GANDHI SCHOOL OF ENGINEERING

Chidananda Hills, Bhabandha, Berhampur, Ganjam

IAD LABORATORY EXPERIMENTS

EXPERIMENT NO. 01

Aim

To dismantle the given DC motor / AC motor, identify its different parts, study their functions, and reassemble the motor correctly.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	DC Motor / Single-Phase AC Induction Motor	1	Laboratory model	Motor for dismantling
02	Screwdriver Set	1 set	Flat and Phillips	Removing screws
03	Spanner / Wrench Set	1 set	Standard sizes	Loosening nuts and bolts
04	Allen Key Set	1 set	Standard	Removing socket screws
05	Puller Key Set	1	Bearing puller	Removing bearings / pulleys
06	Soft Mallet	1	Rubber / Plastic	Gentle tapping
07	Cleaning Cloth	1	Cotton	Cleaning motor parts
08	Safety Gloves	1 pair	Insulated	Personal safety
09	Safety Goggles	1	Standard	Eye protection

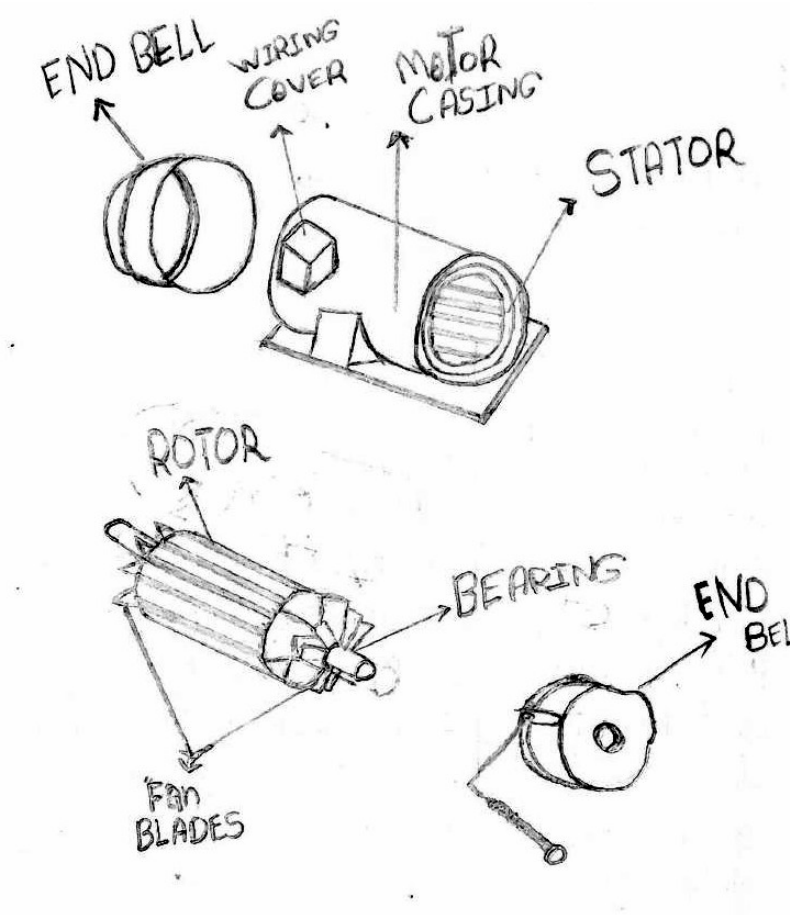


Fig.: Parts of an induction motor (end bell, wiring cover, motor casing, stator, rotor, bearing, fan blades)

Theory

An electric motor converts electrical energy into mechanical energy based on the principle of electromagnetic induction.

DC Motor

A DC motor consists of:

- Stator (Yoke)
- Field poles
- Field windings
- Armature core
- Armature winding
- Commutator
- Carbon brushes
- Shaft
- Bearings
- End shields

The commutator and brushes convert the supplied DC into rotating torque.

Single-Phase AC Induction Motor

An AC induction motor mainly consists of:

- Stator
- Rotor
- Stator windings
- Shaft
- Bearings
- Cooling fan
- Fan cover
- Terminal box
- End covers
- Motor frame

The rotating magnetic field produced by the stator induces current in the rotor, causing it to rotate.

Procedure

1. Ensure that the motor is disconnected from the power supply.
2. Clean the exterior of the motor before dismantling.
3. Remove the terminal box cover and disconnect the terminal connections.
4. Unscrew the bolts securing the end covers.
5. Remove the front and rear end shields carefully.
6. Withdraw the rotor (or armature in a DC motor) from the stator carefully without damaging the windings.
7. Remove the bearings, if required, using a bearing puller.
8. Identify each motor component and study its construction and function.
9. Inspect the components for wear, damage, or insulation failure.
10. Reassemble all parts in the reverse order.
11. Tighten all fasteners securely and verify smooth shaft rotation.

