INTERNSHIPWORK DIARY

WEEK - 1

DATE/DAY	WORK DONE
24-01-2025	Introduction to PLC
25-01-2025	Plc Architecture
28-01-2025	Classification of Plc
29-01-2025	Plc Advantages and Disadvantages
30-01-2025	Basic Plc Programming

WEEK - 2

DATE/DAY	WORK DONE
31-01-2025	Programming languages
01-02-2025	Sequential Functional Chart
03-02-2025	Ladder Diagram
04-02-2025	Basic Ladder Programming
05-02-2025	Timers

WEEK - 3

DATE/DAY	WORK DONE
06-02-2025	Plc Timer Functions
07-02-2025	On- Delay Timer
08-02-2025	Off - Delay Timer
10-02-2025	Plc Counters Functions
11-02-2025	Up Counter

INTERNSHIPWORK DIARY

WEEK – 4

DATE/DAY	WORK DONE
12-02-2025	Down Counter
13-02-2025	Up/Down Counter
14-02-2025	PLC Laboratory
15-02-2025	PLC Laboratory
17-02-2025	PLC Laboratory

WEEK - 5

DATE/DAY	WORK DONE
18-02-2025	PLC Laboratory
19-02-2025	PLC Laboratory
20-02-2025	PLC Laboratory
21-02-2025	Introduction To 7-Axis Robot
22-02-2025	Characteristics of 7-Axis Robot

WEEK – 6

DATE/DAY	WORK DONE
24-02-2025	Applications of 7-Axis Robot
25-02-2025	Robot Controller
27-02-2025	Siemens tia portal v16 steps
28-02-2025	HCI & Teach Pendant
01-03-2025	Working Of Teach Pendent

INTERNSHIPWORK DIARY

WEEK – 7

DATE/DAY	WORK DONE
03-03-2025	About Robot
04-03-2025	Types of Robots
05-03-2025	Robot Components
06-03-2025	NoSQL Databases
07-03-2025	Applications

WEEK – 8

DATE/DAY	WORK DONE
10-03-2025	Programming Modes
11-03-2025	Safety Functions
12-03-2025	How to Handle the Teach Pendant
13-03-2025	Applications
15-03-2025	HCL

WEEK – 9

DATE/DAY	WORK DONE
17-03-2025	Basic Ladder Programming
18-03-2025	AND Gate
19-03-2025	NOT Gate
20-03-2025	OR Gate
21-03-2025	NOR Gate

INTERNSHIPWORK DIARY

WEEK – 10

DATE/DAY	WORK DONE
22-03-2025	XOR Gate
24-03-2025	XNOR Gate
25-03-2025	Connection Between PLC and Mitsubishi GX Works 3
26-03-2025	Sensors
27-03-2025	Actuators

WEEK – 11

DATE/DAY	WORK DONE
28-03-2025	Plc Timer Functions
01-04-2025	On- Delay Timer
02-04-2025	Off - Delay Timer
03-04-2025	Plc Counters Functions
04-04-2025	Up Counter

WEEK – 12

DATE/DAY	WORK DONE
07-04-2025	Applications of 7-Axis Robot
08-04-2025	Robot Controller
09-04-2025	Siemens tia portal v16 steps
10-04-2025	HCI & Teach Pendant
11-04-2025	Working Of Teach Pendent

INTERNSHIPWORK DIARY

WEEK – 13

DATE/DAY	WORK DONE
12-04-2025	About Robot
15-04-2025	Types of Robots
16-04-2025	Robot Components
17-04-2025	NoSQL Databases
21-04-2025	Applications

WEEK – 14

DATE/DAY	WORK DONE
22-04-2025	Programming Modes
23-04-2025	Safety Functions
24-04-2025	How to Handle the Teach Pendant
25-04-2025	Applications
26-04-2025	HCL

WEEK – 15

DATE/DAY	WORK DONE
01-05-2025	Interaction and Working with Robot in Laboratory
02-05-2025	Interaction and Working with Robot in Laboratory
06-05-2025	Interaction and Working with Robot in Laboratory
07-05-2025	Interaction and Working with Robot in Laboratory
08-05-2025	Interaction and Working with Robot in Laboratory

ABSTRACT

This internship report provides an overview of the technical knowledge and practical skills gained during my training at the Government Tool Room and Training Centre (GTTC), Challakere, with a focus on Programmable Logic Controllers (PLCs) and 7-axis industrial robotics. The internship involved learning to program PLCs using Mitsubishi GX Works 3 software, where I designed and simulated ladder logic diagrams for various industrial automation tasks. I explored key PLC functions such as timers, counters, and logical operations, and understood how these components control and automate machines. In addition, I gained hands-on experience working with a 7-axis robotic arm, learning to program it using a teach pendant, and performing tasks like object handling, gripper control, and motion path programming. I also studied important concepts like Human-Machine Interaction (HMI), robot controllers, and safety systems to ensure efficient and secure operations. This internship helped me understand the real-world application of automation, mechatronics, and control systems in industries such as manufacturing, automobile, and aerospace, and greatly improved my problem-solving, technical, and programming abilities. It was a valuable opportunity to connect theoretical knowledge with practical industrial applications.

CONTENTS

LIST OF FIGURES

CHAPTER 1

INTRODUCTION OF COMPANY

1.1 About Company:

GTTC was established in 1972 at Bangalore with the participation of the Karnataka State Government, in collaboration with the Government of Denmark under the Bilateral Development Co-operation Agreement. The excellent performance of GTTC Bangalore, proactive Government of Karnataka which saw the need for expansion, got second unit of GTTC started in 1992 with DANIDA assistance.

Proliferation of technology for development of the industries with supply of skilled manpower is the key to meet the needs of the global requirement. With this Government of Karnataka encouraged GTTC to start 10 more sub-centres to train in the area of tool and die making in various parts of Karnataka.

