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 judgment 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 TEN: **[20M]**

a) Define: i) Zero Drift ii) Hysteresis effects

Ans(Each definition: 1M)

Zero drift:-

If the whole calibration gradually shifts due to slippage, permanent set or due to undue warning of a electronic circuit, zero drift sets in the instrument. It is a deviation of the output from the actual output.

Hysteresis effect:-

Hysteresis effect is due to magnetic effects of the metals. It gives the relation between field current and the output voltage.

The magnetization of ferromagnetic substances due to a varying magnetic field lags behind the field. This **effect** is called **hysteresis**, and the term is used to describe any system in whose response depends not only on its current state, but also upon its past history.

b) State the principle of calibration.

Ans :(2M)

- The process of deriving the value of a quantity by comparing that quantity with a standard quantity is called as calibration.
- Calibration of instrument is done to obtain correct unknown value of each scale reading on measuring instrument

c) Define the transducer. Give any one example.

Ans: (Definition 01M, Any 1 Example 01M)

Transducer is defined as a device which coverts one form of energy into another form.

Example:-

Bourdon tube, diaphragm, bellows, LVDT, strain gauge.

d) List any two sources of error in thermistor.

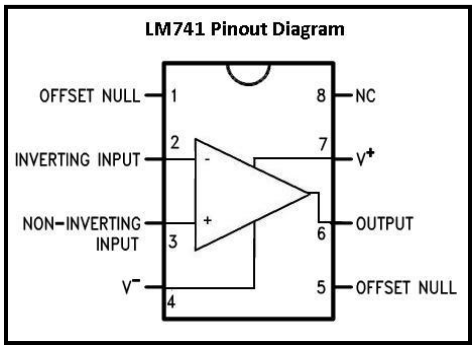
Ans: (Any 2, 1 M each)

Sources of errors:

i) Self-heating effect due to high bias current.
ii) Lead wire resistance
iii) Insulation cover / material

e) Draw neat labeled pin diagram for 741 IC.

Ans: (For labeled diagram-2M)



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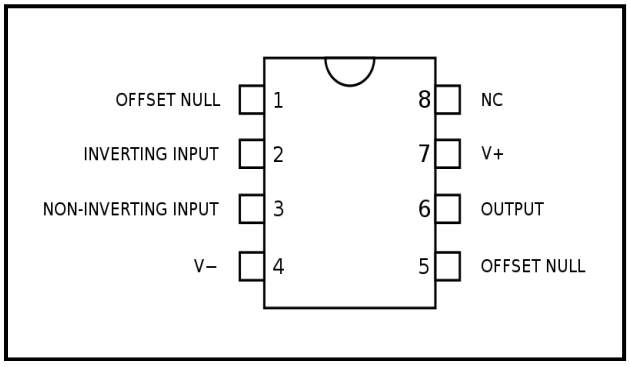


f) State any two characteristics of an ideal Op-amp.

Ans: (Any Two- 2 M)

Characteristics of Op-amp:

i) Input offset voltage
ii) Input offset current
iii) Input bias current
iv) Differential input resistance
v) Input capacitance
vi) CMRR-common mode rejection ration
vii) Supply voltage rejection ratio(SVRR)
viii) Output resistance

ix) Voltage gain
x) Bandwidth
xi) Slew rate

g) Define pressure and write its SI unit.

Ans: (Definition 01M, Any one Unit 1M)

Pressure is defined as force acting (perpendicular) on unit surface area.
P = F/A
Units of pressure Kg/cm^2,psi (pounds per Sq inch), Pascal

h) Define volumetric flow rate. List any one device used to measure volumetric flow.

Ans: (Definition 01M, Any one Device 1M)

The volume of flow passes through pipe in unit time.

