Discrete Control

Discrete Control

Discrete control systems deal with parameters and variables that change at discrete moments in time.

Parameters, variables are themselves are discrete, typically binary. They can be either of two values-1 or 0, true or false, ON or OFF, object present or not present, high voltage or low voltage

Discrete Control

-Input signals to controller generally generated by binary sensors like limit switch, photo sensors.

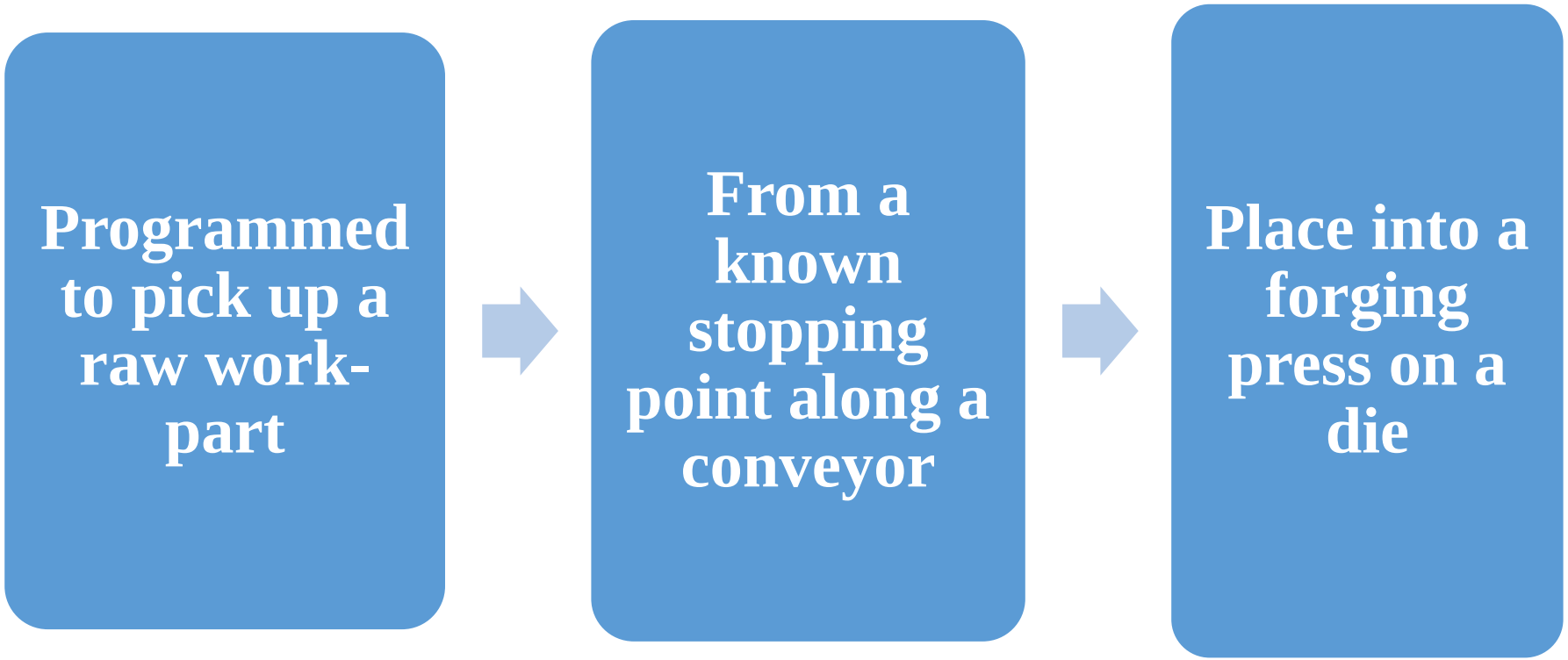
-Output turn on and off switches, motors, valves and other binary actuators related to the process.

-Two categories are:

- Logic control-concern with event driven changes
- Sequencing- concern with time-driven changes in the system.

