IPE-419 Computer Integrated Manufacturing

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June 2022

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Discrete Control Using PLCs and PCs

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Discrete Control Using PLCs and PCs

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

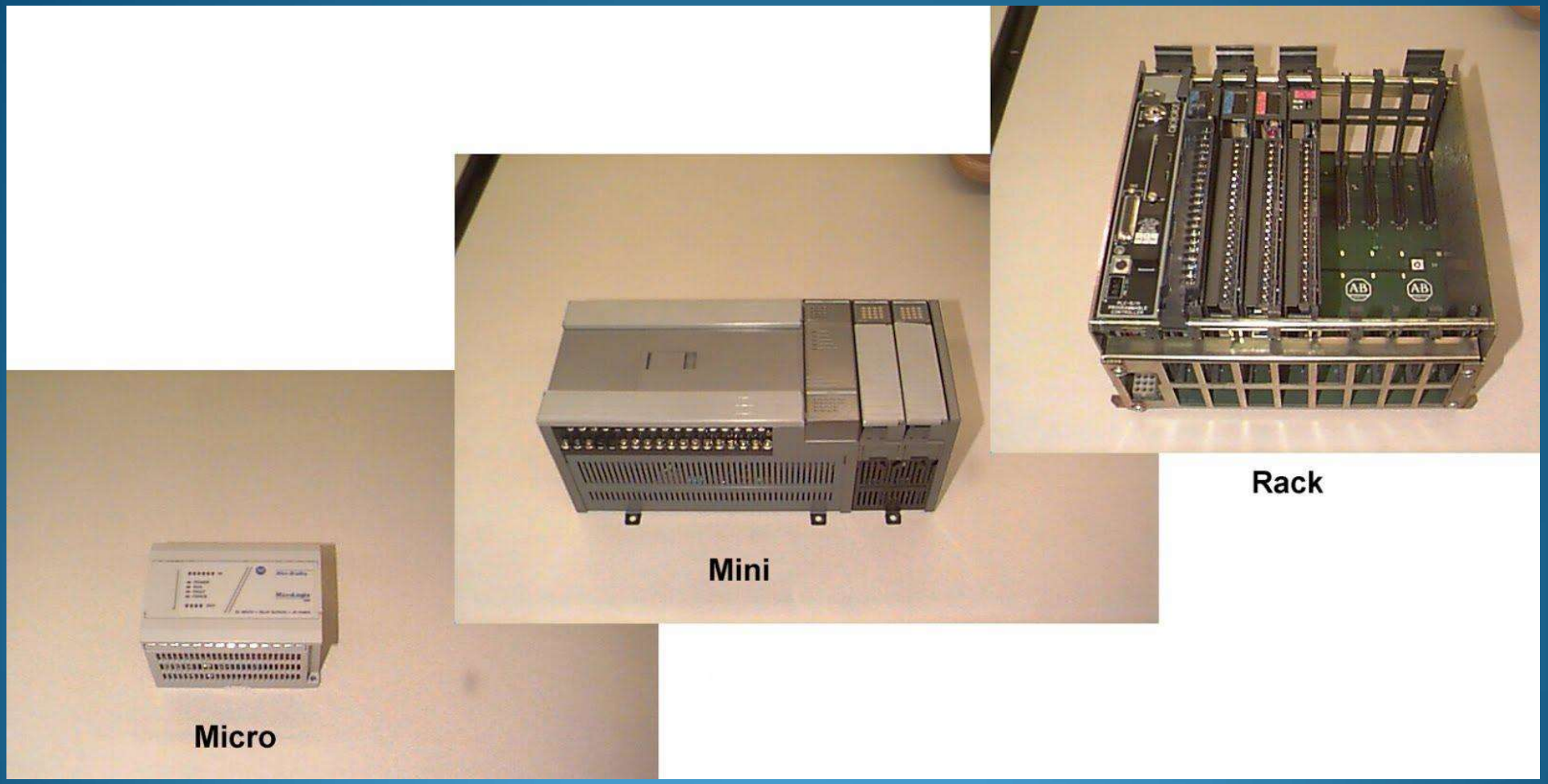
-Input signals to controller generally generated by binary sensors like limit switch, photo sensors.

-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.