List :-

Magnetic **Flow sensor**, turbine **Flow sensor**, vortex shedding, ultrasonic **Flow sensor**

i) Define the following terms related to Op-Amp:

i) CMRR
ii) SVRR

Ans: (For each definition-1M)

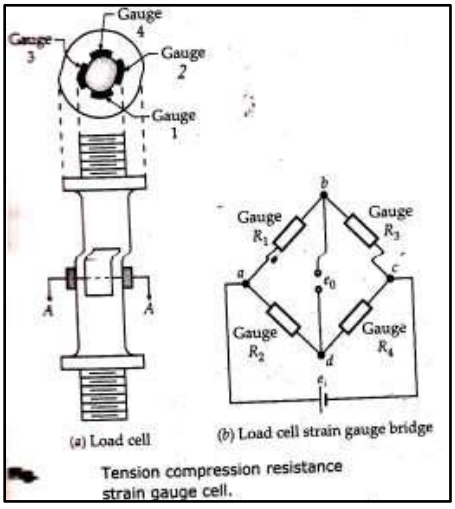
Definition:-

i) SVRR: It is defined as the ratio of change of input offset voltage to the change in one supply voltage while keeping other supply voltage constant.
Ideally,SVRR=0

ii)CMMR:-The CMRR is defined as the ratio of the powers of the differential gain over the common-mode gain, measured in positive decibels (thus using the 20 log rule):
As differential gain should exceed common-mode gain, this will be a positive number, and the higher the better.

j) Draw the neat labeled diagram for measurement of force using load cell.

Ans:- [For labeled diagram-2M]

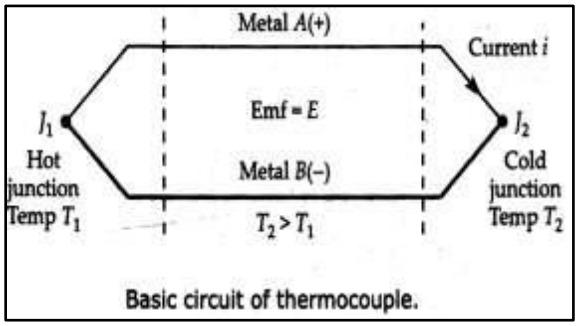


Tension compression resistance strain gauge cell.

k) List any four applications Op-Amp in signal conditioning circuits.
Ans: (Any four –Each 1/2M)

Application of Op-amp in Signal conditioning circuit:
1) Electronic Weighing scale
2) Temperature indicator and controller
3) Light intensity meter
4) Pressure monitoring and control

l) Draw the circuit diagram for measurement of temperature using thermocouple.
Ans:- (For labeled diagram-2M)



Basic circuit of thermocouple.

Q.2. Attempt any FOUR of the following: [16M]

a) List and explain dynamic characteristics of instrument.

Ans: (List: 2 M, Explanation: 2 M)

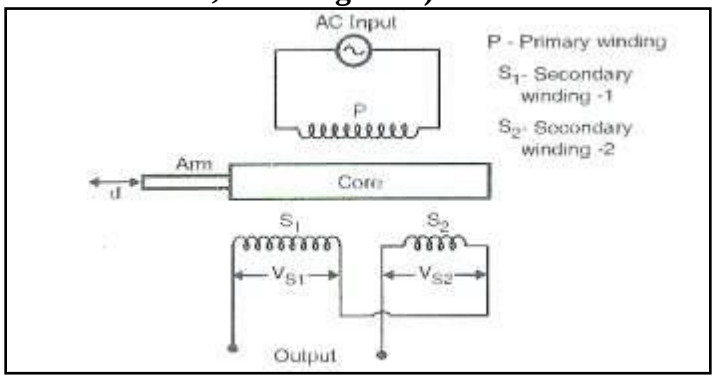
Dynamic characteristics of Instruments are:

1) **Speed of Response**: It is the rapidity with which a measurement system responds to changes in the measured quantity.
2) **Measuring Lag:** It is the retardation or delay in the response of a measurement system responds to changes in the measured quantity. There are two types of it: i) Retardation type, ii) Time delay type.
3) **Fidelity:** It is the degree to which a measurement system indicates changes in the measured quantity without dynamic error.
4) **Dynamic Error**: It is the difference between true values of quantity changing with time and the value indicated by the measurement system if no static error.

b) Different types of thermocouple with Material used and temperature ranges.
Ans: (Any 4Types: - 4M)