Logic Control Concern with Event-Driven Changes

Task:



Logic Control Concern with Event-Driven Changes

Conditions:

- **Raw work-part must be at the stopping point**
- **The forge press must have completed the process on the previous part**
- **Previous part must be removed from the die**

Logic Control Concern with Event-Driven Changes

Solution

Discrete Control Using PLC

Elements of Logic Controls

Elements of logic controls are several logic gates

- AND-output is 1 only when all inputs are 1
- OR-output is 1 if either of the inputs is 1
- NOT-output is 1 when input is 0 and vise versa

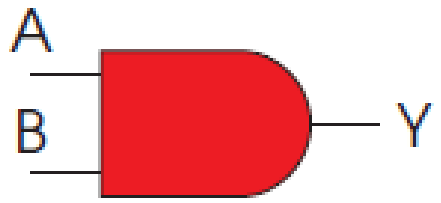
-Two more elements are:

- NAND-combining an AND and a NOT gates in sequence.
- NOR-combining an OR and a NOT gates in sequence.

Logic Gates

AND Gate

Boolean expression: $Y = A \cdot B$

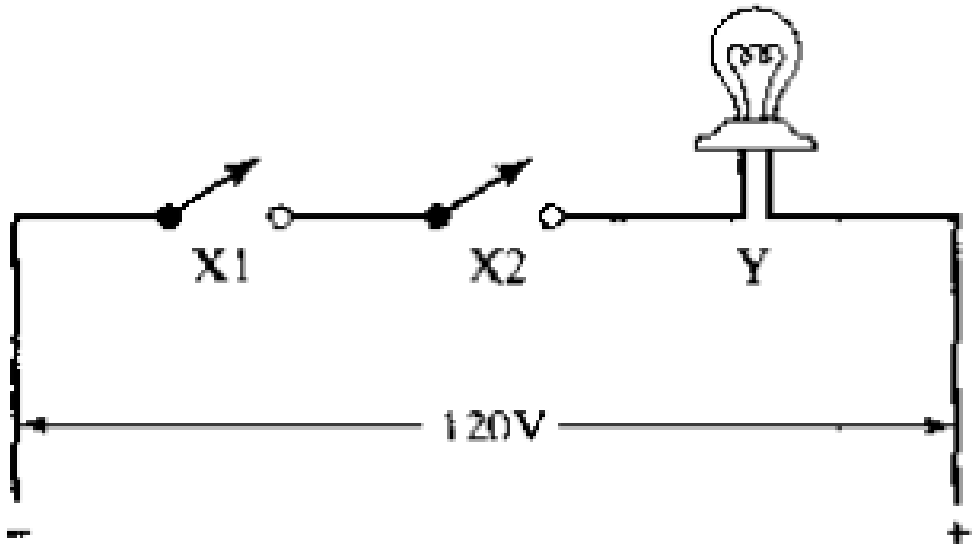


Two-input AND gate

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

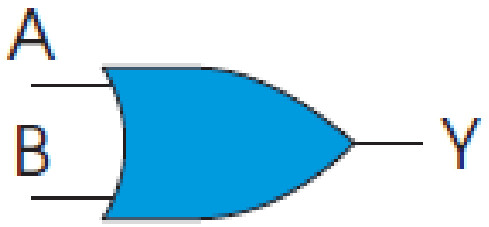
Truth table

Circuit Illustration of And Gate



OR Gate

Boolean expression: **Y = A + B**

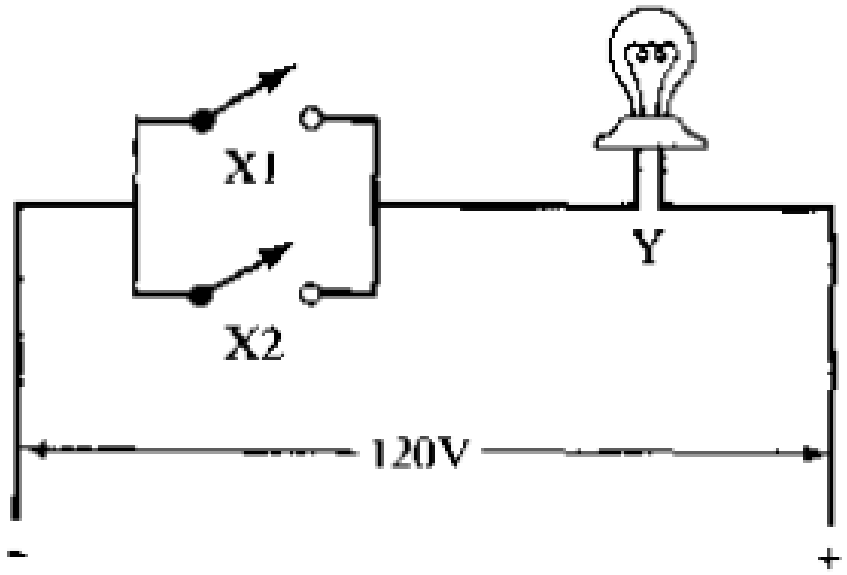


Two-input OR gate

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

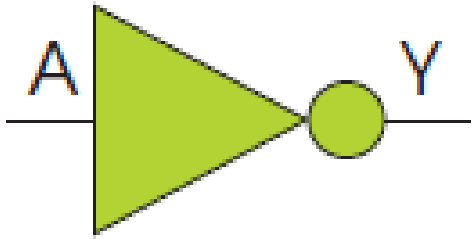
Truth table

Circuit Illustration of OR Gate



NOT Gate

Boolean expression: $Y = A'$



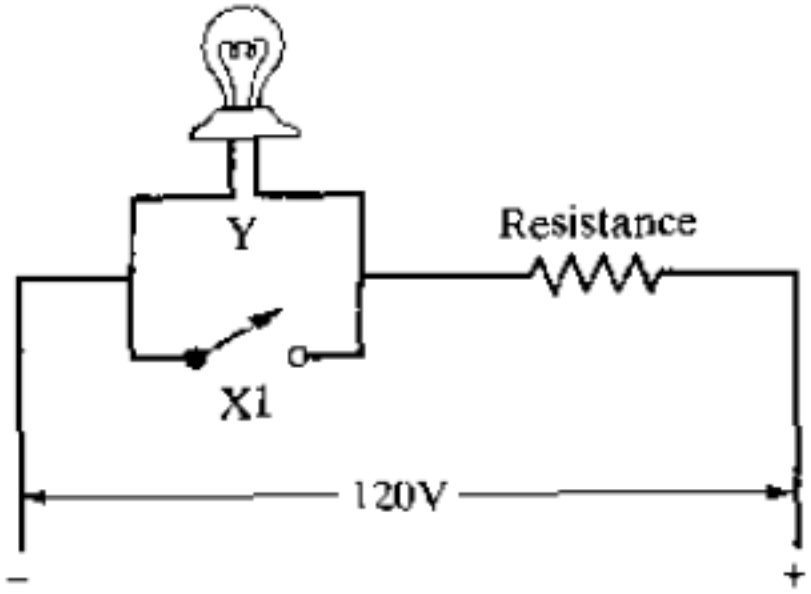
NOT gate symbol

A	Y
0	1
1	0

Truth table

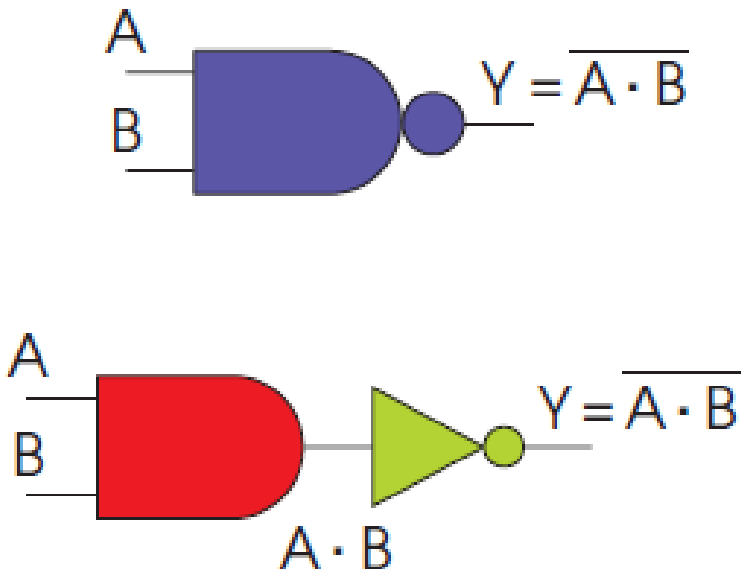
Boolean expression, gate symbol, and truth table for NOT logic gate.