Fig 1.1 Symbol of Govt. Tool Room & Training centre

GTTC is an autonomous society, and a recognised Scientific and Research Organisation by the Government of India. Govt. Tool Room and Training Centre (GTTC), is serving industry by way of precision tooling and providing in well trained craftsmen the area of tool and die making.

Today, the GTTC has acquired mastery in Mould and Die making technology and have blossomed into an epitome of precision and quality in the development and manufacture of sophisticated moulds, dies and tools.

Fully aware of the rapid advancement in technology the world over, the GTTC is periodically adding new technologies to the existing set of advanced equipment like CAD / CAM, CNC machines for tooling, Precision Components, Laser for Industries, Rapid prototyping, vacuum casting etc.

GTTC is concentrating on the Integrated Development of the related segments of industries by way of providing international quality tools, trained personnel and consultancy in tooling and related areas. In future, the focus would be more on turnkey projects in Tooling, Aerospace components & their assemblies, and also to support the development of small and medium scale enterprises.

1.2 Company Profile:

Company Name: Govt Tool Room and Training Centre – Challakere

Management Type: Government Business

Establish: 2021

Nature of Business: Training Centre

Director: Dr. Dinesh Kumar Y.K., I.F.S.

Name of the Principal: Mr. Thippeswamy G R

Address: Plot No: Government Tool Room & Training Centre, Sy.No.117, Bellary Road, Challakere-577522. Chitradurga (D)

Email: gttcchallakere@gmail.com

Phone: 9731754567`

Parent Organization: GTTC

1.3 Vision And Mission:

VISION: To emerge as an International Centre of Excellence in Training, Production, R&D and Consultancy Services related to Tooling & Precision Manufacturing – from concept to end product.

MISSION: To continuously improve the skills in training, develop innovative process to optimize production using latest facilities/ methodologies, trends, technologies tomeet all the stake holder needs and be the leader.

CHAPTER 2

PLCs (Programmable Logic Controller)

2.1 Introduction:

A PLC is Digital electronic device that uses a programmable memory to store instruction and implement logic functions (such as logic timing, counting and arithmetic operations) in order to control machine.

- The term logic is used because the programmable is primarily concerned with implementing logic and switching
- PLC is designed as the replacement of hardwire relay and timer logic control system
- PLC monitors the input status and produces output according to the program stored in the PLC by the operator and controls the machines

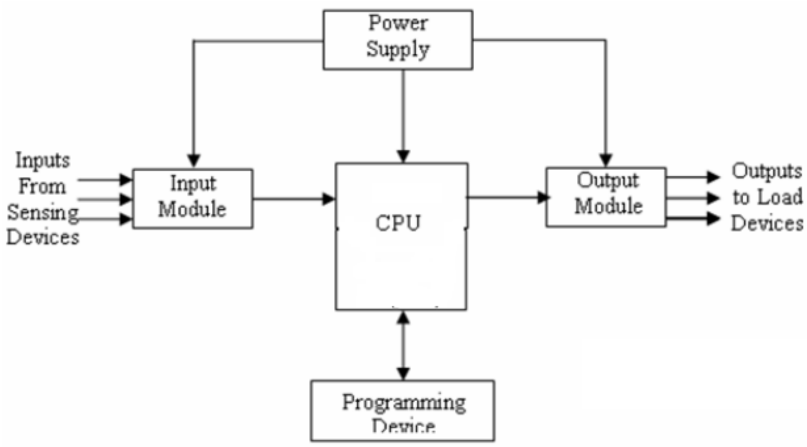


Fig 2.1 Block diagram of PLC

2.2 Plc Architecture:

- The architecture of PLC consists of central processing unit, memory and the input output interfaces.
- The CPU controls and processes all the operations within PLC.
- The CPU is supplied with a clock frequency between 1-8 MHz This frequency
- determines the operating speed of PLC and provides timing and synchronization for all elements in the system.

- A bus system carries the information and data to and from the CPU, memory andinput/output units.
- There are several memory elements A system ROM to give permanent storage for the operating system and fixed data RAM for the user program and temporary buffer, Latch stores input output channels.

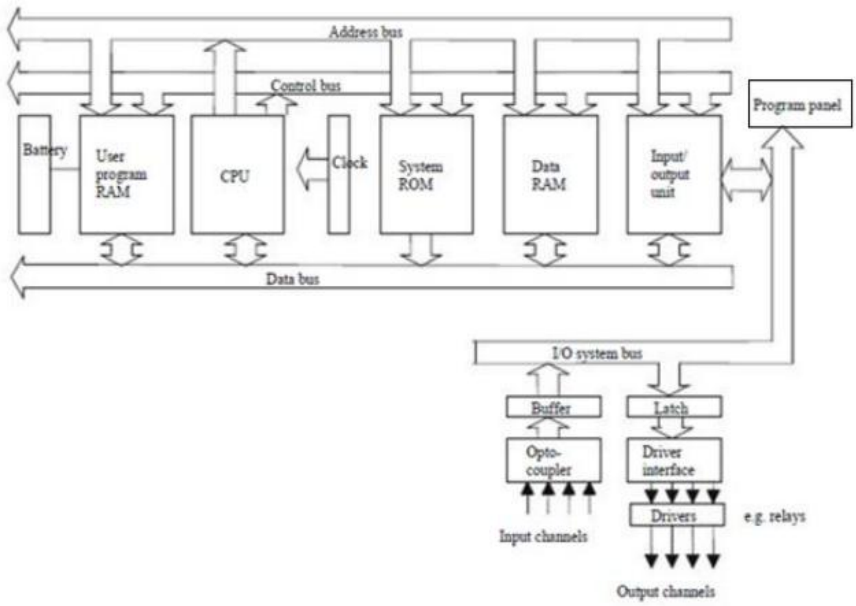


Fig 2.2 Plc Architecture

2.3 Classification of Plc:

1. Depending upon the physical assembly:

a) Compact type or fixed type

b) Modular type or rack mounted system

2. Depending upon no. of I/O'S (modular type) classified into:

a) Small

b) Medium

c) large

3. Depending upon the I/O supported:

a) Digital

b) Analog

2.4 Plc Advantages and Disadvantages:

ADVANTAGES:

- Flexibility
- Implementing changes and correcting errors is easier.
- Large no. of contacts
- Low cost
- PILOT RUNNING
- Visual observation
- Speed of operation
- Ladder or Boolean programming method
- Reliability and maintainability
- 10.Simplicity of ordering control system components.
- 11.Documentation
- 12.Security
- 13.Ease of changes of reprogramming.

