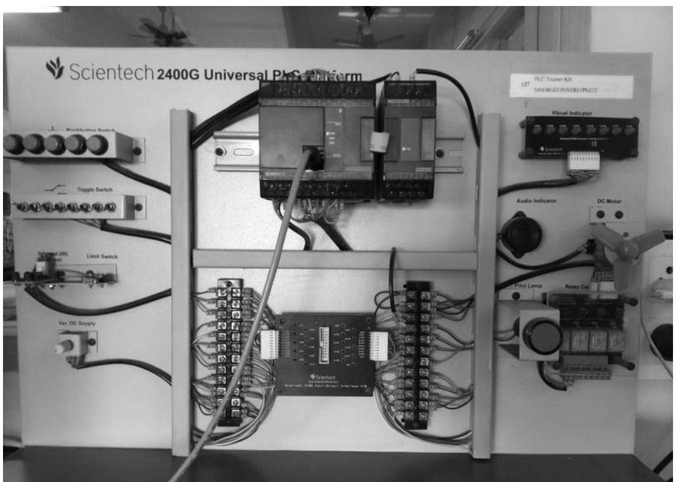

Figure 11.5 Expermental setup for PLC

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Create new project by clicking on the file from the toolbar.
2. Draw ladder diagram for **De Morgan's first Theorem**
3. Save the project by clicking on save option.
4. Run the ladder diagram with Run option available on toolbar.
5. Observe the result.
6. Repeat step 1 to 5 for **De Morgan's second Theorem.**

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1.			
2.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations

Table No: 11.1 De Morgan's first Theorem observation:

Inputs		Outputs	
Input-X_1	**Input-X2**	**LHS (Y_1) $= \overline{X_0 + X_1}$**	**RHS(Y_2) $= \overline{X_0}.\overline{X_1}$**

Table No: 11.2 De Morgan's second Theorem observation:

Inputs		Outputs	
Input-X_1	Input-X_2	LHS $(Y_1) = \overline{X_0.X_1}$	RHS$(Y_2) = \overline{X_0} + \overline{X_1}$

XVI Results

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XVII Interpretation of Results (Give meaning of the above obtained results)

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XVIII Conclusions and Recommendation (Actions/decisions to be taken based on the interpretation of results).

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XIX Practical Related Questions

1. Express each of the following equations as ladder logic program and verify it on PLC.
   a) $Y = ABC + D$
   b) $Y = (\overline{A}B\overline{C}) + (D\overline{E}F)$
2. Verify Associative and Distributive laws of Boolean algebra using PLC.

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella ,Programmable Logic Controllers, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.youtube.com/watch?v=ic9crSVVF9Q

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 12: Develop the ladder diagram for Adder and Subtractor by using PLC.

I Practical Significance

Adder and Subtractor are used in control systems to implement combinational logic. Adders are used to count the number of actions in repetitive processes such as object counting on conveyer belt. This practical will enable the students to use Adder and Subtractor to simplify efficient hardware implementation using PLC.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Individual and team work:** Function effectively as a leader and team member in diverse/ multidisciplinary teams.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Built up digital circuits using PLC.
- Develop ladder logic programs for Adder and Subtractor.
- Test ladder logic programs for Adder and Subtractor.
- Troubleshoot ladder logic programs for Adder and Subtractor.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop the ladder diagram for Adder and Subtractor by using PLC.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping

VII Minimum Theoretical Background

Half-Adder: It is used to add two bits. Therefore, half-adder has two inputs and two outputs, with SUM and CARRY.

Table No: 12.1 Truth table for Half Adder

A	B	Sum	Carry out
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

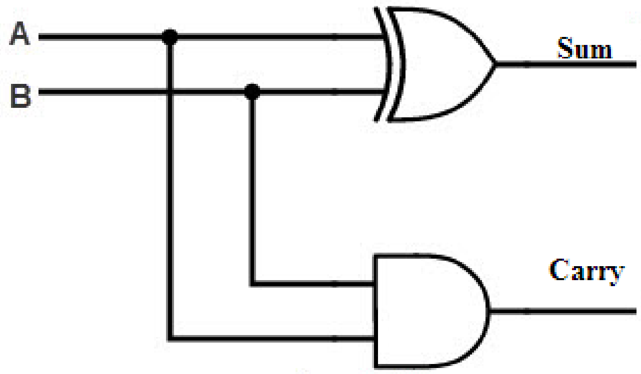

Figure 12.1 Logic circuit of Half Adder

Full Adder: Full adder is used to add three bits and produce a SUM and a CARRY outputs. Full adder is mainly needed to add large number of bits.

Table No: 12.2 Truth table for Full Adder

C_{in}	A	B	Sum	Carry out
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

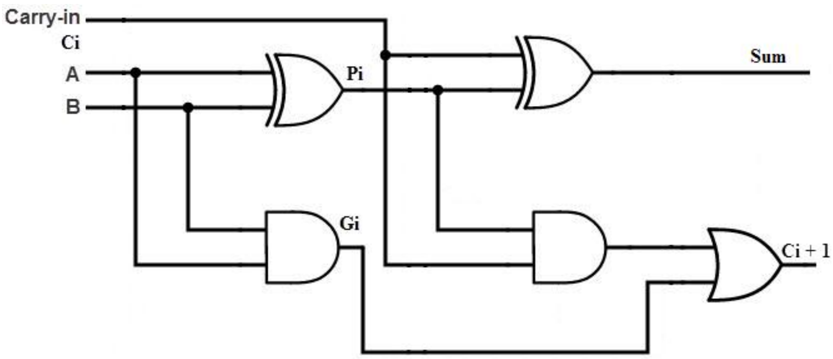

Figure 12.2 Logic circuit of Full Adder

Half Subtractor: It is used to subtract one binary digit from another to give DIFFERENCE output and a BORROW output.

Table No: 12.3 Truth table for Half Subtractor.

A	B	Difference	Borrow
0	0	0	0
0	1	1	1
1	0	1	0
1	1	0	0

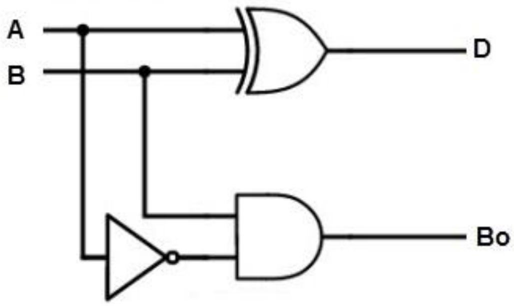

Figure 12.3 Logic circuit of Half Subtractor

Full Subtractor: It performs subtraction of two bits, one is minuend and other is subtrahend. In full subtractor '1' is borrowed by the previous adjacent lower minuend bit. Hence there are three bits are considered at the input of a full subtractor. There are two outputs, that are DIFFERENCE output D and BORROW output Bo. The BORROW output indicates that the minuend bit requires borrow '1' from the next minuend bit.

