KALINGA INSTITUTE OF INDUSTRIAL TECHNOLOGY
KIIT DEEMED TO BE UNIVERSITY, BHUBANESWAR,
ODISHA – 751024

A Laboratory Report

On

PLC laboratory

Submitted by

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List of Experiments:

SNO	Experiments
1	Introduction of plc and Industrial automation
2	Study hardware and software used in PLC
3	Study of plc field device
4	PLC Programming Using SPST Switch
5	PLC Programming Using SPDT Switch
6	Latching Concept Using PLC Programming
7	Implementation of On-OFF Delay Timer using PLC Programming
8	Implementation Of Up-Down Counter and Comparator using PLC Programming
9	PLC Programming for Bottle filling plant and Traffic System
10	PLC Programming for Garage shutter opening and closing,

Experiment1:

Aim: Introduction of plc and Industrial automation

WHAT IS AUTOMATION:

Automation is the act of making a system self regulating by using a control system where human interaction is very less.

- Higher productivity.
- Superior quality of end product.
- Efficient usage of energy and raw materials.
- Improved safety in working conditions.

HISTORY OF PROCESS CONTROL AND AUTOMATION

- Manual Control
- Hard Wired Logic Control
- Electronics Control Using Logic Gates
- Programmable Logic Controller

Manual Control:

All the action related to process control & automation is taken by the operators.

- Major drawback here is a human error.
  Which effect on quality of final product
- The hard wired control has its own limitations on mass production, so it cannot provide quality goods with an affordable price.
- The safety or efficient use of raw material is totally dependent on accuracy of human action.

Hard Wired Logic Control:

This is considered to be the first step towards automation.

Here contactor and relays together with timers and counters were used in achieving the desired level of automation.

This method served the tasks for many years, but still it had certain limitations as:

- Bulky and Complex wiring.
- Involves lot of rewiring to implement changes in control circuit.

ELECTRONIC CONTROL USING LOGIC GATES:

Here the digital logic gates replace the relays and contactors in the control circuits.
The mechanical timers are replaced by electronic timers etc.

So the benefits are:

- Reduced space.
- Energy saving.
- Less maintenance.
- Greater reliability.

ELECTRONIC CONTROL USING LOGIC GATES:

Even with this the changes in the control logic and reducing the project time was not possible.

But this method automation was popular for quite some time.

PROGRAMMABLE LOGIC CONTROLLER:

- With development of microprocessor the process of control and automation was totally changed.
- Instead of doing the control in physical wiring, using a PLC it is done by a program.
- Due to use of "program" it is called programmable logic controllers.

The programmable logic controllers nowadays are frequently used in every industrial automation

IMPORTANT ADVANTAGES OF PLC:

- REDUCED SPACE.
- ENERGY SAVING.
- EASY OF MAINTENANCE.ICAL.
- GREATER LIFE AND RELIABILITY.
- TREMENDOUS FLEXIBILITY.
- HIGHLY AUTOMATED SYSTEM
-

REDUCED SPACE:

PLC'S are fully solid state device and hence extremely compact as compared to hardwired control where electromechanical devices are used.

ENERGY SAVING:

Average power consumption is just $1/10^{th}$ of power consumed by an equivalent relay logic control.

EASY OF MAINTENANCE:

- Modular replacement.
- Easy trouble shooting.
- Error diagnostics with programmer.

ECONOMICAL:

- Cost of plc recovers within a short period (low pay back period).
- Considering one time investment plc is most economical system.

GREATER LIFE AND RELIABILITY:

- Static devices hence lesser number of moving parts which reduces wears and tears.

TREMENDOUS FLEXIBILITY:

- To implement changes in control logic no rewiring is required so considerable time is saved.

Plc can carry out complex function such as generation of time delay, counting, comparing arithmetic operations

TREMENDOUS FLEXIBILITY:

- ONLINE" as well as "OFFLINE" programming is possible.

- High processing speed and greater flexibility in the processing of both analog and digital signals.

WHY INDUSTRIAL AUTOMATION:

- Today all production units are looking towards more production by utilizing their existing assets and man power.
- This can happen when one can effectively utilize his present existence with modern facilities.
- Which can be easily achieved by implementing automation process in the Industry

AUTOMATION APPLICATION:

- **Power generation :-Hydro, coal, gas, oil, shale, nuclear, wind, solar**
- **Transmission :- electricity, gas, oil**
- **Distribution :- Electricity, water**
- **Process :- Paper, food, pharmaceutical, metal, processing, glass, cement, chemical, refinery, oil & gas**
- **Manufacturing :- Computer aided manufacturing ,(CAM), flexible fabrication, appliances, automotive, aircrafts**
- **Building :- Heat, ventilation, air conditioning (HVAC), access control, fire, energy supply, tunnels, highways**
- **Transportation :-Rolling stock, street cars, sub- urban trains, busses, cars, ships, airplanes, satellites**

- **Manufacturing Automation**
  - Car manufacturing
  - Bottling systems
  - Storage systems
- **Building Automation**
  - Heating, air-conditioning
- **Process Automation**
  - Purification plants
  - Chemical and petrochemical plants
  - Paper and textile industries
- **Power industry and power distribution**
  - Power plants
  - Switchgear

WHAT IS A CONTROL?

Control means to make an output ON or OFF by help of Controlling Devices like simple toggle switch to a complex system with components such as relays, timers, and switches.

TYPES OF CONTROL:

(1) On-Off control
(2) Sequential control
(3) Feedback control
(4) Motion control

Experiment2:

Aim: Study hardware and software used in PLC

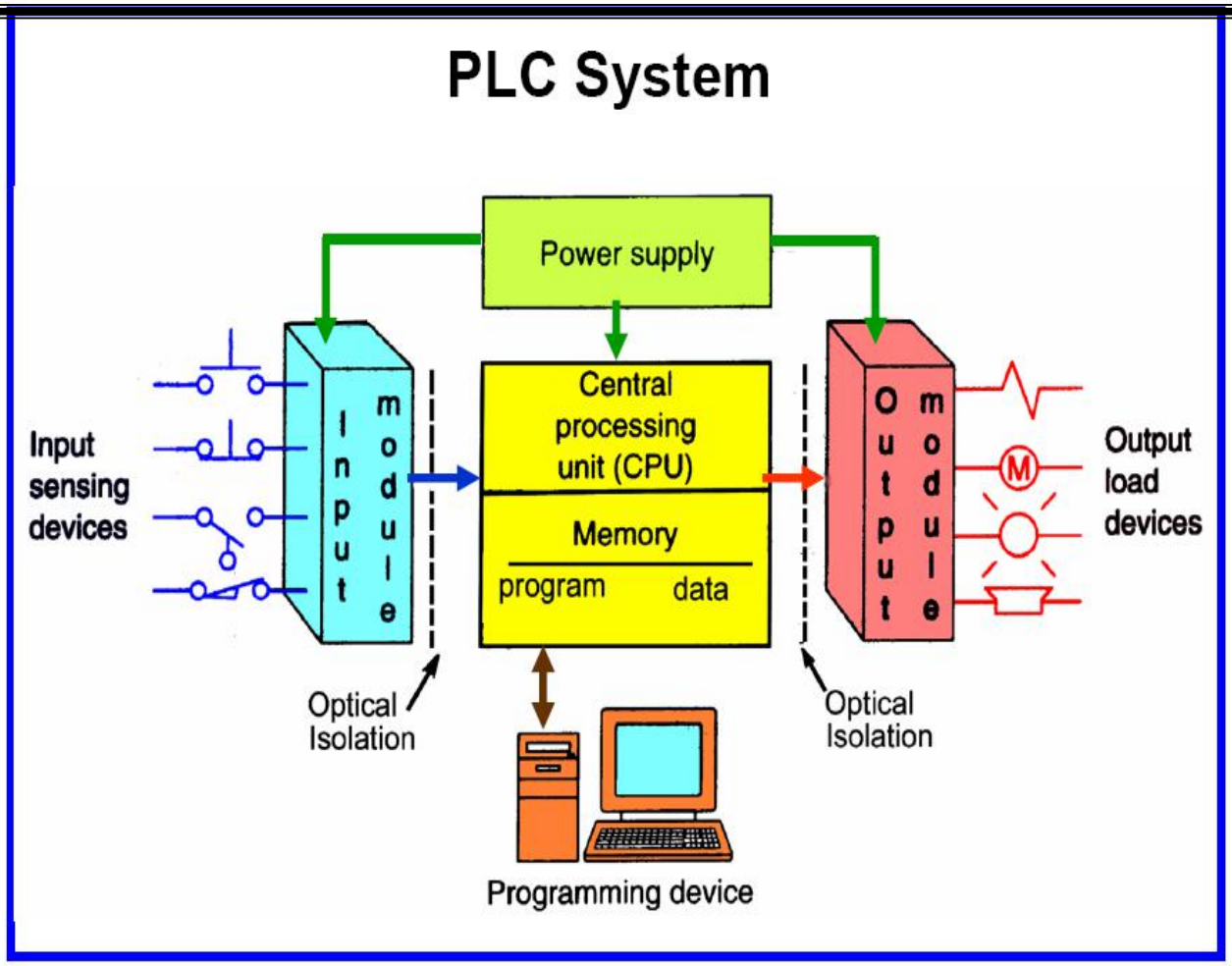
OBJECTIVES: Simulator kit (Simatic manager) introduction will help students to understand the basic information of PLC (S7-1200). Further students can perform well with all hardware and software information.

THEORY:

- A Programmable Logic Controller (PLC for short) is simply a special computer device used for industrial control systems.

- They are used in many industries such as oil refineries, manufacturing lines, conveyor systems and so on.

- Where ever there is a need to control devices, the PLC provides a flexible way to "soft wire" the components together.



COMPONENT OF PLC

POWER SUPPLY MODULE
CENTRAL PROCESSING UNIT(CPU) MODULE
SIGNAL MODULE
INTERFACE MODULE
PROGRAMMING DEVICE

POWER SUPPLY MODULE: Provides the voltage needed to run the primary PLC components like CPU module, DI/DO Module and AI/AO module.

CPU MODULE: CPU Module controls the Input module to give the required output throughout put module as per the down loaded programme written by the Programmable Device.

SIGNAL MODULES: SIGNAL MODULES ARE OF TWO TYPES:-

1) INPUT SIGNAL MODULE.

2) OUTPUT SIGNAL MODULE.

INTERFACE MODULE: Interface Module is use for communicating PLC with other physical devices. May be another PLC or may be any industrial load like Drive.

WHAT IS A PLC?

- A Programmable Logic Controller (PLC for short) is simply a special computer device used for industrial control systems.

- They are used in many industries such as oil refineries, manufacturing lines, conveyor systems and so on.

- Where ever there is a need to control devices, the PLC provides a flexible way to "soft wire" the components together**.**

HISTORY OF A PLC:

- The PLC was invented in response to the needs of the American automotive industry
- Before the PLC was developed in automobiles manufacturing industries relays, timers, contactors are used for control and safety interlock logic.
- The process for updating such facilities was very time consuming and expensive, as the relay systems needed to be rewired by skilled electricians.