DISADVANTAGES:

- Fixed program applications
- Newer technology
- Environment consideration
- Fail-safe operation
- Fixed-circuit operation

CHAPTER 3

BASIC PLC PROGRAMMING

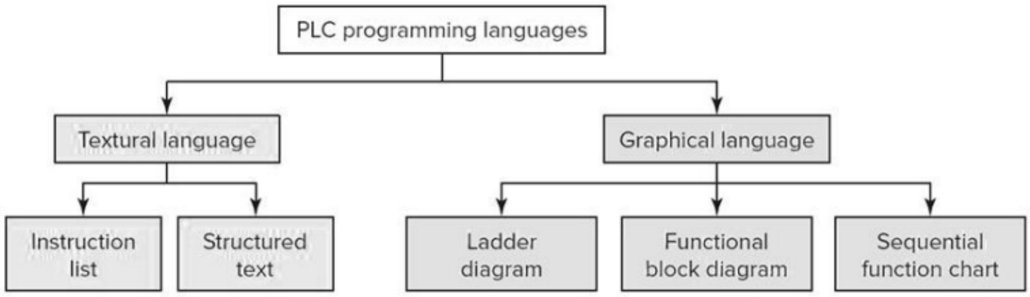


Fig 3.1 programming languages

3.1 Programming languages:

1. Instruction list (IL)
2. Structured list (SL)
3. Functional block diagram (FBD)
4. Sequential functional chart (SFC)
5. Ladder diagram (LD)

➢ **INSTRUCTION LIST (IL):**

The instruction list uses lower-level language.

In programming, lower-level language means that it gets closer to machine language (the 1's and 0's) and the commands closely resemble that of the microprocessor's programs.

- It gives a series of instructions for each new line and uses mnemonics for each one.
- In instruction list operation shown on left and operand on right.

➢ **STRUCTURED LIST (SL):**

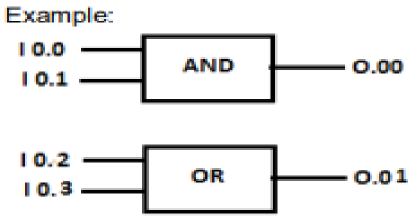
The structured text is a high-level language developed for industrial control.

- The structured text language is written as a series of statements terminated by semicolons (like in C).
- Text uses operator such as logical branching, multiple branching and loops.

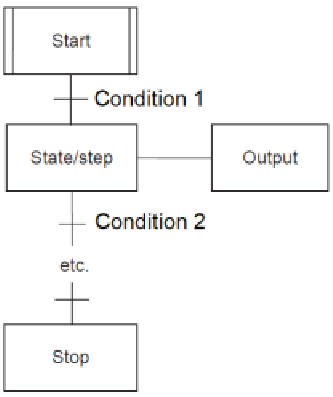
Example: LIGHT = SWITCH A or SWITCH B;

➢ **FUNCTIONAL BLOCK DIAGRAM (FBD):**

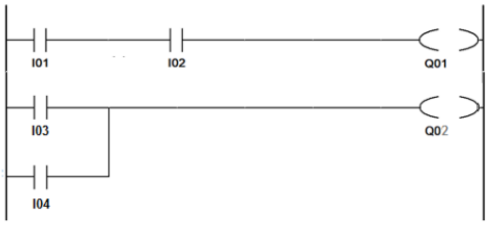
The function block diagram is a simple way of PLC programming where there are "Function blocks" (hence the name) are available in the programming software.



- **SEQUENTIAL FUNCTIONAL CHART (SFC):**
    - Sequential Function charts represent each function in a PLC control system in a sequential fashion.
    - A sequential function chart is a visual representation of the system's operation to display the sequence of actions involved in the operation.



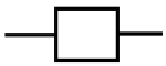
- **LADDER DIAGRAM (LD):**



The most commonly used PLC programming language is the Ladder Logic Diagram.

The ladder logic diagram consists of two fundamental parts, which you can see as the vertical and the horizontal lines. They are called, respectively, the rails and the rungs. The two vertical rails represent the Vdc source and the other one the 0 Vdc terminal They are power rails. The devices on a rung must provide continuity from the left rail to the right rail for an output element to become powered up. To scan the program for continuity of rungs, the PLC uses a top to bottom, left to right sequence (reading like a book), thus checking continuity between the two rails for each scan.

Symbols in ladder diagram:

	NORMALLY OPENED CONTACT
	NORMALLY CLOSED CONTACT
	SPECIAL TASK INSTRUCTION
	OUTPUT COILS

3.2 Basic Ladder Programming:

AND GATE

(Y=A.B)

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

- The AND gate operation is when all inputs are high(1) ,output is high.
- The two inputs must BOTH have continuity (high) in order for the output to turn on.
- The AND condition in ladder logic is, all inputs are to be in series with each other .

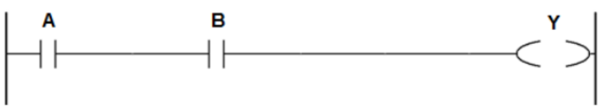
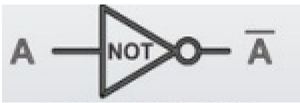


Fig 2.2.1 AND Gate

NOT GATE

Y=$\overline{A}$



INPUT	OUTPUT
A	Y
0	1
1	0

- An output is high when input is zero.
- The output is inverse of the input.

In Ladder Logic, a NC contact is connected in series with output coil.

