Automation

Automation: **Automation** is the technique, method, or system of operating or controlling a process that operates automatically. It reduces human efforts and saves time and also increases accuracy.

Automation has been achieved by various things including mechanical, hydraulic, pneumatic, electrical, electronic devices, and computers and its have wide use in every sector such as all engineering industries, medical science, home appliances, etc.

Types of industrial automation: Automation can be classified into 3 major categories: **Fixed automation**, **Programmable automation**, and **Flexible automation**

Fixed automation: It is a system in which the sequence of processing (or assembly) operations is fixed by the equipment configuration. Example – Distillation Process, Conveyors, Paint Shops, Transfer lines, etc.

Programmable Automation: It is used for a changeable sequence of operations using electronic controls. This is done by controlling the automation through a program, which can be coded in certain ways to change the sequence. It's used more commonly in low to medium levels of production, often being most suitable for batch production. Example – CNC Machine, Industrial Robot.

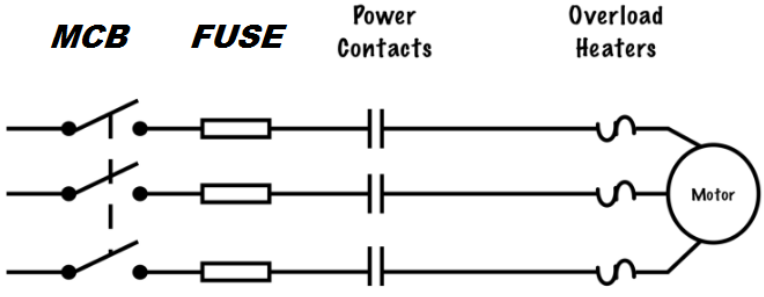
- **Flexible automation**: Flexible automation, also known as "soft automation", is similar to programmable automation, although it is a little more complicated. Essentially, flexible automation enables the production of different types of products without losing time when reprogramming. Example – Welding gun can be reoriented during the process, Highly mechanized (often robotic).

Basic elements of industrial automation:

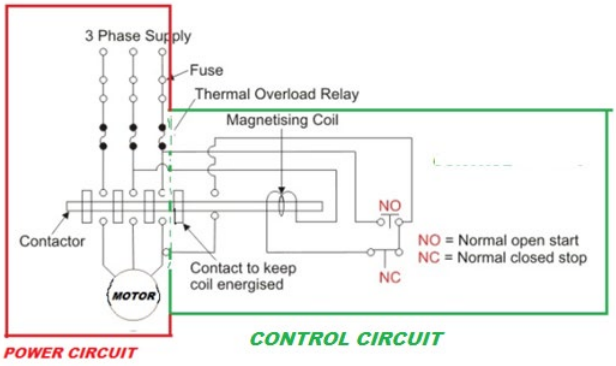
a) Program of instruction.
b) Power circuit
c) Control circuit

a) **Program of instruction**: The programmed instructions determine the set of actions that are to be achieved automatically by the system. The program specifies what is the automated system should do and how its various components must function to accomplish the desired result.

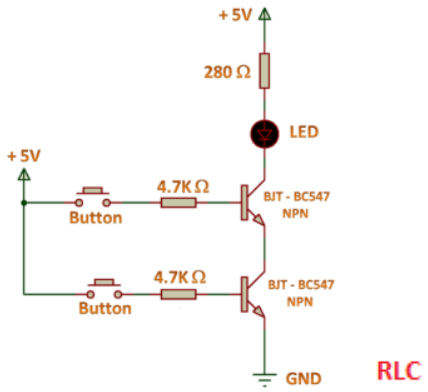
b) **Power Circuit**: A power circuit is defined as any circuit which used to carry electricity that directly operates a load with the help of control circuits. Power circuit contains Circuit breakers, isolator, MCCB, MPCB, Busbars, VFD etc. The power supply and control supply have different control accessories. They never interfere with each other. Most of the power circuit output should be more than five ampre.

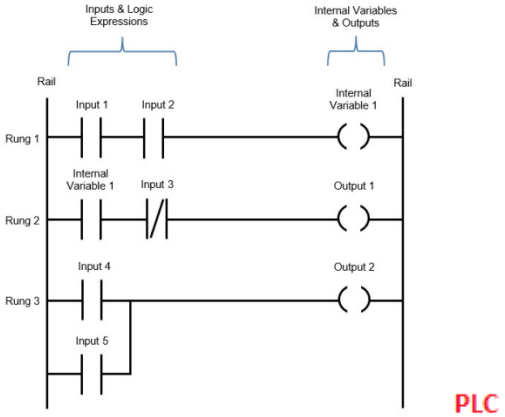


c) **Control Circuit**: A control circuit is a special type of circuit used to control the operation or control the power circuit and it is completely separate from power circuit.



Controls can be classified into two types: RLC (Relay logic control) and PLC (Programmable logic control).

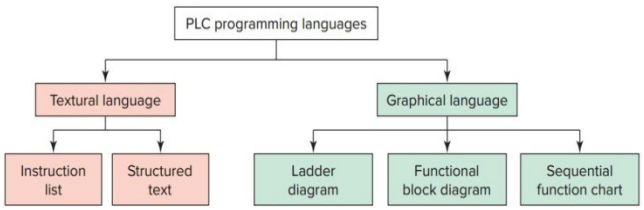


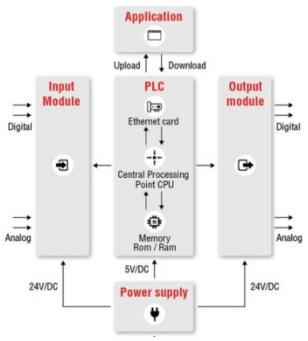


RLC (Relay logic control): **RLC** circuit is a hardware control circuit consisting of resistor, inductor, capacitor, NO/NC switches, Relay contactor, timer, counter, etc connected in series or parallel. The traditional process of automation was accomplished using relay logic. It requires a lot of wiring, switches, Relay, timer, etc. Its troubleshooting and modification are also difficult.