PLC AVAILABLE IN THE MARKET:

Well known PLC brands are:-

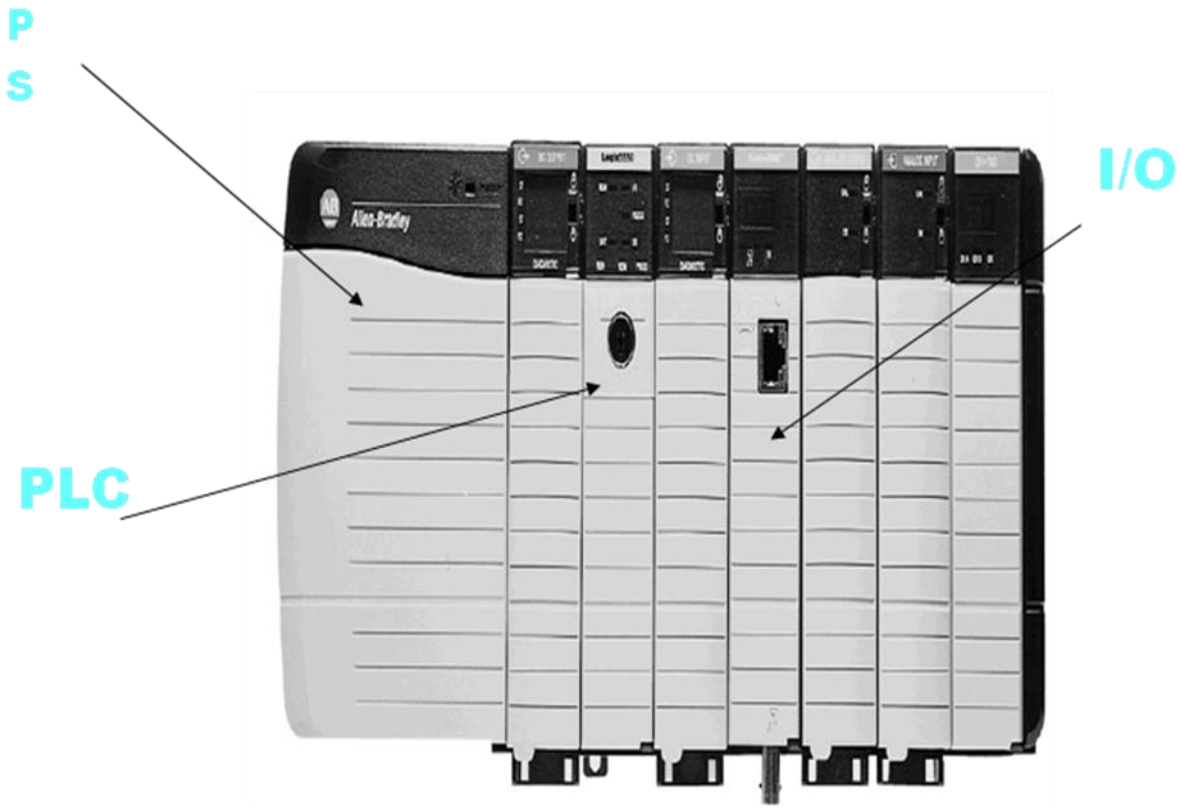
- ABB Ltd.
- Koyo
- Honeywell
- Siemens
- Modicon
- Omron
- Allen-Bradley
- General Electric
- Mitsubishi

DIFFERENT PLCS:

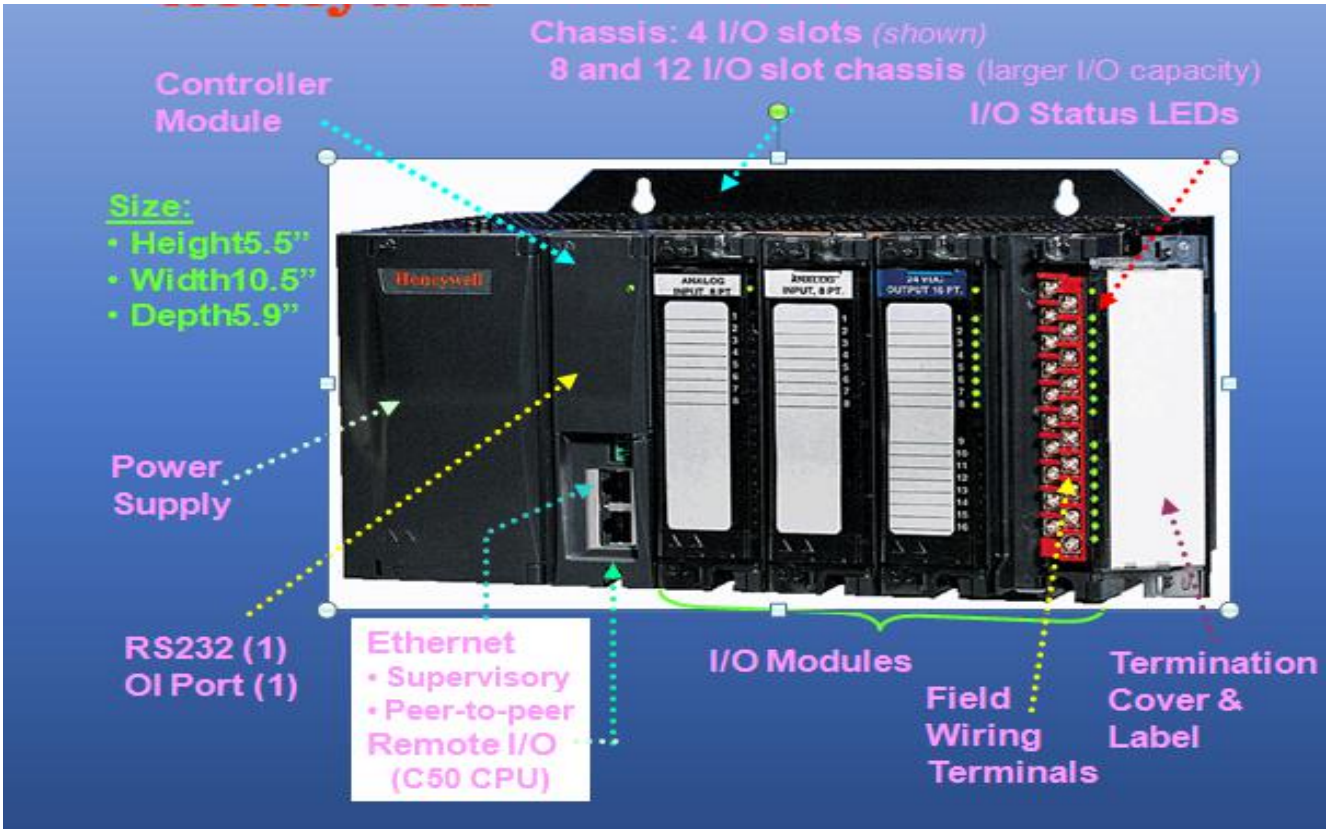
Siemens'

Schneider's

Allen Bradley:


P
S
I/O
PLC

Honeywell


Chassis: 4 I/O slots (shown)
8 and 12 I/O slot chassis (larger I/O capacity)
Controller Module
I/O Status LEDs
Size:
• Height5.5"
• Width10.5"
• Depth5.9"
Power Supply
RS232 (1)
OI Port (1)
Ethernet
• Supervisory
• Peer-to-peer
Remote I/O
(C50 CPU)
I/O Modules
Field Wiring Terminals
Termination Cover & Label

ABB

SOFTWARES OF PLCS:

PLCS	***SOFTWARES***
SIEMENS	*SIMATIC MANAGER*
MITSUBISHI	GX DEVELOPER
ABB	CONTROL BUILDER
ALLEN BRADLEY	RS VIEW
GEFANUC	SIMPLICITY, VISA PRO
MODICON	CONCEPT
WANDER WAVE	IN TOUCH.
INTELLUTION	FIX 32
SCHNEDIER	PL7, UNITY
WAGO	WAGO-IO-PRO

Experiment3:

Aim: Study of plc field device

OBJECTIVES: To Study the hardware field device it will help to understand the automated hardwire logic Circuit.

THEORY:

SWITCHES AND PUSH BUTTONS
CONTACTORS
RELAYS
TIMERS
SENSORS

SWITCHES AND PUSH BUTTONS: A switch is a device that connects or disconnects a circuit.
CLASSIFICATION

According to number of poles and throws
According to mode of operation
According to construction

Types of Switch and their Symbol:

ON-OFF

Single Pole, Single Throw = SPST

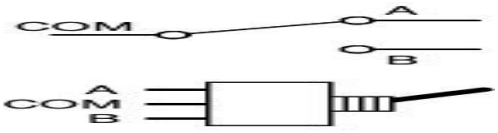
Simple on-off switch. This type can be used to switch the power supply to a circuit. When used with mains electricity this type of switch *must* be in the live wire, but it is better to use a DPST switch to isolate both live and neutral.

SPST toggle switch

ON-ON

Single Pole, Double Throw = SPDT

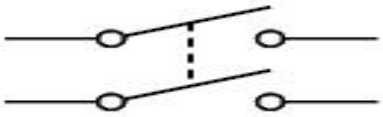
This switch can be on in both positions, switching on a separate device in each case. It is often called a changeover switch. For example, a SPDT switch can be used to switch on a red lamp in one position and a green lamp in the other position



Dual ON-OFF

Double Pole, Single Throw = DPST

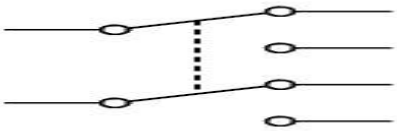
A pair of on-off switches which operate together (shown by the dotted line in the circuit symbol) A DPST switch is often used to switch mains electricity because it can isolate both the live and neutral connections.



Dual ON-ON

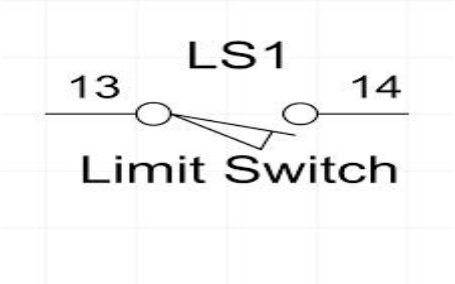
Double Pole, Double Throw = DPDT

A pair of on-on switches which operate together (shown by the dotted line in the circuit symbol) A DPDT switch can be wired up as a reversing switch for a motor as shown in the diagram.



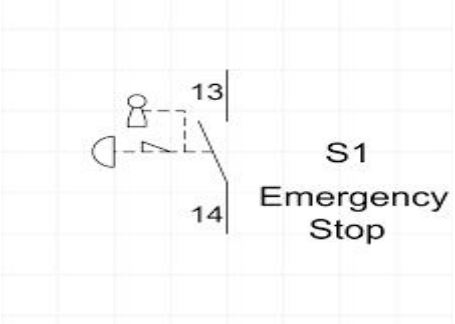
LIMIT Switch

The limit switch then regulates the electrical circuit that controls the machine and its moving parts. These switches can be used as pilot devices for magnetic starter control circuits, allowing them to start, stop, slow down, or accelerate the functions of an electric motor.



Emergency Switch

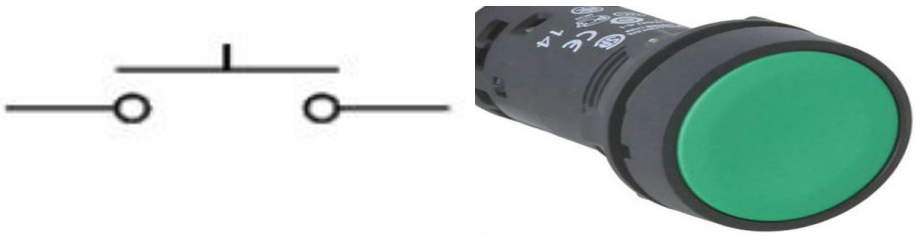
When using emergency stop buttons and kill switches, are they designed in such a manner in which their role is more physical, such as interrupting a power supply (apparently in some of the models, like the one pictured, the button has to be turned before operation can resume), or are they just basic big red pushbutton



(ON)-OFF

Push-to-make = SPST Momentary

A push-to-make switch returns to its normally open (off) position when you release the button, this is shown by the brackets around ON. This is the standard doorbell switch



ON-(OFF)

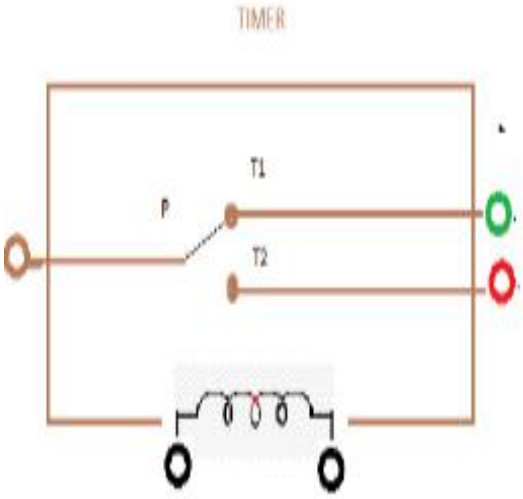
Push-to-break = SPST Momentary

A push-to-break switch returns to its normally closed (on) position when you release the button

Timer

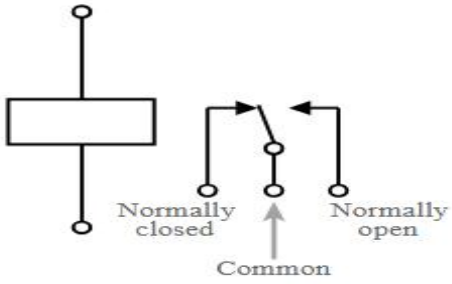
PLC timers are instructions that provide the same functions as on-delay and off-delay mechanical and electronic timing relays. A PLC timer provides a preset delay to the control

A timer is a specialized type of clock used for measuring specific time intervals. Timers can be categorized into two main types. A timer which counts upwards from zero for measuring elapsed time is often called a stopwatch, while a device which counts down from a specified time interval is more usually called a timer.