Table No: 12.4 Truth table for Full Subtractor

A	B	B_{in}	Difference	Borrow out
0	0	0	0	0
0	0	1	1	1
0	1	0	1	1
0	1	1	0	1
1	0	0	1	0
1	0	1	0	0
1	1	0	0	0
1	1	1	1	1

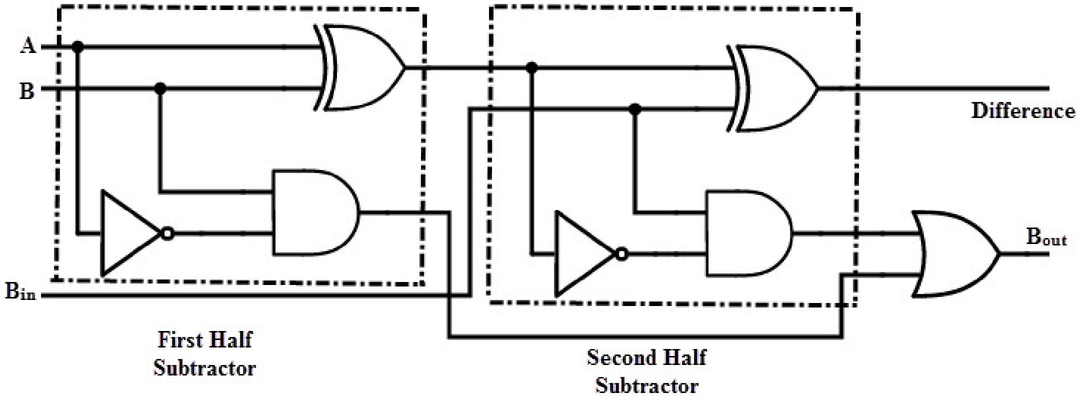

Figure 12.4 Logic circuit of full Subtractor

VIII Practical Ladder diagram :

a) Sample Ladder diagram

Figure 12.5 Ladder diagram for Half Adder

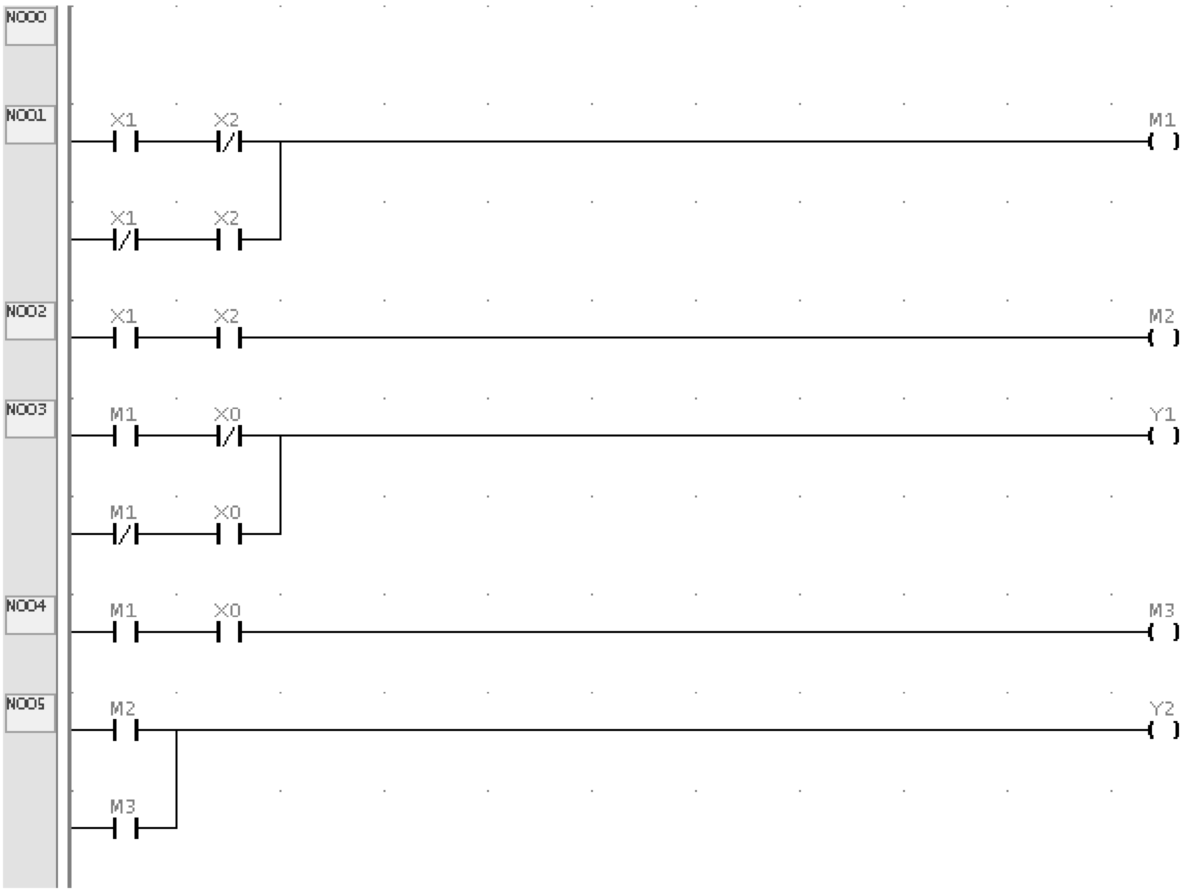

Figure 12.6 Ladder diagram for Full Adder

Figure 12.7 Ladder diagram for Half Subtractor

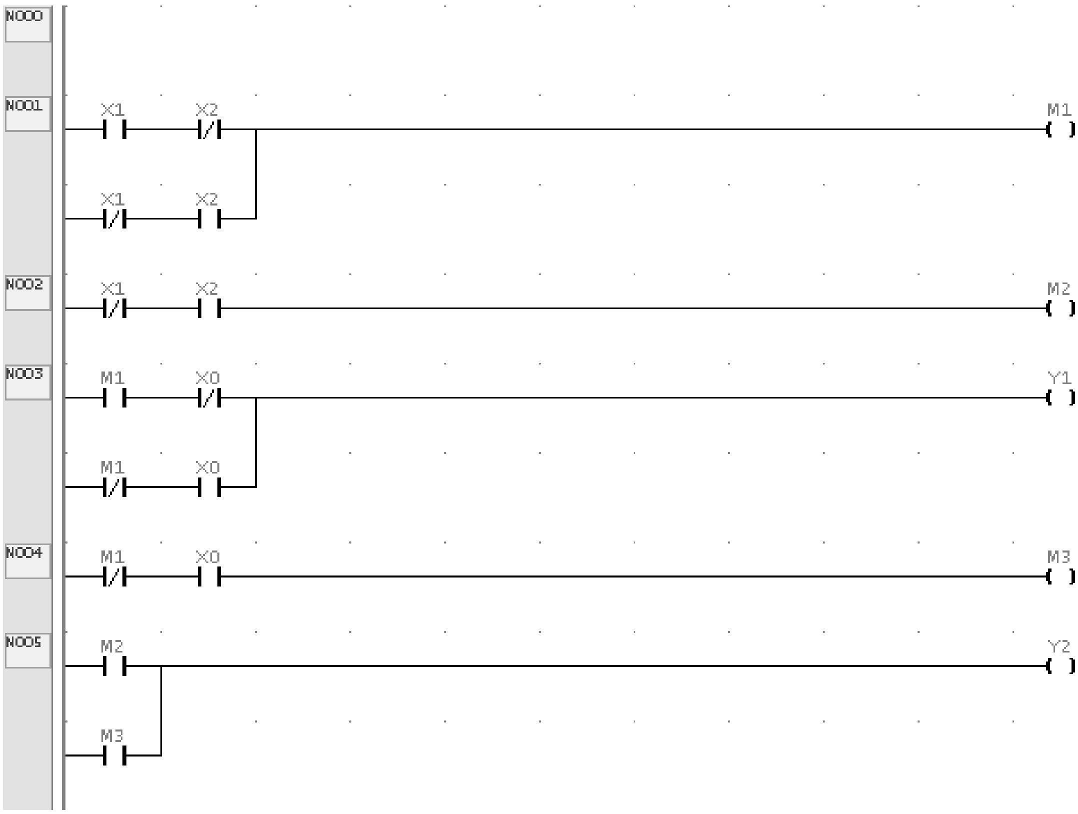

Figure 12.8 Ladder diagram for Full Subtractor

b) Actual Ladder diagrams

c) Sample Experimental set up

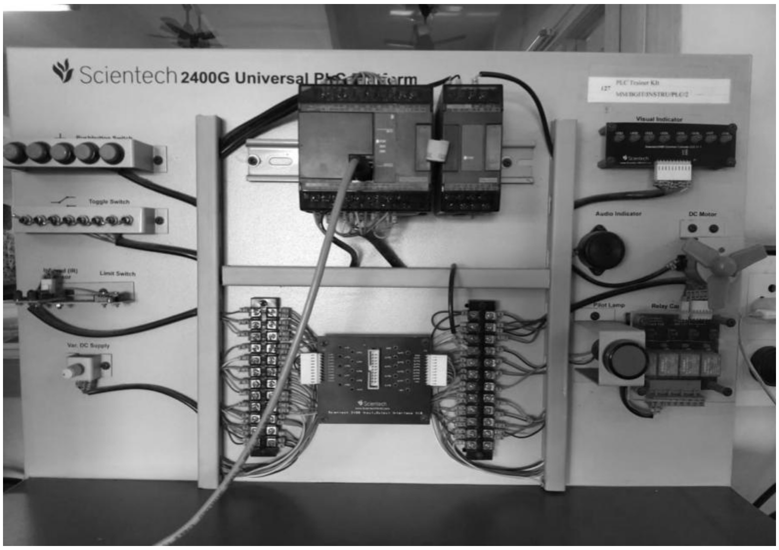

Figure 12.9 Experimental setup for PLC.