PLCs



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Logic Control

-A logic control system is a switching system whose output at any moment is determined exclusively by the values of inputs. It has no memory and does not consider previous values of inputs.

Example: A robot picks up a part at some point on a conveyor belt and place the part into a forging press. To initiate the loading cycle

- raw part must be at the specific point (simple limit switch can sense)
- process on the previous part must be completed (machine can send signal)
- previous part must be removed from the die (a photo detector can detect the presence or absence of the part)

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Elements of logic control

-Three basic elements of logic control:

- 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.

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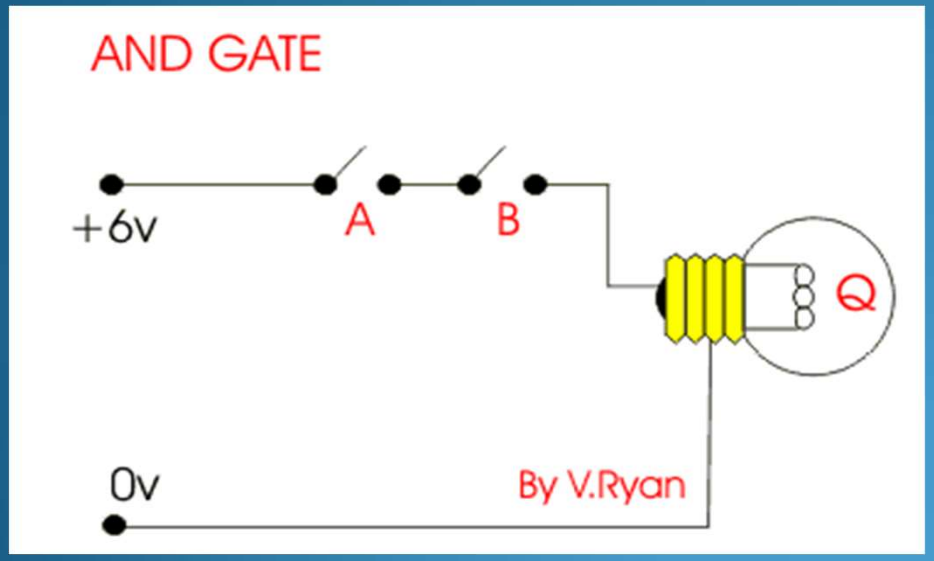
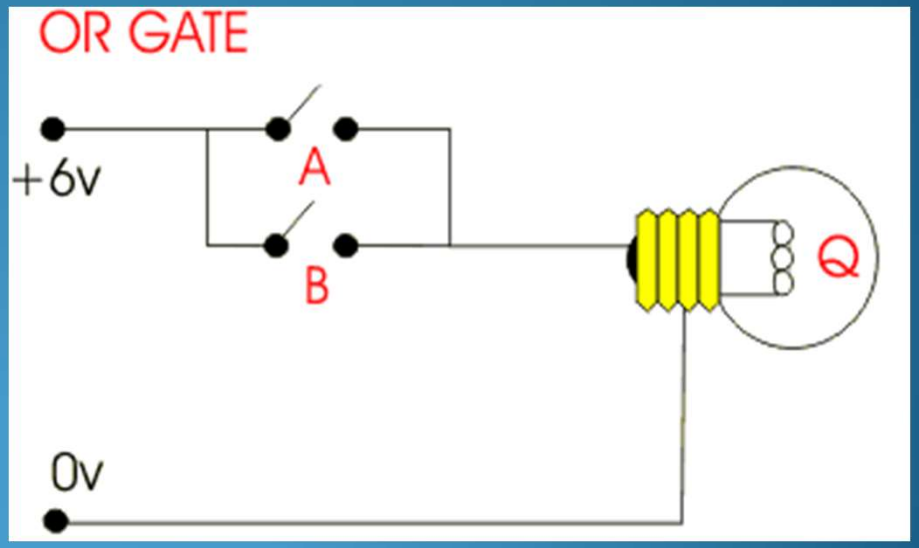
AND-output is 1 only when all inputs are 1

OR-output is 1 if either of the inputs is 1





Source:http://www.technologystudent.com/elec1/dig2.htm

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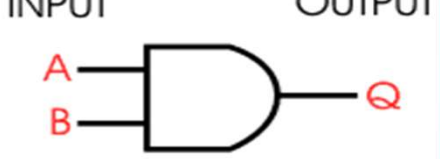
Symbols and truth tables