Circuit Illustration of NOT Gate



NAND (NOT AND) Gate

Boolean expression: $Y = \overline{A \cdot B} = \overline{A} + \overline{B}$



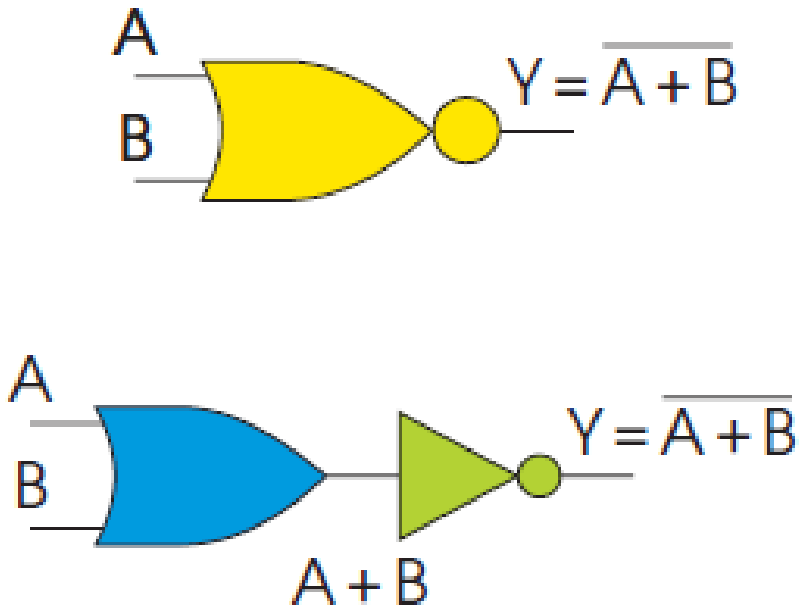
NAND gate

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

Truth table

NOR (NOT OR) Gate

Boolean expression: $Y = \overline{A + B} = \overline{A} \cdot \overline{B}$



NOR gate

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

Truth table

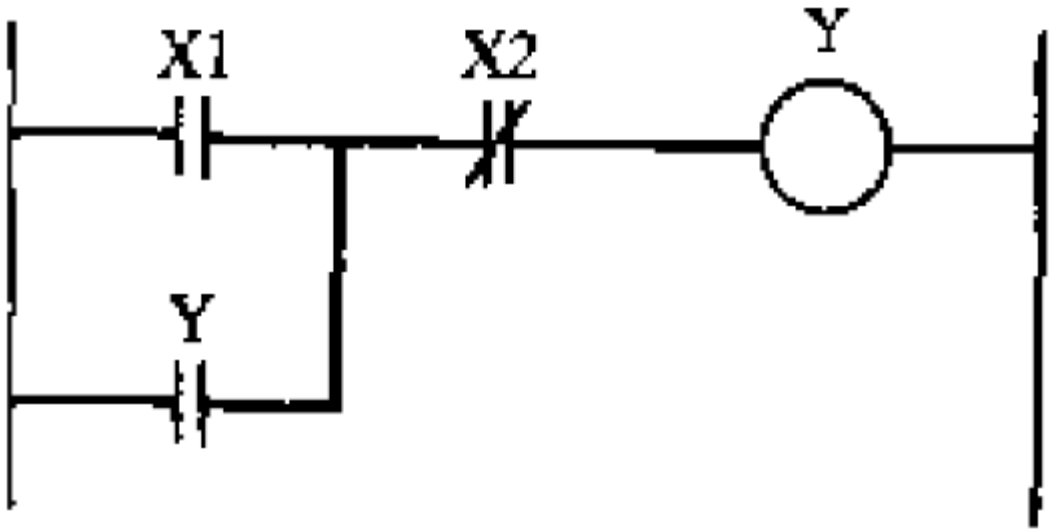
Sequencing Concern with Time Driven Changes

A sequencing system uses internal timing devices to determine when to initiate changes in output variables.