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.

2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR or any other higher version	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in 'off' condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Create new project by clicking on the File from the toolbar.
2. Draw ladder diagram for Adder
3. Save the project by clicking on Save option.
4. Run the ladder diagram with Run option available on toolbar.
5. Observe the result.
6. Repeat steps 1to 5 for full adder, half subtractor and full subtractor.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1			
2			

XIII Actual Procedure Followed

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XIV Precaution Followed

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XV Observations

Table No: 11.5 Half Adder observation:

Input-X_1	Input-X_2	Sum- Y_1	Carry- Y_2
0	0		
0	1		
1	0		
1	1		

Table No: 11.6 Full Adder observation:

Input carry in-X_0	Input-X_1	Input-X_2	Sum-Y_1	Carry out-Y_2
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

Table No: 11.7 Half subtractor observation:

Input-X_1	Input-X_2	Difference- Y_1	Borrow- Y_2
0	0		
0	1		
1	0		
1	1		

Table No: 11.8 Full subtractor observation:

Input-X_0	Input-X_1	Input Borrow –X_2	Difference-Y_1	Borrow out-Y_2
0	0	0		
0	0	1		
0	1	0		
0	1	1		
1	0	0		
1	0	1		
1	1	0		
1	1	1		

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. List Arithmetic instructions of PLC
2. Develop and verify ladder logic program to add two inputs X0 and X1 using Arithmetic Instruction.

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.youtube.com/watch?v=TxwJ2uQwKg0

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 13: Develop ladder diagram for ON and OFF control of lamp using timer and counter.

I Practical Significance

Timers are used in control system to activate or deactivate a device after a preset interval of time. Counters are used for counting the number of times a field device has been turned ON and OFF. This practical will enable the students to use timer and counter instructions in applications such as bottle filing systems, Traffic control systems etc.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Life-long learning:** Engage in independent and life-long learning activities in the context of technological changes also in the Electronics and Telecommunication engineering and allied industry.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Develop ladder logic programs for ON and OFF control of lamp using timer and counter.
- Test ladder logic programs for ON and OFF control of lamp using timer and counter.
- Troubleshoot ladder logic programs for ON and OFF control of lamp using timer and counter.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram for ON and OFF control of lamp using timer and counter.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping
- Practice energy conservation.

VII Minimum Theoretical Background

Timer Instructions: Three types of timers can be used in PLC ladder diagram.

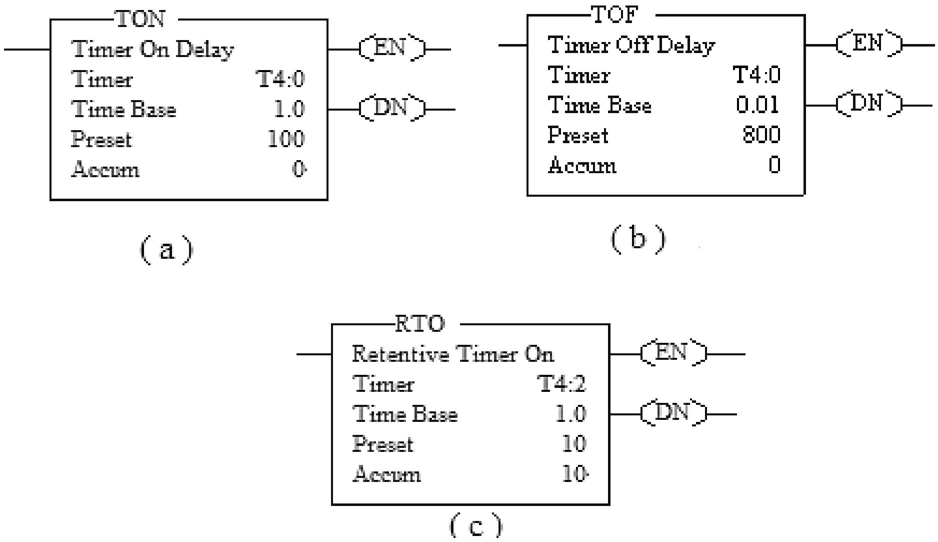

Figure 13.1 a. ON Delay Timer Instruction b. OFF Delay Timer Instruction c.RetentiveTimer Instruction

ON Delay Timer Instruction: TON instruction is used to turn an output on or off after the timer has been on for a preset time interval.

OFF Delay Timer Instruction : TOF instruction is used to turn an output on or off after its rung has been off for a preset time interval.

RetentiveTimer Instruction: RTO instruction is used to turn an output on or off after its timer has been on for a preset time interval.

When programming a timer instruction programmer must specify the Timer address, Time base and Preset value.

Timer Settling time = Preset value × Time Base

Counter Instructions: Two types of counters can be used in PLC ladder diagram.

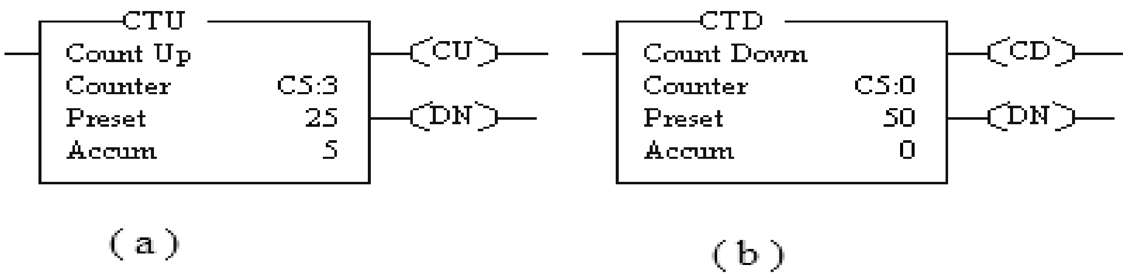

Figure 13.2 a. Count up counter Instruction b. Count down counter Instruction

Count Up Counter: CTU is an instruction whose function is to increment its accumulated value on FALSE-to-TRUE rung transitions. Rung transitions can be caused by events occurring in the program (from internal logic or by external field devices)
Count Down Counter: The CTD is an instruction that count down or decrement by 1 on FALSE-to-TRUE rung transitions.

VIII Practical Ladder diagram :

a) Sample Ladder diagram

Problem statement: Develop the ladder logic diagram to turn ON and OFF lamp after 10 Seconds for 5 times.