PLC (Programmable logic control): PLC is a microprocessor-based solid-state device used in the industrial automation system. PLC works on the principle of logic gates. PLC replaces the RLC with software. Its also suitable for addition, subtraction, division, multiplication, etc.

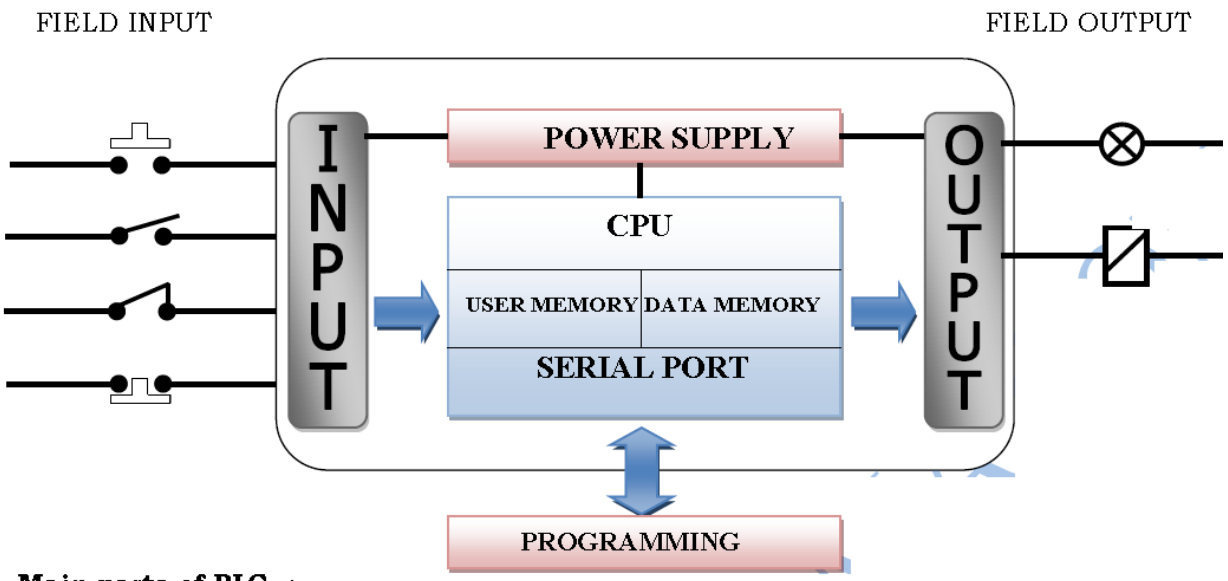
Different PLC languages:





Main parts of PLC: Input, Output, Memory, CPU, and Power supply.

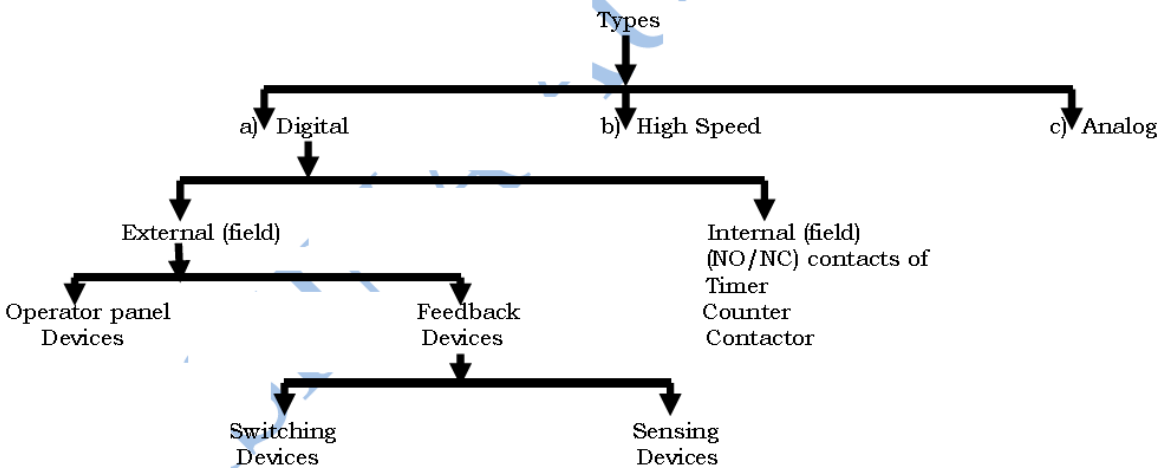
Block Diagram of PLC



Main parts of PLC : -

- Input
- Output
- Memory
- CPU
- Power supply

i)**Input** – input are basically controlling elements of output. There are three types of inputs.

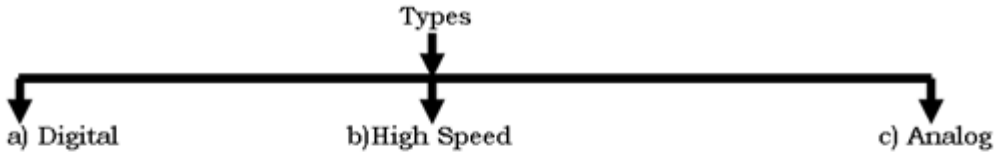


a) **Digital Input** – all discrete value signal input are known as digital input. Digital input having two states either 'OFF'(0) or 'ON'(1). All switching and sensing devices belongs to digital I/Ps. **Ex**: Start PB, Stop PB, Emg Stop, L/S, Pressure S/W, Float Switch, Proximity Sensors, Photo Electric sensors etc.

b) **High Speed Input** – these are similar to digital input only the difference is of switching frequency. If the switching frequency of input is increases to normal sequencly the input elements belongs to high speed input.

c) **Analog Input** – All types of value variable signals, continuous value signal elements or more than binary status known as analog input.
Ex – Transducer, thermocouple, Photo cell etc.

ii) **Output** – Output is the end of any function or instruction it is load type device.



a) **Digital Output** –All types of discrete value signal outputs are known as digital output.

b) **High Speed Output** – these are similar to digital but pulse frequency rate is higher.

c) **Analog Output** – All types of continuous value signal output belongs to analog output.

iii) **Memory** – memory is used for holding the data & backup of data. Memory is the space In software & it is made by memory registers.