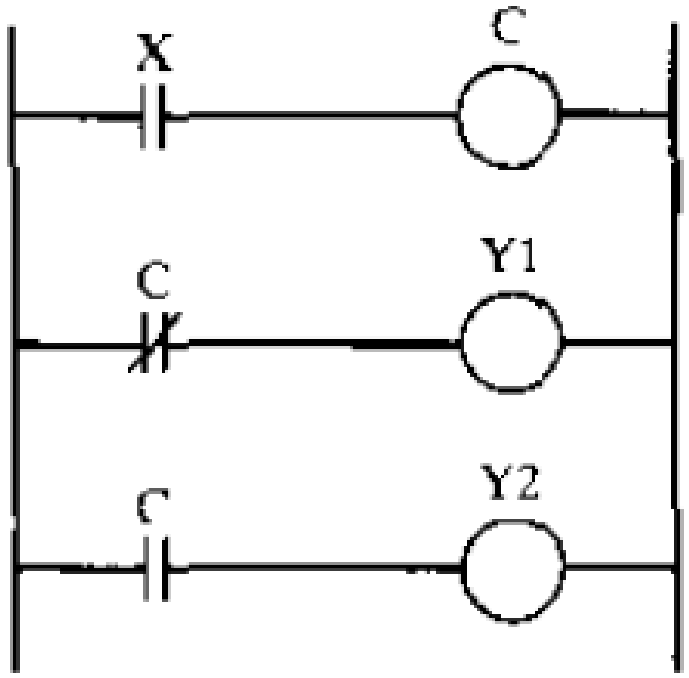
Ex- Timer, counter, relays

Relays

- The output is used as input
- Ex- on off control at remote location



Control Relay



Symbols for Common and Ladder Logic Elements