Relay

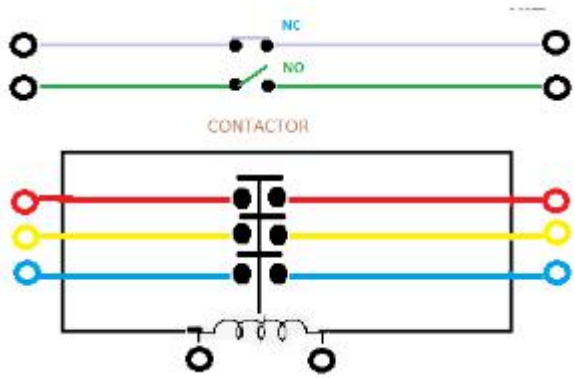
Relays are switches that open and close circuits electromechanically or electronically. Relays control one electrical circuit by opening and closing contacts in another circuit. As relay diagrams show, when a relay contact is normally open (NO), there is an open contact when the relay is not energized.



Circuit symbol of a relay

Contactor

When a relay is used to switch a large amount of electrical power through its contacts, it is designated by a special name: contactor. Contactors typically have multiple contacts, and those contacts are usually (but not always) normally-open, so that power to the load is shut off when the coil is de-energized



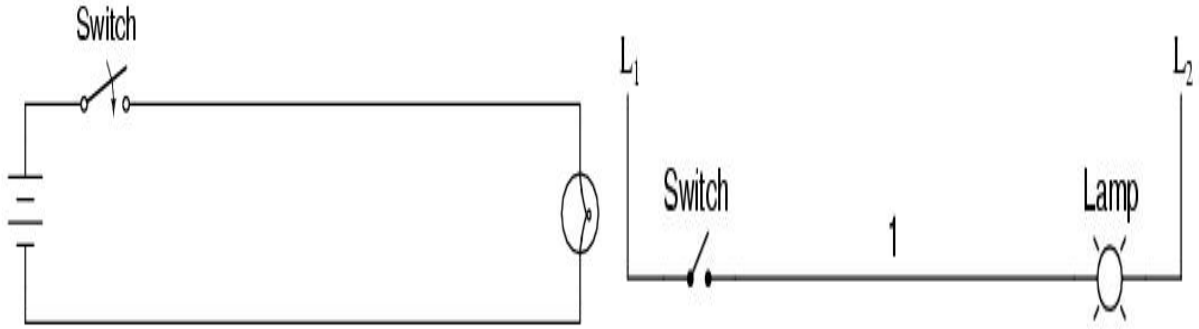
Experiment4:

Aim: PLC Programming Using SPST Switch

OBJECTIVES: To Draw the Single line diagram this will help to understand the ladder programming.

THEORY:

One line diagram is the representation of a Electrical Circuit using the simple symbol for each component



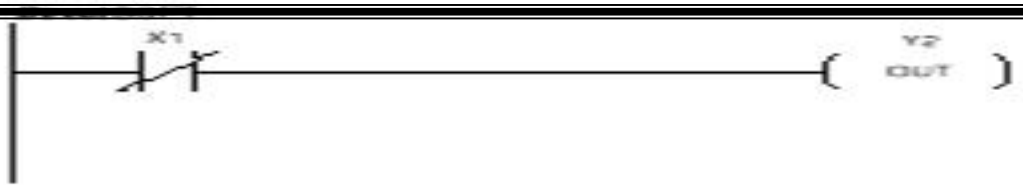
Normally opened contact:

A normally opened contact "energizes" or turns on the rung when the input is on. For example in the following:

Y2 will turn on when X1 is sensed to be on by the PLC.

Normally closed contact:

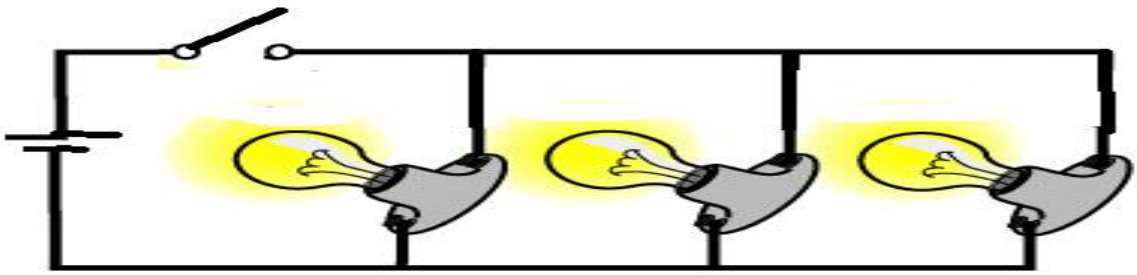
A normally closed contact works just the opposite of a normally opened contact. In this example:



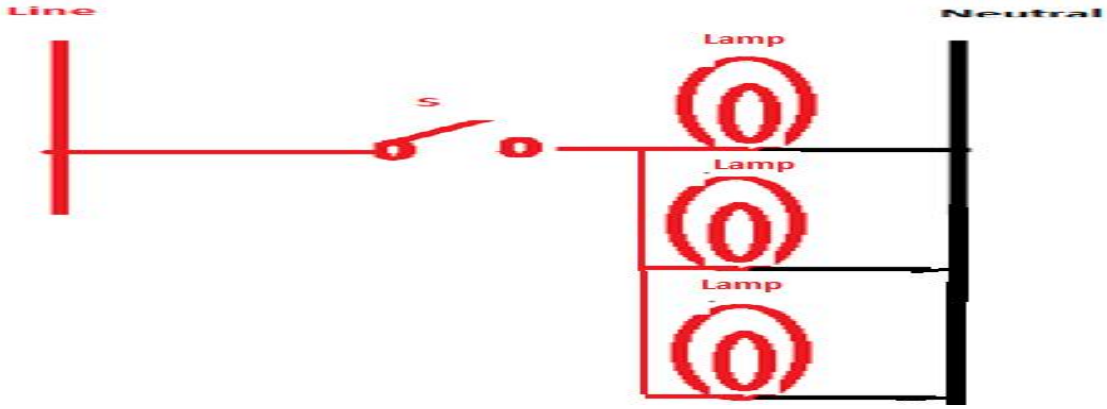
Y2 will go on when X1 is sensed to be off.

1. Electrical Schematic diagram to Ladder logic

Parallel load Connected:

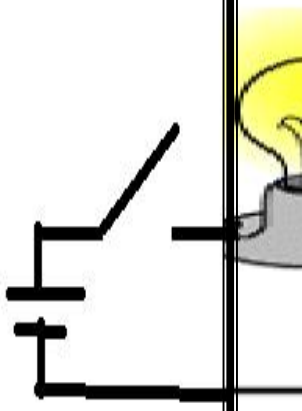


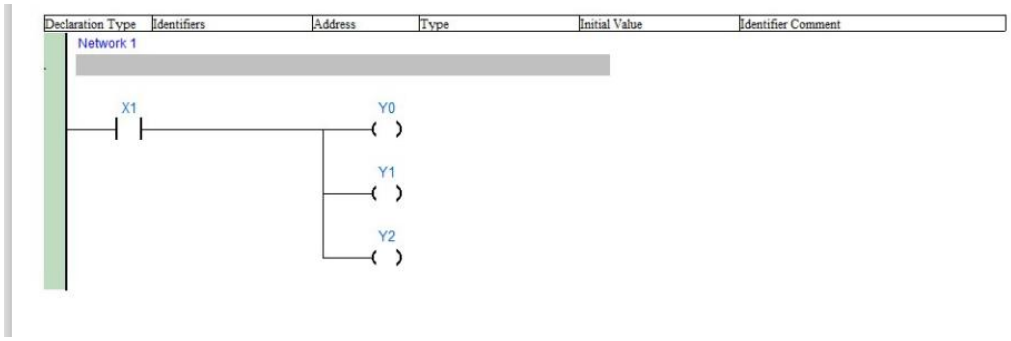
Solution



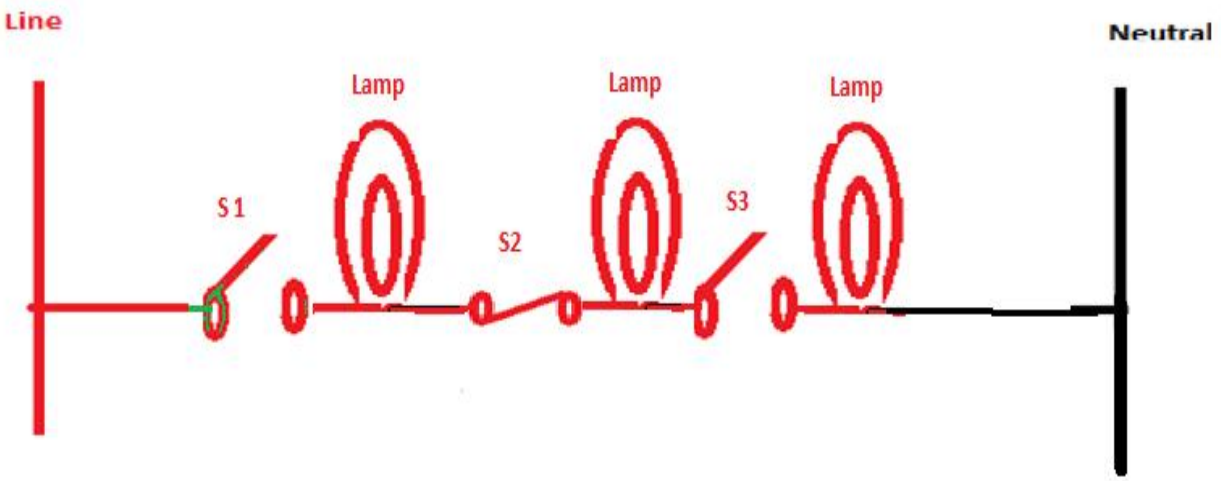
Ladder diagram in Delta PLC:

Series load Connected:

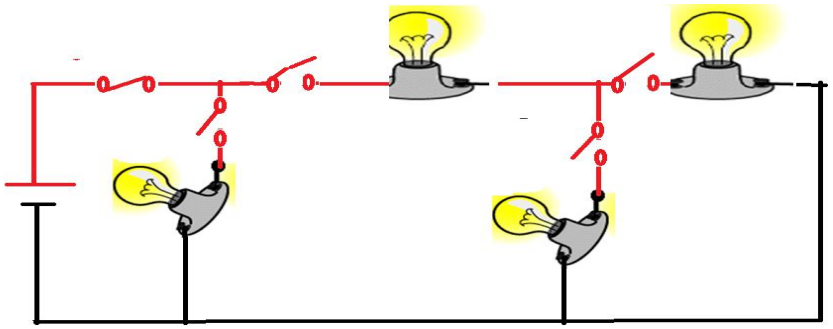




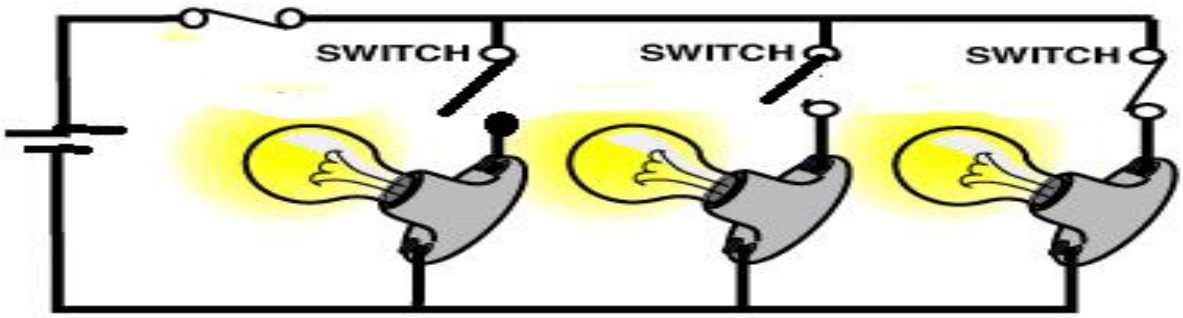
Solution



Question: (1)

