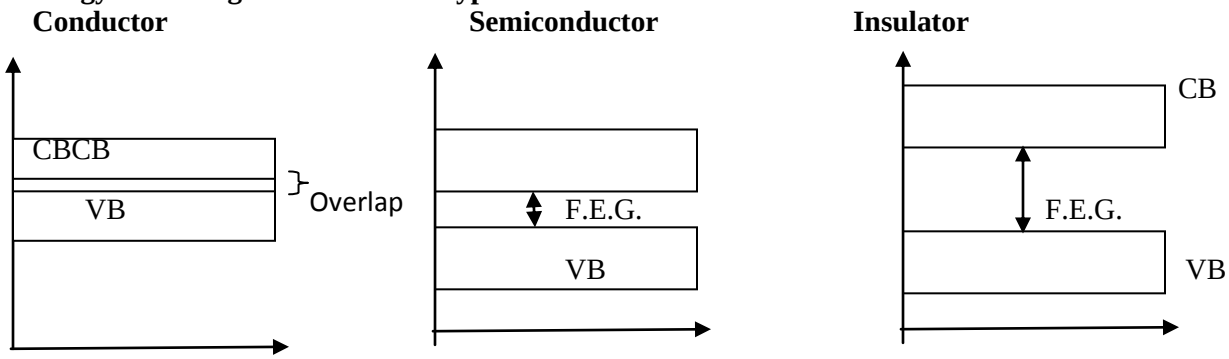
Model Answer

Important Instructions to examiners:

1) The answers should be examined by key words and not as word-to-word as given in the model answer scheme.
2) The model answer and the answer written by candidate may vary but the examiner may try to assess the understanding level of the candidate.
3) The language errors such as grammatical, spelling errors should not be given more Importance (Not applicable for subject English and Communication Skills.
4) While assessing figures, examiner may give credit for principal components indicated in the figure. The figures drawn by candidate and model answer may vary. The examiner may give credit for any equivalent figure drawn.
5) Credits may be given step wise for numerical problems. In some cases, the assumed constant values may vary and there may be some difference in the candidate's answers and model answer.
6) In case of some questions credit may be given by judgement on part of examiner of relevant answer based on candidate's understanding.
7) For programming language papers, credit may be given to any other program based on equivalent concept.