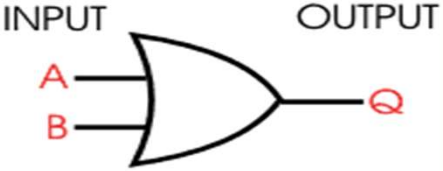
AND gate

A	B	Q
0	0	0



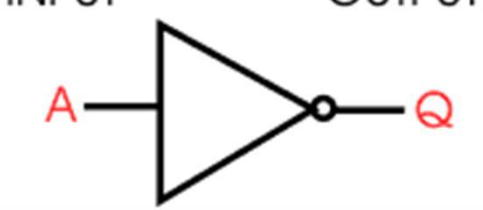
OR gate

A	B	Q
0	0	0



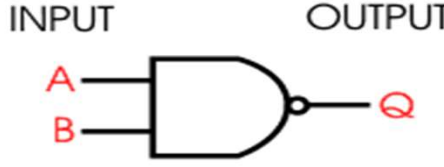
INVERTER gate

A	Q
0	1



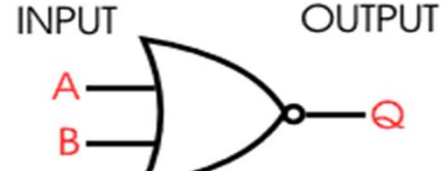
NAND gate

A	B	Q
0	0	1



NOR gate

A	B	Q
0	0	1



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Example of logic network diagram

A push button switch consists of a box with two switches, one for START and the other for STOP. When START button is depressed momentarily by a human operator, power is supplied to a motor until the stop button is pressed. What will be the logic network diagram and truth table for the push-button switch?

Here, values of variables are:
START = 0 (normally open contact status)
START = 1 (when START is pressed)
STOP = 0 (normally closed contact status)
STOP = 1 (when STOP is pressed to break contact)
MOTOR = 0 when off
MOTOR = 1 when on
POWER-TO-MOTOR = 0 when contacts are open
POWER-TO-MOTOR = 1 when contacts are closed

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Example of logic network diagram

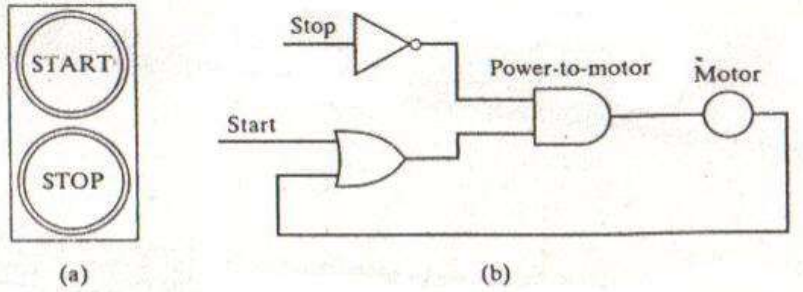

Figure 8.6 (a) Push-button switch of Example 8.2 and (b) its logic network diagram.

TABLE 8.7 Truth Table for Push-Button Switch of Example 8.2

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

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Sequencing

Uses internal timing devices to determine when to initiate changes in the output variables.

Example : Washining machine, drier, dishwasher etc.
Industrial applications: heating by induction coil, in such case there is no feed back (open-loop system).

Common sequencing elements: timer, drum timer, counters.