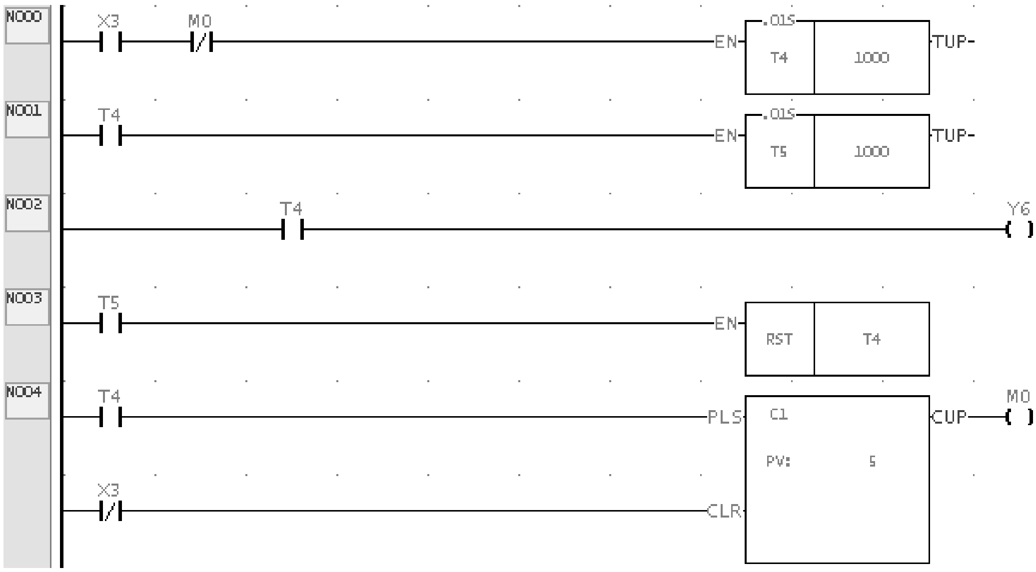

Figure 13.3 Ladder diagram to turn ON and OFF lamp after 10 seconds for 5 times.

b) Actual Ladder diagrams

(Teacher shall guide the students to develop ladder diagram based on PLC available in the institute)

c) Sample Experimental set up

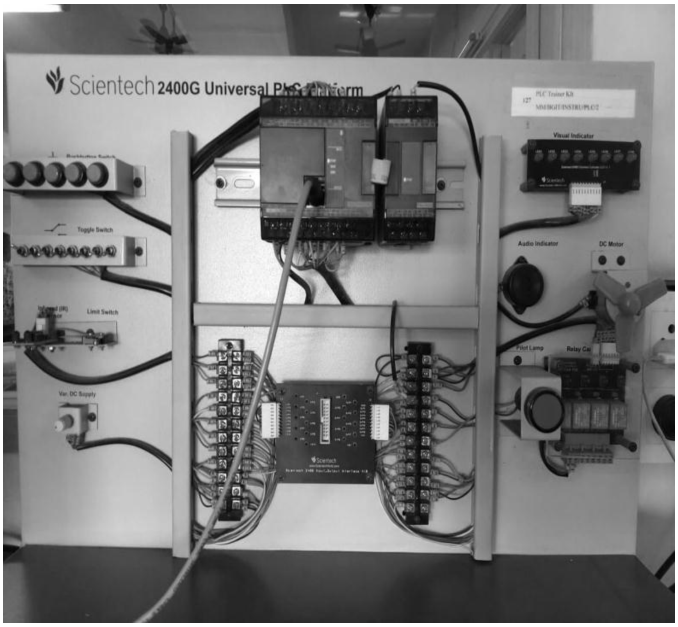

Figure 13.4 Experimental setup for PLC.

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Create new project by clicking on the File from the toolbar.
2. Draw ladder diagram to turn on and off lamp after 10 Seconds for 5 times
3. Save the project by clicking on save option.
4. Run the ladder diagram with run option available on toolbar.
5. Observe the status of timer and counter status used in the ladder.
6. Repeat the steps 1to 5 to turn on and off lamp after 15 Seconds for 10 times.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1			
2			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations

Table No: 13.1 Lamp ON- OFF Observation:

Sr. No.	Preset value of Timer	Preset value of Counter	No. of times the lamp is ON/OFF (Count)	Time period between ON and OFF of lamp (Time in Seconds)
1				
2				

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. In this practical, When does the enable bit of timer change state?
2. Is cascading of timer is possible in this practical?
3. Draw ladder diagram for the following truth table and verify its operations.

Switch-1	Switch-2	Lamp-1	Lamp-2
0	0	1	0
0	1	0	0
1	0	0	0
1	1	0	1

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.youtube.com/watch?v=4NLcOov8oLg

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			Dated signature of Teacher
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.14: Develop ladder diagram for traffic light Control system

I Practical Significance

Traffic light is an arrangement of three lights used for controlling traffic on the road by providing particular sequence of these lights. Timers are used to control the length of time between signal changes. This practical will enable the students to use cascading of timer instructions in Traffic control systems.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **The engineer and society:** Assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to practice in field of Electronics and Telecommunication engineering.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Develop ladder logic for traffic light Control system
- Test ladder logic programs for traffic light Control system
- Troubleshoot ladder logic programs for traffic light Control system using timer.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram for traffic light Control system.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping
- Practice energy conservation.

VII Minimum Theoretical Background

Traffic Control System: A four way traffic control is shown below, Red and Green LEDs are shown for giving signal to vehicle drivers. If Red LED is glowing then traffic of that particular road should stop. And if Green LED is glowing traffic which is halted should move straight or right side When we are making PLC in run mode then Green LEDs of W side will glow and at that time Red LED of W side will be 'Off' and on rest side Red LEDs are 'On' and Green LEDs are 'Off'. After some delay Green LEDs of N side will glow and at that time Red LED of N side will be 'Off' and on rest side Red LEDs are 'On' and Green LEDs are 'Off'. This process is continues for E side and then for S side also. This will be continues in same manner until the PLC is placed in stop mode.

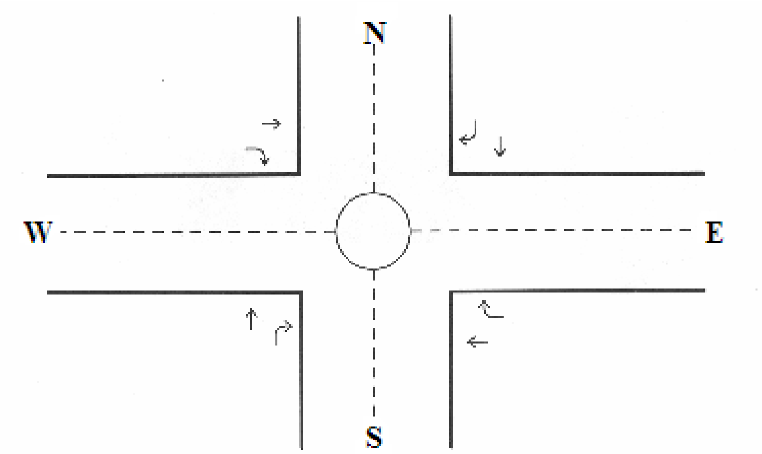

Figure 14.1 : Traffic Light Control by PLC

Timers are operated sequentially to control Red, Green and Yellow signal for respective time period.

VIII Practical Ladder diagram :

a) Sample Ladder diagram

X3-Input toggle Switch
Y1, Y2, Y3 and Y3 Output LEDS.