Fig 2.2.2 NOT Gate

OR GATE

(Y=A+B)

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

- OR gate logic is, if any or all the inputs are high the output is high.
- ANY of them high may create continuity between the two power rails thus turning the output ON.
- OR condition in ladder logic is, all the inputs are connected in parallel.

Fig 2.2.3 OR Gate

NOR GATE

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

INPUT		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

- The NOR condition is just a negated version of the OR condition.
- The output is high only when both the inputs are low.

$\bar{A}.\bar{B}$

$\overline{A+B}$

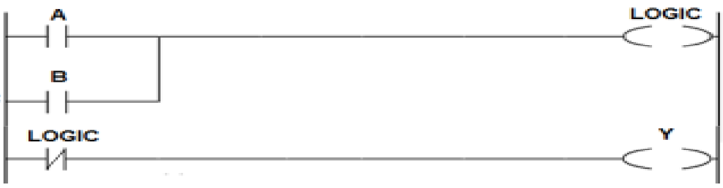


Fig 2.2.4 NOR Gate

NAND GATE

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

- The NAND condition is a negated version of AND condition.
- The output is low only when both inputs are high.

INPUT		OUTPUT
A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

$\bar{A}+\bar{B}$

$\overline{A.B}$

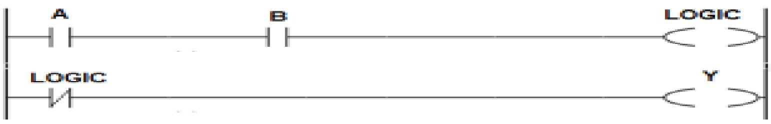


Fig 2.2.5 NAND Gate

X OR GATE

$\overline{A}\,B + A\,\overline{B}$

INPUT		OUTPUT
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

- Only ONE input variable is allowed to control the output AT A TIME.
- The output is high only when one of the inputs is high.

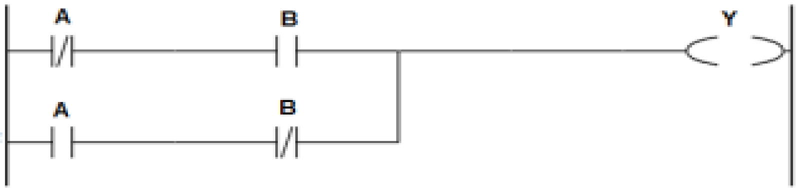


Fig 2.2.6 XOR Gate

XNOR GATE

$\overline{A}\,\overline{B} + A\,B$

- XNOR have a negated output for XOR.
- An output exists when both inputs are high or low.

INPUT		OUTPUT
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

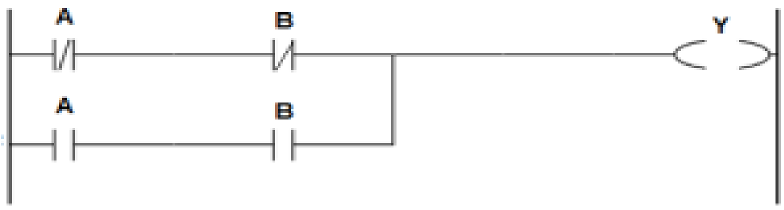


Fig 2.2.7 XNOR Gate

3.3 Timers:

Introduction to timers

- The process controlled device after coils and contacts energized is the timer.
- Industrial timing task include timing of the intervals for welding, painting, heat treatment etc.
- Timers can also predetermine the interval between two operations.
- The common timing function is time delay ON function and time delay OFF function.
- Timers can be of industrial timer or digital solid state electronic timers.
- The PLC timer is more versatile and flexible than either the industrial or digital electronic timers.
- The major advantage of PLC timer is that its time may be a programmable, variable time as well as a fixed time.
- Another advantage of the PLC timer is that its time accuracy, repeatability and reliability are extremely high based on the solid state technology.

Plc timer functions:

Timers behave like relay with coils that when energized result in the closures or opening of contact after some pre-set time.

A timer is a delay blocks that when inserted in a rung, delay signal in that rung from reaching the output considering the output conditions after the delay.

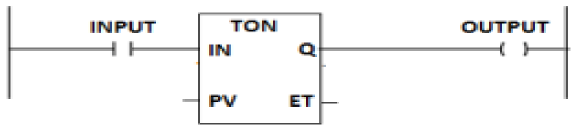
The main types of timers are:

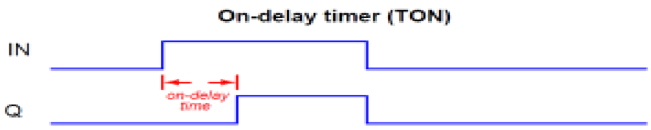
- ON delay timer
- OFF delay timer

➢ **ON- DELAY TIMER:**

ON-delay timer (TON) comes ON after a particular time delay.

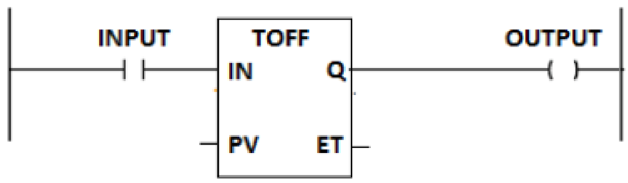
As the input goes from 0 to 1 the elapse time starts to increase and when it reaches the pre-set time specified, the output goes on.



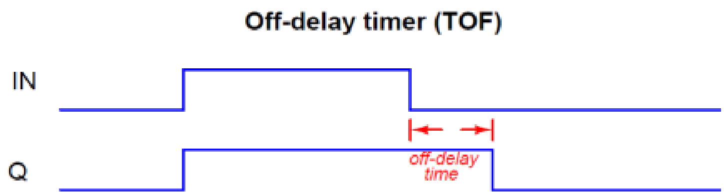


➢ **OFF - DELAY TIMER:**

An OFF-delay timer (TOFF) is ON for a fixed period of time before turning OFF. As the input goes from 0 to 1, the timer and output are ON. The elapse time starts to increase and when it reaches the pre-set time specified, the output goes



Timing diagram



3.4 Plc counter functions:

Counters are provided as built in elements in PLC'S and allow the no.of occurrences of input signal to be counted. Some of the users includes where item as to be counted as they pass along the conveyor belt, the no.of people passing through a door or no. oh revolution of a shaft.