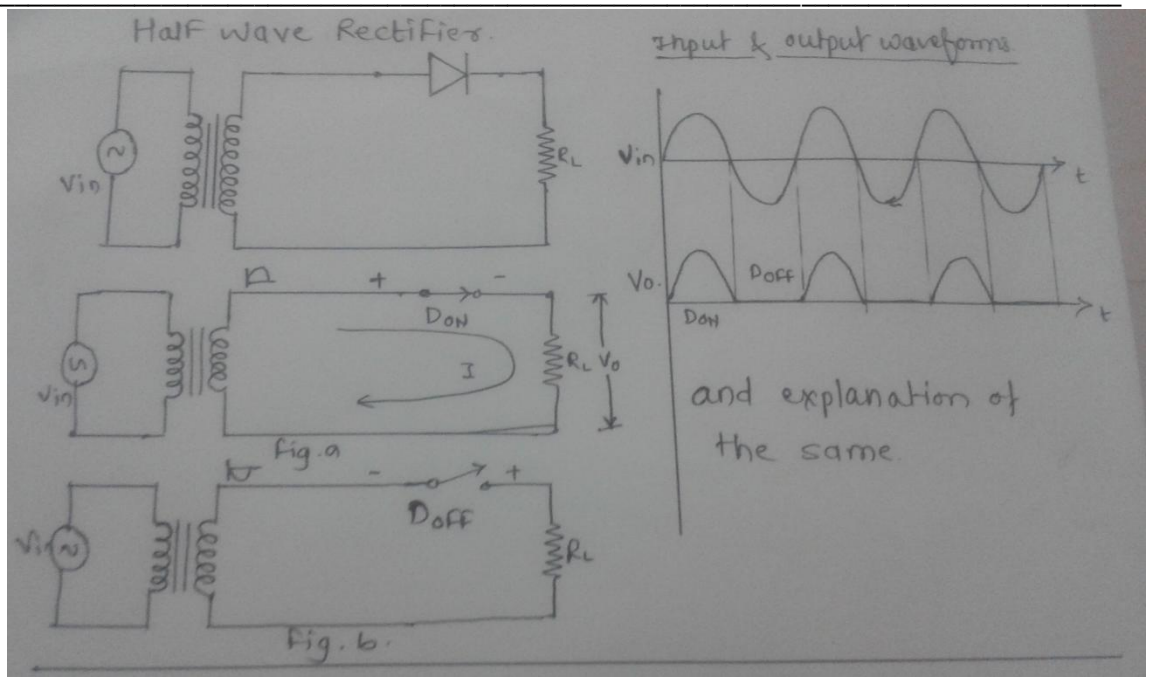
Q.1 Attempt any Five **20**

a. Energy band diagram for various types of materials

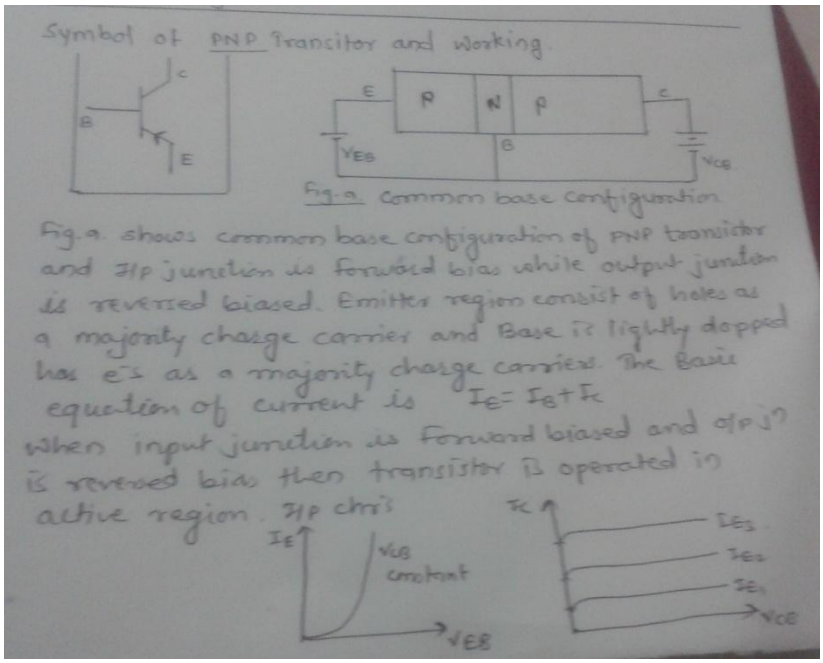


Conductor	Semiconductor	Insulator
No forbidden Energy gap	Less forbidden energy gap	Large forbidden energy gap
Conduction band is filled with electrons	Conduction band is partially fill	Conduction band is almost empty

b. Circuit diagram of Half wave rectifier.



Q.1c. Symbol of PNP transistor and its working



d. Compare RC and LC oscillator **1M * 4 = 4M**

RC Oscillator	LC Oscillator
Resistor and capacitors are used with transistor	Inductors and capacitors are used with transistor
This type of oscillators generates low frequency of oscillations	This type of oscillators generates High frequency of oscillations
Resistive load is used in this type	Inductive load is used in this type

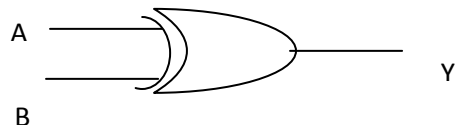
of oscillators	of oscillators
There are two types of RC oscillator i.e. Wein bridge and RC phase shift	There are two types of LC oscillator i.e. Heartly and Colpitt's oscillator.

Any suitable and relevant point may also considered.

e. Truth table and Symbol of XOR and XNOR gate.

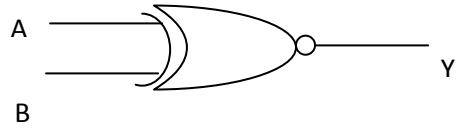
XOR Gate **1M + 1M = 2M**

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



XNOR Gate **1M + 1M = 2M**

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



f. Concept of Primary and Secondary Transducer

Primary Transducer: In this type of Transducer, energy conversion is only one times i.e. from physical to required one{Electrical or mechanical}.

For example: - Thermocouple converts temperature into voltage or C type Burdon tube converts pressure into Deflection of pointer.

Secondary Transducer: In this type of Transducer, energy conversion is two times i.e. from physical to To suitable {may another physical} and suitable to required one{Electrical or Mechanical}.

For example: - RTD or Thermister converts temperature into change in resistance and change in resistance is converted into voltage or C type Bourdon tube converts pressure into Displacement and displacement is converted into electrical signal using LVDT.

g. Advantages and Disadvantages of Mechatronics system

Advantages: -1. Fast speed of response **[2M]**

2. High accuracy

3. More flexible

4. Overall cost is low

Disadvantages:-1. More complex **[2M]**

2. Need of Expert

3. Difficult to maintain

4.Due to mechanical parts more Noisy system

Any suitable and relevant point may also considered.