Observation Table

A. Parts of a DC Motor

Sl. No.	Part Identified	Function	Observation
1	Yoke (Frame)	Mechanical support and magnetic path	Good condition
2	Field Pole	Produces magnetic field	Properly mounted
3	Field Winding	Generates magnetic flux	Insulation intact
4	Armature Core	Supports armature winding	No damage
5	Armature Winding	Carries armature current	Good insulation

Sl. No.	Part Identified	Function	Observation
6	Commutator	Current commutation	Clean surface
7	Carbon Brushes	Supply current to armature	Moderate wear
8	Shaft	Transfers mechanical power	Straight
9	Bearing	Supports rotating shaft	Smooth rotation
10	End Cover	Supports bearing	Good condition

B. Parts of an AC Induction Motor

Sl. No.	Part Identified	Function	Observation
01	Motor Frame	Mechanical support	Good
02	Stator	Produces rotating magnetic field	No damage
03	Stator Windings	Produce magnetic flux	Insulation healthy
04	Rotor	Rotates under induced torque	Good condition
05	Shaft	Delivers mechanical output	Smooth
06	Bearings	Reduce friction	Good
07	Cooling Fan	Motor cooling	Working properly
08	Fan Cover	Protects cooling fan	Intact
09	Terminal Box	Electrical connection	Clean
10	End Shields	Bearing support	Good

Conclusion

The experiment provided practical knowledge of the internal construction and operation of DC and AC motors. By dismantling and reassembling the motor, the functions of important components such as the stator, rotor (or armature), windings, bearings, shafts, commutator (for DC motors), brushes, and cooling system were understood. This exercise is valuable for developing skills in motor maintenance, troubleshooting, inspection, and repair, which are essential in industrial electrical engineering and maintenance practices.

EXPERIMENT NO. 02

Aim

To control the speed of a DC shunt motor using the armature voltage control method and the field current control method, and observe the variation in motor speed.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	DC Motor Speed Control Trainer Kit	1	DC shunt motor trainer	Experimental setup
02	DC Shunt Motor	1	220 V, 0.5–1 HP	Test motor
03	DC Power Supply	1	0–220 V DC	Armature supply
04	Field Rheostat	1	Variable resistance	Field current control
05	Armature Voltage Controller / Variac	1	Variable DC output	Armature voltage control
06	DC Voltmeter	1	0–300 V	Measure armature voltage
07	DC Ammeter	2	0–5 A	Measure armature and field currents
08	Tachometer	1	Digital (0–5000 RPM)	Measure motor speed
09	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

The speed of a DC shunt motor depends upon the armature voltage and the magnetic flux produced by the field winding. The speed equation is:

$$N = (V - Ia\ Ra) / (K\ \varphi)$$

where,

- N = Motor speed (RPM)
- V = Armature voltage (V)
- Ia = Armature current (A)
- Ra = Armature resistance (Ω)
- φ = Flux per pole
- K = Motor constant