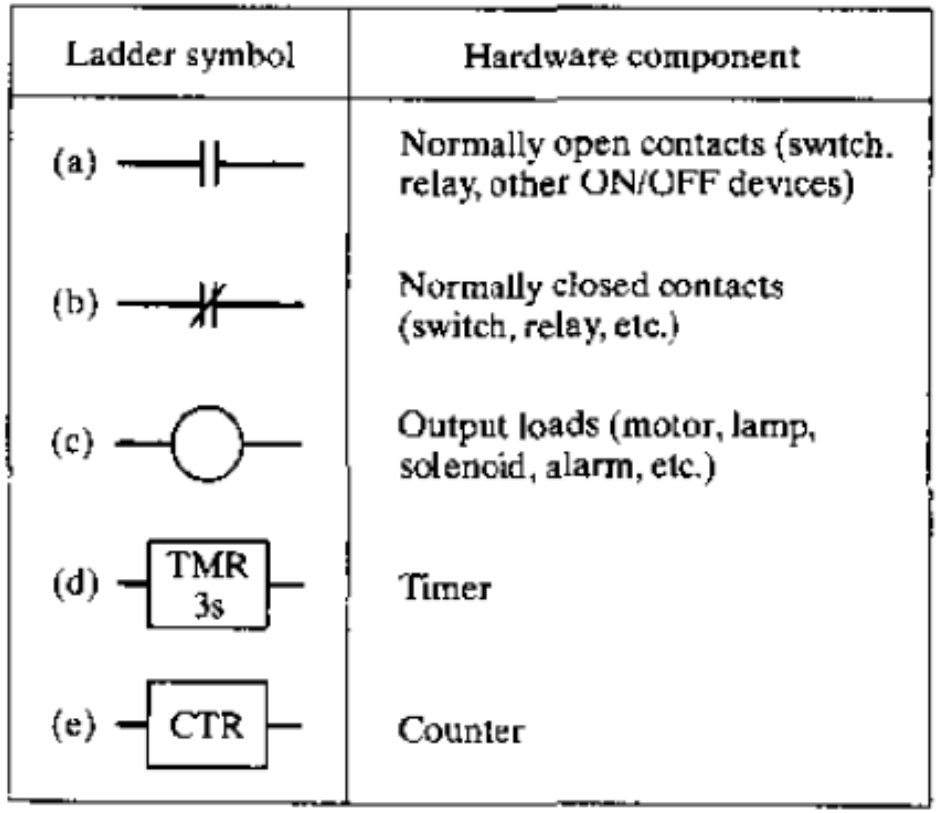
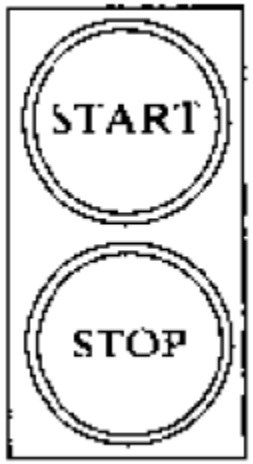
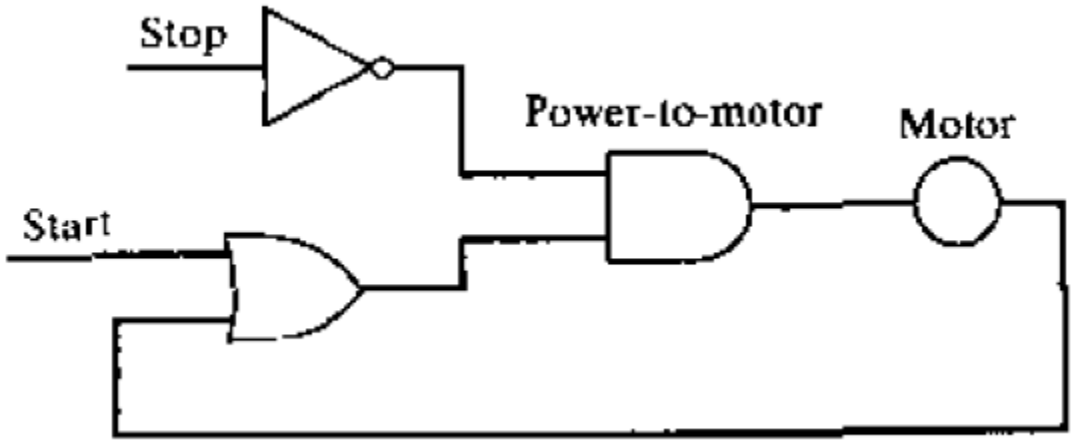


Figure 8.8 Symbols for common logic and sequence elements used in ladder logic diagrams.