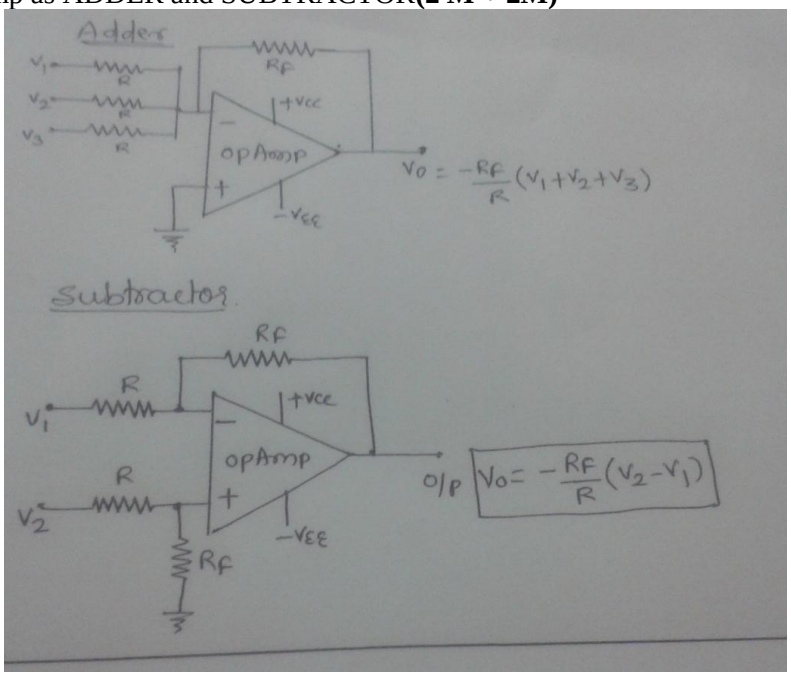
Q.2 Attempt any four **16**

a. Semiconductor: - A type of material has 4 valence electrons. And resistivity lies in between conductor and insulator. Semiconductors are available in systematic structure called as crystalline structure. There are two types of Semiconductors **[1M]**

Intrinsic semiconductor :- These is a pure form of semiconductors available in nature. It has high resistivity silicon and germanium are the most popularly used semiconductors. Each atom of semiconductor is forms a covalent bond with neighboring atom and completes its octet. **[1.5M]**

Extrinsic semiconductor :-when some purity is added to a pure semiconductor, the resultant semiconductor is known as Extrinsic semiconductor. The process of adding impurity is called as Doping. Generally trivalent and pentavalent impurities are used to get p-type and n-type semiconductors. **[1.5M]**

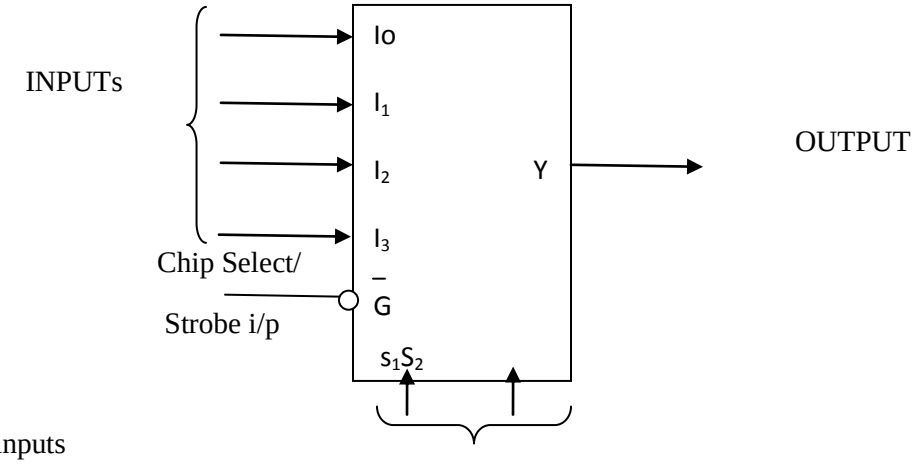
b. Opamp as ADDER and SUBTRACTOR **(2 M + 2M)**



c. Multiplexer :- A combination logic circuit consist of many inputs and only one output. Particular input is selected at output with the help of Select input. The relation between select inputs and inputs

is given as $2^N \geq M$ where M is the number of inputs to multiplexer and N is the number of Select inputs. The standard multiplexer available are 2:1,4:1,8:1,16:1 ……..**[2M]**

Logical symbol of 4:1 multiplexer for 4:1 mux we required 2 select inputs.[2M]



d. Selection Criteria for Transducer for any application. **1M * 4 = 4M**

1. Type and nature of the physical quantity.
2. Accuracy of the transducer should be high.
3. Working principle of the transducer i.e. resistive, inductive, capacitive etc.
4. Transducer should have flat and stable frequency response.
5. Operating temperature of the transducer.
6. Transducer should have ability to withstand against shocks and vibrations
7. Transducer should not produce any loading effect on the next stages.
8. Transducers should have better linearity and stability.
9. Transducers should have high accuracy.
10. Transducers should be affected by noise and drift.

e.Definition of PLC **1M**

"Programmable logic controller is defined as a sequential logic device that generates output signals" according to the logic operations performed on the input signals." or PLC is a digitally operated electronic system which used programmable memory for the internal storage of user-oriented instructions for implementing specific functions such as logic sequencing, timing counting and arithmetic to control through analog inputs and outputs, various types of machines or processes.