SR.NO	THERMOCOUPLE TYPE	MATERIALS USED	TEMPERATURE RANGE in °C
1	T	Copper/ Constantan	-200^0 to 400^0
2	E	Chromel/Constantan	0^0 to 850^0
3	J	Iron/Constantan	-200^0 to 900^0
4	K	Chromel/Alumel	-200^0 to 1250^0
5	R	Platinum/Platinum 13% Rhodium.	0^0 to 1600^0
6	S	Platinum/Platinum 10% Rhodium.	0^0 to 1500^0
7	B	Platinum 6% Rhodium/ Platinum 30% Rhodium	30^0 to 1800^0
8	G	Tungsten/ Tungsten 26% Rhenium	15^0 to 2800^0
9	C	Tungsten 5% Rhenium / Tungsten 25% Rhenium	0^0 to 2750^0

c) Explain working of LVDT with suitable diagram.
Ans: (Diagram -1 M, Characteristics-1 M, Working -2 M)



Case I: When there is no displacement.
i) When there is no displacement attached to the core the core is at normal position, the flux linking with both the secondary winding are equal.
ii) Equal e.m.f. are induced in both secondary winding when the core is at null position VS1=VS2
iii) Hence the output voltage Vo at null position is zero.

Case II: When there is positive displacement
i) When there is positive displacement applied to the core i.e. the core is moved to left of null position, more flux links with winding S1 than winding S2
ii) Here e.m.f. induced with winding S1 is greater than winding S2 that is VS1>VS2

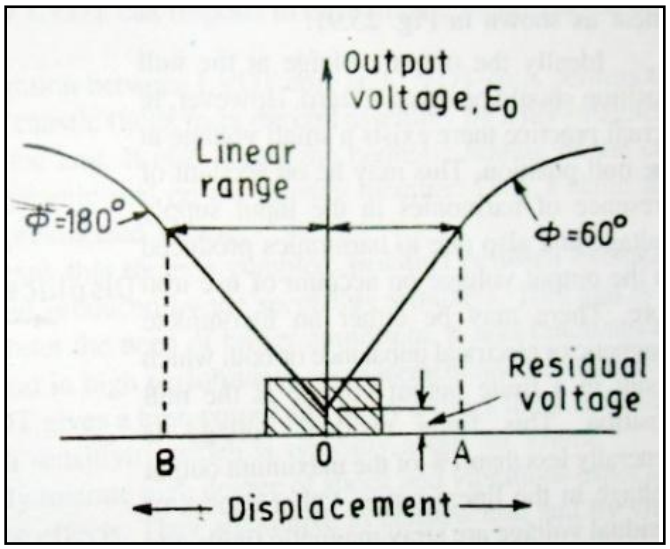
iii) Hence the output voltage Vo= VS1-VS2 and the output voltage is in phase with the input primary voltage.

Case III: When there is negative displacement

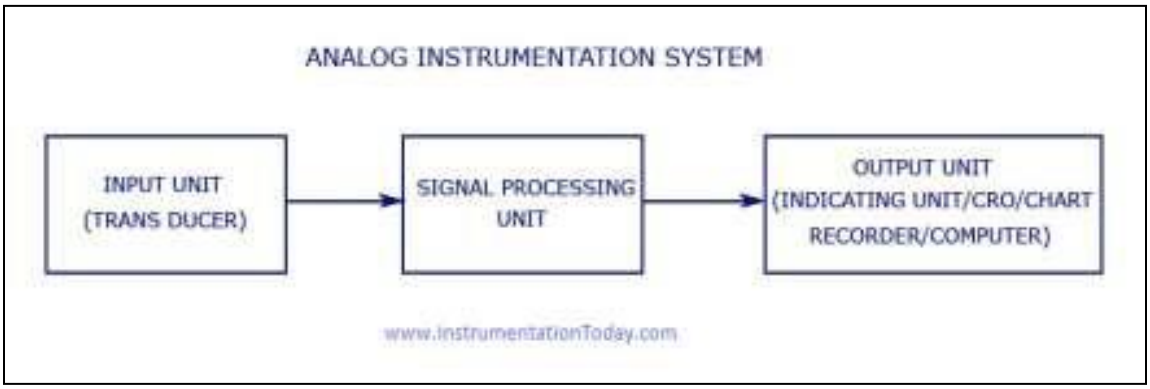
i) When there is negative displacement applied to the core i.e. the core is moved to right of null position, more flux links with winding S2 than winding S1.