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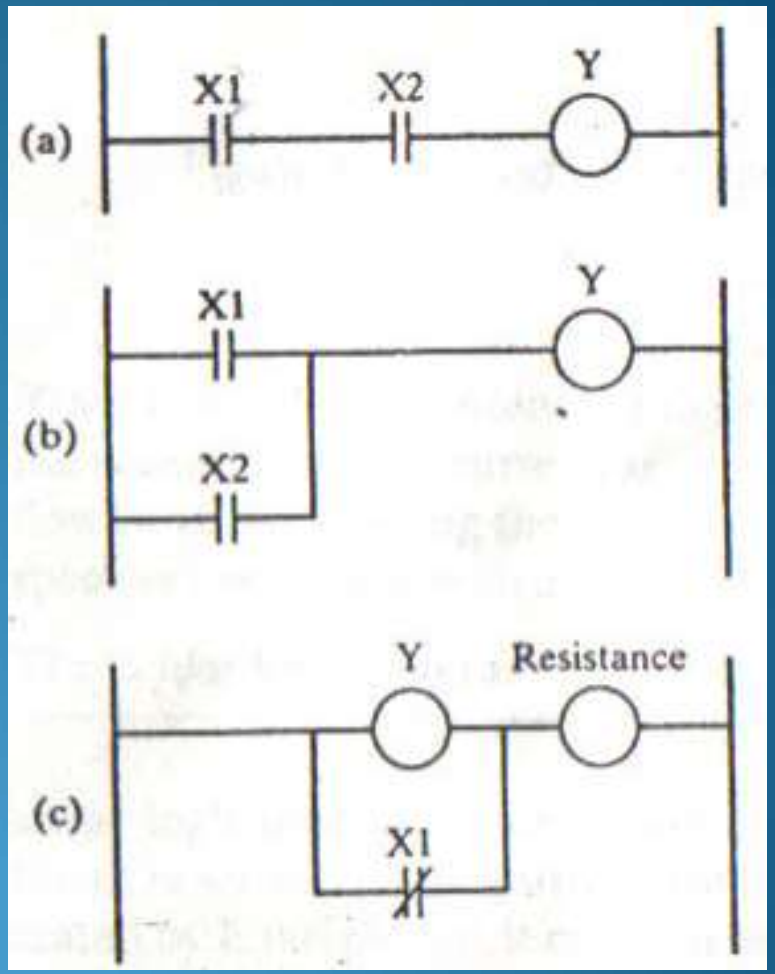
Ladder Logic diagram

- Exhibits the logic
- (to some extent) timing and sequencing
- Looks like electrical circuit
- rung-horizontal lines along which logic elements and other components are displayed



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Ladder Logic diagram Examples

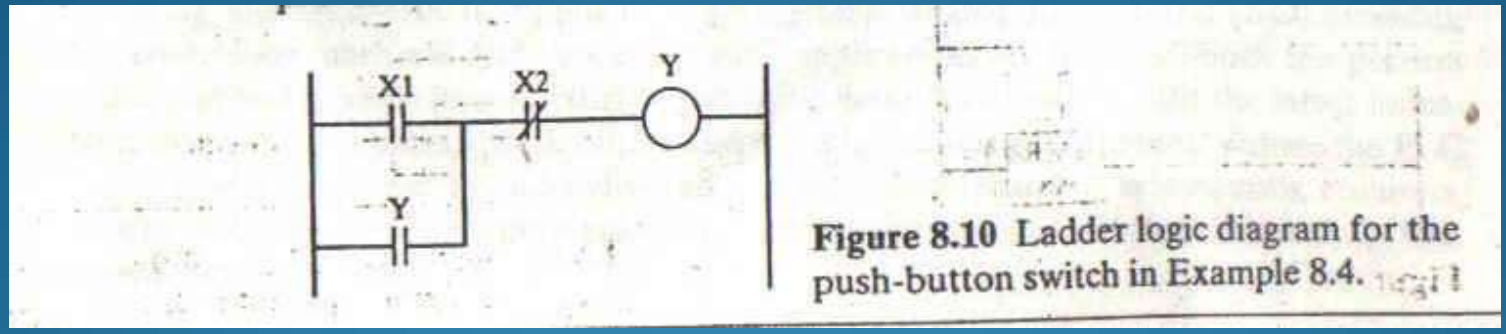

Figure 8.10 Ladder logic diagram for the push-button switch in Example 8.4.

Top: Push button switch

Bottom: Control relay to actuate two motors

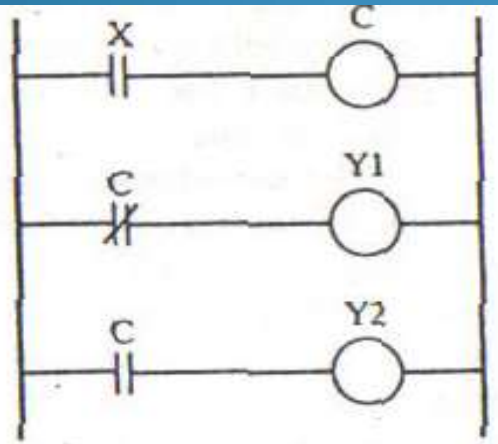

Figure 8.11 Ladder logic diagram for the control relay in *Example 8.5.*

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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