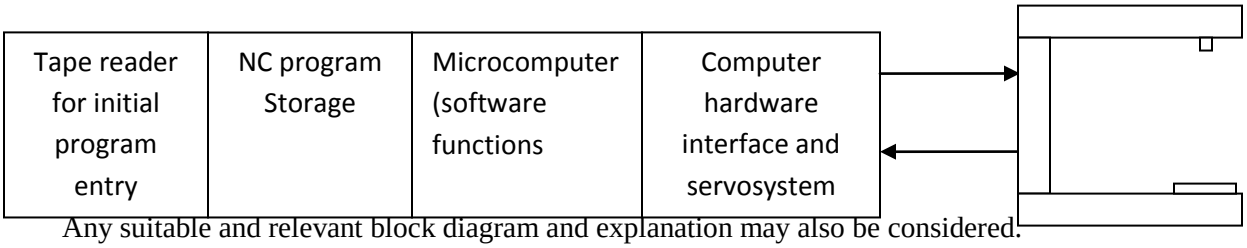
Applications of PLC: 1) In pharmaceutical industries. 2) Robotics or robot control systems. 3) Bottle filling plants. 4) Control systems.**1M**

2M

Programming device

Any suitable and relevant block diagram may also considered.

f. Block diagram of CNC Machine: (2M for Block diagram + 2M for Explanation)



Any suitable and relevant block diagram and explanation may also be considered.

Q.3 Attempt any four

a) Explain following terms

a) Load Regulation (2 marks)

It is defined as the change in output voltage when the load current changes from zero (no load value) to maximum (full load value).

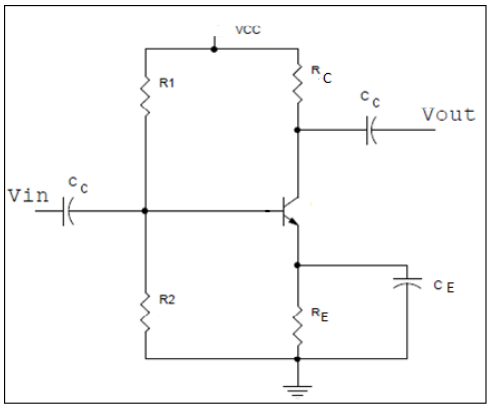
$$\%L.R. = \frac{V_{NL} - V_{FL}}{V_{FL}} \times 100$$

b) Line Regulation (2 marks)

It is defined as the change in output voltage when line voltage changes in a specified range of 230V± 10% at constant load current

$$\% S.R. = \frac{V_{LH} - V_{LL}}{V_{NOR}} \times 100$$

b) Explain RC coupled amplifier with the help of neat diagram.
(Circuit - 2 marks , explanation- 2 marks)



- R_1, R_2, R_E are used for biasing the transistor in active region.
- R_C is collector resistor to control collector current.
- Cc are coupling capacitors to block DC component and only pass AC signal.
- C_E is emitter bypass capacitor to keep transistor in active region and provide high gain
- When Input is absent dc current will flow through circuit viz. I_{BQ}, I_{CQ}.
- When small ac signal is applied at the input it will vary above and below dc value. i.e. I_B & I_C
- Ic is magnified version of I_B as $Ic = \beta I_B$.
- This varying Ic passes through Rc to produce voltage drop.
- Collector voltage is given by Vc= Vcc – IcRc
- As Ic increase Vc decreases.
- This Vc is available at the output through Ccc. Which is amplified version of input.

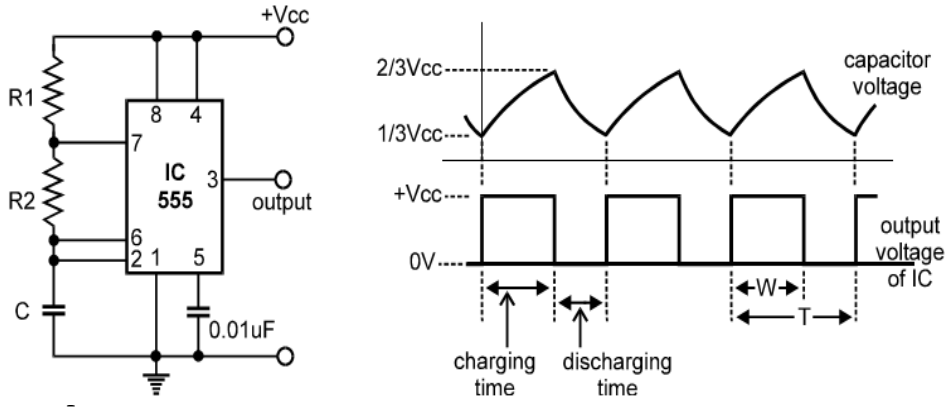
c) Instrumentation Amplifier

Definition (2 Marks) : An instrumentation amplifier is a type of differential amplifier which amplifies the low level output signal of a transducer to such a level that it can drive the indicator or display.