ii) Here e.m.f. induced with winding S2 is greater than S1 that is VS2>VS1.

iii) Hence the output voltage Vo= VS1-VS2 and is 180^0 out of phase with the input primary voltage.



d) Draw the basic block diagram of generalized instrumentation system and explain each block.
Ans: (Diagram-2M)



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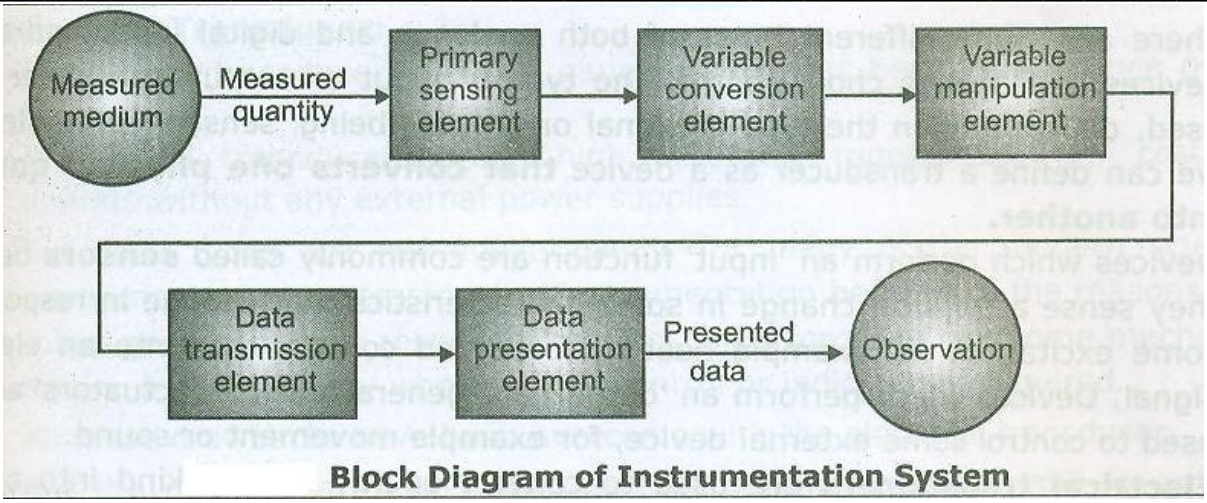


Block diagram of instrumentation system

(Functions: - 2M)

- **The Primary Element/Transducer**

The input receives the quantity whose value is to be measured and is converted into its proportional incremental electrical signal such as voltage, current, resistance change, inductance or even capacitance. Thus, the changed variable contains the information of the measured variable. Such a functional element or device is called a **transducer**.

- **The Secondary Element/Signal Processing Unit**

The output of the **transducer** is provided to the input of the signal processing unit. This unit amplifies the weak
transducer output and is filtered and modified to a form that is acceptable by the output unit. Thus this unit may have devices like: amplifiers, filters, analog to digital converters, and so on.

- **The Final Element/Output Unit**

The output from the signal processing unit is fed to the input of the output unit. The output unit measures the signal and indicates the value to the reader. The indication may be either through: an indicating instrument, a CRO, digital computer, and so on.

