NPTEL: Automation & Controls
Module: 4: Programmable Logic Controllers

Q.1. What is a PLC how is it useful in automated systems?

Ans: A PLC (i.e. Programmable Logic Controller) is a device that was invented to replace the necessary sequential relay circuits for machine control. The PLC works by looking at its inputs and depending upon their state, turning on/off its outputs. The user enters a program, usually via software, that gives the desired results. PLC acts as a controller in automated systems which are responsible for automatic controlling of various devices associated with the system.

Q.2. Why are relays required in a PLC circuit?

Ans: Usually PLCs have low voltage at their outputs about 24 volts which are unable to operate devices of higher voltage ratings, in such cases the relays are used which are energized using PLC's outputs and relays themselves connect or disconnect devices from higher power sources.

Q.3. What are the basic instructions used in the PLC programming?

Ans: Few basic instructions used in PLC programming are:

- **Input Instruction**

  -- [ ] -- This Instruction is Called IXC or Examine If Closed. ie; If a NO switch is actuated then only this instruction will be true. If a NC switch is actuated then this instruction will not be true and hence output will not be generated.

  -- [\] -- This Instruction is Called IXO or Examine If Open
  i.e.; If a NC switch is actuated then only this instruction will be true. If a NC switch is actuated then this instruction will not be true and hence output will not be generated.

- **Output Instruction**

  -- ( ) -- This Instruction Shows the States of Output. ie; If any instruction either XIO or XIC is true then output will be high. Due to high output a 24 volt signal is generated from PLC processor.

- **Rung**

  Rung is a simple line on which instruction are placed and logics are created

Q.4. Explain Timers and its types used in PLC programming.

Ans: **TIMERS:**

There are three fundamental types of timers.

TON – On delay timer

TOF – Off delay timer

RTO – Retentive on delay

- An on-delay timer will wait for a set time after a line of ladder logic has been true before turning on, but it will turn off immediately.
- An off-delay timer will turn on immediately when a line of ladder logic is true, but it will delay before turning off.
- An RTO function the same as a TON with the exception that once it has begun timing, it holds its count of time even if the rung goes false, a fault occurs or power is lost.

Q.5. Explain different types of counters used in PLC programming.

Ans: **COUNTERS:**

There are two types of counters used:

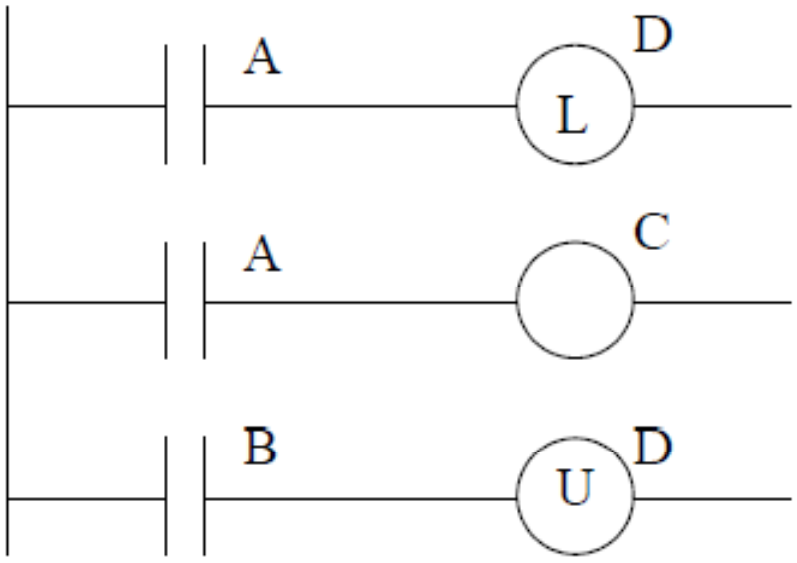
CTU – count up

CTD – count down

- CTU - This output instruction counts up for each false-to-true transition of conditions preceding it in the rung and produces an output when the accumulated value reaches the preset value.
- CTD - This output instruction counts down for each false-to-true transition of conditions preceding it in the rung and produces an output when the accumulated value reaches the preset value.