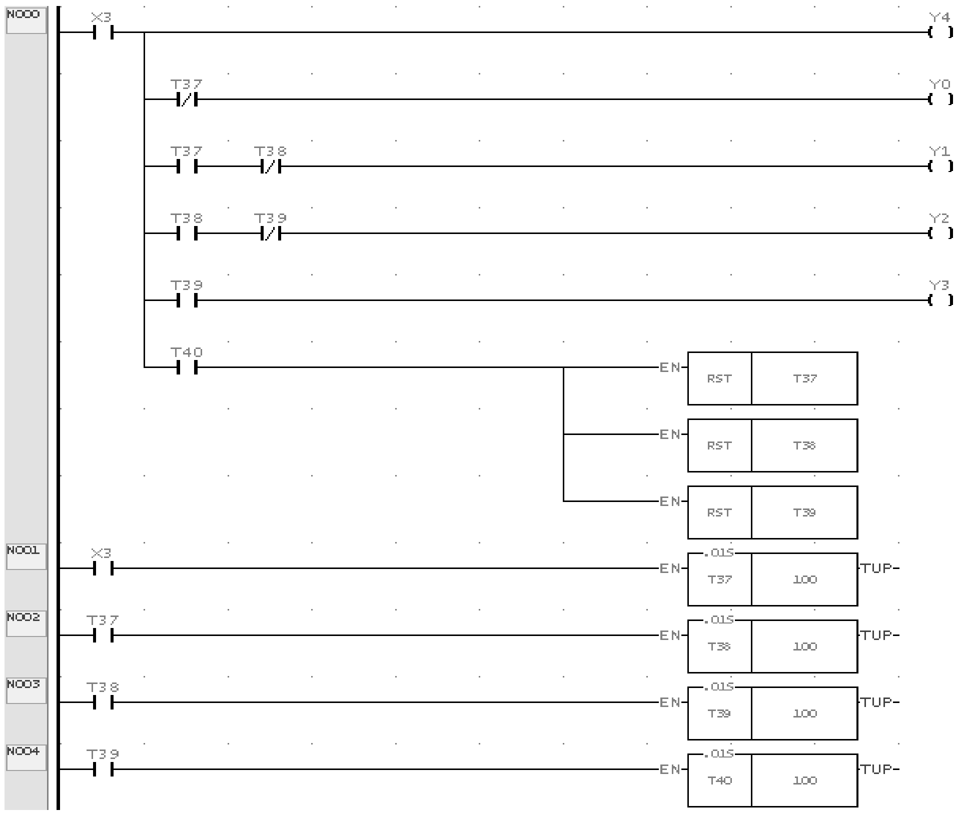

Figure 14.2 Ladder diagram traffic light Control system.

b) Actual Ladder diagrams

(Teacher shall guide the students to develop ladder diagram based on PLC available in the institute)

c) Sample Experimental set up

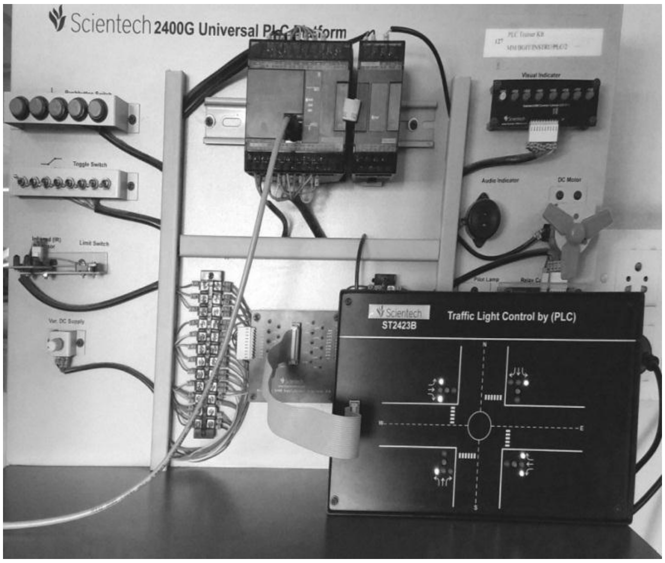

Figure 14.3 Experimental setup for Traffic light control using PLC.

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.
3.	Traffic light module	4 way junction Traffic light module with 20 pin FRC cable.	01

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.

XI Procedure

1. Connect traffic control module to PLC using 20 Pin FRC connector.
2. Create new project by clicking on the File from the toolbar.
3. Draw ladder diagram for traffic light Control system.
4. Save the project by clicking on Save option.
5. Run the ladder diagram with run option available on toolbar.
6. Observe the sequence of traffic lights.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1			
2			
3			

XIII Actual Procedure Followed

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XIV Precaution Followed

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XV Observations

Table No: 14.1 Traffic light observation:

Red light will be ON for	**------Seconds**
Green light will be ON for	**------Seconds**
Yellow light will be ON for	**------Seconds**

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. State the condition when the done bit of timer changes it's state?
2. Describe difference between operation of non-retentive and that of retentive timer with reference to the accumulated value?
3. State the maximum value of preset of timer instruction used in the experiment.
4. Change the time duration of red light and green light in ladder diagram and measure the time duration.

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://in.video.search.yahoo.com/yhs/search?fr=yhs-trp-001&hsimp=yhs-001&hspart=trp&p=traffic+light+PLC+videos#id=2&vid=6767cf51295fd678586c2001172318ac&action=view

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. ……………………………………..
2. ……………………………………..
3. ……………………………………..
4. ……………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No. 15: Develop ladder diagram for stepper motor control.

I Practical Significance

Stepper motors are DC motors that move in discrete steps. Stepper motors are used in control systems for precision motion control applications such as 3D printers, CNC, Camera platforms Speed Control and Robotics. This practical will enable the students to control the motion of stepper motor using PLC

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Experiments and practice:** Plan to perform experiments and practices to use the results to solve broad-based Electronics and Telecommunication engineering problems.
- **Environment and sustainability:** Apply Electronics and Telecommunication engineering solutions also for sustainable development practices in societal and environmental contexts.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries':**

- Develop ladder logic programs for stepper motor motion control.
- Test ladder logic programs for stepper motor motion control.
- Troubleshoot ladder logic programs for stepper motor motion control

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram for stepper motor control.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping
- Practice energy conservation.

VII Minimum Theoretical Background

Stepper motors convert electrical energy into mechanical energy. It moves in discreet steps, known as the step angle.

Step angle usually ranges from 90 degrees (360° / 90° per step = 4 steps per revolution) to 0.75 degrees (360° /0.75° per step = 500 steps per revolution). Their basic construction consists of an outer stator and an inner rotor. Stator has uniform teeth around its perimeter and containing a specified number of poles. Poles are simply magnetic sections of the stator, and each pole has a winding that is connected to the pole opposite it on the stator. Thus, the opposing poles are magnetized with the opposite polarity when current is applied to the windings.

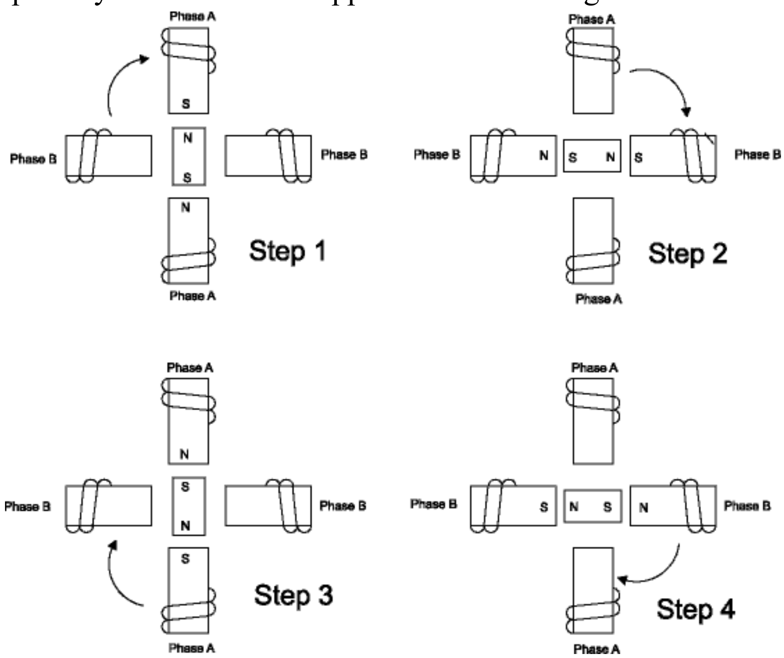

Figure 15.1 Position control of Stepper motor

***Courtesy**: https://www.pc-control.co.uk/step-motor.htm*

Table No: 15.1 Truth table for clock wise motion

Step	Terminal –A	Terminal –B	Terminal –C	Terminal –D
1	1	0	0	1
2	1	1	0	0
3	0	1	1	0
4	0	0	1	1

Table No: 15.2 Truth table for anticlockwise motion

Step	Terminal –A	Terminal -B	Terminal –C	Terminal –D
1	0	0	1	1
2	0	1	1	0
3	1	1	0	0
4	1	0	0	1

VIII Practical Ladder diagram :

a) Sample Ladder diagram

Below given program runs the stepper motor continuously in clockwise direction.