Example 8.2



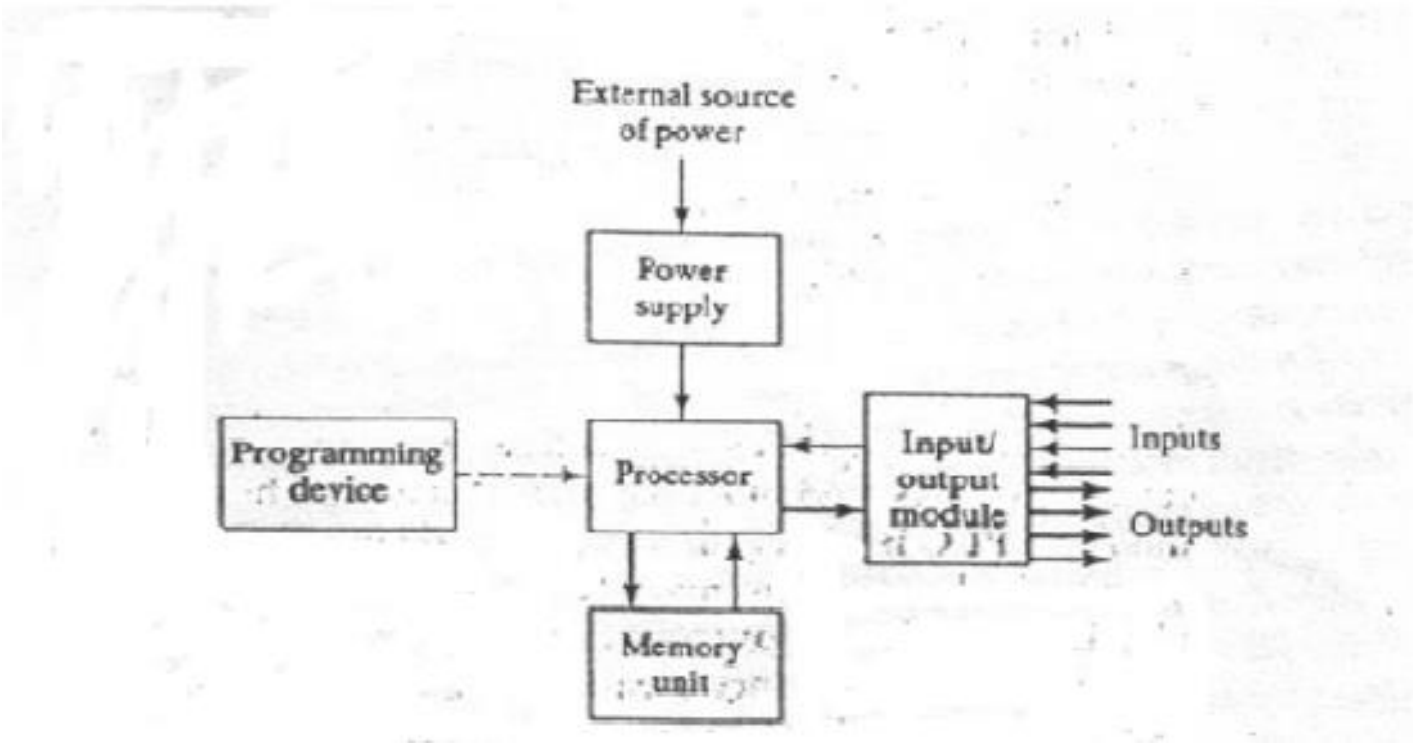


Truth Table

Start	*Stop*	*Motor*	*Power-to-Motor*
0	0	0	0
0	1	0	0
1	0	0	1
1	1	0	0
0	0	1	1
0	1	1	0
1	0	1	1
1	1	1	0

- Worked examples of class
- Examples and exercises from book

PLC and its Components



PLC and its Components

PLC can be defined as a microcomputer-based controller that uses stored instructions in programmable memory to implement logic, sequencing, timing, counting, and arithmetic functions through digital or analog input/output modules, for controlling machines or process.
-Primarily associated with discrete manufacturing to control machines, transfer lines, and material handling equipments.

Advantages of PLCs over relays: easier than wiring relay control panel, reprogrammable, compact, more reliable, more functionality

PLC and its Components

1. Processor: Executes various logic and sequencing functions based on the PLC inputs to determine appropriate output.
2. Memory unit: contains the programs of logic, sequencing and I/O operations. Also holds data files associated with these programs, including input/output status bits, counter and timer constants, and other variable and parameter values.
3. Power supply: supply the power required for the PLC and also to operate some equipments.
4. I/O module: Provides the connection to the industrial equipment or processes that is to controlled.
5. Programming device: is used to program PLC. Usually detachable like teach pendant, keyboard with LCD/CRT display

PLC Operation Cycle

Typical operation cycle of the PLC is know as SCAN. It consists of three parts.

1. Input scan: inputs to the PLCs are read and stored in the memory.
2. Program scan: control program is executed during this scan. Input values are used to determine appropriate outputs.
3. Output scan: outputs are update to agree with the calculated values.

Scan time: time to perform the scan. It depends on number of inputs to be read, complexity of the control function and number of outputs that must be changed. It also depends on the clock speed of the processor. Rang is 1~25msec.

What will happen if input changes faster than scan time?

PLC Vs PC

Before 90s, PLCs were always seen to have advantage of being designed for harsh environment, with built in I/O interface PLCs can be readily connected to the industrial equipments. However compared to PLCs,

-PCs have much greater frequency than PLCs

-Speed of PC is increasing much more rapidly

-In case of PCs, proprietary software and architecture are limited.

-PCs are now available in more sturdy enclosures, have membrane type keyboard, I/O cards/hardware to interface with the factory equipments are easily available.

-Now PCs have software (soft-logic) to emulate the operations of the built-in software used in PLCs