- **Memory Capacity –** memory capacity depends on total quantity of registers & types of registers.
- **Memory bit –** It is the smallest unit of digital electronics memory bit having binary status means two either 0 or 1.
- **Memory Registers –** Memory registers are made by memory bits. These are also known as memory parameters.

Types of Memory Registers :–

- Nibble– 4 Bit register.
- Octal (byte) – 8 Bit register.
- Decimal – 10 Bit register
- Hex. Decimal – 16 Bit register

To start reading PLC ladder logic we need to know some basic **binary concepts**, how they apply to ladder logic, **how ladder logic is executed**, and the basic **logic functions** that are built into each rung. Let's begin

A microprocessor is an electronic device, and it understands only two things: on and off, Therefore, it uses the binary number system (0, 1), **because they represent two different voltages**.

Types of Memory :–

- RAM – Random Access Memory
  It is volatile in nature
- ROM – Read Only Memory
  It is Non – Volatile in nature
- EPROM – Erasable Programmable Read Only Memory For Removing the data EPROM Cassette has to be placed in front of ultra violet rays for 15 minutes, the complete data will be washed out. Data can't be changed at site for changing data EPROM Cassette has taken out from panel & carry it in any lab.
- EEPROM – Electrical Erasable Programmable Read Only Memory It is micro chip already fixed in card the editing will be done at sight. Its speed is high.
- FLASH PROM – Its Speed is faster than EEPROM.

CPU – Central Processing Unit (CPU)

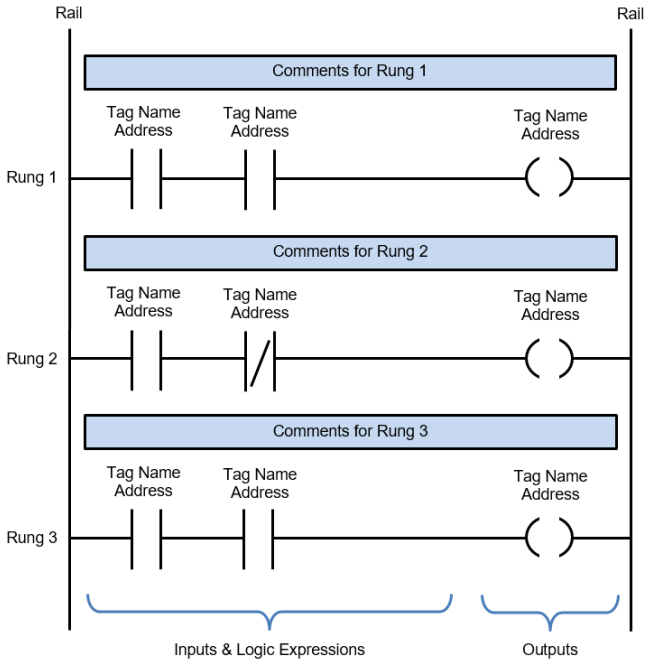
Microprocessor based, may allow arithmetic operations, logic operators, block memory moves, computer interface, local area network, functions, etc. CPU makes a great number of check-ups of the PLC controller itself so eventual errors would be discovered early.CPU replaces contactors, timers, counters or RLC by software.

Power supply -

Most PLC controllers work either at 24 VDC or 220 VAC. Some PLC controllers have electrical supply as a separate module, while small and medium series already contain the supply module. Power supply is used for supplying the diff. supply voltages to diff. PLC sections.

Ladder logic is the most popular method of PLC programming because it has an easy-to-use graphics-based interface and the programming language resembles an electrical schematic drawing. Engineers, electricians, and students find the transition from an electric circuit to ladder logic relatively easy. Compared to text-based programming languages, ladder logic programming is a lot easier to use.

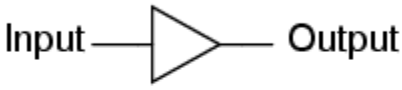
A ladder diagram is the symbolic representation of the control logic used for the programming of a PLC. Ladder diagrams have horizontal lines of control logic called rungs and vertical lines at the start and end of each rung called rails. It looks just like a ladder, hence the name "ladder diagram"



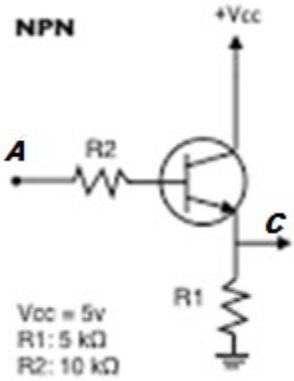
Logic gates with RLC and PLC

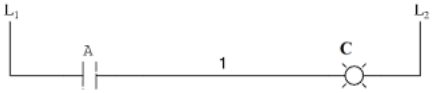
Buffer Gate:

"Buffer" gate



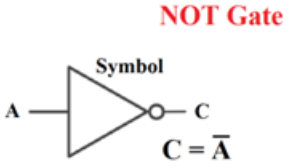
Input	Output
0	0
1	1





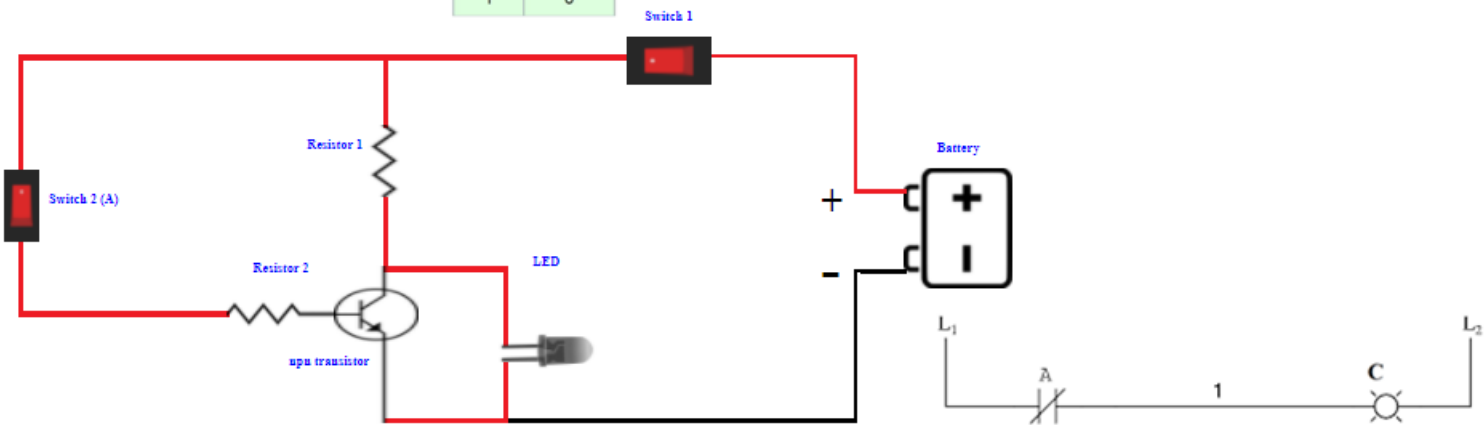
PLC

NOT GATE:



Truth Table

INPUT	OUTPUT
A	NOT A
0	1
1	0

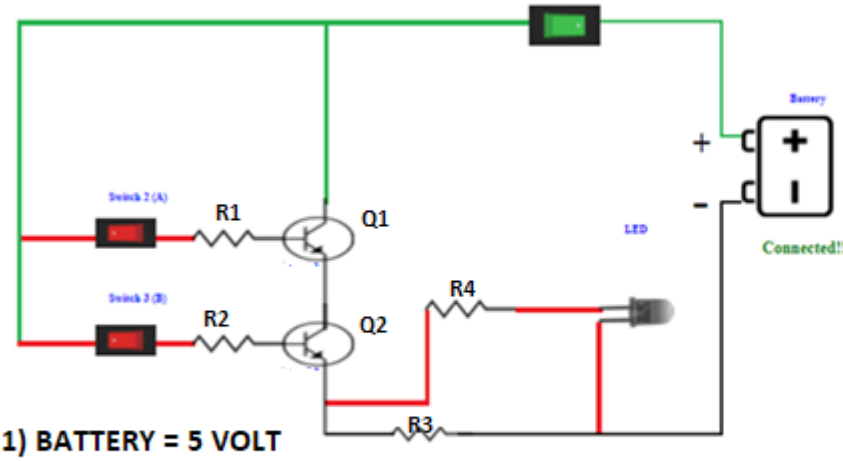


RLC CIRCUIT

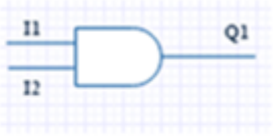
PLC

1) BATTERY = 5 VOLT
2) RESISTOR - R1= 1 Kohm
3) RESISTOR - R2 = 10 Kohm
4) TRANSISTOR Q1 & Q2 = NPN 2N3904

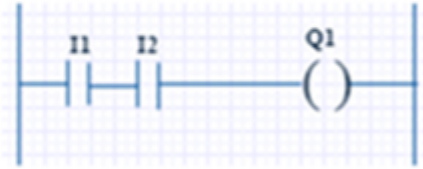
And Gate:



Inputs		Output
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1



Symbol And gate

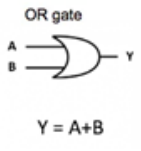


PLC Ladder diagram

1) BATTERY = 5 VOLT
2) RESISTOR - R1 & R2 = 5 Kohm
3) RESISTOR - R3 & R4 = 10 Kohm
4) TRANSISTOR Q1 & Q2 = NPN 2N3904

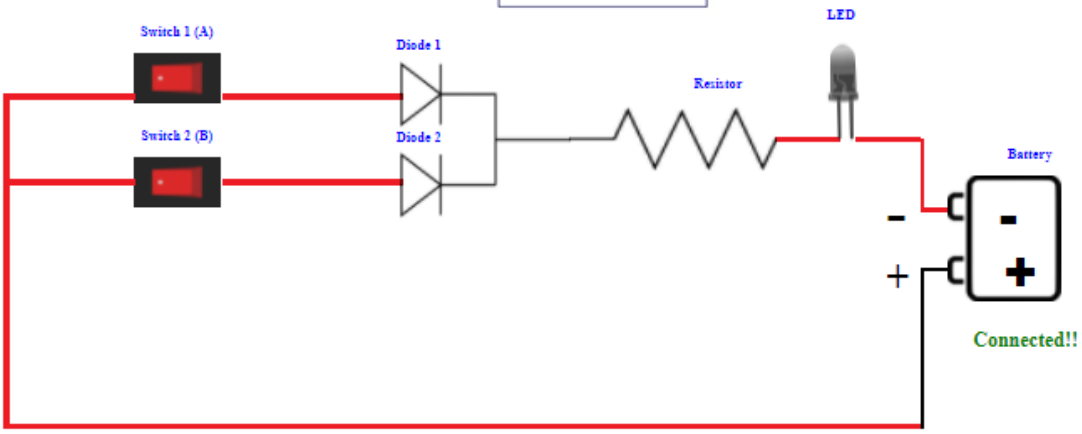
RLC CIRCUIT

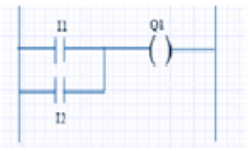
OR GATE:



OR gate

Input A	Input B	Output
0	0	0
1	0	1
0	1	1
1	1	1





PLC Ladder diagram

RLC CIRCUIT

1) BATTERY = 5 VOLT
2) RESISTOR = 1 KOHM
3) DIODE D1 D2 = 1N4007

NAND GATE:

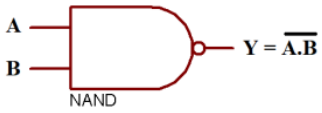
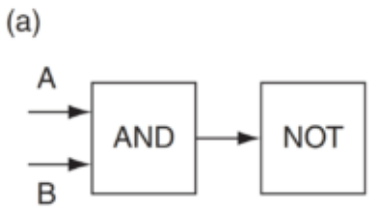
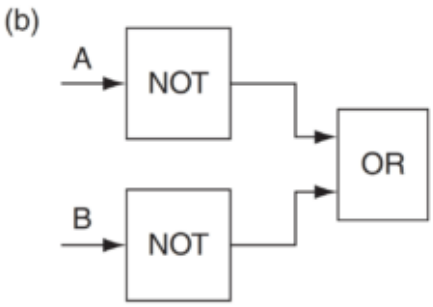
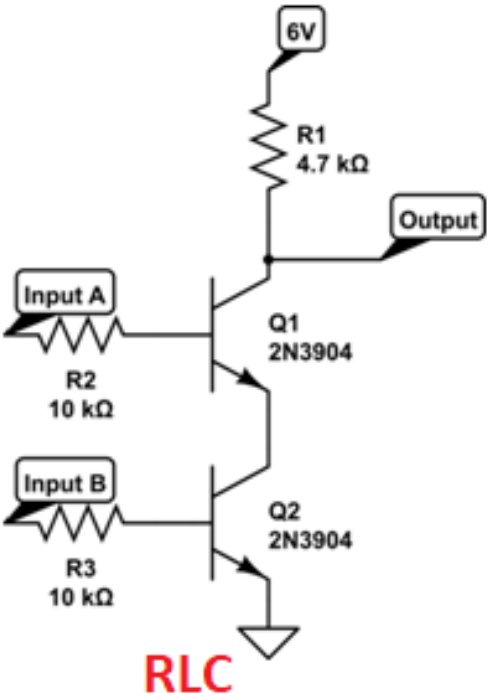


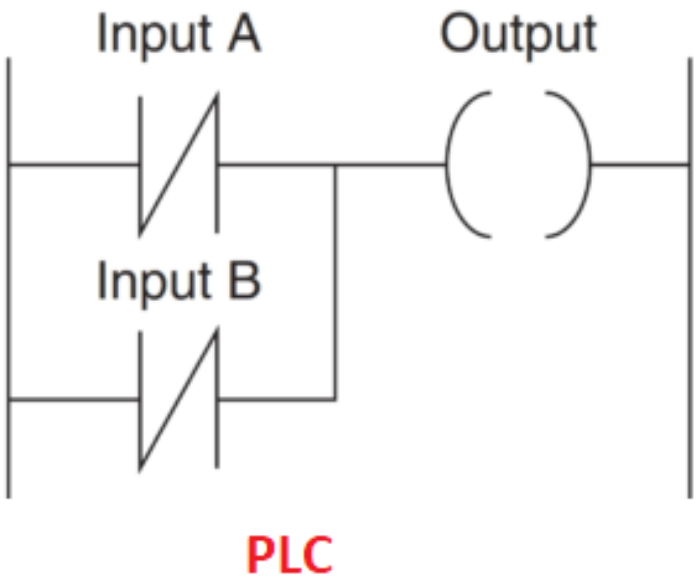
Figure 1.12: NAND gate



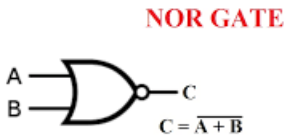


Inputs		Output
A	B	
0	0	1
0	1	1
1	0	1
1	1	0



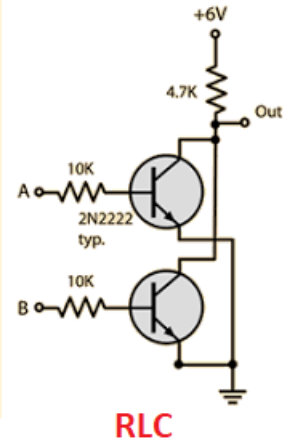


NOR GATE:



TRUTH TABLE

INPUT		OUTPUT
A	B	A NOR B
0	0	1
0	1	0
1	0	0
1	1	0



RLC

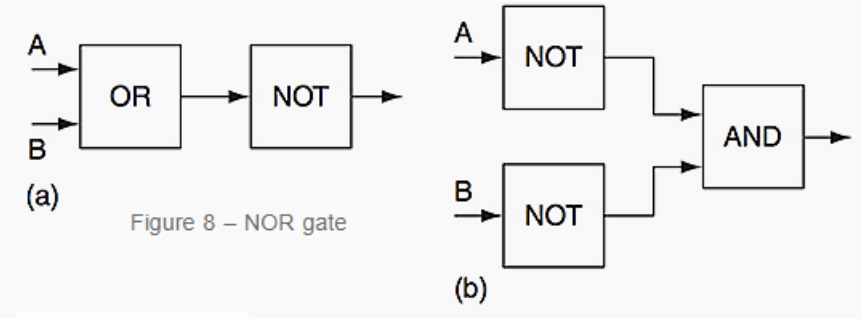
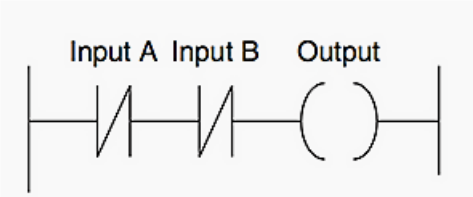
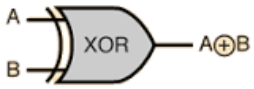