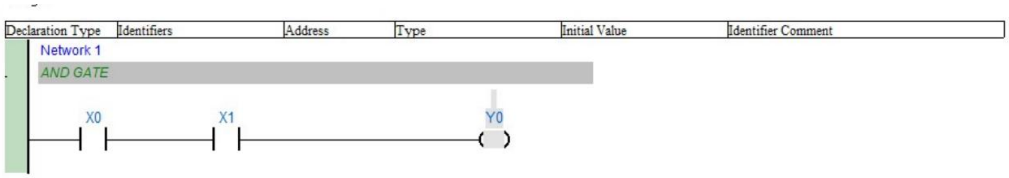


(2)

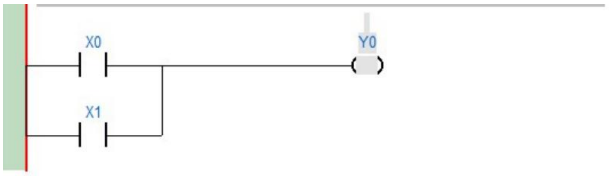


2. Ladder programming for logic gates in **DELTA PLC** Software.

AND gate

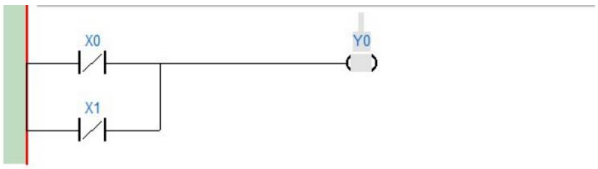


OR gate



NOT gate

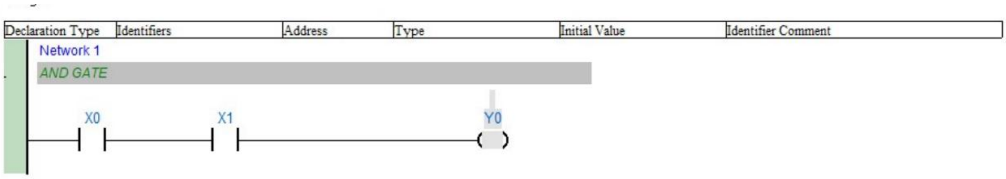
NAND gate



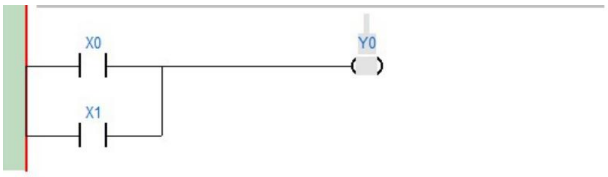
NOR gate

3. Draw an one line diagram (OLD) such that when a toggle switch(S1) is made ON a lamp L gets ON and when the same toggle switch (S1) is made OFF, the lamp (L) gets OFF.

4. Draw a one line diagram by using two Toggle Switch (S1 and S2) such that when both the Toggle Switches are made ON a Lamp (L) gets ON and when any of the Toggle Switch is made OFF the lamp (L) gets OFF.



5. Draw a one line diagram by using two toggle Switches (S1 and S2) such that : When S1 and S2 are made OFF Lamp (L) also remains OFF. But when S1 is made ON and S2 is made OFF Lamp (L) gets ON. Also when S1 is made OFF and S2 is made ON Lamp (L) gets ON.



Experiment5:

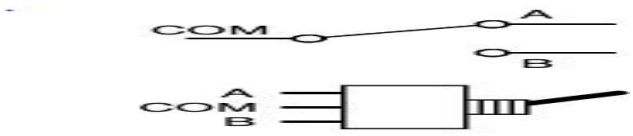
Aim: PLC Programming Using SPST Switch

OBJECTIVES: To write the ladder programming for SPDT Switch for better understanding of NO/NC Contact of PLC

Theory: ON-ON

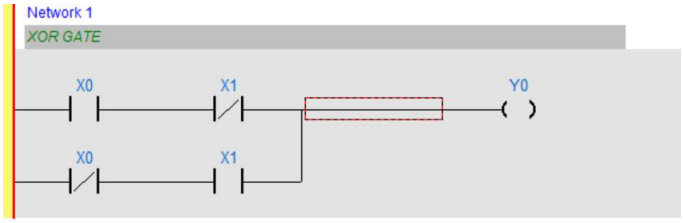
Single Pole, Double Throw = SPDT

This switch can be on in both positions, switching on a separate device in each case. It is often called a changeover switch. For example, a SPDT switch can be used to switch on a red lamp in one position and a green lamp in the other position

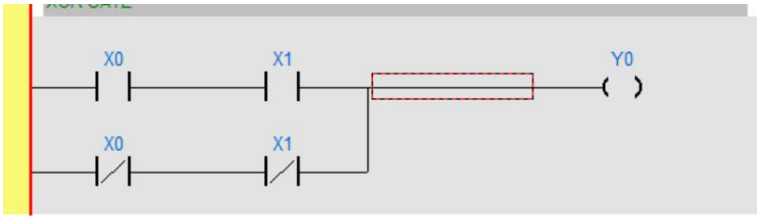


PLC Programming Using SPDT Switch:

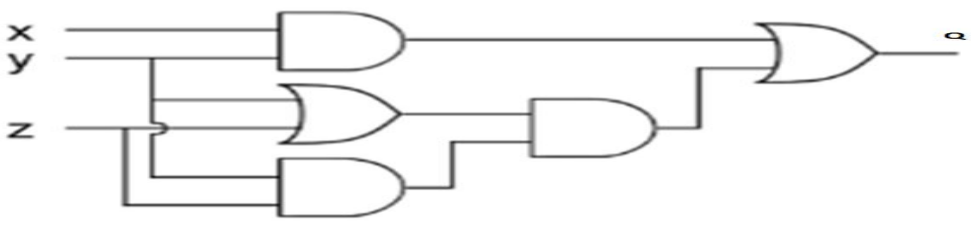
1. Ladder programming for logic gates
   - ➢ *ExOR gate*



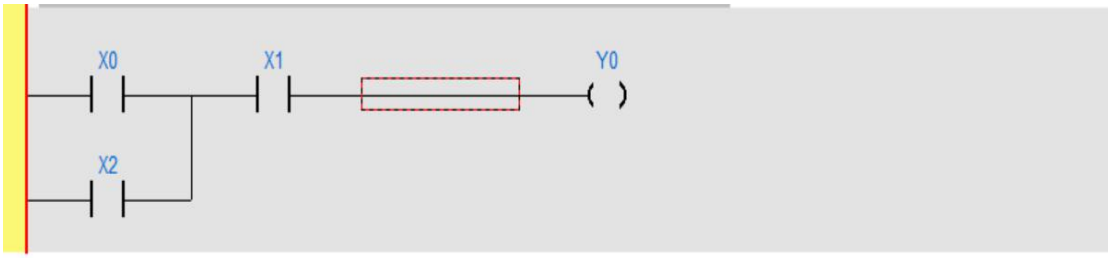
   - ➢ *ExNOR gate*



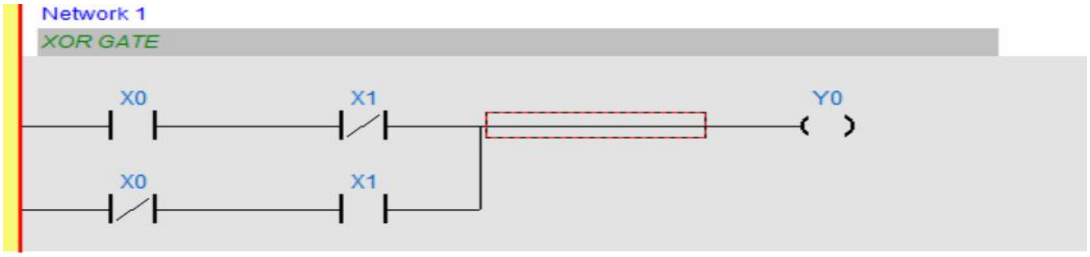
   - ➢ *For any Boolean Expression*



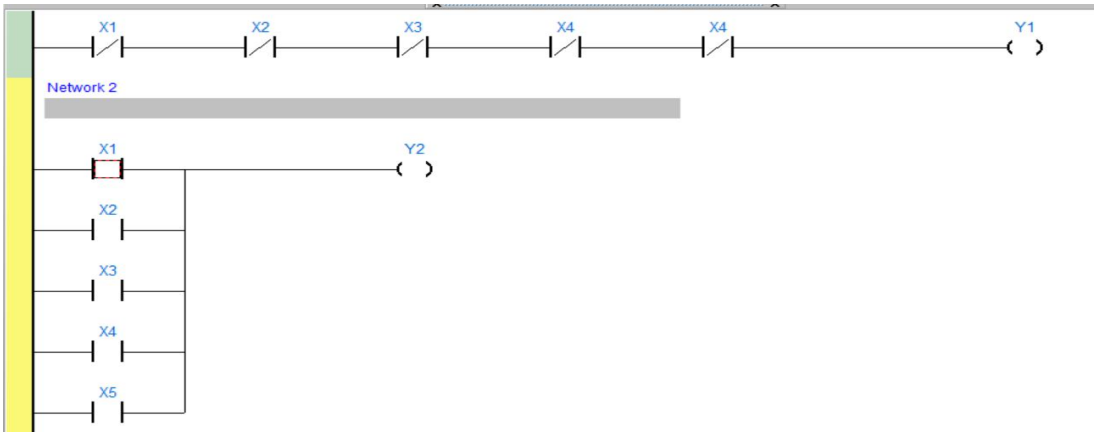
Ladder diagram in DELTA PLC



2. Draw a one line diagram by using two SPDT Switch (S1 and S2) such that:
   When S1 and S2 are made ON Lamp (L) remains OFF. Even S1 and S2 are made OFF Lamp (L) also remains OFF. But when S1 is made ON and S2 is made OFF Lamp (L) gets ON. Also when S1 is made OFF and S2 is made ON Lamp (L) gets ON.

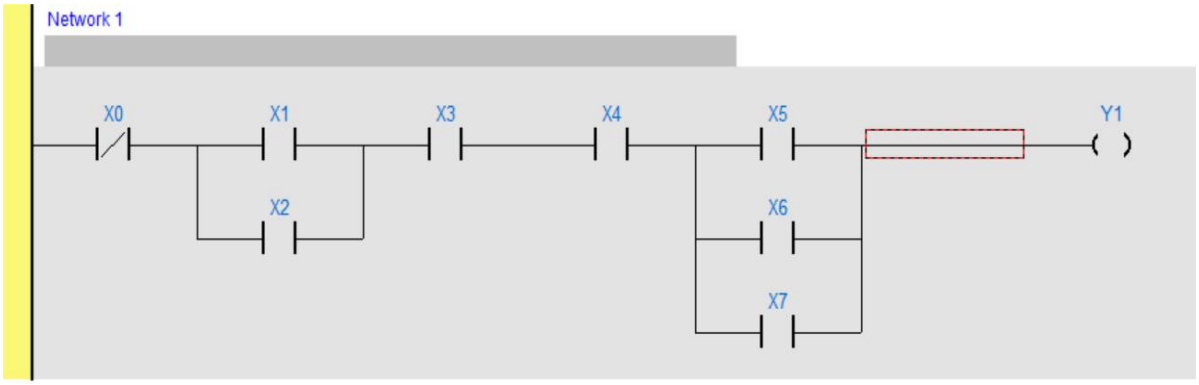


3. Lamp L2 is glowing previously. Another lamp L1 should glow when any of the switches S1, S2, S3, S4, and S5 is pressed. Lamp L2 gets OFF when the lamp L1 glows.



4. A fan is to run when all the following conditions are met:
   a) Switch S1 is kept OFF.
   b) Switch S2 or S3 is made ON.
   c) Switch S4 & S5 are made ON

d) Switch S6 or S7 or S8 is made ON

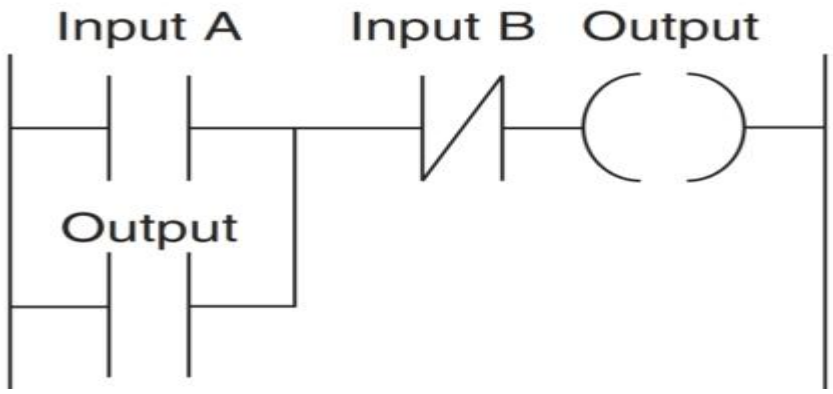


Experiment6:

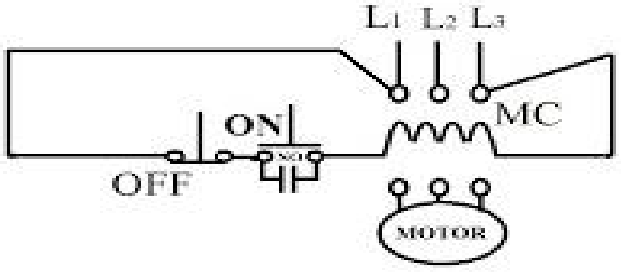
Aim: Latching Concept Using PLC Programming

OBJECTIVES: To Study the latching concept for Start Stop DOL Starter Design and its application.