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PLC and its Components

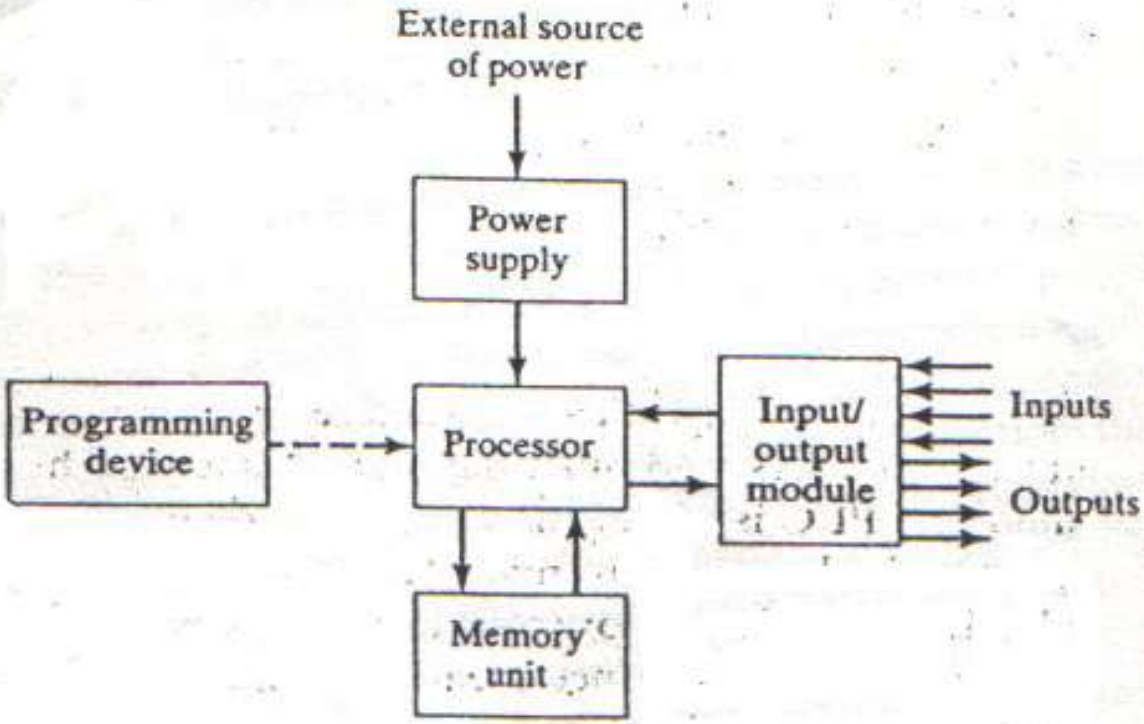

Figure 8.13 Components of a PLC

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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