- Switch X0 is to start the operation.
- Y0,Y1,Y2,Y3 are the four windings of stepper motor.

- T37,T38,T39,T40 are the timers used for giving delay.
- SET & RESET function blocks are used to make the windings of stepper motor either HIGH or LOW.

Logic: Initially, Timer T37 is turned ON:-which SETs or RESETs the corresponding windings, after its given delay,T38 is switched ON, then T39 and followed by T40.

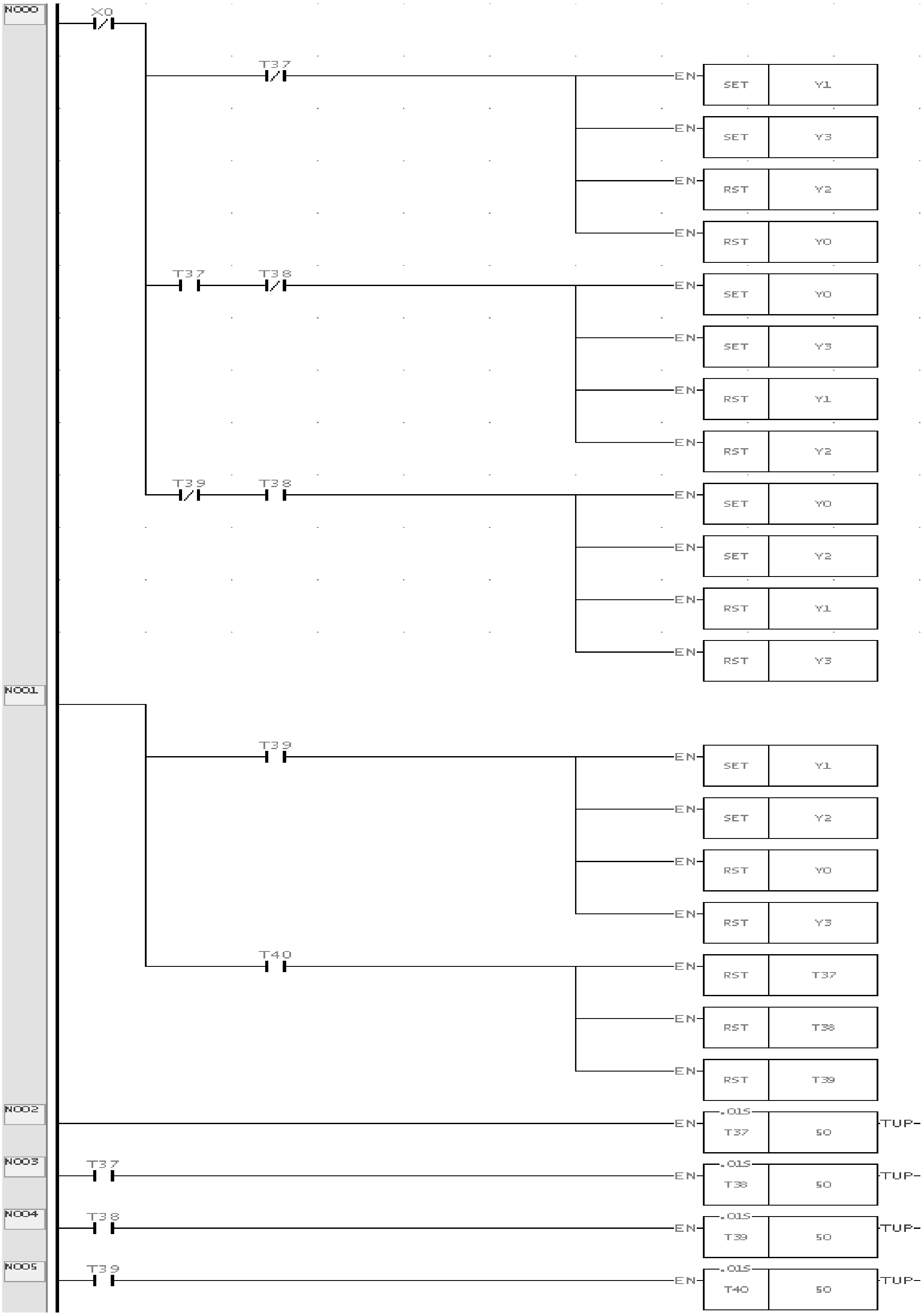

Figure 15.2 Ladder diagram Stepper motor motion in clock wise direction

b) Actual Ladder diagrams

c) Sample Experimental set up

Figure 15.3 Experimental setup for traffic light control using PLC.

d) Actual practical set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16” or 18.5” LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.
3.	Stepper motor Module	5 V DC, With 20 Pin FRC cable	1 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.
4. Check the ratings for PLC output relay voltage and current.
5. If output relay rating is less than motor voltage rating then you have to use External relay, it should be actuated by a DC supply

XI Procedure

1. Connect stepper motor module to PLC setup using FRC connectors.
2. Create new project by clicking on the File from the toolbar.
3. Draw ladder diagram for stepper motor control.
4. Save the project by clicking on Save option.
5. Run the ladder diagram with run option available on toolbar.
6. Observe the motion of the stepper motor.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1.			
2.			
3.			

XIII Actual Procedure Followed (use blank sheet provided if space not sufficient)

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XIV Precaution Followed (use blank sheet provided if space not sufficient)

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XV Observations

Table No: 15.3 Stepper motor Observation:

Step	Terminal –A	Terminal -B	Terminal –C	Terminal -D
1				
2				
3				
4				
1				

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Give the practical applications of stepper motor.
2. Develop and verify ladder diagram for anticlockwise motion of stepper motor.
3. List the specification of stepper motor used in this practical.
4. Write no. of analog and digital input/output of PLC used in this practical.

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.youtube.com/watch?v=eyqwLiowZiU

XXI Assessment Scheme

Performance Indicators		**Weightage**
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

Practical No.16: Develop ladder diagram for temperature controller.

I Practical Significance

The PLC-based temperature control system provides higher accuracy and faster response. The PLC-based temperature control systems are used in production and industrial control processes such as iron and steel smelting process. This practical will enable the students to use of PLC in temperature control system.

II Relevant Program Outcomes (POs)

- **Basic knowledge:** Apply knowledge of basic mathematics, sciences and basic engineering to solve the broad-based Electronics and Telecommunication engineering problems.
- **Discipline knowledge:** Apply Electronics and Telecommunication engineering knowledge to solve broad-based Electronics and Telecommunications engineering related problems.
- **Environment and sustainability: Apply Electronics and Telecommunication** engineering solutions also for sustainable development practices in societal and environmental contexts.
- **Engineering tools:** Apply relevant Electronics and Telecommunications technologies and tools with an understanding of the limitations.

III Competency and Practical Skills

This practical is expected to develop the following skills for the industry identified competency **'Maintain electronic automated systems in process and manufacturing industries'**:

- Develop ladder logic diagram for temperature controller
- Test ladder logic programs for temperature controller.
- Interface temperature sensor to PLC
- Troubleshoot ladder logic programs for temperature controller.

IV Relevant Course Outcome(s)

Maintain PLC based process control systems.

V Practical Outcome

Develop ladder diagram for temperature controller.