- When the input A contacts close, there is an output. However, when there is an output, another set of contacts associated with the output closes.
- These contacts form an OR logic gate system with the input contacts. Thus, even if the input A opens, the circuit will still maintain the output energized. The only way to release the output is by operating the normally closed contact B.



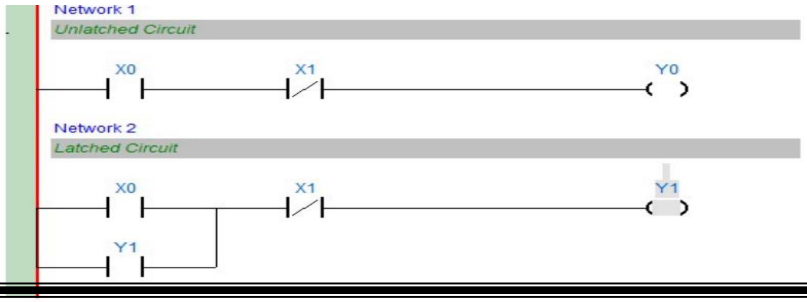
DOL starter



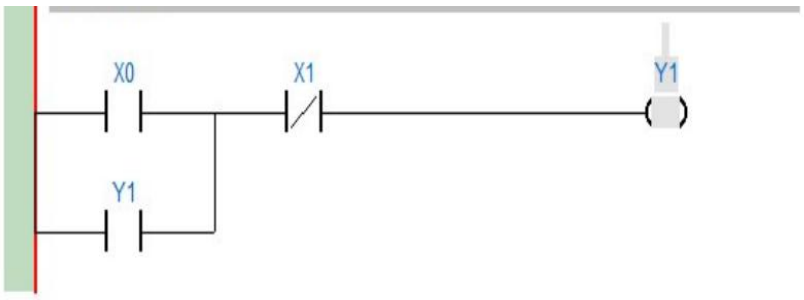
DOL Starter

Latching Concept Using PLC Programming

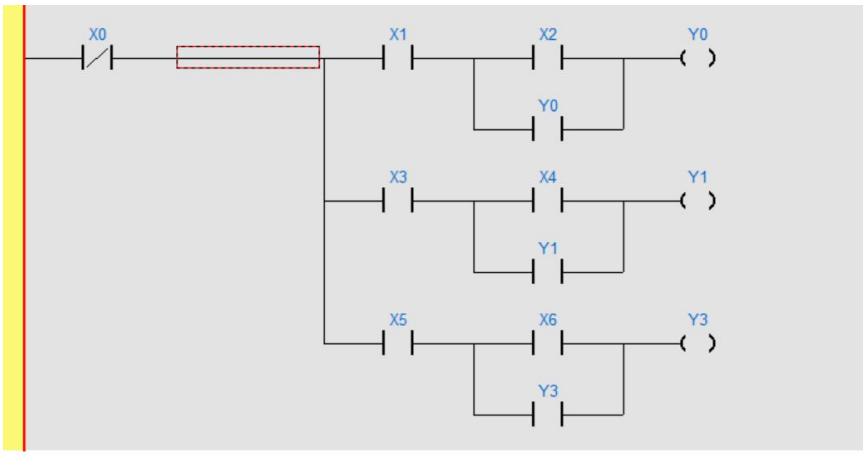
1. Concept of latching and unlatching



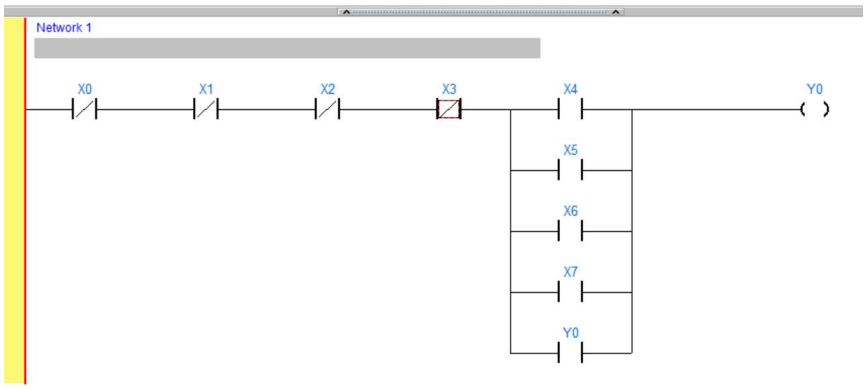
2. DOL Starter ladder Programming.



3. Three conveyors are to be started and stopped indifferent sequences with help of two three sets of push buttons each (One START/NO and One STOP/NC). Whenever it is required any conveyer can be started and stopped with these set of push buttons separately. When all the conveyers are running or any two is running it can be stopped only with an emergency stop.



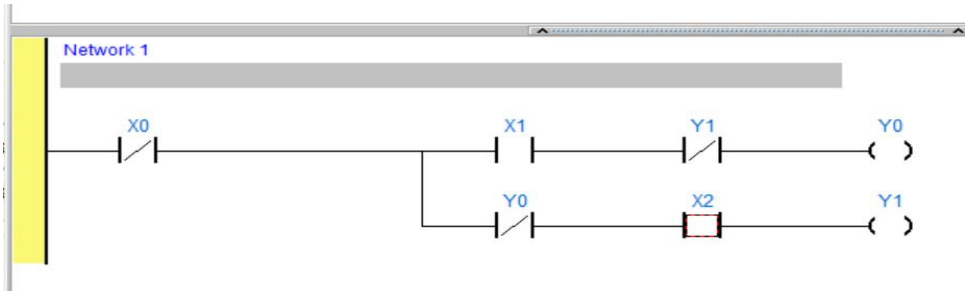
4. A conveyer 'C' is to run when any of the four push button is pressed. The conveyer is to stop when anyone of the four Stop Push button is pressed.



5. Write a ladder programming by using two set of push button for the following Conditions:

Turn ON light 1 when pushbutton pb1 is pressed.
Turn ON light 2 when pushbutton pb2 is pressed.

Electrically interlock the pushbuttons so that L1 and L2 cannot be turned ON at the same time.



Experiment7:

Introduction to TIMER BLOCKS and its Types

OBJECTIVES: To Study the Timers blocks and its related programming

THEORY:

Timer On-Delay (TON)

Use the TON instruction to turn an output on or off after the timer has been on for a preset time interval. The TON instruction begins to count time base intervals when rung conditions become true. As long as rung conditions remain true, the timer adjusts its accumulated value (ACC) each evaluation until it reaches the preset value (PRE). The accumulated value is reset when rung conditions go false, regardless of whether the timer has timed out.

Timer Off-Delay (TOF)

Use the TOF instruction to turn an output on or off after is rung has been off for a preset time interval. The TOF instruction begins to count time base intervals when the rung makes a true-to-false transition. As long as rung conditions remain false, the timer increments its accumulated value (ACC) each scan until it reaches the preset value (PRE). The accumulated value is reset when rung conditions go true regardless of whether the timer has timed out.

Pulse Timer (TP)

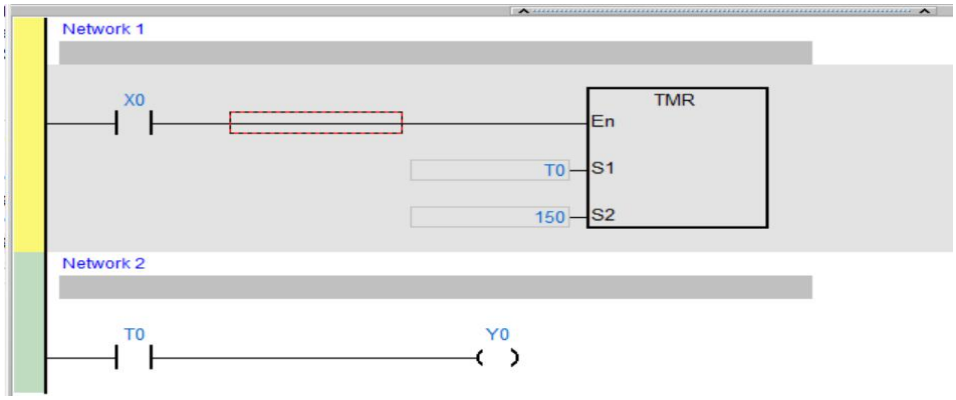
Use this timer to generate a pulse of specific duration. The TP Timer Out bit is ON when the timer is running and OFF at all other times.

Turn on Retentive Timer (TONR)

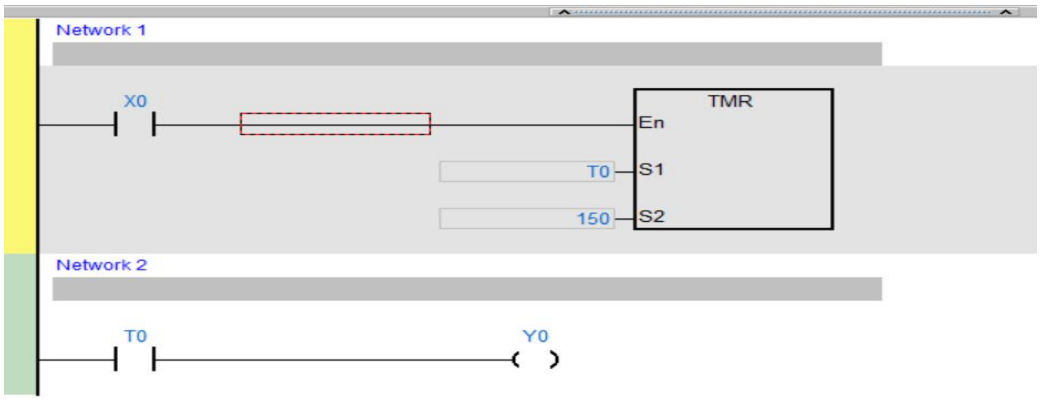
Use the RTO instruction to turn an output on or off after its timer has been on for a preset time interval. The RTO instruction is a retentive instruction that begins to count time base intervals when rung conditions become true. As long as rung conditions remain true, the timer increments its accumulated value (ACC) until it reaches the preset value (PRE).

Implementation of On-OFF Delay Timer using PLC

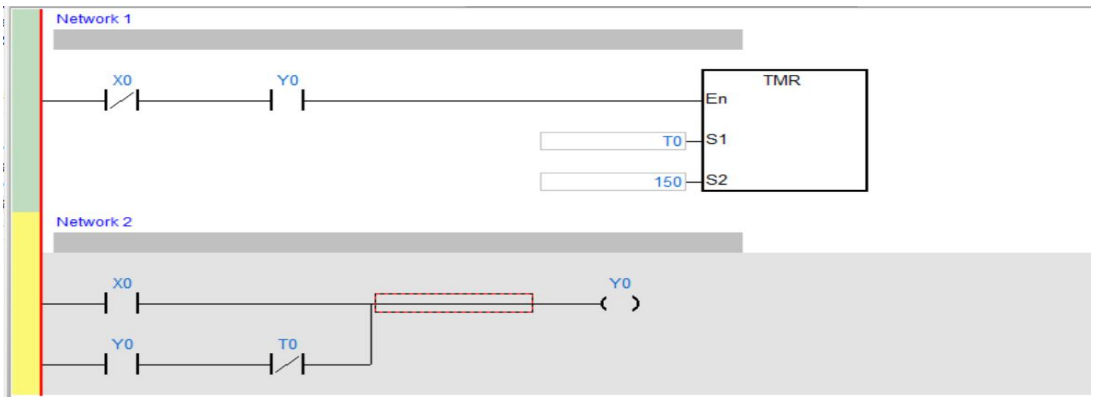
1. Lamp should glow after a delay of 15 sec when start switch S1 is made ON.Lamp should go OFF immediately also when start switch switch S1 is made OFF.