Figure 8 – NOR gate

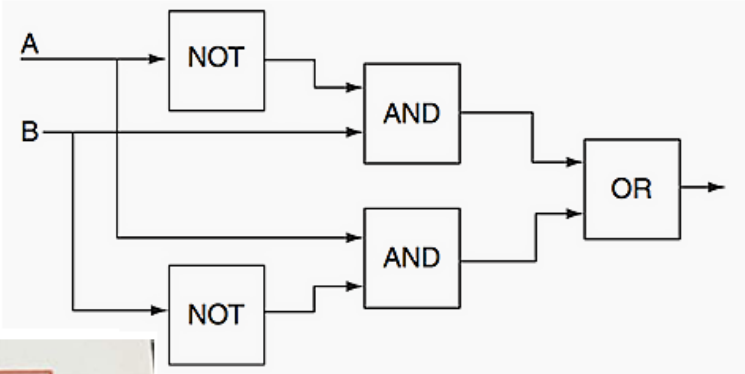


PLC

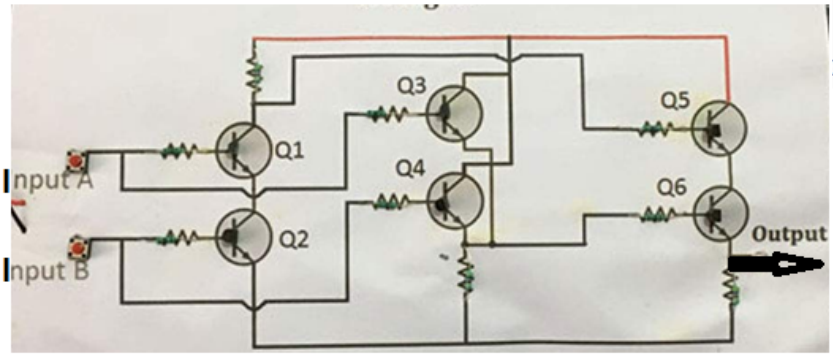
XOR GATE:

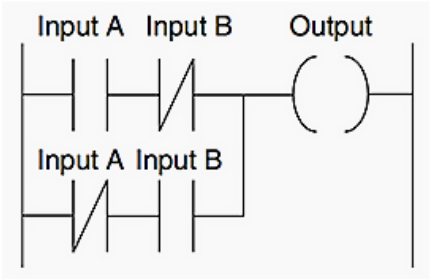


A	B	Out
0	0	0
0	1	1
1	0	1
1	1	0

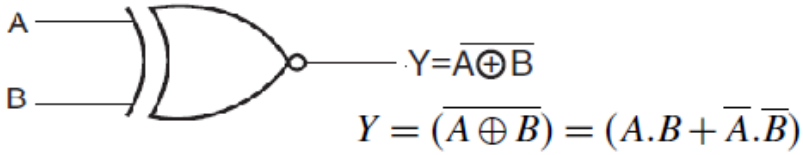


OR gate



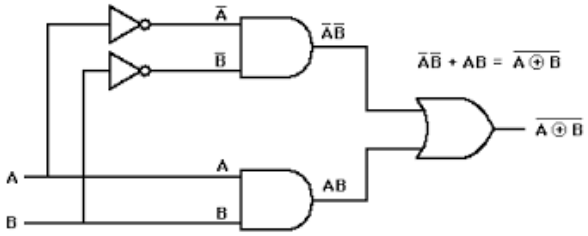


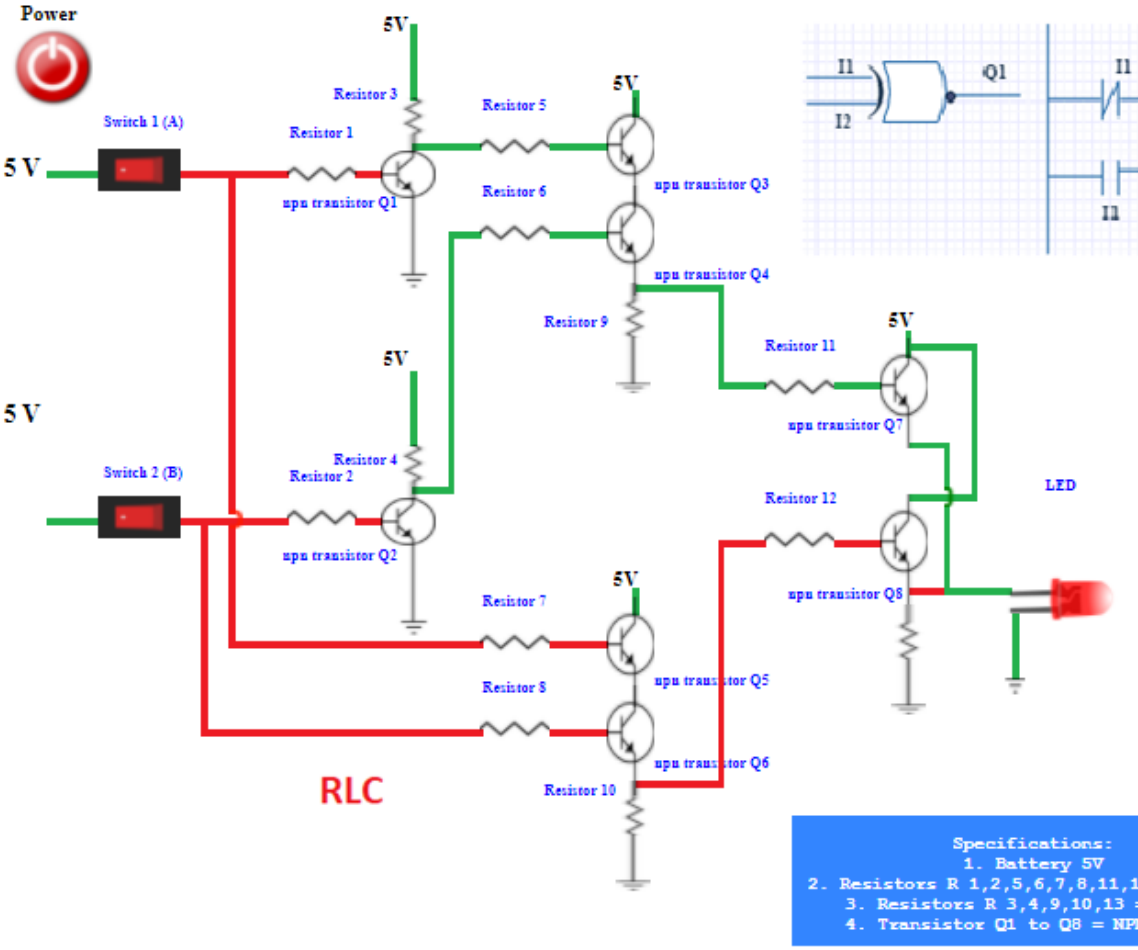
XNOR GATE:



$$Y = (\overline{A \oplus B}) = (A.B + \overline{A}.\overline{B})$$

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

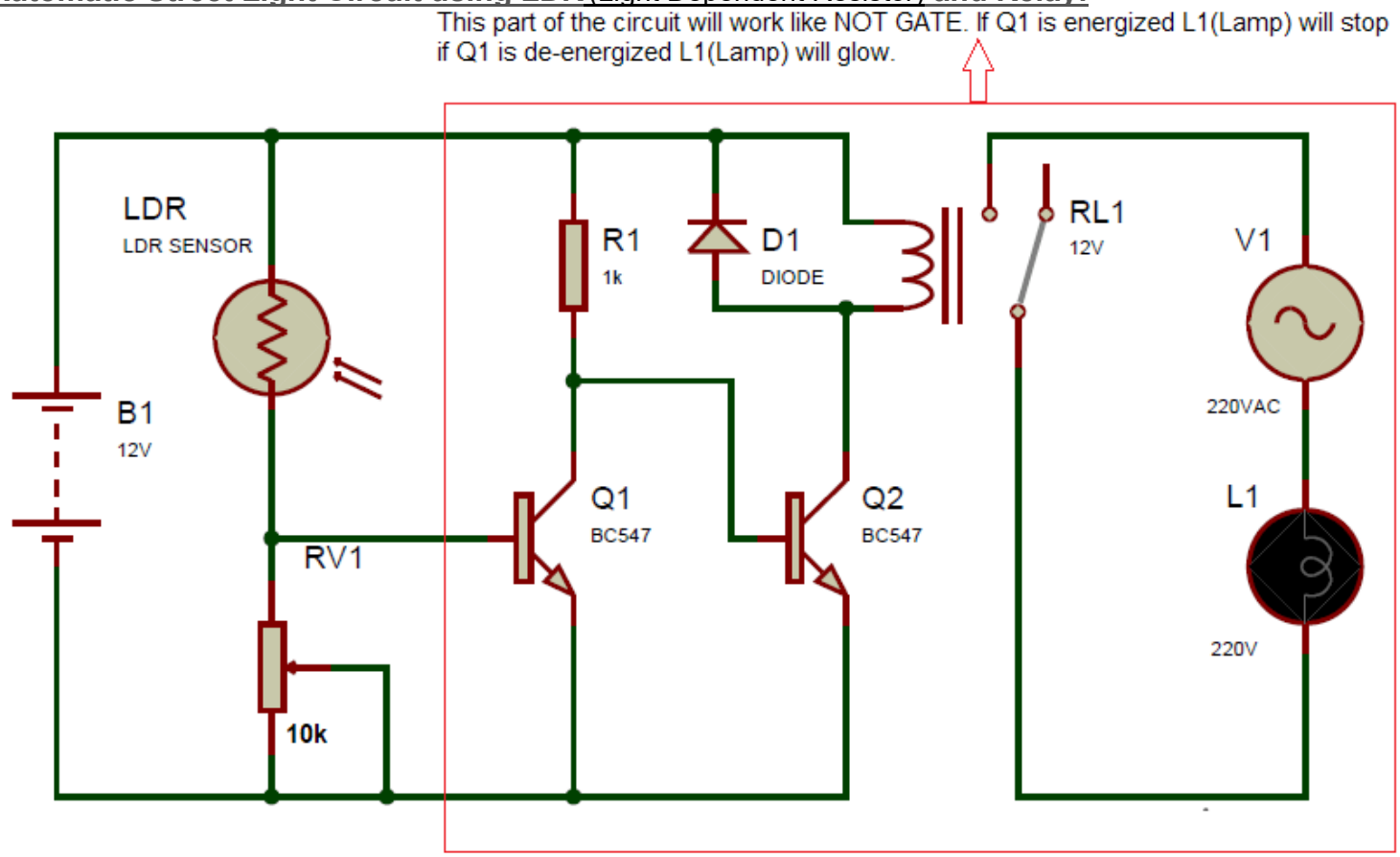




Specifications:
1. Battery 5V
2. Resistors R 1,2,5,6,7,8,11,12 = 10 Kohm
3. Resistors R 3,4,9,10,13 = 5 Kohm
4. Transistor Q1 to Q8 = NPN 2N3904

Example :1

Automatic Street Light Circuit using LDR (Light Dependent Resistor) and Relay:



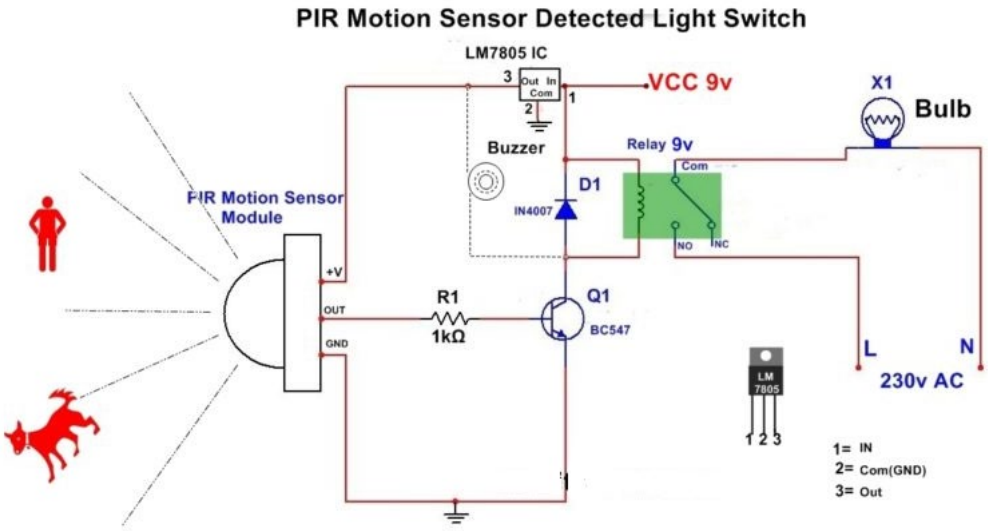
In this project, we have used an **LDR (Light Dependent Resistor)** which is responsible for detecting light and darkness. The resistance of LDR increases in darkness and reduces in presence of light. This circuit is same as a Dark Detector or Light Detector Circuit, only here we have replaced simple LED with a AC load, using a Relay. Two BC547 NPN transistors are used to drive the relay.