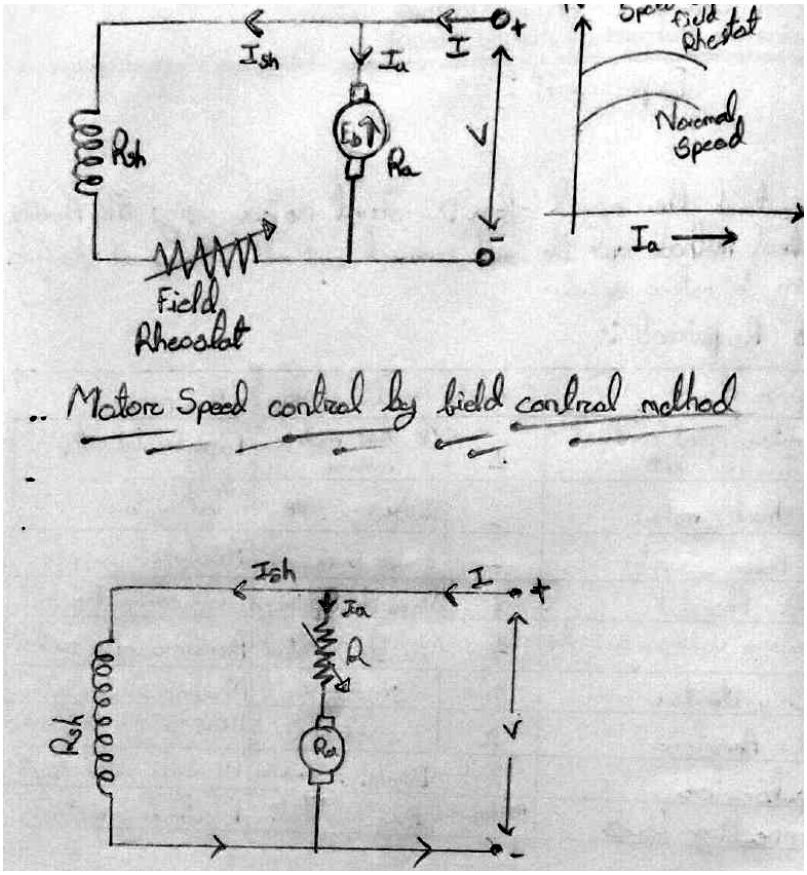


Fig.: Motor speed control by field control method and by armature resistance

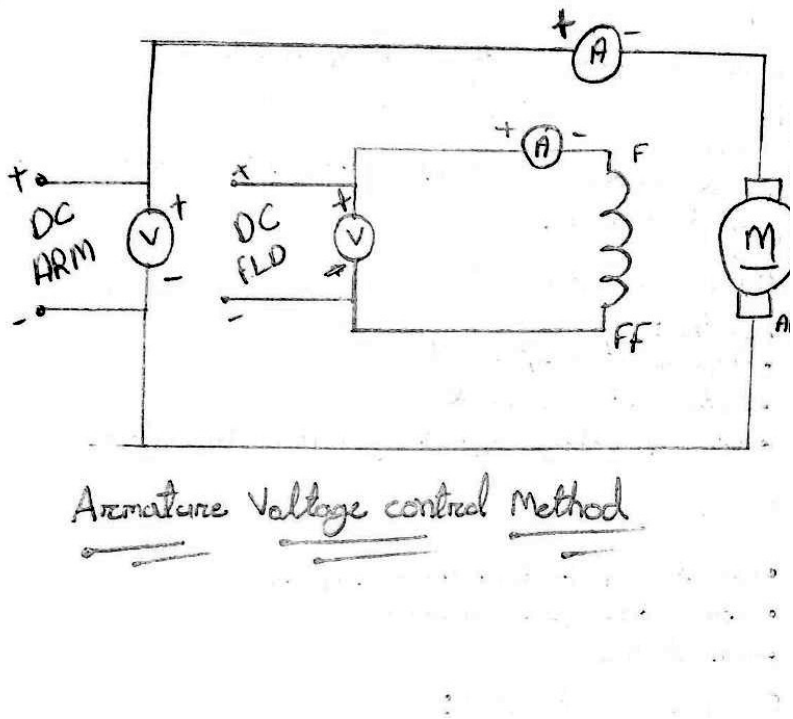


Fig.: Armature voltage control method

Relationship

- Increasing armature voltage increases the motor speed.

- Decreasing field current weakens the magnetic flux, causing the motor speed to increase.
- Increasing field current strengthens the magnetic flux, causing the motor speed to decrease.

Method 1: Armature Voltage Control

In this method:

- Field current is kept constant.
- Armature voltage is varied.
- Motor speed changes approximately in proportion to the armature voltage.

Characteristics:

- Used for speeds below the rated speed.
- Provides good speed regulation.
- High starting torque.

Method 2: Field Current Control

In this method:

- Armature voltage is kept constant.
- Field current is varied using a field rheostat.
- Reducing field current increases motor speed.

Characteristics:

- Used for speeds above the rated speed.
- Simple and economical.
- Torque decreases as field current decreases.

Procedure

A. Armature Voltage Control

1. Connect the circuit as per the armature voltage control diagram.
2. Keep the field current constant.
3. Switch ON the DC supply.
4. Increase the armature voltage gradually.
5. Measure the armature voltage, armature current, and motor speed.
6. Record the observations for different voltage settings.

B. Field Current Control

1. Keep the armature voltage constant at its rated value.
2. Vary the field rheostat to change the field current.
3. Measure the field current and motor speed.
4. Record the observations.
5. Switch off the supply after completing the experiment.

Observation Table

A. Armature Voltage Control

Sl. No.	Armature Voltage (V)	Armature Current (A)	Speed (RPM)
1	80	0.70	720
2	120	0.82	1050
3	160	0.95	1380
4	200	1.10	1710
5	220	1.20	1800

B. Field Current Control (Armature voltage = 220 V constant)

Sl. No.	Field Current (A)	Speed (RPM)
1	0.80	1800
2	0.70	1920
3	0.60	2050
4	0.50	2200
5	0.40	2350

Calculation / Observation

Armature Voltage Control

Armature Voltage (V)	Speed (RPM)
80	720
120	1050
160	1380
200	1710
220	1800

It is observed that increasing the armature voltage increases the motor speed approximately linearly.

Field Current Control

Field Current (A)	Speed (RPM)
0.80	1800
0.70	1920

Field Current (A)	Speed (RPM)
0.60	2050
0.50	2200
0.40	2350

It is observed that decreasing the field current increases the motor speed due to field weakening.

Conclusion

The experiment successfully demonstrated two common methods of DC motor speed control. In the armature voltage control method, increasing the armature voltage increased the motor speed while maintaining constant field flux, making it suitable for operation below the rated speed. In the field current control method, decreasing the field current weakened the magnetic flux and increased the motor speed above the rated speed. The observed results closely matched the theoretical speed characteristics of a DC shunt motor, confirming the effectiveness of both control methods for industrial speed regulation.

EXPERIMENT NO. 03

Aim

To control the speed of a three-phase squirrel cage induction motor by varying the stator voltage and observe the corresponding change in motor speed.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
1	Three-Phase Induction Motor Speed Control Trainer Kit	1	Laboratory trainer	Experimental setup
2	Three-Phase Squirrel Cage Induction Motor	1	415 V, 50 Hz, 0.5–1 HP	Test motor
3	Three-Phase AC Supply	1	415 V, 50 Hz	Power source
4	Three-Phase Stator Voltage Controller / Three-Phase Variac	1	0–415 V	Vary stator voltage
5	AC Voltmeter	1	0–500 V	Measure stator voltage
6	AC Ammeter	1	0–5 A	Measure stator current
7	Digital Tachometer	1	0–5000 RPM	Measure motor speed
8	MCB / Starter with Overload Protection	1	Standard	Motor protection
9	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

A three-phase squirrel cage induction motor operates on the principle of electromagnetic induction. The rotating magnetic field produced by the stator induces currents in the rotor, producing torque.