2. The lamp should glow after a delay of 15 second when start switch s1 is made on.The lamp should remain in glowing condition till the start switch s1 is made on. The lamp should go immediately off when start switch s1 is made 0ff.

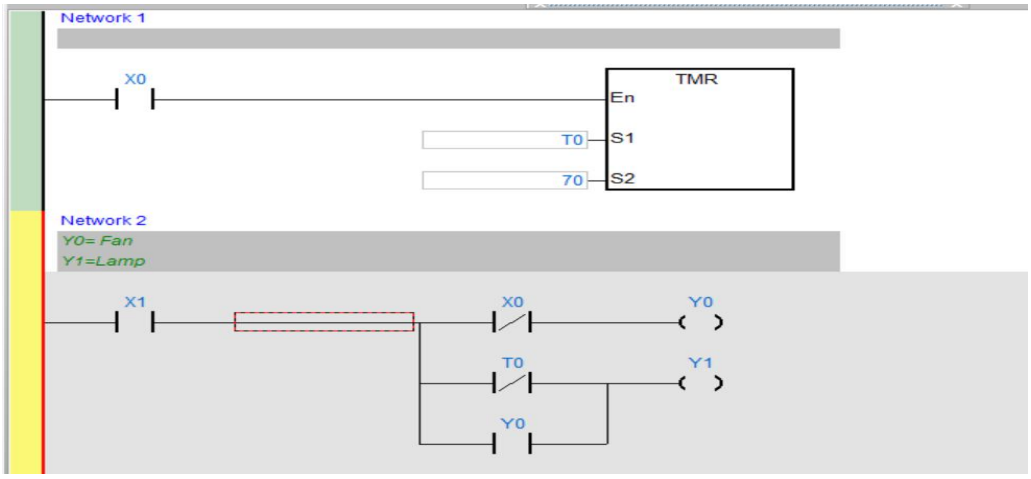


3. The lamp should glow immediately when a start switches S1is made ON. The lamp should remain in ON condition as long as S1 is ON. The lamp should go OFF after a delay of 15 second when the start switch S1 is made OFF.



4. When a switch S1 is turned ON
   - ➢ A Light & a Fan are turned ON.

   When the switch S2 is turned OFF
   - ➢ The Fan goes OFF immediately but
   - ➢ The Lamp remains ON for another 7 sec & then goes OFF.



Experiment8:

Introduction to COUNTER and Comparator

OBJECTIVES: To study the different Counter blocks and its programming

Counter:

Count Up (CTU):

The CTU is a retentive output instruction that counts false-to-true rung transitions. Rung transitions can be caused by events occurring in the program such as parts traveling past a detector or actuating a limit switch.

Count Down (CTD):

The CTD is a retentive output instruction that counts false-to-true rung transitions Rung transitions can be caused by events occurring in the program such as parts traveling past a detector or actuating a limit switch.

Comparator

Equal (EQU):

Use the EQU instruction to test whether two values are equal. If source A and source B are equal, the instruction is logically true. If these values are not equal, the instruction is logically false.

Not Equal (NEQ):

Use the NEQ instruction to test whether two values are not equal. If source A and source B are not equal, the instruction is logically true. If the two values are equal, the instruction is logically false

Less than (LES):

Use the LES instruction to test whether one value (source A) is less than another (source B). If source A is less than the value at source B the instruction is logically true. If the value at source A is greater than or equal to the value at source B, the instruction is logically false.

Less Than or Equal (LEQ):

Use the LEQ instruction to test whether one value (source A) is less than or equal to another (source B). If the value at source A is less than or equal to the value at source B, the instruction is logically true. If the value at source A is greater than the value at source B, the instruction is logically false.

Greater Than (GRT):

Use the GRT instruction to test whether one value (source A) is greater than another (source B). If the value at source A is greater than the value at source B. The instruction is logically true. If the value at source A is less than or equal to the value at source B, the instruction is logically false.

Greater Than or Equal (GEQ):

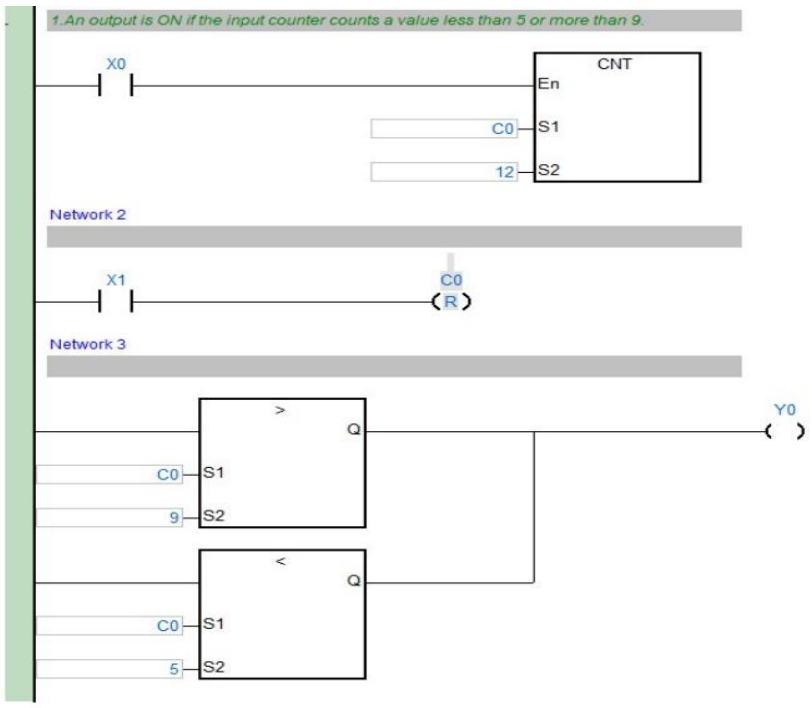
Use the GEQ instruction to test whether one value (source A) is greater than or equal to another (source B). If the value at source A is greater than or equal to the value at source B, the instruction is logically true. If the value at source A is less than the value at source B, the instruction is logically false.

Limit Test (LIM):

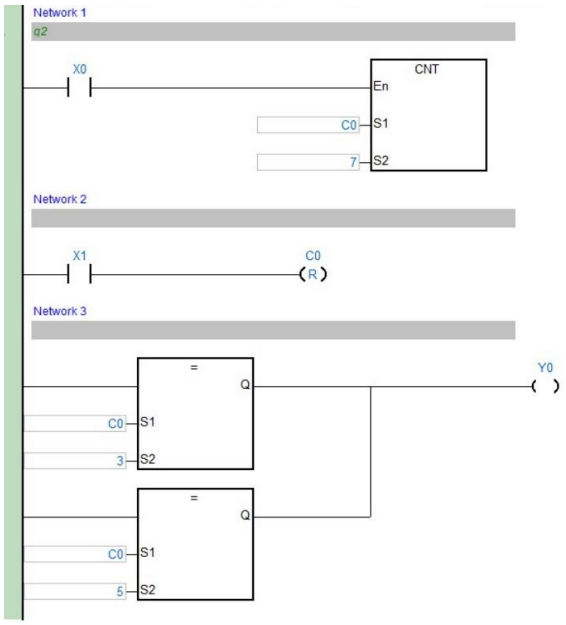
Use the LIM instruction to test for value within or outside a specified range, depending on how you set the limits

Write the following ladder programme using Counter Blocks:

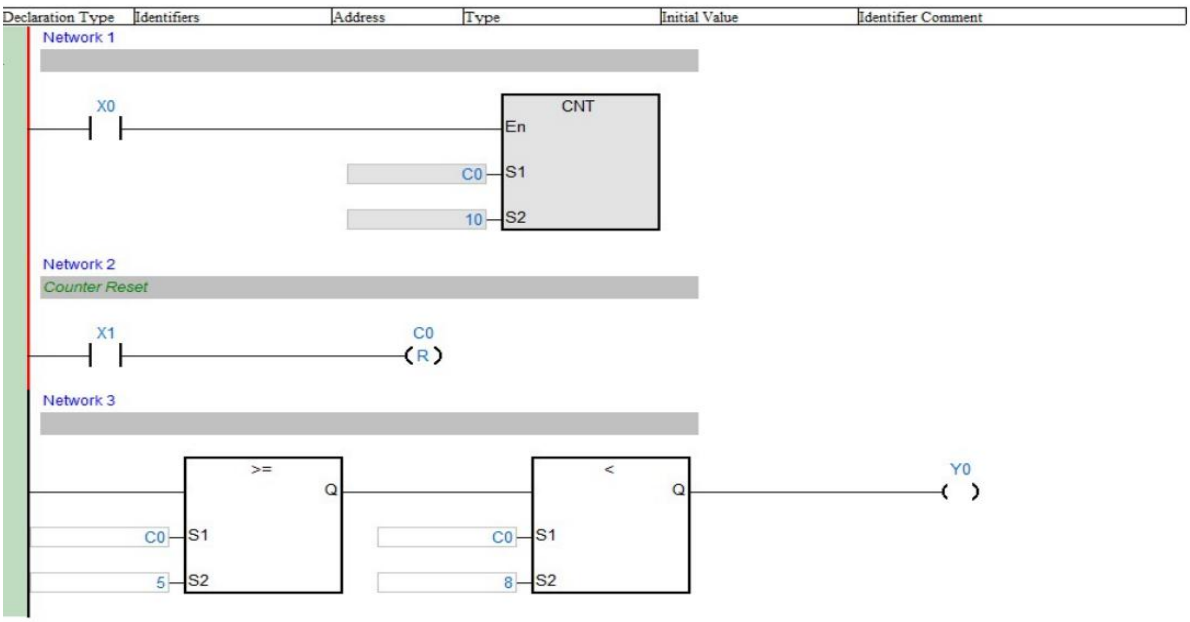
1. An output is ON if the input counter counts a value less than 5 or more than 9.



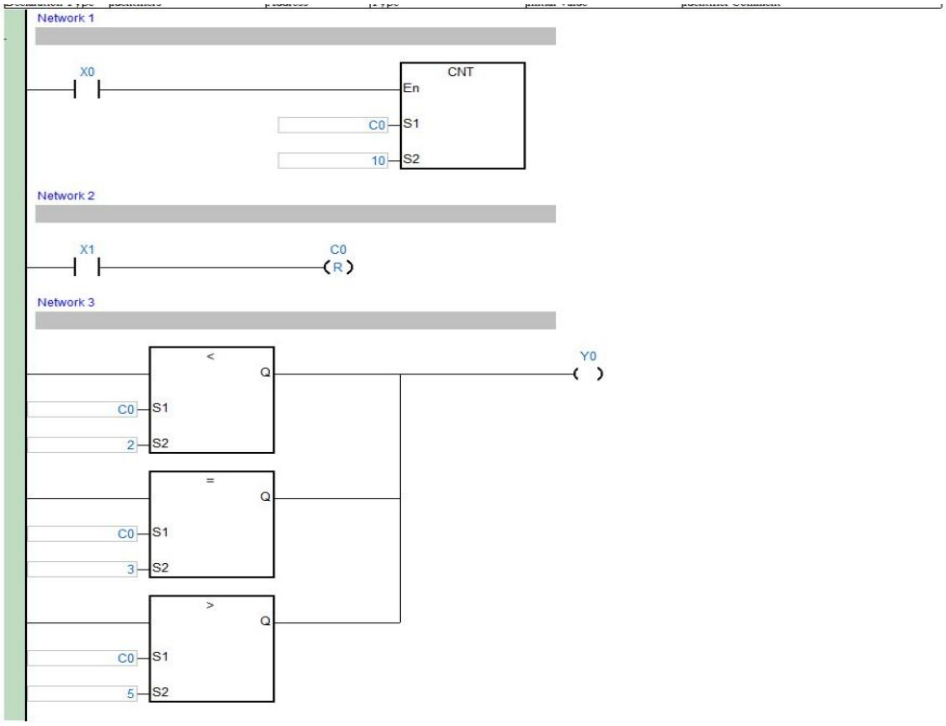
2. A light is to be ON only if a plc counter has a value either equal to 3 or 5.