Q.6. What is latching how is it useful?

Ans: A latch is like a sticky switch - when pushed it will turn on, but stick in place, it must be pulled to release it and turn it off. A latch in ladder logic uses one instruction to latch, and a second instruction to unlatch, as shown in Figure. The output with an L inside will turn the output D on when the input A becomes true. D will stay on even if A turns off. Output D will turn off if input B becomes true and the output with a U inside becomes true (Note: this will seem a little backwards at first). If an output has been latched on, it will keep its value, even if the power has been turned off.



Q.7. What are shift registers and their applications?

Ans: Shift registers Loads a bit of data into a bit array, shifts the pattern of data through the array, and unloads the last bit of data in the array. We use the shift register whenever we need to store the status of an event that had previously happened so that we can act upon it at a later time. This is accomplished by shifting either status or values through data files. Two types of shift registers are in use viz. BSL, BSR. The BSL shifts data to the left and the BSR shifts data to the right.
Applications of shift registers:

Common applications include:

- Tracking parts through an assembly line
- Controlling machine or process operations
- Inventory control System diagnostics

Q.8. What are the basic components of a PLC?

Ans: There are five basic components in a PLC system:

- The PLC processor, or controller
- I/O (Input /Output) modules
- Chassis or backplane
- Power supply
- Programming software that runs in a PC

In addition to these 5, most PLCs also have:

- A network interface

Q.9. What is ladder logic?

Ans: Ladder logic is a method of drawing electrical logic schematics. It is now a graphical language very popular for programming Programmable Logic Controllers (PLCs). It was originally invented to describe logic made from relays. The name is based on the observation that programs in this language resemble ladders, with two vertical "rails" and a series of horizontal "rungs" between them. Ladder logic is widely used to program PLCs, where sequential control of a process or manufacturing operation is required. Ladder logic is useful for simple but critical control systems, or for reworking old hardwired relay circuits. As programmable logic controllers became more sophisticated it has also been used in very complex automation systems.

Q.10. Develop a simple ladder logic that allows a single light to be controlled by two switches in a room.

Ans: There are two possible approaches to this problem. The first assumes that any one of the switches on will turn on the light, but both should be off for the light to be off. The second approach assumes that each switch can turn the light on or off regardless of the state of the other switch. Figure below gives the ladder logic for the two approaches.

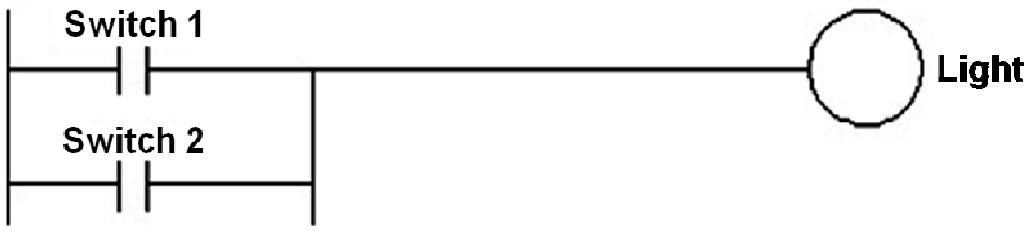


Fig 1: Both switches should be on to turn the light on

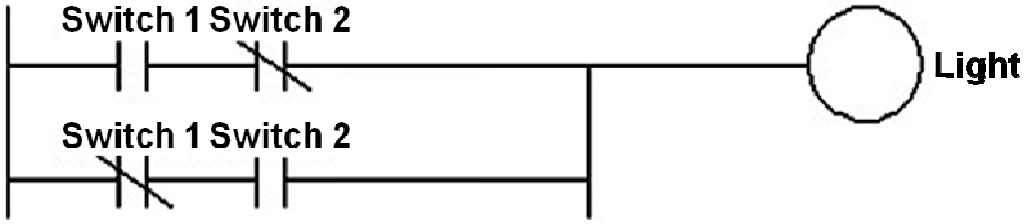


Fig 1: Any switch can turn the light on