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PLC Operation Cycle

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

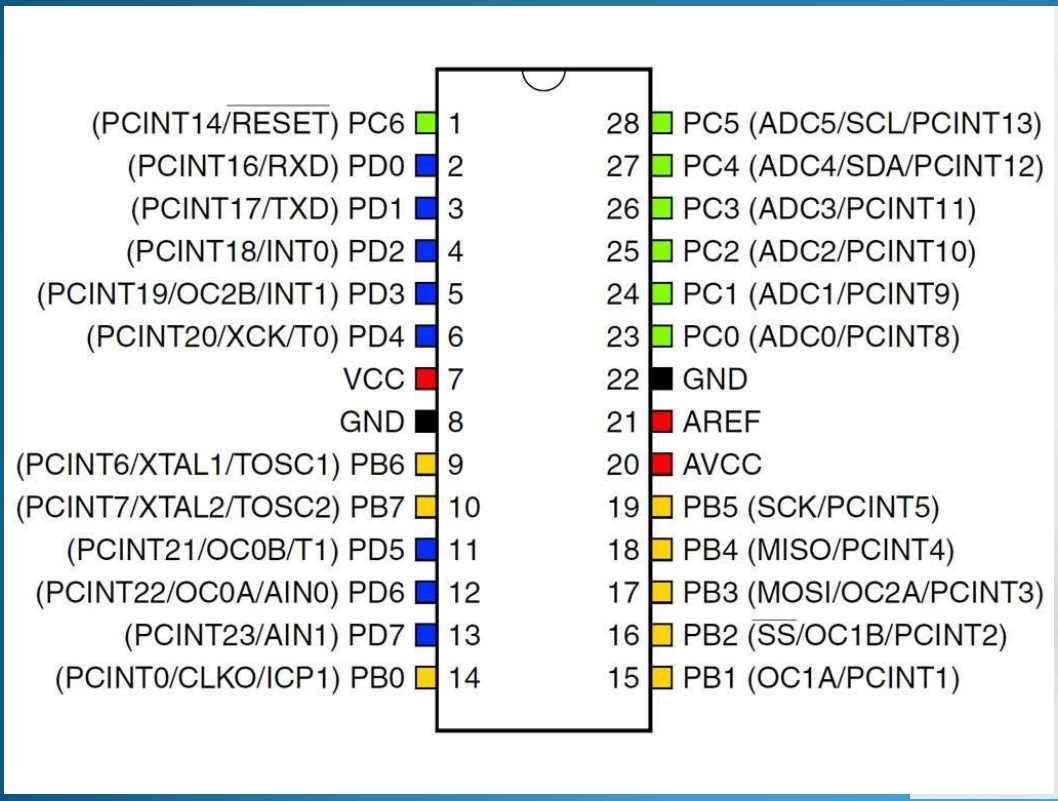
1. Input scan: inputs to the PLCs are read and stored in the memory.
2. Program scan: control program is executed during this scan. Input values are used to determine appropriate outputs.
3. Output scan: outputs are update to agree with the calculated values.

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?

Simple Microcontroller

- ATmega328P



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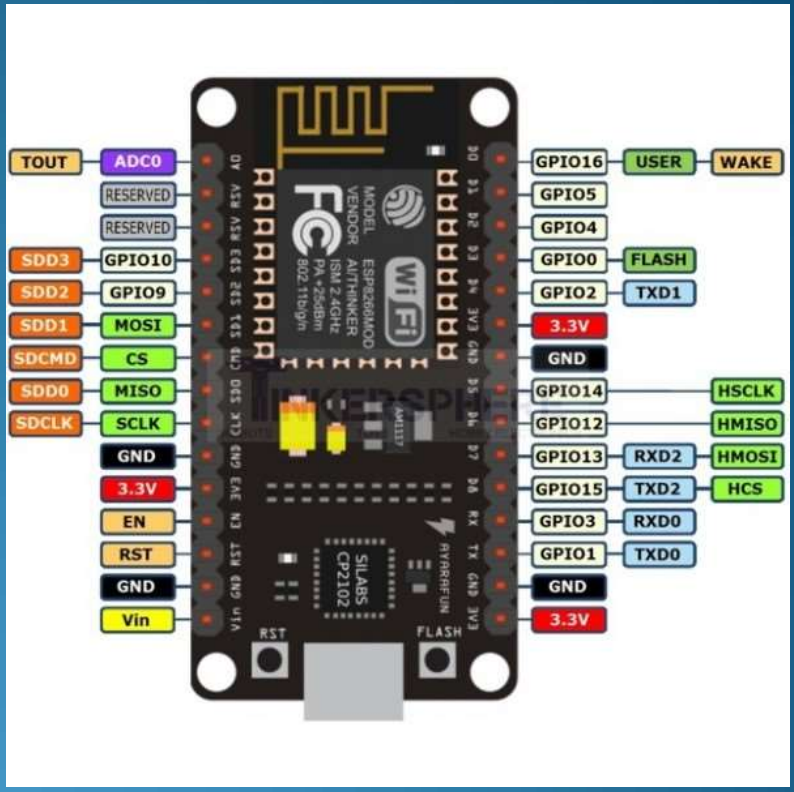
PC Using Soft Logic