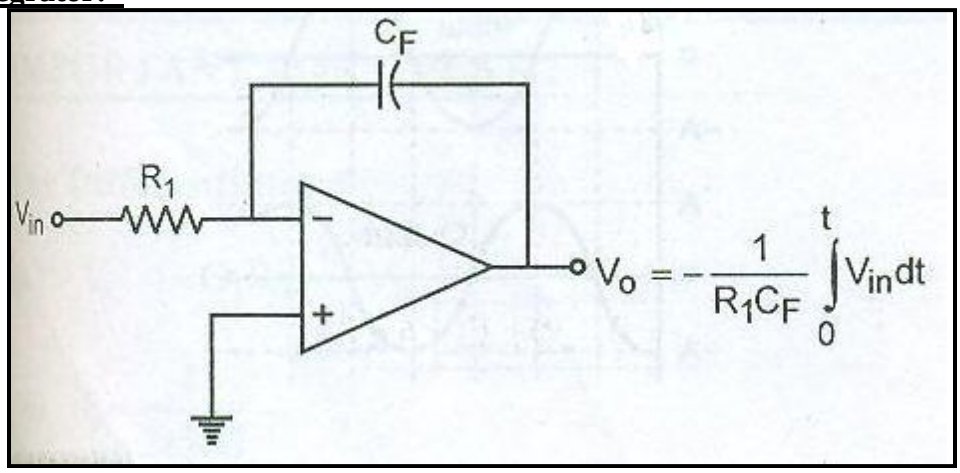
OR

(As per second block diagram)

- **Primary Sensing Element:** primary sensing element of system is that which first receives energy from the measured medium and produces an output depending in some way on the value of measured quantity.
- **Variable Conversion Element:** A variable conversion element merely converts the output signal of the primary sensing element into a more suitable variable or condition useful to the function of the instruments.
- **Variable Manipulation Element:** It manipulates the signal represented by some physical variable, to perform the intended task of an instrument. In the manipulation process, the physical nature of the signal is preserved.
- **Data Transmission Element:** It transmits the data from one element to other element.
- **Data presentation Element:** It performs the translation function, such as the simple indication of a pointer moving over a scale or recording of a pen moving over a chart.

e) Describe the use of Op-Amp as integrator with circuit diagram. Draw its I/P and O/P waveform.
Ans: (Diagram- 2 M, Description -1/2 M, Waveform- 1 ½ M)

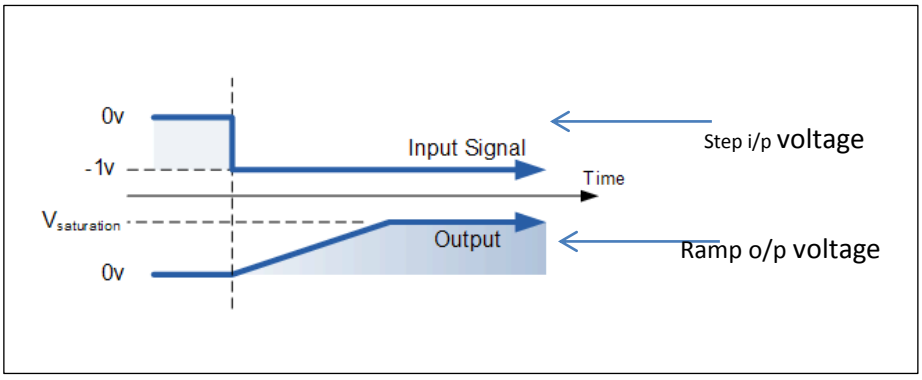
Op-AMP as integrator:



In This Circuit the output voltage is proportional to the integral of the input voltage. By integration we get,

$$vo = \frac{1}{RC}\int v1\, dt$$

I/p –O/p waveform



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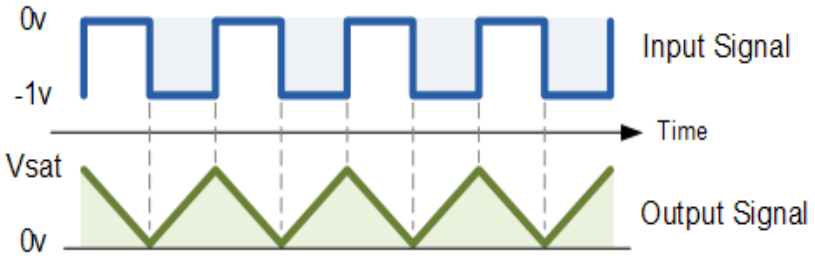


f) What is DAS? Draw a neat labeled diagram of single channel DAS.