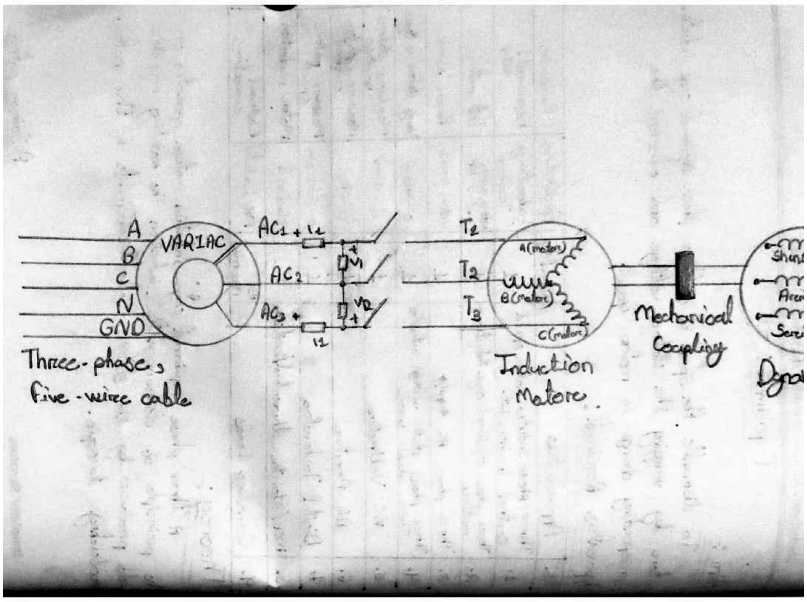


Fig.: Stator voltage control of three-phase induction motor (three-phase variac, induction motor coupled to dynamometer)

The synchronous speed of the motor is given by:

$$Ns = 120\, f / P$$

where,

- Ns = Synchronous speed (RPM)
- f = Supply frequency (Hz)
- P = Number of poles

The actual rotor speed is:

$$N = Ns\,(1 - s)$$

where,

- N = Rotor speed
- s = Slip

The electromagnetic torque developed by an induction motor is approximately proportional to the square of the applied stator voltage.

$$T \propto V^2$$

Reducing the stator voltage decreases the developed torque. Under load, the motor speed decreases slightly due to an increase in slip. This method is mainly suitable for small motors and fan or pump loads, where the load torque decreases with speed.

Procedure

1. Connect the three-phase induction motor to the stator voltage controller (three-phase variac) as shown in the circuit diagram.
2. Connect the AC voltmeter across the stator supply terminals.
3. Connect the AC ammeter in series with one phase of the motor.
4. Connect the digital tachometer to measure the motor speed.

5. Ensure that all connections are tight and correct.
6. Switch ON the three-phase supply.
7. Set the stator voltage to approximately 150 V and note the motor speed.
8. Increase the stator voltage in suitable steps up to the rated voltage.
9. Record the corresponding stator voltage, current, and motor speed.
10. After completing the observations, reduce the voltage to zero and switch off the supply.

Observation Table

Motor Rating: 415 V, 50 Hz, 4 pole

Sl. No.	Stator Voltage (V)	Line Current (A)	Motor Speed (RPM)
1	200	0.85	1180
2	250	1.00	1280
3	300	1.18	1365
4	350	1.35	1435
5	415	1.60	1465

Calculations

Given:

- Supply frequency = 50 Hz
- Number of poles = 4

1. Synchronous speed:

$$Ns = (120 \times 50) / 4 = 1500 \text{ RPM}$$

2. Slip at rated voltage:

Observed speed N = 1465 RPM

$$\text{Slip } (s) = [(Ns - N) / Ns] \times 100 = [(1500 - 1465) / 1500] \times 100 = (35 / 1500) \times 100 = 2.33\%$$

$$s = 2.33\%$$

Conclusion

The experiment verified the stator voltage control method for speed control of a three-phase squirrel cage induction motor. It was observed that increasing the stator voltage increased the developed torque and reduced the slip, resulting in a higher motor speed. Conversely, reducing the stator voltage lowered the torque and increased the slip, causing a decrease in speed. This method is simple and economical, but is suitable mainly for small motors and fan or pump loads.

EXPERIMENT NO. 04

Aim

To identify and study various automation systems used in domestic appliances, commercial devices, and industrial machines, and understand their working principles and applications.