Advantages (2 Marks)

- High differential gain of the circuit
- Large Common mode rejection ratio.
- Even a small value of input voltage can be amplified
- Eliminate the need for input impedance matching
- High input impedance

d) **Explain the operation of astable multivibrator using IC555.**
(circuit – 2mark, explanation – 1 marks, waveform – 1 mark)



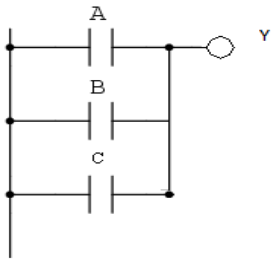
- Initially output voltage(Vcc) is high hence the capacitor starts charging from 1/3Vcc through R1 & R2.
- As V_C (capacitor voltage) reaches 2/3 Vcc the output is reset and o/p voltage is zero. The capacitor then discharges through R_2.
- As Vc reaches 1/3Vcc, capacitor again starts charging through R1 & R2, and output switches to high state.

e) Compare microprocessor and microcontroller (any 4 points- 4 marks)

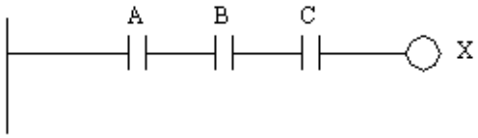
Sr. No.	Microcontroller	Microprocessor
1	Inbuilt RAM & ROM	Do not have Inbuilt RAM & ROM
2	Inbuilt timer	Do not have Inbuilt timer
3	Inbuilt serial port	Do not have Inbuilt serial port
4	I/O ports available	Not available. Requires extra device
5	Separate memory to store program and data	program and data stored in same memory
6	Many multifunction pins on IC	Less multifunction pins on IC
7	Boolean operation on individual bits is possible directly	Boolean operation on individual bits is not possible directly
8	Few instructions to read/write data to/from external memory	Many instructions to read/write data to/from external memory

f) Develop ladder diagram to verify following Boolean equations.

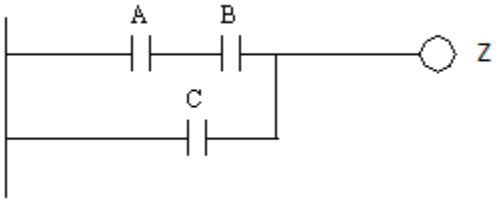
i) A + B + C = Y (1 mark)



ii) A.B.C = X (1 mark)



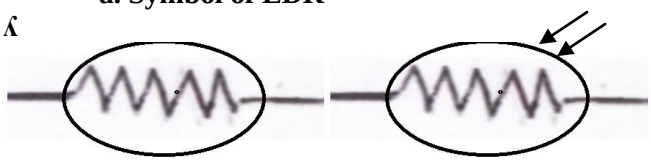
iii) A.B + C = Z (2 marks)



Q.4 Attempt any Four **16**

a. Symbol of LDR

ʎ **1M**



Working Principle:-As the intensity of Light changes the conductivity of this resistor will get Changes and change in conductivity is directly proportional to intensity of light.Andnon linear in nature. **2M**

Application :-1. used in Batch counter or object counter circuit. **½*2=1M**
2. used in opto coupler circuits
Any suitable and relevant application may also considered.

b. Need of Biasing circuit :- used to fix the operating point of the transistor. **2M**

1. To set proper value the zero signal collector current Ic

2.To set proper value of collector to emitter voltage Vce

Types of biasing circuits for BJT :-Base biasing **½*4 = 2M**

Collector to base biasing

Emitter biasing

Voltage divider Biasing

Mid point biasing

c. Any four specification of IC 741 **1 *4 = 4M**

1. Supply voltage range: -**±12V to ±18 Volt**
2. Input impedance: - **2MΩ**
3. Requires dual power supply
4. Offset null pin is available
5. Open loop gain: - **2×10^5**
6. Slewrate: - **0.5 volt /□sec**

Any suitable and relevant specification may also consider.

Q.4 **d.Flip flop :-** it is a one bit storage device or bi-stable device used to store binary bit. **1M**

Different types of Flip flops :- R-S flip flop **2M**

J-K flip flop

J-K MS flip flop

D flip flop

T flip flop

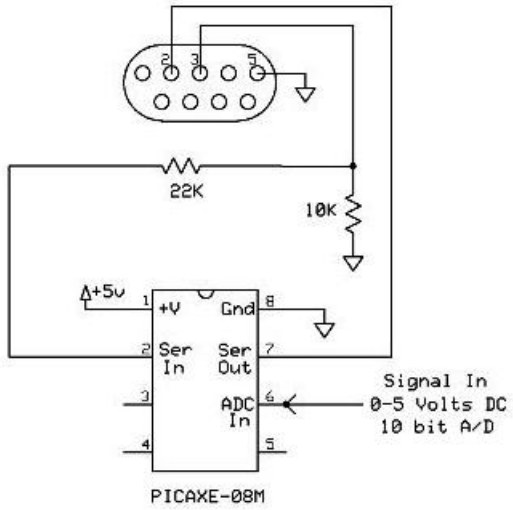
Applications :-Used to implement counters **1M**

Used to implement Registers

e. operation of Analog to Digital Convertor :- (2 M for block diagram + 2 M for explanation)

It is a circuit which converts the analog information into digital signals. There are different types of Analog to Digital Convertor like successive approximation, Ramp, dual slop.