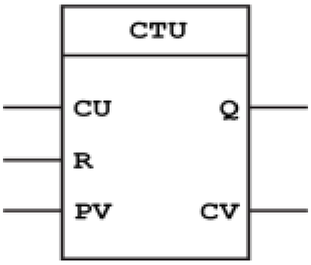
A PLC counter is set to some present number value and when this value of input pulses have been received the counter output goes ON.

There are two basic types of counter. They are:

1. UP counter
2. DOWN counter

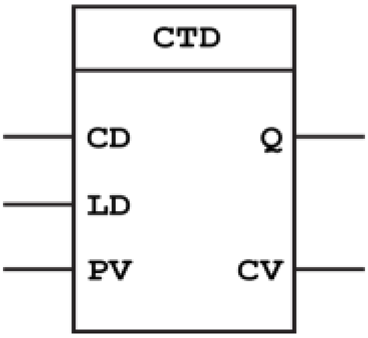
- **UP COUNTER:**

  Pulse at CV (count value) is counted, when count value reaches preset value (PV), Q is set to one and counting stops. An input R (reset) clears Q to zero



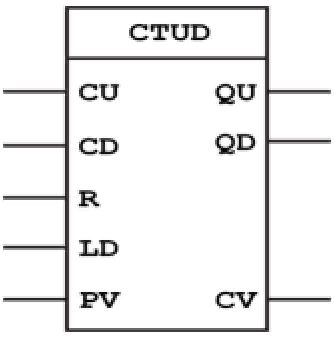
- **DOWN COUNTER:**

  Pulse at CD are counted, when count value count from the preset value to zero, Q is set to one and counting stops, an input LD clears Q to zero.



- **UP/DOWN COUNTER:**

  UP/DOWN counter has to inputs CU and CD(Count UP and Count DOWN), they can be used to count UP in one input and count down in the another input on the counter.



3.5 Problem:

There are 3 mixing devices on a processing line - A, B & C. After the process begins, mixer-A is to start after 5 sec (Elapse). Next mixer B is to start 4 sec after A. Mixer C is to start 6 sec after B. All of them remain on until enable switch is turned off.

Explanation of Ladder Diagram

- Rung 0: Start/Stop Logic
  - X0 (ENABLE SWITCH) — Start button.
  - X1 (STOP SWITCH) — Stop button.

    When X0 is ON and X1 is OFF, M0 (MEM OUTPUT) is activated. This acts as a memory coil to hold the start state.
- Rung 1: Latch for Memory Output
  - Ensures M0 stays ON once activated by X0.
- Rung 2: Timer Activation
  - When M0 is ON, T0 starts counting up to K156 (15.6 seconds).
- Rung 3 (Line 15): Mixer A

  Condition: T0 > K70 → when timer exceeds 7.0 seconds
  - Y2 (Mixer A) turns ON.
- Rung 4 (Line 22): Mixer B

  Condition: T0 > K106 → when timer exceeds 10.6 seconds
  - Y3 (Mixer B) turns ON.
- Rung 5 (Line 29): Mixer C

  Condition: T0 >= K156 → when timer reaches or exceeds 15.6 seconds
  - Y4 (Mixer C) turns ON.
- Rung 6 (Line 36): Program End
  - Marks the END of the ladder logic.

Timers and Delay Interpretation

If the time base is 100 ms (0.1s), the values translate as:

- K70 → 7.0 sec (Mixer A delay)
- K106 → 10.6 sec (Mixer B delay → 3.6s after A)
- K156 → 15.6 sec (Mixer C delay → 5s after B)