Apparatus Required

Sl. No.	Apparatus / Equipment	Quantity	Specification	Purpose
01	Industrial Automation Trainer Kit	1	PLC / Automation demonstration kit	Demonstration of automation system
02	Programmable Logic Controller (PLC)	1	Siemens / Allen-Bradley / Delta or equivalent	Industrial control
03	Human Machine Interface (HMI)	1	Touch-screen display	Monitoring and control
04	Sensors (Proximity, Temperature, IR, Level)	As required	Standard industrial sensors	Input devices
05	Relay Module	1	24 V DC	Switching device
06	Electric Motor with Starter	1	AC induction motor	Industrial drive
07	Conveyor Belt Model	1	Laboratory trainer	Automation demonstration
08	Connecting Leads	As required	PVC insulated	Circuit connections

Theory

Automation is the technology by which a process, machine, or system operates automatically, with minimal or no human intervention. Automation improves productivity, accuracy, safety, reliability, and energy efficiency.

An automation system generally consists of:

- **Input Devices (Sensors):** Detect physical parameters such as temperature, pressure, level, light, and motion.
- **Controller:** Processes input signals and makes control decisions (PLC, microcontroller, DCS, CNC controller).
- **Output Devices (Actuators):** Execute the controller's commands, such as motors, valves, relays, and solenoids.
- **Human Machine Interface (HMI):** Allows operators to control the system.

- **Communication Network:** Enables data exchange between controllers, sensors and supervisory systems.

Automation systems are widely used in homes, commercial buildings, manufacturing industries, transportation, health care, and power plants.

Procedure

1. Observe various automated appliances and industrial machines available in the laboratory.
2. Identify the sensors, controllers, actuators, and output devices used in each system.
3. Study the working principle of each automation system.
4. Record the type of controller and automation technology used.
5. Compare domestic and industrial automation systems.
6. Note the advantages and industrial applications of each automation system.

Observation Table

Sl. No.	Appliance / Device / Machine	Automation System Used	Controller	Sensor Used	Application
01	Automatic Washing Machine	Microcontroller-based automation	Microcontroller	Water level, temperature and door sensors	Automatic washing cycles
02	Automatic Elevator	PLC-based control	PLC	Limit switches, position sensors	Floor selection and door control
03	Traffic Signal System	Timer / PLC automation	PLC / Microcontroller	Vehicle switches, position sensors	Traffic management
04	Automatic Water Pump	Level control automation	Relay / Microcontroller	Water level sensor	Tank level maintenance
05	Automatic Street Lighting	Light-based automation	Microcontroller	LDR (light sensor)	Energy saving
06	Conveyor Belt System	PLC automation	PLC	Proximity sensor	Material handling
07	CNC Machine	CNC automation	CNC controller	Position encoders	Precision machining
08	Industrial Robotic Arm	Robot automation	PLC / Robot controller	Position, vision sensors	Assembly and welding

Sl. No.	Appliance / Device / Machine	Automation System Used	Controller	Sensor Used	Application
09	HVAC System	Building automation	PLC / BMS	Temperature, humidity sensors	Climate control
10	Bottle Filling Plant	Process automation	PLC	Level and proximity sensors	Automatic filling and packing

Classification of Automation Systems

Type of Automation	Characteristics	Examples
Fixed Automation	Performs repetitive operations with high production rate	Assembly lines, transfer machines
Programmable Automation	Can be reprogrammed for different products	CNC machines, PLC-controlled systems
Flexible Automation	Easily adapts to different products with minimal changeover	Industrial robots, FMS
Integrated Automation	Computer-integrated manufacturing with centralized control	Smart factories, Industry 4.0 systems

Conclusion

The experiment provided an understanding of the fundamental components and applications of automation systems. Domestic appliances commonly employ microcontroller-based automation, while industrial systems predominantly use programmable logic controllers (PLC), CNC controllers, and industrial robots. These systems use sensors and actuators to perform tasks automatically with minimal human intervention, leading to higher productivity, consistent quality, improved safety, and optimized resource utilization in modern industries.

EXPERIMENT NO. 05

Aim

To identify the various parts of a programmable logic controller (PLC) and study the functions of its front panel status indicators.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	PLC Trainer Kit	1	Siemens S7-1200 / Allen-Bradley / Delta / Omron or equivalent	Study of PLC components
02	PLC CPU Module	1	Standard PLC CPU	Processing and control
03	Power Supply Module	1	24 V DC	PLC power source
04	Input Devices	As required	Push buttons, limit switches, sensors	PLC input signal
05	Output Devices	As required	Lamps, relays, buzzer	PLC output
06	Programming Cable	1	USB / Ethernet	PLC programming
07	Personal Computer	1	With PLC programming software	Program development
08	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

A programmable logic controller (PLC) is a rugged industrial digital controller used for automating industrial processes. It continuously monitors input devices, executes the user program stored in its memory, and controls output devices according to the programmed logic.

A PLC consists of several hardware modules integrated into one system or arranged as modular units.

Main Parts of a PLC

1. Power Supply Module:

- Converts AC supply into regulated DC voltage required by the PLC.

- Typically provides 24 V DC to the CPU and I/O modules.

2. CPU (Central Processing Unit):

- The brain of the PLC.
- Executes the control program.
- Processes input data and controls outputs.

3. Memory:

- Stores the user program, configuration, and process data.
- Includes RAM, ROM, and flash memory.