The conversion involves quantization of the input, so it necessarily introduces a small amount of error. Instead of doing a single conversion, an ADC often performs the conversions periodically. The result is a sequence of digital values that have been converted from a continuous-time and continuous-amplitude analog signal to a discrete-time and discrete-amplitude digital signal.



(Appropriate Block diagram and explanation should be considered)

f. Features of Real time Mechatronics:- min 8 **8 * 1/2 = 4M**

1. More Flexibility
2. Overall size is less
3. High speed of operation
4. High accuracy.
5. Easy to operate
6. Overall cost decreases
7. Less time delays
8.low power consumption

Any suitable and relevant feature may also consider.

Q.5 Attempt any four **16**

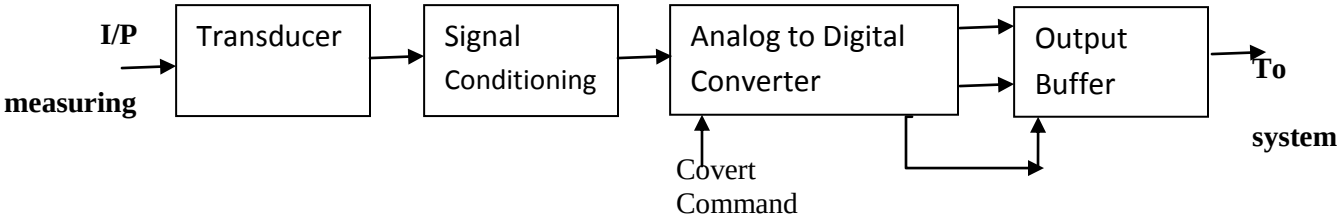
a] Criteria for selection of PLC for an application **1 M x 4 = 4M**

1.Number of inputs and number of outputs of PLC.
2. Nature of input and output i.e. Analog or Digital
3. Speed of operation
4. Programming Flexibility
5. Power consumption.
6. Cost of PLC

{ any other relevant and appropriate criteria may also considered}

b] Block diagram of single channel Data Acquisition system.

2M + 2M= 4M



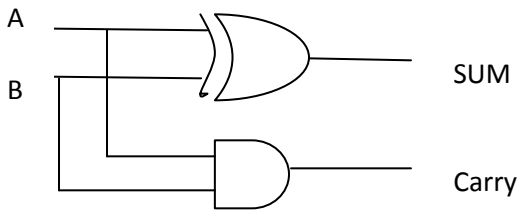
Explanation of Each block

Input – physical quantity which is to be measured or stored is applied at input to transducer.

Transducer – suitable transducer is used to convert physical quantity into electrical signal
Signal conditioner – used to bring a signal into proper condition
ADC- used to convert analog signal into digital signal and given to output buffer
Output buffer- output of this block is connected to a measuring system.

c]Half Adder – A combinational circuit used to perform addition of two binary bits and produces Sum and Carry bits as a result. **1M**

Logical Circuit diagram- **2M**



Truth Table **1M**

A	B	Sum	Carry
0	0	0	0
0	1	1	0
1	0	1	0
1	1	0	1

Q. 5 Attempt any <u>FOUR</u>.

a) Criteria for the selection of PLC : (any four. 1 mark for each)

1) Number of inputs and number of outputs required for an application

2) Type of inputs and outputs required (i.e. analog/digital)

3) Size of memory is required.

4) Type of memory required.

5) Electrical requirements.

6) Speed of operation.

7) Operator interface

8) Software. i.e. type of programming required.

b) Single channel data acquisition system.

Explanation (2 marks):

- Single channel data acquisition system is used to convert only single physical quantity into it equivalent digital form
- It consists of transducer, signal conditioner, sample & hold circuit and ADC.
- Transducer: It converts physical quantity into analog electrical signal.
- Signal conditioner: Analog electrical signal is processed & boost by this circuit.

- Sample & Hold circuit: It samples the analog signal at regular interval and converts it into discrete signal.
- ADC: It is used to convert each sampled value into equivalent digital signal.