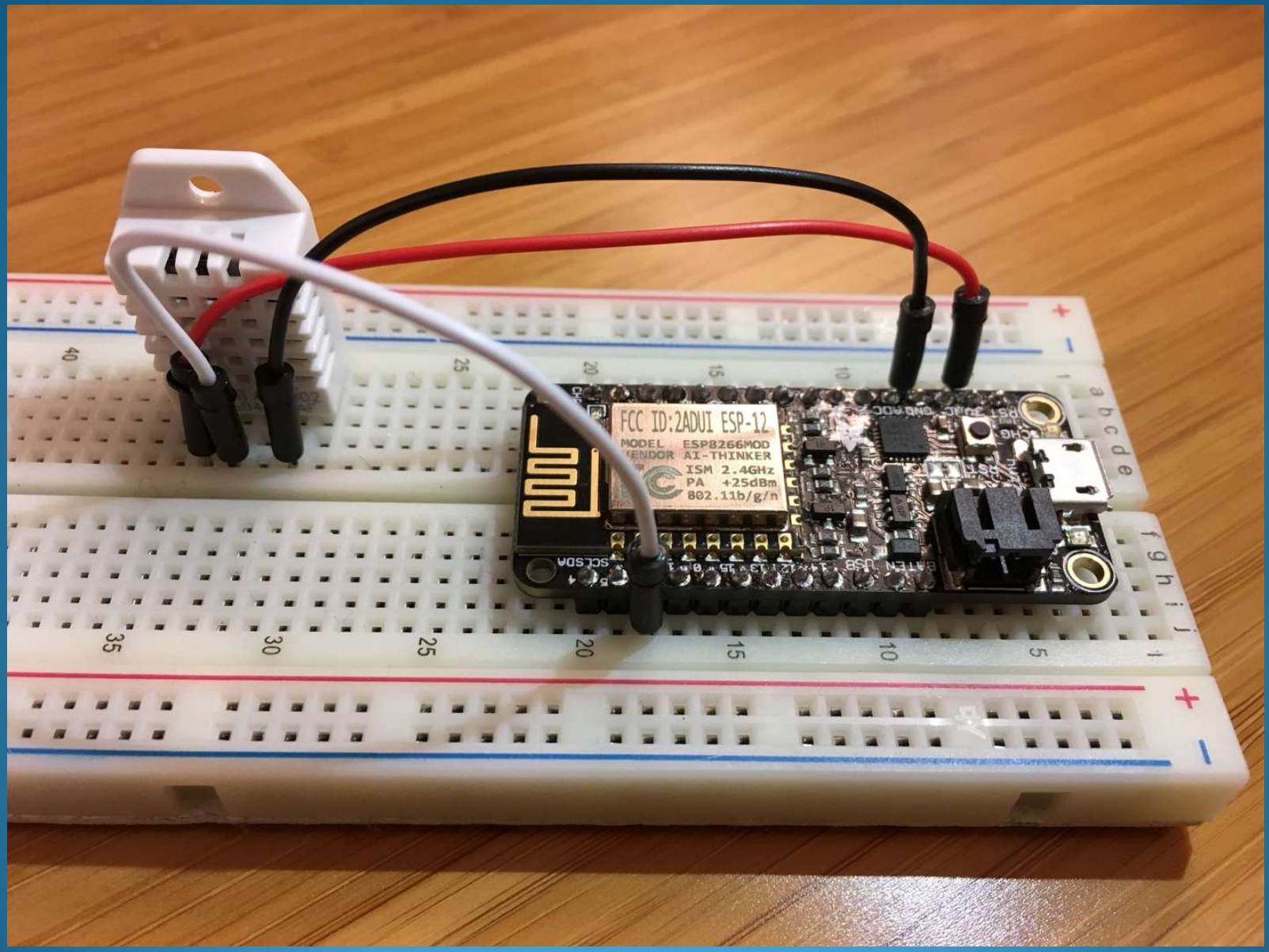
- Before 90s, PLCs were always seen to have advantage of being designed for harsh environment, with built in I/O interface PLCs can be readily connected to the industrial equipments.
- Compared to PLCs, PCs have much greater frequency than PLCs Speed of PC is increasing much more rapidly
- In case of 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

Assignment

- Distance measuring using arduino board, wheel, LED and LDR
- Rotate a motor for revolving a wheel corresponding to a specific distance.
- Popular PLC programming languages



Assignment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MODEL ESP8266MOD
VENDOR AI-THINKER
ISM 2.4GHz
PA +25dBm
802.11b/g/n

End of PLCs