4. Input Module:

- Receives signals from switches, sensors, and push buttons.
- Converts field signals into logic signals for the CPU.

5. Output Module:

- Sends control signals to relays, motors, solenoid valves, lamps, etc.

6. Communication Port:

- Used for programming, diagnostics and networking.
- Examples: USB, Ethernet, RS-232, RS-485, PROFINET, Modbus.

7. Programming Device:

- A computer running PLC programming software such as TIA Portal, FX-Programmer, or WPLSoft.

Front Panel Status Indicators

Indicator	Colour (Type)	Function
Power (PWR)	Green	Indicates that the PLC is powered ON
Run	Green	Indicates the PLC is executing the user program
Stop	Yellow / Amber	Indicates the CPU is stopped and not executing the program
Error	Red	Indicates a hardware or software fault
Fault (SF / BF)	Red	System fault or communication fault
Input LEDs (I0.0, I0.1, etc.)	Green	Show the ON/OFF status of input signals
Output LEDs (Q0.0, Q0.1, etc.)	Green	Show the ON/OFF status of output signals
Communication (COMM / LINK)	Green / Yellow	Indicates data communication or network activity
Battery	(If available)	Indicates low backup battery voltage

Procedure

1. Switch off the PLC trainer kit before inspection.
2. Identify the PLC manufacturer and model number.
3. Locate the power supply module, CPU, input module, output module, communication port, and memory section.
4. Switch ON the PLC power supply.
5. Observe the front panel LEDs and note their status.
6. Press the input push buttons and observe the corresponding input LEDs.
7. Execute a simple PLC program and observe the output LEDs.
8. Identify the Run, Stop, Power, Error and Communication indicators.
9. Record the observations.
10. Switch off the trainer after completing the experiment.

Observation Table

Identification of PLC Parts

Sl. No.	PLC Part	Observation	Function
01	Power Supply Module	Present	Supplies regulated DC power
02	CPU Module	Present	Executes PLC program
03	Input Module	Present	Receives field inputs
04	Output Module	Present	Controls output devices
05	Communication Port	Ethernet / USB	Programming and communication
06	Memory	Built-in flash memory	Stores program and data

Conclusion

The experiment familiarized the user with the construction and operation of a programmable logic controller (PLC). It demonstrated how the CPU, power supply, I/O modules, memory, and communication interfaces work together to perform industrial automation tasks. The front panel status indicators provide real-time information about the PLC's operational state, input/output activity, communication status, and fault conditions, making them essential for monitoring, troubleshooting, and maintaining control systems.

EXPERIMENT NO. 06

Aim

To use a PLC to test the START–STOP logic using two inputs and one output.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	PLC Trainer Kit	1	Siemens S7-1200 / Delta / Allen-Bradley or equivalent	Execution of ladder program
02	Push Button (Green, NO)	1	24 V DC	START input
03	Push Button (Red, NC)	1	24 V DC	STOP input
04	Output Device (Lamp / Relay / Contactor)	1	24 V DC	Load (motor indication)
05	Personal Computer with PLC Software	1	TIA Portal / WPLSoft / RSLogix	Program development
06	Programming Cable	1	USB / Ethernet	Program download
07	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

The START–STOP (latching or seal-in) circuit is the most basic and commonly used logic in industrial motor control. A momentary START push button switches the output ON, and the output keeps itself ON through its own contact (holding contact) even after the START button is released. Pressing the STOP push button breaks the circuit and switches the output OFF.

I/O Assignment

Address	Device	Description
I0.0	START push button (NO)	Starts the output
I0.1	STOP push button	Stops the output
Q0.0	Lamp / Motor contactor	Output

The output Q0.0 is given by the Boolean expression:

$$Q0.0 = (I0.0 + Q0.0) \cdot I0.1'$$

In the ladder, the START contact (NO) and the holding contact Q0.0 (NO) are connected in parallel, and this combination is connected in series with the STOP contact (NC) and the output coil Q0.0.