Diagram (2 marks)

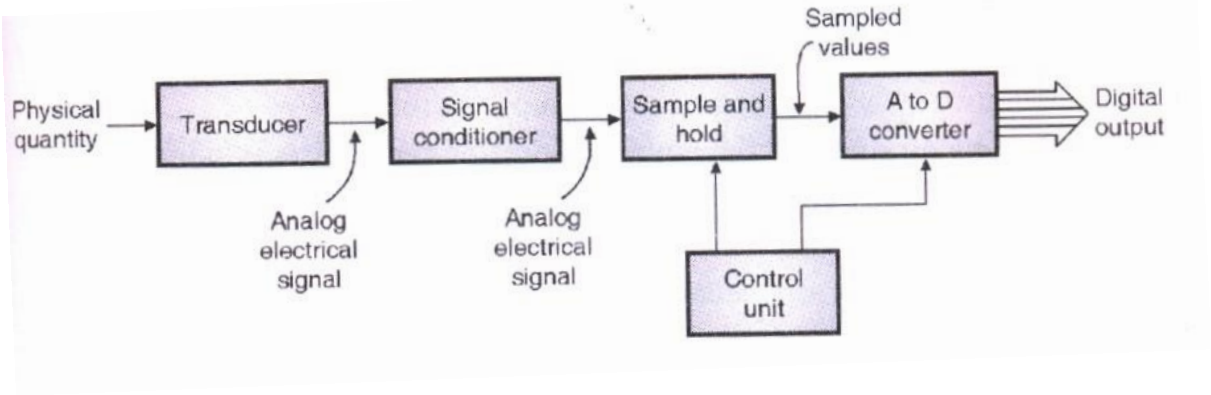
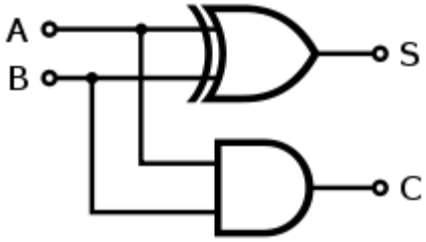


Fig: A single channel Data Acquisition System

c) Half Adder (1 mark):

Half adder is combinational logic circuit with 2 single bit input and 2 outputs i.e. Sum (S) & Carry (C).

Logic circuit diagram: (1 Marks)

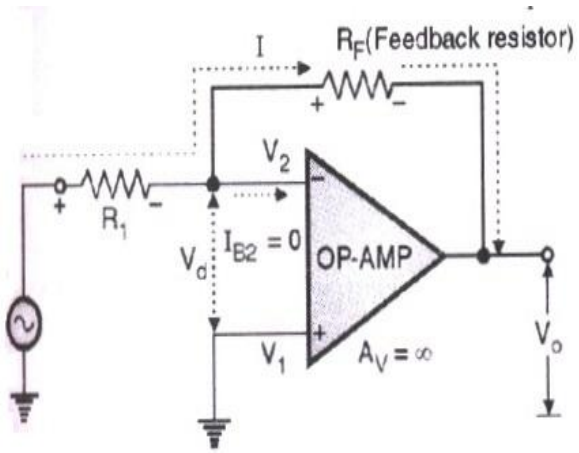


Truth Table: (2 Mark)

Input		Output	
A	*B*	*C*	*S*
0	0	0	0
0	1	0	1
1	0	0	1
1	1	1	0

Truth table

d) Circuit diagram of inverting amplifier: (2 Marks)



Example:

Given: Rf: 12KΩ

R1: 1KΩ

Gain Av = - Rf/R1 (1 mark)

= - 12kΩ/1kΩ

Av = - 12 (1 mark)

e) Gain of Multistage amplifier:

Gain in dB of multi stage amplifier is given as

Av(dB) = Av1 + Av2 (2 marks)

= 12 + 4

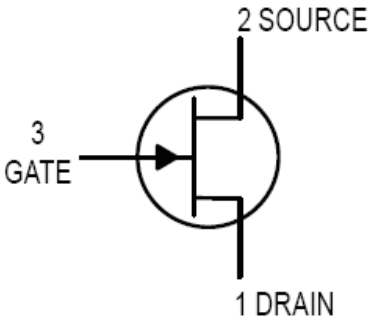
= 16 dB (2 marks)

f) Comparison of full wave & half wave rectifier (any four. 1 mark each)

Parameter	Full wave rectifier	Half wave rectifier
No of diode	2	1
Center tap transformer	Required	Not required
Conduction cycle	Both half of the input	only half of the input
PIV of diode	2Vm	Vm
Ripple frequency	100Hz	50Hz
Ripple factor	0.48	1.21
Rectifier efficiency	81.2%	48%
TUF	69.2%	28.7%

iQ. 6 Attempt any <u>FOUR</u>

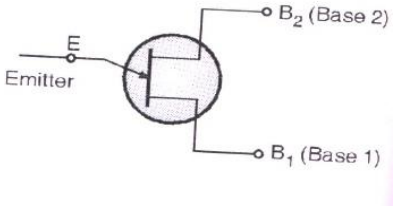
a) i) FET (2 mark) Symbol (n-channel/p-channel) :