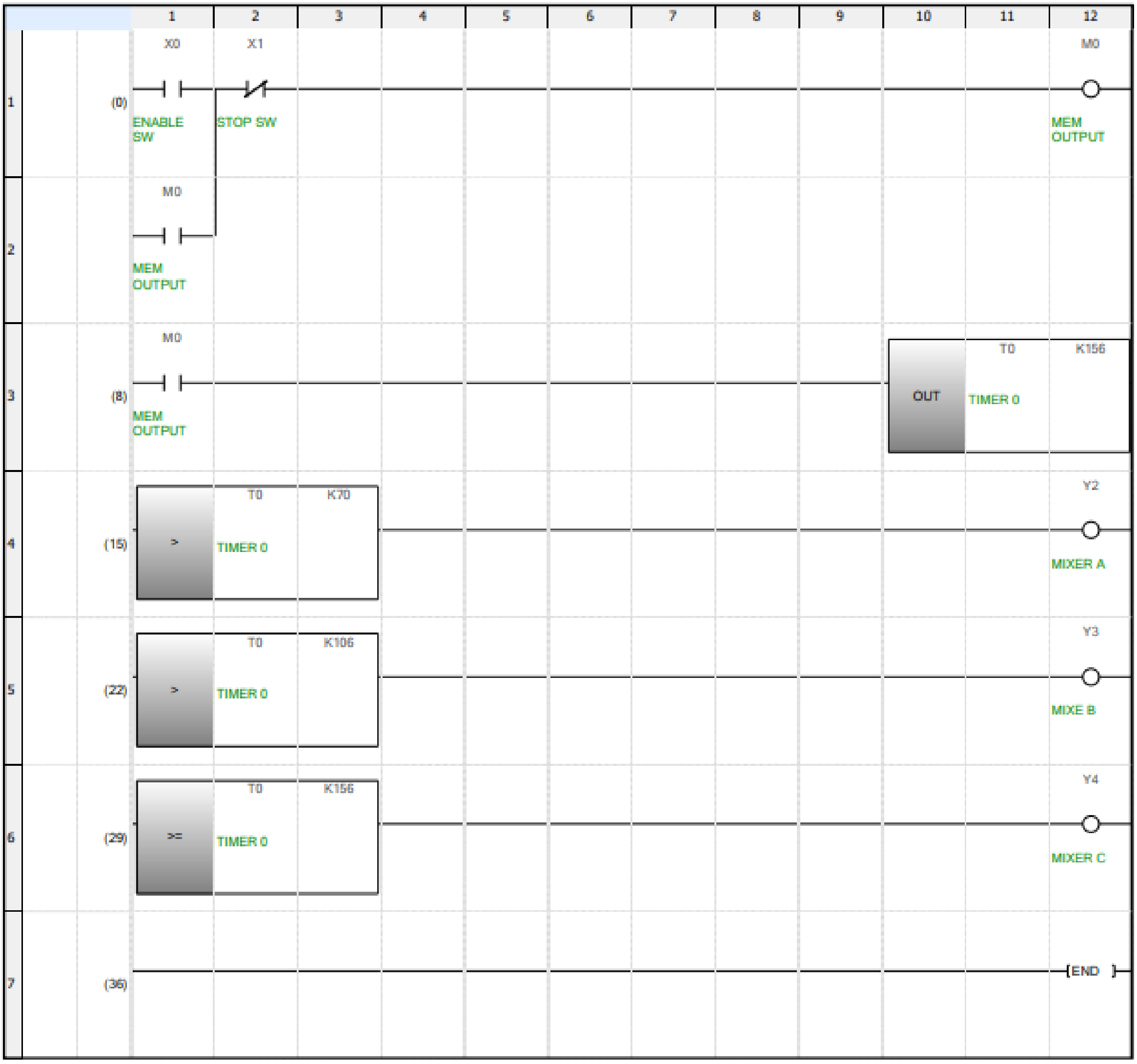


Fig 3.5 Ladder Diagram

CHAPTER 4

7-AXIS ROBOT

4.1 Introduction:

A 7-axis robot is a type of industrial robot that has 7 joints or axes of movement & enabling complex and flexible movements.

4.1.1 Characteristics of 7-Axis Robot

1. **High Flexibility:**
   A 7-axis robot can move in a wide range of motion, making them ideal for tasks that require complex movements**.**
2. **Long Reach:**
   The 7 axes of movement allow for a longer reach, making it possible to access and manipulate objects in order to reach areas that would otherwise be difficult.
3. **High Precision:**
   7-axis robots are capable of precise movements, making them suitable for tasks that require high accuracy.

4.1.2 Applications of 7-Axis Robot

- **Welding and Assembly:**
  These robots are often used in welding and assembly applications where high flexibility and precision are valuable assets.
- **Material Handling:**
  These robots can be used to handle and manipulate materials in a variety of industries, including manufacturing and healthcare.
- **Machine Tending:**
  These robots can be used to tend machines such as CNC machines and injection molding machines.

4.1.3 Robot Controller

A robot controller is a device or system that manages and regulates the actions of a robot. Types of robot controllers:

1. **Microcontrollers:**
   Small computers that control robots, e.g., Arduino & Raspberry Pi.

2. **PLCs (Programmable Logic Controllers):**
   Industrial-grade controllers for complex robotic systems, robot operating systems, and software programs for building and controlling robotic systems.

4.2 About Robot:

A robot is a machine that works automatically and can do some tasks that a human can do.

Types of Robots

1. **Industrial Robots**
   Used in manufacturing, assembly, and material handling.
2. **Autonomous Robots**
   Operate independently, making decisions based on sensors and programming.
3. **Social Robots**
   Interact with humans, providing companionship and entertainment.
4. **Service Robots**
   Assist humans in various tasks such as healthcare, hospitality, and education.

Robot Components

1. **Sensors**
   Detect and respond to environmental changes.
2. **Actuators**
   Convert energy into motion or action.
3. **Microcontroller**
   Processor that controls and processes information for the robot’s actions.
4. **Power Source**
   Batteries, electric motors, or other energy storage systems.

Applications

- **Manufacturing**:
  Assembly, welding, inspection, and material handling.
- **Healthcare**:
  Surgery, patient care, and medical research.

- **Agriculture**:
  Harvesting, crop monitoring, and farming automation.
- **Space Exploration**:
  Satellites and space stations.

4.3 HCI & Teach Pendant:

4.3.1 HCL:

Human-Computer Interaction: Devices that enable humans to interact and control robots.

Applications:

1. Industrial applications
2. Research & development
3. Automation

Functions:

1. **Motion Control:**
   Regulates movement, speed, and direction.
2. **Sensor Integration:**
   Integrates data from sensors such as cameras and GPS.
3. **Task Execution:**
   Manages tasks such as grasping, manipulation, and navigation.
4. **Safety Monitoring:**
   Detects and responds to safety hazards such as collisions or malfunctions.

4.3.2 Teach Pendant:

It is a handheld device used to **program and control industrial robots**. It is an essential tool for robot operators and programmers.

How to Use Teach Pendant:

- **Pre-operation Checks:**
  - Ensure the robot is turned off and the teach pendant is properly connected.
  - Familiarize yourself with the teach pendant layout and functions.
  - Perform powering and initialization.

- **Operation Steps:**
    - Turn on the robot and the teach pendant.
    - Initialize the robot by following the prompts on the teach pendant.

Programming Modes:

1. **Teach Mode:**
   Allows you to manually move the robot to desired positions and record them.
2. **Program Mode:**
   Enables you to create and edit programs using the recorded positions.

Safety Functions

1. **Emergency Stops:**
   Immediately stops the program in case of an emergency.
2. **Safety Zone:**
   Defines areas where the robot is not allowed to enter.
3. **Collision Detection:**
   Detects collisions with objects or people.
4. **Diagnostic Function:**
   Displays error messages and diagnostic information to help identify issues.
5. **Status Displays:**
   Shows the current status of the robot and its program.
6. **Maintenance Alerts:**
   Notifies the user to perform required maintenance tasks.
7. **Additional Functions:**
    - **Menu Navigation:** Helps navigate through menus and options.
    - **Display Help Tutorials:** Provides assistance and instructions.
    - **Settings:** Configures robot parameters and program settings.