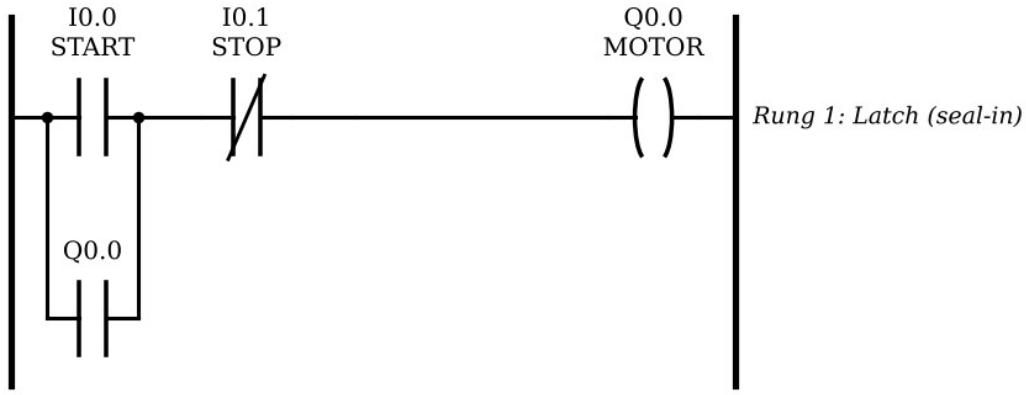


Fig.: Ladder diagram for START–STOP (latching) logic

Procedure

1. Connect the START and STOP push buttons to inputs I0.0 and I0.1 of the PLC.
2. Connect the lamp / relay to output Q0.0 of the PLC.
3. Switch ON the PLC trainer and connect it to the computer with the programming cable.
4. Open the PLC software, create a new project and select the correct PLC model.
5. Develop the ladder program as shown in the ladder diagram.
6. Compile the program and download it to the PLC.
7. Put the PLC in RUN mode.
8. Press START and observe the output; release START and check that the output remains ON.
9. Press STOP and observe that the output switches OFF.
10. Record the observations and switch off the trainer.

Observation Table

Sl. No.	START (I0.0)	STOP (I0.1)	Previous State of Q0.0	Output Q0.0	Remark
1	0	0	0	0	Output OFF
2	1	0	0	1	Output switched ON
3	0	0	1	1	Output latched ON
4	0	1	1	0	Output switched OFF
5	1	1	0	0	STOP has priority

Conclusion

The START–STOP latching logic was developed and tested on the PLC. The output switched ON with the START button, remained ON through the holding contact after START was released, and switched OFF when STOP was pressed. This logic is used for starting and stopping motors in industry.

EXPERIMENT NO. 07

Aim

To develop a ladder program for a traffic light control system.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	PLC Trainer Kit	1	Siemens S7-1200 / Delta / Allen-Bradley or equivalent	Execution of ladder program
02	Traffic Light Module (Red, Yellow, Green lamps)	1	24 V DC	Output devices
03	Push Buttons	2	24 V DC, NO / NC	START and STOP inputs
04	Personal Computer with PLC Software	1	TIA Portal / WPLSoft / RSLogix	Program development
05	Programming Cable	1	USB / Ethernet	Program download
06	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

A traffic light controller switches the Red, Green and Yellow lamps in a fixed sequence, each for a fixed time. In a PLC this is done using ON-delay timers (TON). When a timer's input is ON for its preset time, the timer's "done" bit becomes ON.

The sequence used in this experiment is:

Step	Lamp ON	Time
1	Red	10 s
2	Green	10 s
3	Yellow	3 s

After the Yellow time, the cycle repeats from Red.

I/O Assignment

Address	Device	Description
I0.0	START push button	Starts the sequence

Address	Device	Description
I0.1	STOP push button	Stops the sequence
M0.0	Memory bit	Run latch
Q0.0	Red lamp	Output
Q0.1	Green lamp	Output
Q0.2	Yellow lamp	Output
T1, T2, T3	ON-delay timers	Red, green and yellow times

Working

- Timer T1 starts when the system is running. While T1 is timing, the Red lamp is ON.
- When T1 is done, T2 starts and the Green lamp is ON.
- When T2 is done, T3 starts and the Yellow lamp is ON.
- When T3 is done, T1 is reset; this resets T2 and T3, and the cycle starts again.

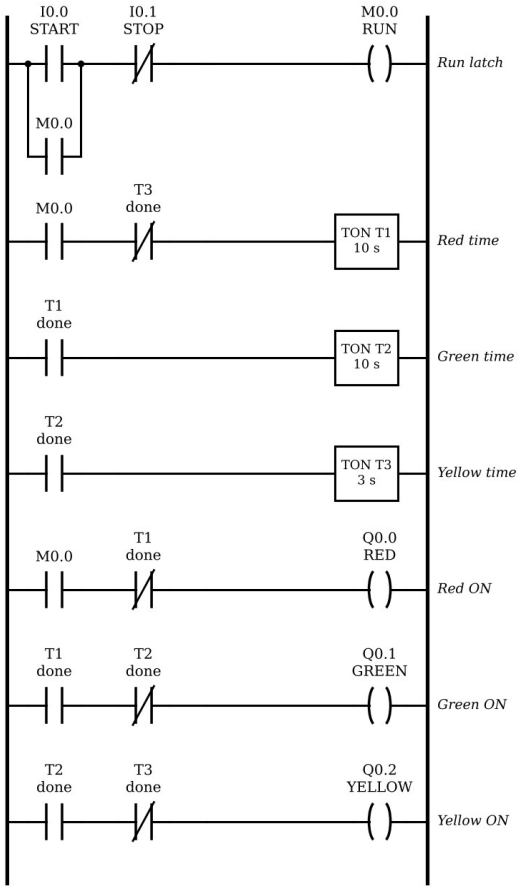


Fig.: Ladder diagram for traffic light control

Procedure

1. Connect the START and STOP push buttons to I0.0 and I0.1.
2. Connect the Red, Green and Yellow lamps to Q0.0, Q0.1 and Q0.2.

3. Open the PLC software and create a new project.
4. Develop the ladder program as shown in the ladder diagram and set the timer presets.
5. Compile and download the program to the PLC and put it in RUN mode.
6. Press START and observe the sequence of the lamps with a stopwatch.
7. Note the ON time of each lamp.
8. Press STOP and check that all lamps switch OFF.