VI Relevant Affective domain related Outcome(s)

- Follow safe practices.
- Practice good housekeeping
- Practice energy conservation.

VII Minimum Theoretical Background

Analog DC Input Module: Analog DC input modules detect a DC voltage or current level, convert that variable into a proportional digital signal and transmit that data to the CPU for processing. The modules can be configured to operate on standard instrumentation signal ranges such as 4-20 mA, 10-50 mA, 15V, 0-1 0V.

In Temperature controller analog DC input module is required to convert the temperature sensor output (Analog) into equivalent digital signal.

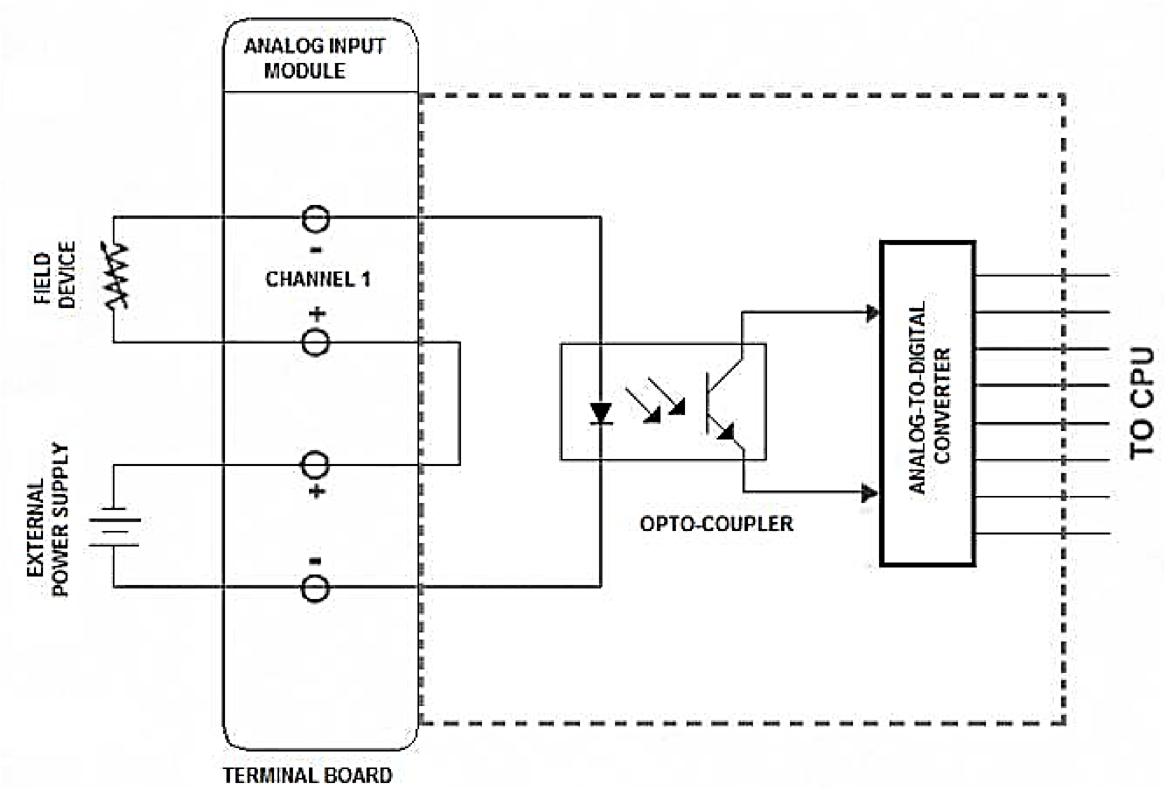

Figure 16.1 : Analog DC Input Module

Courtesy :*https://www.myodesie.com/wiki/index/returnEntry/id/2962#DC Input Analog Modules*

In Temperature controller system comparative action takes place between measured value and set point.

VIII Practical Ladder diagram :

a) Sample Ladder diagram

- X3-Input toggle Switch
- Y1 – Cooling fan
- Y2- Heater.

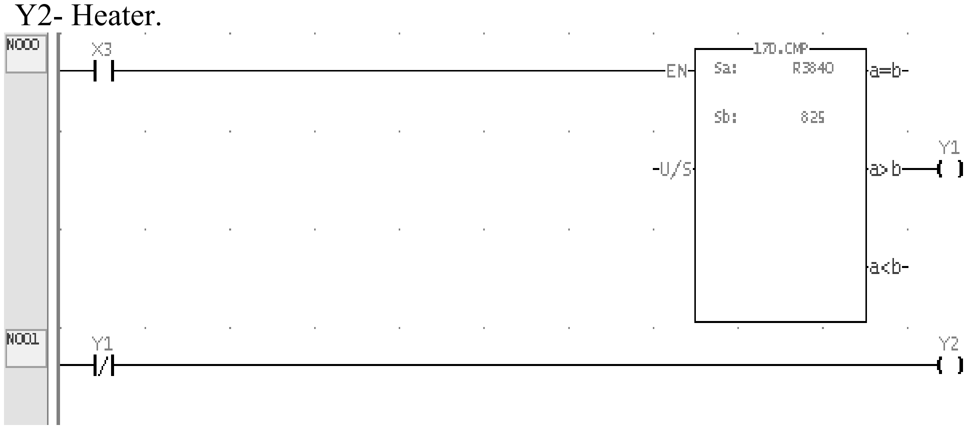

Figure 16.2 Ladder diagram temperature controller.

b) Actual Ladder diagrams

(Teacher shall guide the students to develop ladder diagram based on PLC available in the institute)

c) Sample Experimental set up

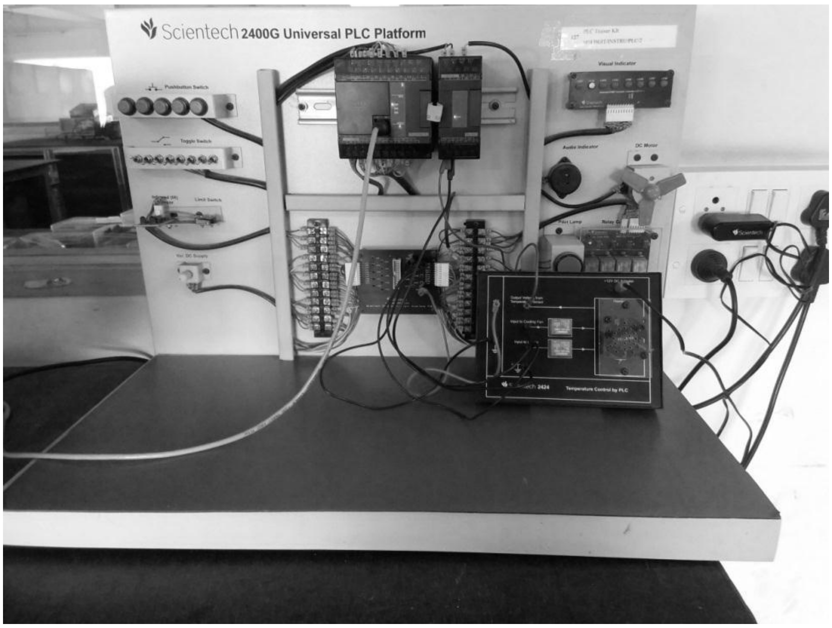

Figure 16.3 Experimental setup for temperature controller using PLC.

d) Actual Experimental set up used in laboratory

IX Resources Required

Sr. No.	Instrument/ Component	Specification	Quantity
1.	PLC	PLC System hardware and software for ladder programming, computer interface with digital and analog I/O, Switches, relay lamp operation digital I/O-16 Nos. Analog I/O-4 Nos. Each I/O module shall have a LED per channel to indicate the status of each input/output. (Allen Bradly, Siemens, Fatek or other suitable make)	1 No.
2.	Personal Computer	Intel Processor core I3 or I7 or latest with mother board intel chipset 41/61/latest with 4 USB,1 Serial port,1 LPT port,2GB DDR III,500GB Sata hard disk, 16" or 18.5" LCD/LED monitor,ATX cabinet with SMPS and lock system, DVD writer, Keyboard, USB mouse, 1Gigabit Network card/latest configuration (or higher version)	1 No.
3.	Temperature control module	Analog Input Range : 0 to 5V Digital Output Pin Voltage : 5VDC When particular O/P activated from PLC Output of Sensor : 0-2V max. 0 to 200^0C Heater : 7 Watt register	01 No.