How to Handle the Teach Pendant

- Hold the teach pendant **firmly with both hands**.
- Place your thumbs on the joystick or buttons and **lightly bend your fingers**.
- Keep your arms relaxed and elbows slightly bent.

➢ **Operating Instructions:**

- Use the joystick or buttons to move the robot **steadily and deliberately**.
- Use teach pendant functions to **record, play, and edit programs**.

- Navigate menus using **navigation buttons** or **joystick** to access various options.
- Select desired options smoothly and precisely.

- **Troubleshooting:**
- Refer to the user manual for troubleshooting guides.
- Contact the manufacturer's support team for critical errors.
- Perform regular maintenance to prevent errors.

Applications

- **Robot Programming:**
  Teach pendants are used to program robots for various tasks such as welding and assembly.
- **Material Handling:**
  Robots are used to move and manipulate materials in manufacturing.
- **Robot Operation:**
  Teach pendants are used to control and monitor robots during operation.

4.4 Program:

Steps to update program in Teach Pendent

- Click on Menu button
- Go to Home > Utilities
- Click on Render
- Click on Previous
- Write a program
- Use Shift + F

- **Example 1 Robot Program:**

1: J P[2] 100% FINE
2: J P[3] 100% FINE
3: J P[4] 100% FINE
4: J P[5] 100% FINE
5: RO [1: GRIPPER DECLAMP] = ON
6: J P[7] 100% FINE
7: J P[8] 100% FINE
8: J P[9] 100% FINE

9: RO [1: GRIPPER DECLAMP] = OFF

10: J P[1] 100% FINE

11: J P[12] 100% FINE

12: J P[13] 100% FINE

13: J P[14] 100% FINE

14: J P[15] 100% FINE

END

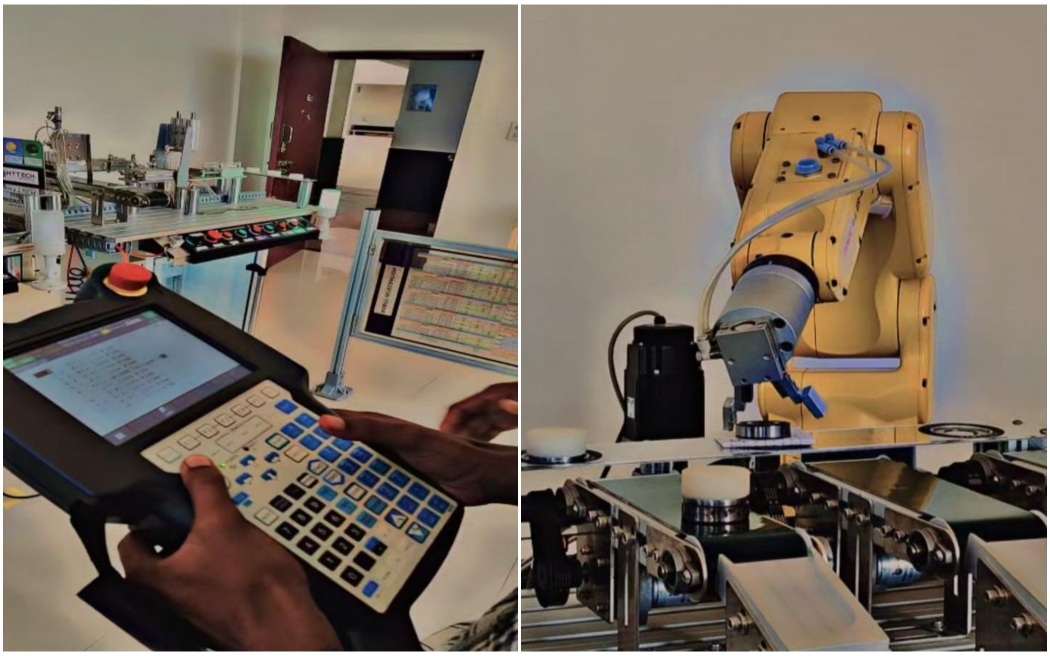


Fig 4.1 Robot and Teach Pendent

- **<u>Example 2 Robot Program:</u>**

1: J P[2]   100% FINE

2: J P[3]   100% FINE

3: J P[4]   100% FINE

4: J P[5]   100% FINE

5: RO [1: GRIPPER DECLAMP] = ON

6: J P[7]   100% FINE

7: J P[8]   100% FINE

8: J P[9]   100% FINE

9: RO [1: GRIPPER DECLAMP] = OFF

10: J P[10] 100% FINE

11: J P[11] 100% FINE

12: J P[12] 100% FINE

13: J P[13] 100% FINE

14: J P[14] 100% FINE

15: J P[15] 100% FINE

END

<u>Explanation of Program Line:</u>

1: J P[2] 100% FINE

- **Joint move** to position P[2] at 100% speed with fine motion control.
- **J:** Represents a **joint move command**, which moves all robot joints simultaneously.
- **P[2]:** Specifies the target **position 9**, which was previously taught or defined as a robot location.
- **100%:** Denotes the **speed** set at **100% of the robot's maximum velocity**.
- **FINE:** Indicates the use of **fine motion control**, ensuring a **high level of precision** during the movement.

RO [1: GRIPPER DECLAMP] = ON

- **GRIPPER:** A device used to hold or manipulate objects.
- **DECLAMP:** Means to release or remove the clamp.

CHAPTER 5

WORKING OF PLCs & 7-AXIS ROBOT

5.1 Working of PLCs:

- **<u>Working:</u>**

  Step 1: Initial Setup & Connection

  - The PLC is programmed using Mitsubishi GX Works 3 to define automation tasks.