Application : any four

- FET can be used as amplifier
- FET can be used as Switch
- As a VVR
- In digital circuit

ii) UJT (2 mark): Symbol



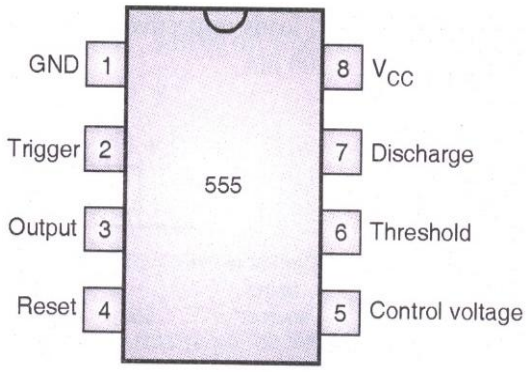
Application : any four

- Relaxation oscillator
- In UJT Timer
- In voltage sweep generator
- In Automobile ignition circuit

b) Comparison of CB & CE configuration for BJT (Any four, 1 mark each)

Parameter	**CB**	**CE**
Input resistance	Low	Medium
Output resistance	High	Medium
Current gain	Less than 1	High
Voltage gain	High	High
Phase shift	0^0	180^0
Application	Low noise pre-amplifier, wide band amplifier	AF voltage amplifier

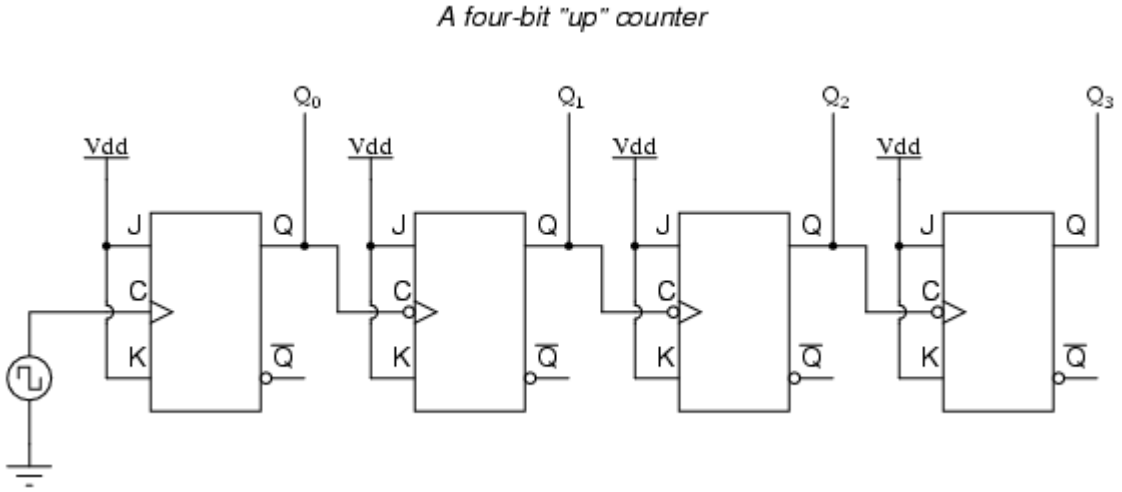
c) Pin diagram of IC 555. (2 marks)



Specification of IC 555 (any two, 1 mark each)

- Supply voltage range : 5 to 18 volts
- Current sinking and sourcing capacity : 200mA

d) 4- bit asynchronous counter (up/down): (4 marks)



e) 1 mark each

i) Thermocouple : Active transducer

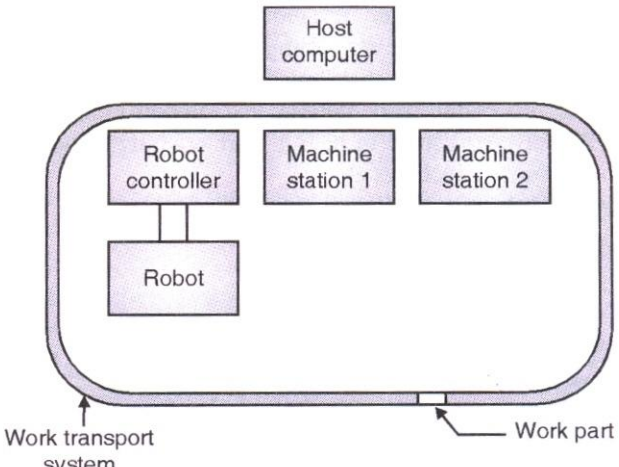
ii) RTD : Passive thermocouple

iii) Strain gauge: Passive thermocouple

iv) Piezoelectric crystal: Active transducer

f) Flexible manufacturing system (FMS)

Diagram (2 marks)



Explanation (2 marks):

- A flexible manufacturing system (FMS) is a manufacturing system in which there is some amount of Flexibility that allows the system to react in case of changes, whether predicted or unpredicted.
- Most **FMS** consist of three main systems.
  i) the work machines which are often automated CNC machines
  ii) Material handling system to optimize parts flow and
  iii) The central control computer which controls material movements and machine flow.
- The work machine perform various operations on work parts using CNC
- Material handling system used to optimize parts flow between work center or from storage system to work station.
- The central control computer located at the center of FMS to controls material movements and to acquire data from each work machine.