Whenever light falls over LDR its resistance get decreased and transistor Q1 turns ON and collector of this transistor goes LOW, and this makes the second transistor turns OFF due to getting a LOW signal at its base, so relay also remain turned OFF due to second transistor.

Now **whenever LDR senses Darkness,** mean no light, then transistor Q1 turned ON due to increase in the resistance of LDR which is responsible for voltage drop at the base of Q1. Due to a LOW signal at the Q1 base, Q2 transistor gets a HIGH signal from the collector of Q1 and turns ON the relay. Relay turned ON the AC load that is connected to relay. A 10K pot (variable resistor) is also used for setting up the sensitivity of the circuit.

Example :2

Automatic light and Automatic Security Alarm Circuit using PIR Motion sensor:



In This Circuit PIR (Passive infrared) Motion Sensor Is used as a motion Detector. When Any Person, Animal Or Any Object Comes In The Range of the sensor. then Automatic Light Switched on. This Can Also used in Automatic Room Light, When Any Person Enter in The Room Then Light Automatic Turn on.

• Use 9v DC to operate this circuit But Make sure that Sensor is Required only **5v dc** so use a 5v voltage regulator LM7805.

• The Vcc pin of Sensor Is Connected with 5v Dc, Ground Pin Is connected With Negative DC Supply And Output Of Sensor Is Connected With BASE Of NPN Transistor (Here BC547 Is used).

• Use a 9v Relay For connecting any Light And Make the Circuit As Relay Get supply 9v And Rest Part of Circuit Get 5v.

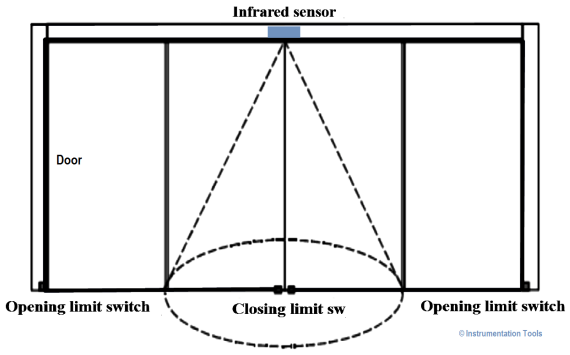
• If There is No Any Movement Or Motion Occur, Then Sensor Give LOW output And Transistor Is Turned Off Because There is No Any Input Of BASE terminal. When any Motion/Movement Occur, Then It Detects by Sensor And Its Output Is High. Because The Output Is HIGH, The Transistor Gets High input at the BASE and it Turns ON and Relay is activated. As Relay is activated the Light connected with this will Switched ON.

Example :3

PLC Automatic Door Control System

Problem Description: Implement logic for the automatic door open & close system in PLC using ladder diagram programming language.

Problem Diagram



Problem Solution

- We will use PLC S7-300 for this application. Also we will use TIA portal software for programming.
- In this system when someone enters the infrared sensing field, opening motor starts working to open the door automatically till the door touches the door opening limit switch.
- If the door touches the opening limit switch for 8sec and no body enters the sensing field/area, then closing motor starts to close the door automatically till the door touches the closing limit switch.
- Stop the closing action immediately if someone enters the sensing field during the door closing process.

List of inputs/outputs

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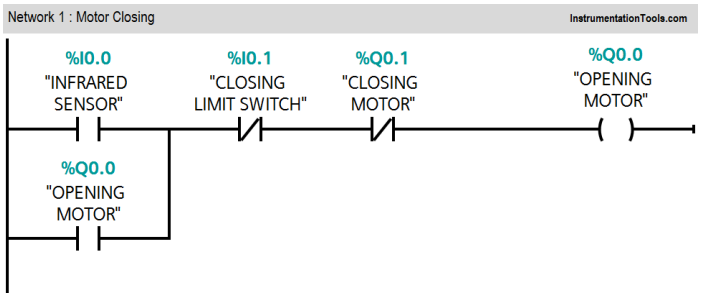
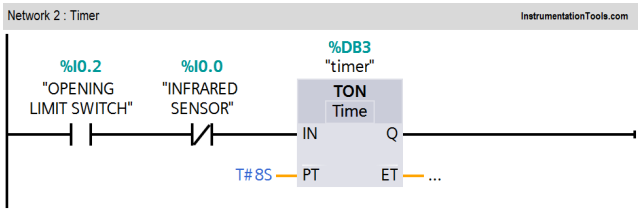
- Infrared sensor :- I0.0
- Closing limit switch :- I0.1
- Opening limit switch :- I0.2

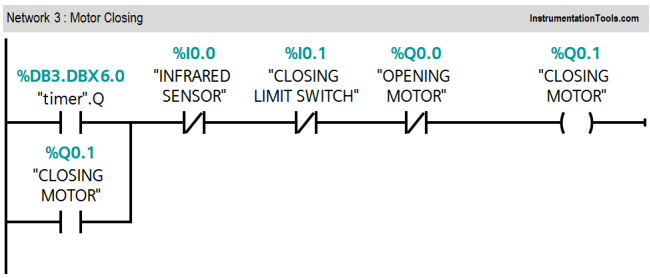
List of outputs

- Opening motor :- Q0.0
- Closing motor :- Q0.1

PLC Ladder diagram for Automatic Door Control System







Program Description

For this application we used S7-300 PLC and TIA portal software for programming.

Network 1 :-

When infrared sensor is detected (I0.0), door opening motor (Q0.0) will start. The door will be open. When it touches the close limit switch (I0.1), opening motor will be stop.

Network 2 :-

When the door touches the opening limit switch (I0.2), timer will be executed.

Network 3 :-

After 8sec time closing motor (Q0.1) will start. When it touches the closing limit switch, closing motor (Q0.1) will turn OFF.

Note :- Above application may be different from actual application. This example is only for explanation purpose only. We can implement this logic in other PLC also. This is the simple concept of automatic door open and close application.