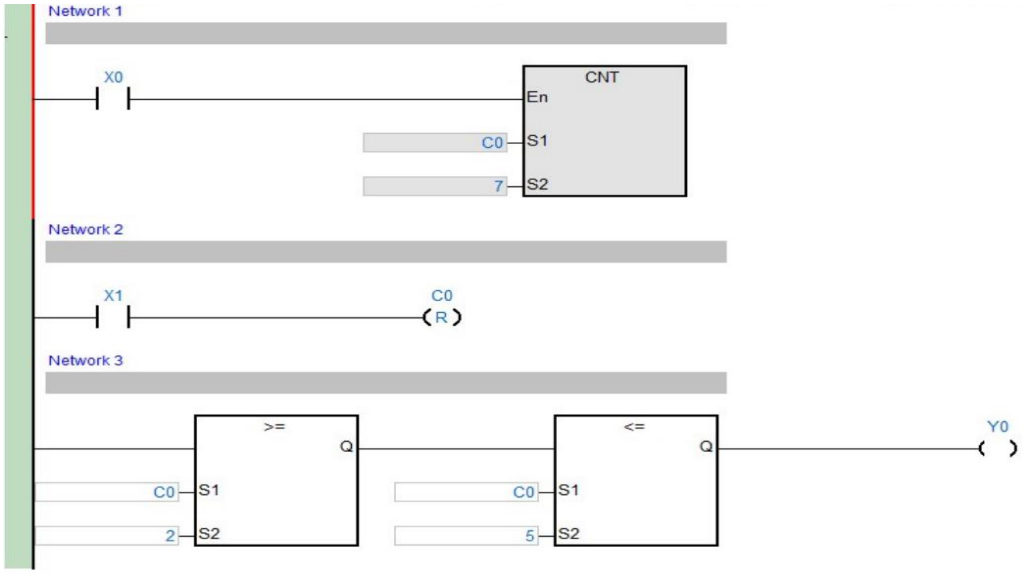
3. An indicating light is to go on when a counter reaches 5. The light is then to go off when a count of 8 reaches.



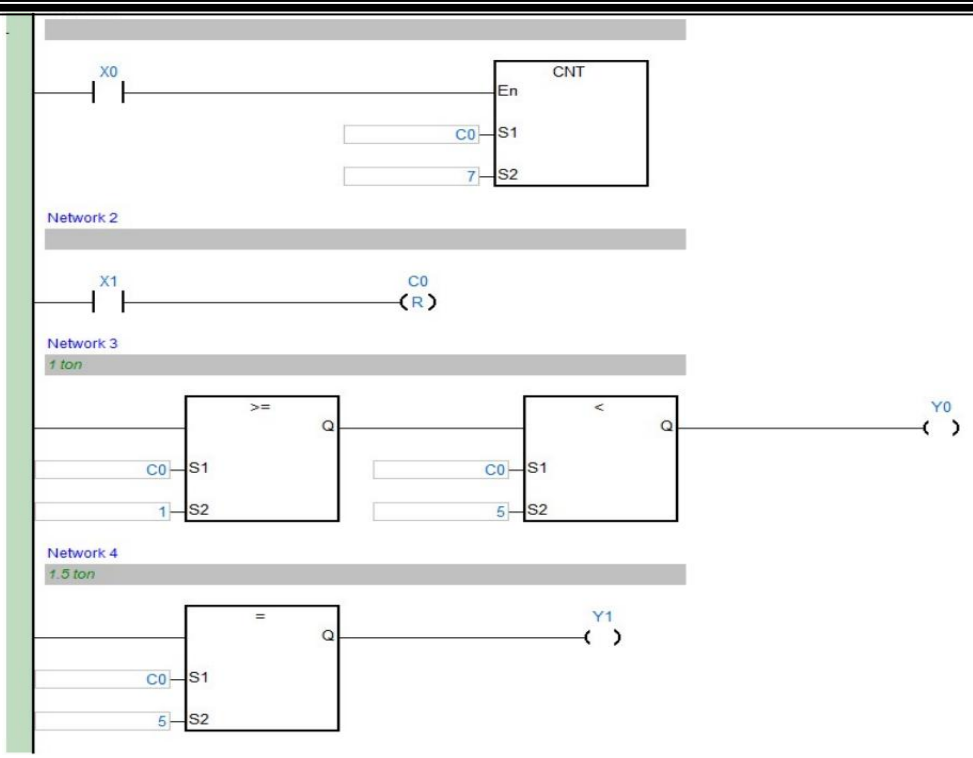
4. An output is ON if the input counter counts a value less than 2 or more than 5 but if it counts 3 then also, the output is ON.



5. An output is to be ON if the input counter is in between 2 and 5. The count value includes 2 and 5.



6. In an air condition (AC) room there are two airs conditioners of 1 ton and 1.5 ton. When a man comes inside the room,1-ton AC gets started when 5 men comes inside the room 1-ton AC gets off and 1.5 ton AC gets started.



Experiment9:

Aim:

Design the PLC Programming for Bottle filling plant.

- Understanding of Problem Statement
- What are Components blocks are use in the program
- Write the ladder program according to the problem statement

Experiment10:

Aim:

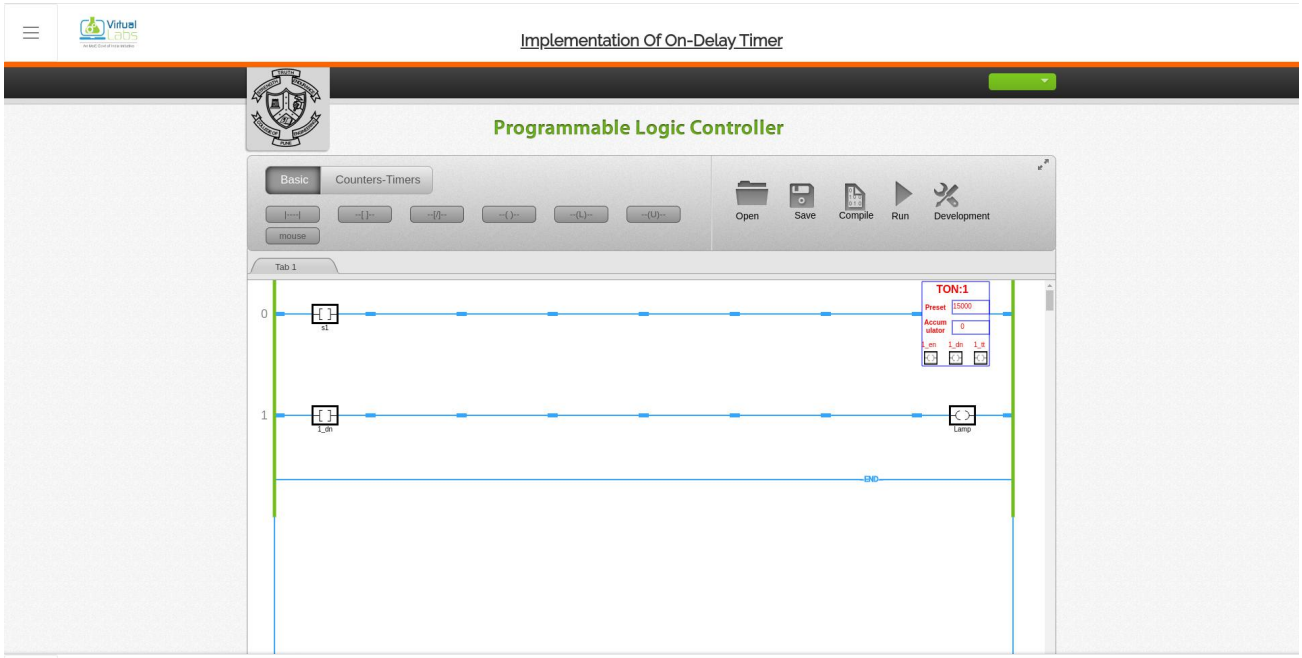
1. Design the PLC Programming for Garage shutter opening and closing.

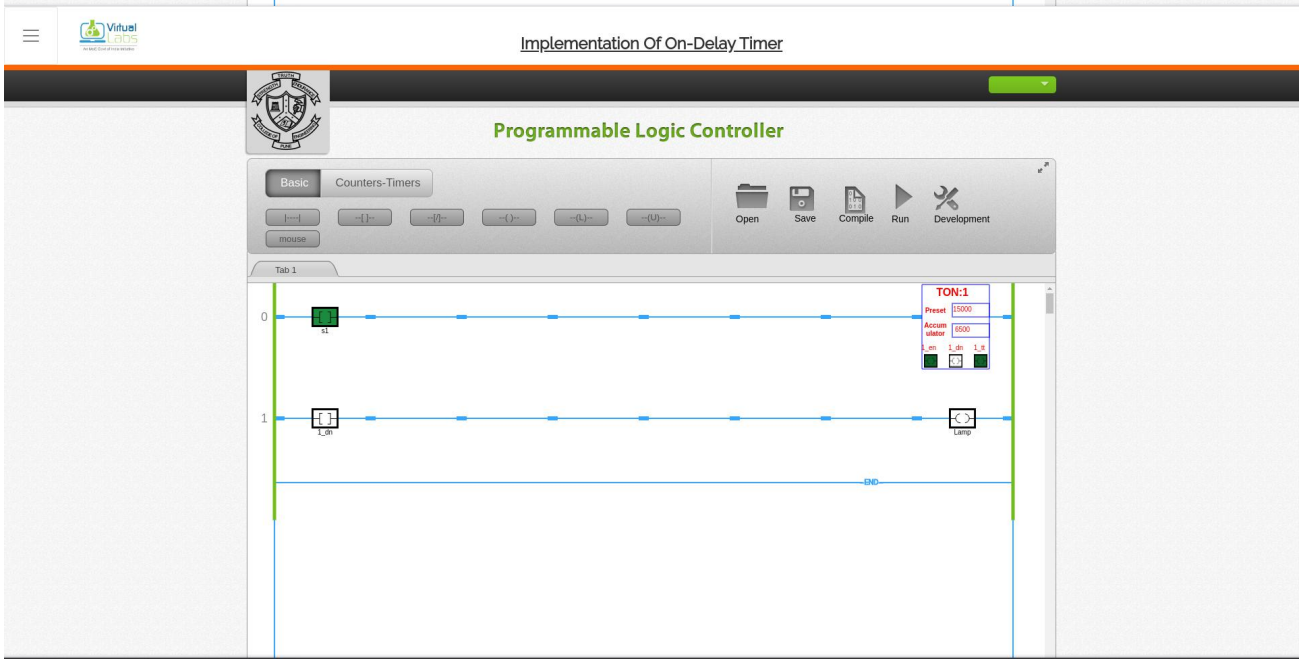
2. Design Traffic System using PLC programming

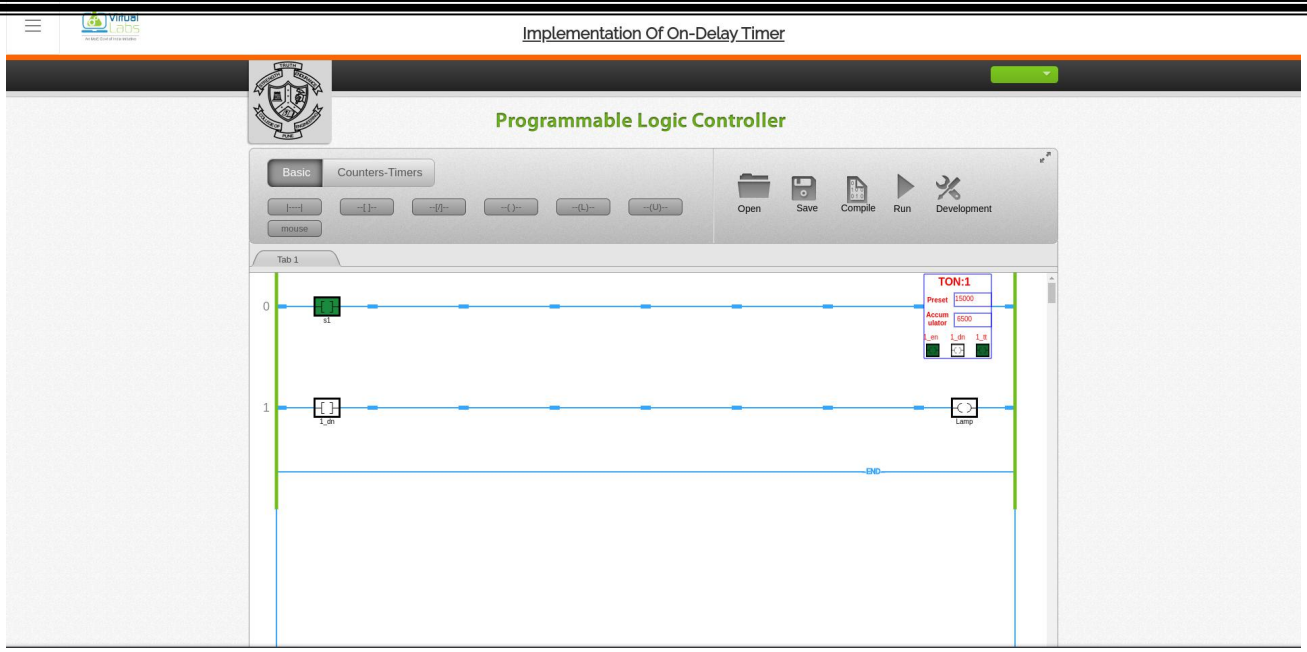
- Understanding of Problem Statement
- What are Components blocks are use in the program
- Write the ladder program according to the problem statement