X Precautions to be Followed

1. Ensure proper connections are made.
2. Ensure the power switch is in ‘off’ condition initially.
3. Do not operate the instrument if suspect any damage to it.
4. Do not operate in wet / damp conditions.

XI Procedure

1. Connect temperature control module to Analog input module of PLC.
2. Create new project by clicking on the File from the toolbar.
3. Draw ladder diagram for temperature controller system.
4. Save the project by clicking on Save option.
5. Run the ladder diagram with run option available on toolbar.
6. Observe the switching of cooling fan and heater.

XII Resources Used

Sr. No.	Instrument/ Component	Specification	Quantity
1			
2			
3			

XIII Actual Procedure Followed

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XIV Precaution Followed

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XV Observations

Table No: 16.1 Temperature Controller observation:

Sr.No.	Value of set Temperature	Temperature when heater is		Temperature when Cooler is	
		ON	OFF	ON	OFF
1					
2					
3					
4					

XVI Results

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XVII Interpretation of Results

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XVIII Conclusions and Recommendation

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XIX Practical Related Questions

1. Explain temperature controller using PLC better than conventional controller.
2. List various data manipulation instructions available in PLC.
3. List various manufactures of PLC.
4. List specification of various components used in this practical.

[Space for Answers]

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XX References / Suggestions for further reading

1. Frank D.Petruzella , *Programmable Logic Controllers*, McGrow Hill Education(India) Private Limited,3rd edition, 2015,ISBN-13 : 978-0-07-106738-6, ISBN-10 :0-07-106738-8,
2. https://www.myodesie.com/wiki/index/returnEntry/id/2962#DC Input Analog Modules.

XXI Assessment Scheme

Performance Indicators		Weightage
Process related: 15 Marks		**60%**
1.	Handling of the components	10 %
2.	Drawing Ladder Diagrams	20 %
3.	Observing output	20 %
4.	Working in team	10 %
Product related: 10 Marks		**40%**
5.	Interpretation of result	10 %
6.	Conclusions	10 %
7.	Practical related questions	10 %
8.	Submitting the journal in time	10%
Total (25 Marks)		**100 %**

Names of student Team Member

1. …………………………………..
2. …………………………………..
3. …………………………………..
4. …………………………………..

Marks Obtained			**Dated signature of Teacher**
Process Related (15)	**Product Related (10)**	**Total (25)**	

List Of Laboratory Manuals Developed by MSBTE

First Semester:

1	Fundamentals of ICT	22001
2	English	22101
3	English Work Book	22101
4	Basic Science (Chemistry)	22102
5	Basic Science (Physics)	22102

Second Semester:

1	Bussiness Communication Using Computers	22009
2	Computer Peripherals & Hardware Maintenace	22013
3	Web Page Design with HTML	22014
4	Applied Science (Chemistry)	22202
5	Applied Science (Physics)	22202
6	Applied Machines	22203
7	Basic Surveying	22205
8	Applied Science (Chemistry)	22211
9	Applied Science (Physics)	22211
10	Fundamental of Electrical Engineering	22212
11	Elements of Electronics	22213
12	Elements of Electrical Engineering	22215
13	Basic Electronics	22216
14	‘C’ programming Language	22218
15	Basic Electronics	22225
16	Programming in “C”	22226
17	Fundamentals of Chemical Engineering	22231

Third Semester:

1	Applied Multimedia Techniques	22024
2	Advanced Serveying	22301
3	Highway Engineering	22302
4	Mechanics of Structures	22303
5	Building Construction	22304
6	Concrete Technology	22305
7	Strength Of Materials	22306
8	Automobile Engines	22308
9	Automobile Transmission System	22309
10	Mechanical Operations	22313
11	Technology Of Inorganic Chemicals	22314
12	Object Oriented Programming Using C++	22316
13	Data Structure Using ‘C’	22317
14	Computer Graphics	22318
15	Database Management System	22319
16	Digital Techniques	22320
17	Principles Of Database	22321
18	Digital Techniques & Microprocessor	22323
19	Electrical Circuits	22324
20	Electrical & Electronic Measurment	22325
21	Fundamental Of Power Electronics	22326
22	Electrical Materials & Wiring Practice	22328
23	Applied Electronics	22329
24	Electrical Circuits & Networks	22330
25	Electronic Measurments & Instrumentation	22333
26	Principles Of Electronics Communication	22334
27	Thermal Engineering	22337
28	Engineering Matrology	22342
29	Mechanical Engineering Materials	22343
30	Theory Of Machines	22344

Fourth Semester:

1	Hydraulics	22401
2	Geo Technical Engineering	22404
3	Chemical Process Instrumentation & Control	22407
4	Fluid Flow Operation	22409
5	Technology Of Organic Chemicals	22410
6	Java Programming	22412
7	GUI Application Development Using VB.net	22034
8	Microprocessor	22415
9	Database Managment	22416
10	Electric Motors And Transformers	22418
11	Industrial Measurements	22420
12	Digital Electronics And Microcontroller Applications	22421
13	Linear Integrated Circuits	22423
14	Microcontroller & Applications	22426
15	Basic Power Electronics	22427
16	Digital Communication Systems	22428
17	Mechanical Engineering Measurments	22443
18	Fluid Mechanics and Machinery	22445
19	Fundamentals Of Mechatronics	22048

Fifth Semester:

1	Design of Steel and RCC Structures	22502
2	Public Health Engineering	22504
3	Heat Transfer Operation	22510
4	Environmental Technology	22511
5	Operating Systems	22516
6	Advanced Java Programming	22517
7	Software Testing	22518
8	Control Systems and PLC’s	22531
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10	Mobile and Wireless Communication	22533
11	Industrial Machines	22523
12	Switchgear and Protection	22524
13	Energy Conservation and Audit	22525
14	Power Engineering and Refrigeration	22562
15	Solid Modeling and Additive Manufacturing	22053
16	Guidelines & Assessment Manual for Micro Projects & Industrial Training	22057

Sixth Semester:

1	Solid Modeling	17063
2	Highway Engineering	17602
3	Contracts & Accounts	17603
4	Design of R.C.C. Structures	17604
5	Industrial Fluid Power	17608
6	Design of Machine Elements	17610
7	Automotive Electrical and Electronic Systems	17617
8	Vehicle Systems Maintenance	17618
9	Software Testing	17624
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11	Mobile Computing	17632
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13	Testing & Maintenance of Electrical Equipments	17637
14	Power Electronics	17638
15	Illumination Engineering	17639
16	Power System Operation & Control	17643
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19	Advanced Communication System	17656
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23	Industrial Automation	17664
24	Industrial Drives	17667
25	Video Engineering	17668
26	Optical Fiber & Mobile Communication	17669
27	Therapeutic Equipment	17671
28	Intensive Care Equipment	17672
29	Medical Imaging Equipment	17673

Pharmacy Lab Manual

First Year:

1	Pharmaceutics - I	0805
2	Pharmaceutical Chemistry - I	0806
3	Pharmacognosy	0807
4	Biochemistry and Clinical Pathology	0808
5	Human Anatomy and Physiology	0809

Second Year:

1	Pharmaceutics - II	0811
2	Pharmaceutical Chemistry - II	0812
3	Pharmacology & Toxicology	0813
4	Hospital and Clinical Pharmacy	0816

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