Observation Table

Sl. No.	Lamp	Set Time (s)	Observed Time (s)	Remark
1	Red	10		
2	Green	10		
3	Yellow	3		

Conclusion

The ladder program for the traffic light control system was developed and tested on the PLC using ON-delay timers. The lamps glowed in the sequence Red → Green → Yellow and the cycle repeated continuously until STOP was pressed.

EXPERIMENT NO. 08

Aim

To develop and test a ladder program for tank water level control.

Apparatus Required

Sl. No.	Apparatus	Quantity	Specification	Purpose
01	PLC Trainer Kit	1	Siemens S7-1200 / Delta / Allen-Bradley or equivalent	Execution of ladder program
02	Water Tank Model with Pump	1	Laboratory model	Process setup
03	Level Sensors / Float Switches	2	24 V DC	Low and high level detection
04	Push Button (STOP)	1	24 V DC	Emergency stop
05	Indicator Lamps	2	24 V DC	Tank full and low level alarm
06	Personal Computer with PLC Software	1	TIA Portal / WPLSoft / RSLogix	Program development
07	Connecting Leads	As required	PVC insulated	Electrical connections

Theory

In automatic tank level control, the pump is switched ON when the water falls below the low level and switched OFF when the water reaches the high level. Two level sensors are used:

- **Low level sensor (I0.0):** ON when water is present at the low level.
- **High level sensor (I0.1):** ON when water reaches the high level.

When the tank is empty, both sensors are OFF and the pump starts. The pump keeps running (holding contact) while the water rises above the low level, and it stops when the high level sensor becomes ON. The pump does not start again until the water falls below the low level.

I/O Assignment

Address	Device	Description
I0.0	Low level sensor	ON when water is above low level
I0.1	High level sensor	ON when water is at high level
I0.2	STOP push button	Stops the pump
Q0.0	Pump motor	Output

Address	Device	Description
Q0.1	Tank full lamp	Indication
Q0.2	Low level alarm	Indication

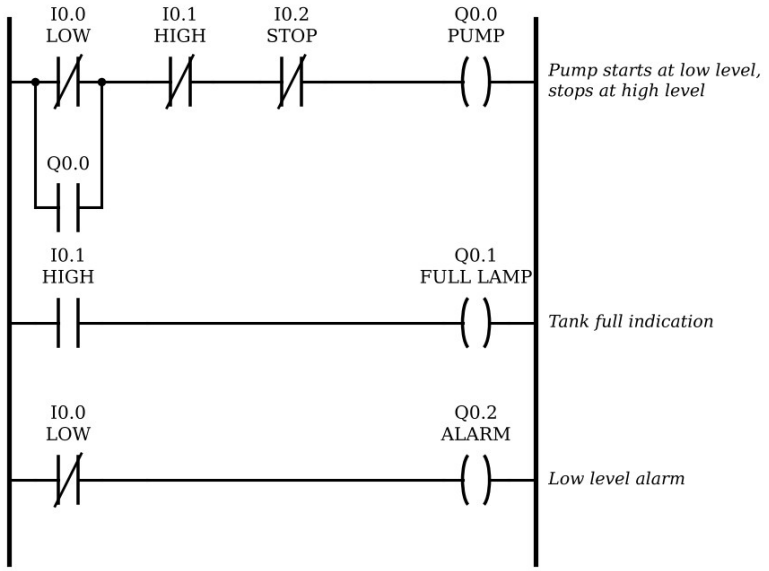


Fig.: Ladder diagram for tank water level control

Procedure

1. Connect the level sensors to I0.0 and I0.1, and the STOP button to I0.2.
2. Connect the pump to Q0.0 and the indicator lamps to Q0.1 and Q0.2.
3. Develop the ladder program as shown in the ladder diagram.
4. Compile and download the program to the PLC and put it in RUN mode.
5. Start with an empty tank and observe that the pump starts and the alarm lamp glows.
6. Observe that the pump continues running after the water crosses the low level.
7. Observe that the pump stops and the tank full lamp glows when the water reaches the high level.
8. Drain the water and check that the pump starts again only below the low level.
9. Record the observations.

Observation Table

Sl. No.	Water Level	Low Sensor (I0.0)	High Sensor (I0.1)	Pump (Q0.0)	Full Lamp (Q0.1)	Alarm (Q0.2)
1	Below low level	0	0	ON	OFF	ON
2	Between low and high (filling)	1	0	ON	OFF	OFF

Sl. No.	Water Level	Low Sensor (I0.0)	High Sensor (I0.1)	Pump (Q0.0)	Full Lamp (Q0.1)	Alarm (Q0.2)
3	At high level	1	1	OFF	ON	OFF
4	Between low and high (draining)	1	0	OFF	OFF	OFF
5	Below low level again	0	0	ON	OFF	ON

Conclusion

The ladder program for tank water level control was developed and tested. The pump started automatically at the low level, continued running until the high level was reached, and then stopped. The indication lamps showed the tank full and low level conditions correctly.