  Step 2: PLC Ladder Logic Programming

  - The PLC is programmed with ladder logic, which defines when and how the robot moves.
  - Input signals (e.g., from sensors, buttons, or external triggers) are processed by the PLC.
  - Based on the logic, the PLC sends output signals to control the robot's actuators and motors.

  Step 3: Continuous Monitoring & Feedback

  - The PLC monitors sensor inputs (e.g., object detection, pressure sensors).
  - If a process change is required, the PLC dynamically adjusts robot movement in Realtime.
  - Any errors or faults are detected and displayed in Mitsubishi GX Works 3 for troubleshooting

- **<u>Connection Between PLC and Mitsubishi GX Works 3:</u>**

  <u>Hardware Connection</u>

  PLC is connected to the PC running Mitsubishi GX Works 3 via:

  - USB Cable (for local programming).
  - Ethernet (LAN) (for remote monitoring & control).
  - RS-232/RS-485 (for serial communication with older PLCs).

  <u>Software Configuration</u>

  - GX Works 3 detects the connected PLC and allows direct programming.
  - Engineers configure:

- Input/output modules.
- Communication settings.
- Memory allocation for variables.

Program Uploading & Execution:

- The ladder diagram or function block program is uploaded to the PLC.
- The PLC starts executing the automation tasks as per the programmed logic.

Real-Time Monitoring

- Engineers can track sensor inputs, motor outputs, and program execution in real time.
- If needed, changes can be made without stopping the system.

5.2 Working of 7-Axis Robot:

➢ **<u>Working:</u>**

Step 1: Initial Setup & Connection

- The robot is connected to the power source via industrial communication protocols (Ethernet/IP, Modbus, or CC-Link).
- A Teach Pendant is used to manually program or guide the robot.

Step 2: Robot Movement Execution

- The robot follows predefined motion paths based on the programmed logic.
- The 7-axis flexibility allows the robot to manoeuvre in constrained spaces more efficiently than a 6-axis system.
- The Teach Pendant can be used to refine or modify movements manually

➢ **<u>Working of Teach Pendant for 7-Axis Robot:</u>**

Step 1: Powering On the System

- Turn on the robot controller and PLC system.
- Enable the Teach Pendant from the control panel.

Step 2: Jogging the Robot (Manual Movement)

- The Teach Pendant has joystick controls or arrow buttons to manually move the robotic arm.
- Each axis (1 to 7) can be controlled independently:

    - Axes 1-6 → Control basic movements (rotation, bending, extension).
    - Axis 7 → Provides additional flexibility for better positioning in complex environments.
- Operators can adjust speed and precision while moving the robot.

Step 3: Recording and Teaching Positions

- Move the robot to a desired position and record it as a waypoint.
- Continue this for all necessary positions (e.g., pick-up, move, place).
- The system stores these points in memory to create an automation sequence.

Step 4: Defining Motion Paths

- Set motion types:
    - Point-to-Point (PTP): Moves directly between positions.
    - Linear Motion: Moves along a straight line.
    - Circular Motion: Moves along a curved path.
- Specify speed, acceleration, and movement order for smooth transitions.

Step 5: Running and Testing the Program

- Operators can simulate the recorded sequence before full execution.
- If errors occur, adjustments can be made using the Teach Pendant interface.
- Once verified, the robot can execute the programmed sequence autonomously.

Step 6: Execution in Auto Mode

- After finalizing the program, switch to Auto Mode.
- The robot will perform the recorded tasks without manual intervention.
- Operators can monitor and adjust using the Teach Pendant if needed

5.3 Hardware and Software Requirements:

1. Hardware Requirements

Component	Description
Programmable Logic Controller (PLC)	Mitsubishi PLC (compatible with GX Works 3, e.g., Mitsubishi FX Series, Q Series, or iQ-R Series).

Component	Description
7-Axis Robotic Arm	Industrial robotic arm with seven degrees of freedom for precise automation tasks.
Teach Pendant	Handheld device used to program and control the robotic arm.
Sensors	Proximity sensors, limit switches, infrared sensors for detecting objects and automation triggers.
Actuators	Pneumatic, hydraulic, or electric actuators to control robotic movement.
Motor Drivers	Stepper or servo motor drivers to control the robotic arm and other mechanical components.
Industrial Power Supply	24V DC or appropriate voltage supply for PLC and robot operation.
Communication Cables	USB, Ethernet, RS-232/RS-485 cables for PLC-to-PC and PLC-to-robot communication.
Human-Machine Interface (HMI) (Optional)	Touchscreen interface for easier control and monitoring of the automation process.
Networking Devices (Optional)	Routers or switches for connecting PLCs and robotic controllers in a networked system.

2. Software Requirements

Software	Description
Mitsubishi GX Works 3	PLC programming software for writing, simulating, and debugging ladder logic programs.
Robot Control Software	Proprietary software for the 7-axis robot (depends on the manufacturer).
Teach Pendant Software	Built-in software for controlling and programming the robotic arm manually.
Simulation Tools (Optional)	Software like RoboDK or MATLAB Simulink for testing robotic movements in a virtual environment.

Software	Description
Operating System	Windows 10/11 (64-bit) or a compatible OS for running GX Works 3.
Drivers & Communication Protocols	USB, Ethernet, or serial communication drivers for connecting PLC and robots.
SCADA Software (Optional)	Supervisory Control and Data Acquisition software for real-time monitoring and data visualization.

CONCLUSION

The internship at Government Tool Room and Training Centre (GTTC), Challakere, provided a valuable and enriching learning experience in the fields of industrial automation, PLC programming, and robotics. Through hands-on exposure to Mitsubishi GX Works 3, ladder logic programming, and practical implementation of PLCs, I gained a deep understanding of how automated control systems are designed and executed. The training on the 7-axis robot further enhanced my knowledge of advanced robotic systems, human-machine interfaces, and their industrial applications. Overall, this internship strengthened both my theoretical foundation and practical skills, preparing me to take on real-world challenges in the automation and manufacturing industries.

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