PLC Lab Test

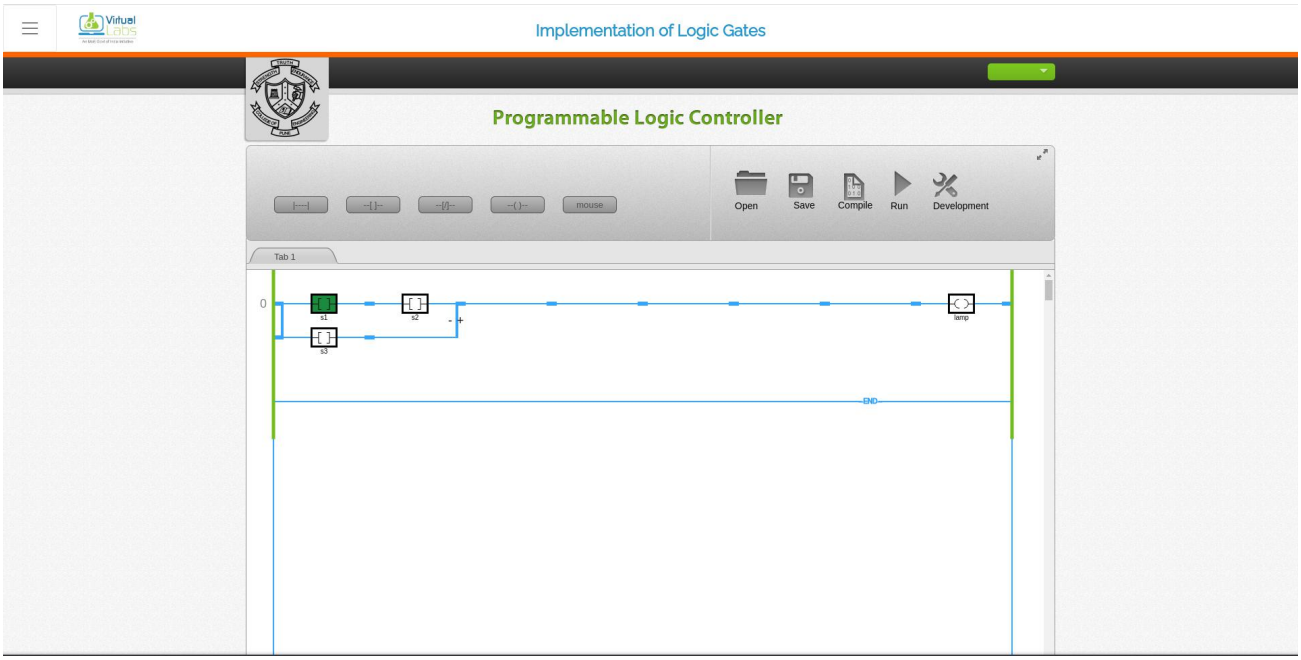
Q1. Write a ladder Program when the lamp should glow after a delay of 15 second when start switch s1 is made on. The lamp should remain in glowing condition till the start switch s1 is made on. The lamp should go immediately off when start switch s1 is made Off.

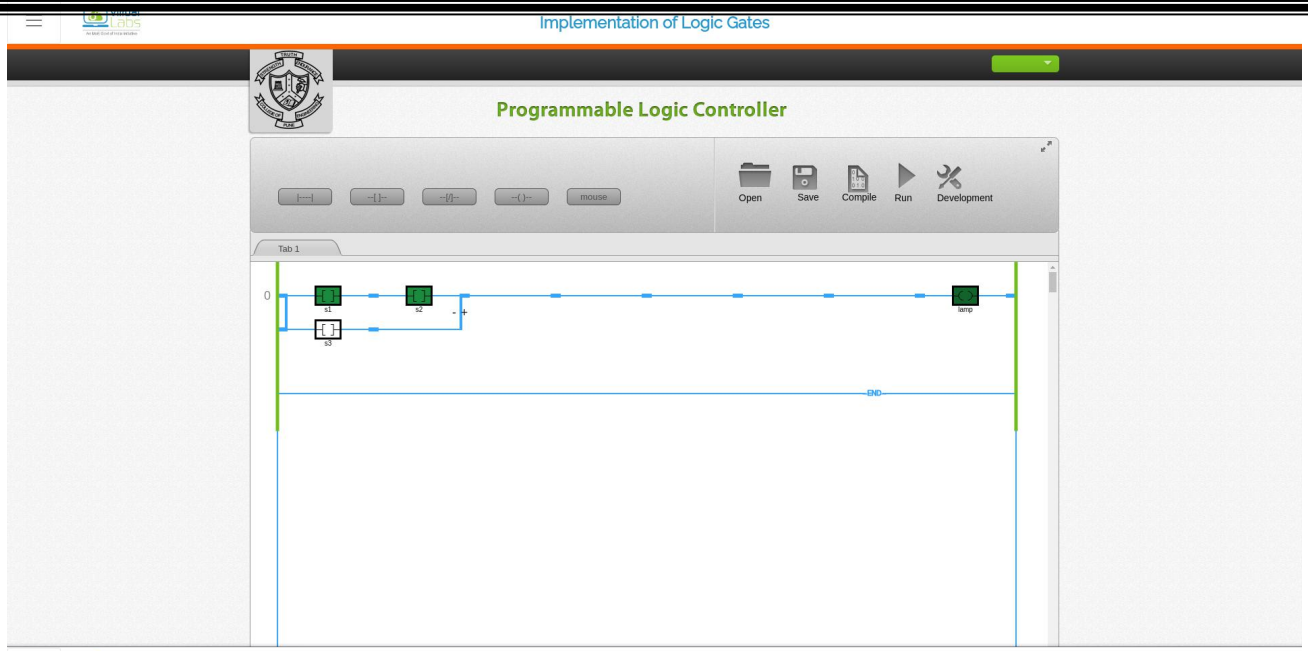


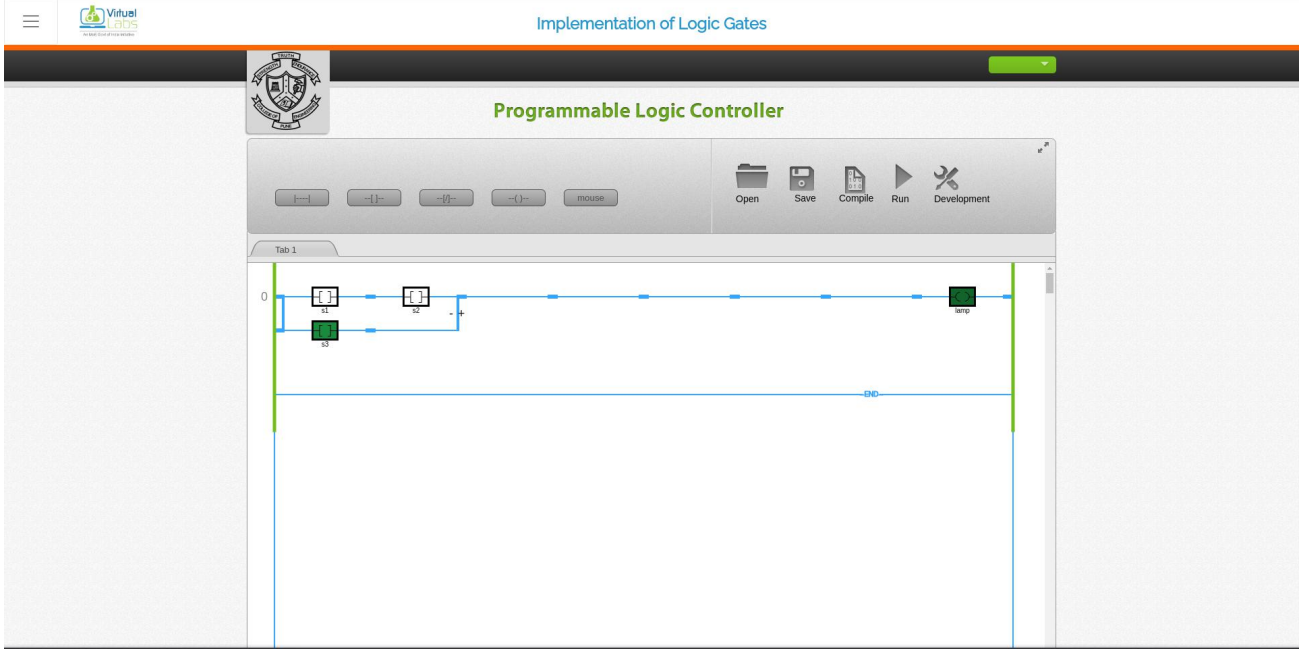




Q3. Write a ladder Program such that The lamp should glow when either the switch (S1 & S2) or S3 is ON.




Implementation of Logic Gates
Programmable Logic Controller
mouse
Open
Save
Compile
Run
Development
Tab 1
0
s1
s2
s3
lamp
END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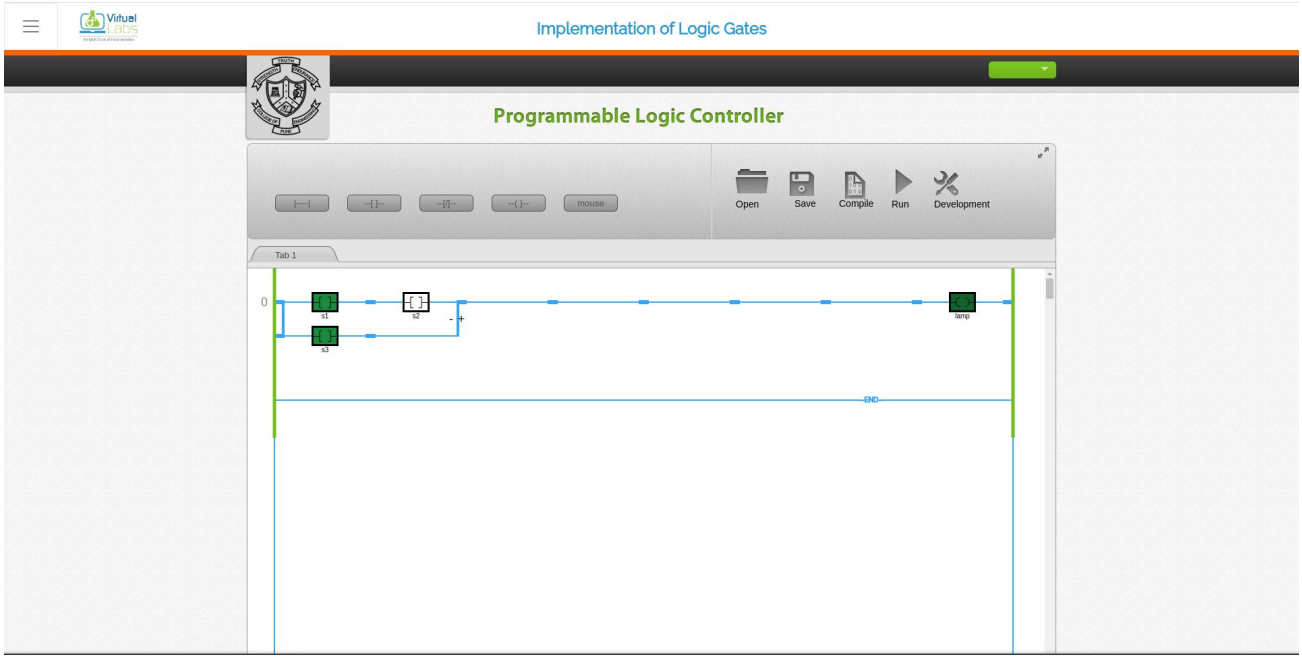
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