Ans: (Concept-1M, Diagram-3M)

DAS: Data acquisition systems are which is used to measure and record analog signals either in analog form or in digital form.

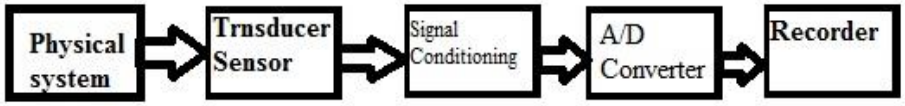


Fig. Single Channel DAS

Q.3 Attempt any FOUR of the following: (16M)

a) Explain the terms with suitable examples:

Ans: (For each term 1M and any one example 1M)

i) Precision:

It is a measure of the reproducibility of the measurements that is given a fixed value of a quantity, precision of measure of the degree of agreement within a group of measurements.

OR

A measure of the consistency of measurements, i.e. successive readings does not defer.

Example: Consider the measurement of a known voltage of 100V with a meter. Five readings are taken, and the indicated values are 104,103,105,103 and 105V from these value, it is seen that the instrument cannot be depended on for an accuracy better than 5% (5V in this case), while a precision of ±1% is indicated since the maximum deviation from the mean reading of 104V is only 1.0V.

ii) Repeatability: Repeatability conditions are when replicate measurements are made in one laboratory, by a single analyst, using the same equipment over a short time period. It is defined as variation of scale reading and it is random in nature.

Example: In medical monitoring of conditions. In these situations, there is often a predetermined "critical difference", and for differences in monitored values that are smaller than this critical difference, the possibility of pre-test variability as a sole cause of the difference may be considered in addition to, for examples, changes in diseases or treatments.

b) Draw the construction diagram of bonded metal foil strain gauge and give it's any two application.
Ans: (Diagram-2M)
Bonded type Strain gauge:

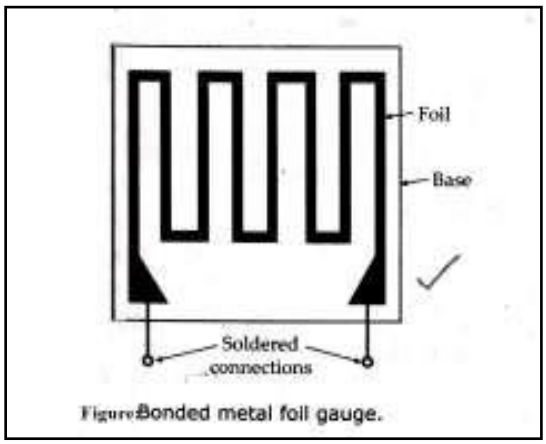
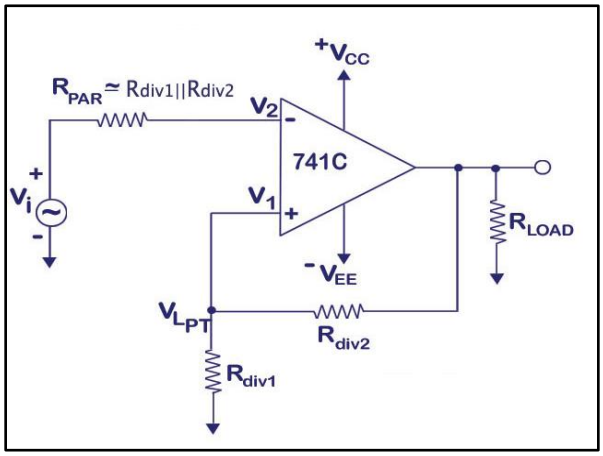


Figure Bonded metal foil gauge.

Applications:(Any Two, 2 M)
1. Vibration Measurement
2. Pressure Measurement
3. Displacement Measurement
4. Force Measurement

c) Explain the design of Schmitt trigger using Op-Amp with suitable circuit diagram and output waveform.
Ans: (Diagram: 1.5 M, Explanation: 1 M, Waveform: 1.5 M)

Schmitt trigger:



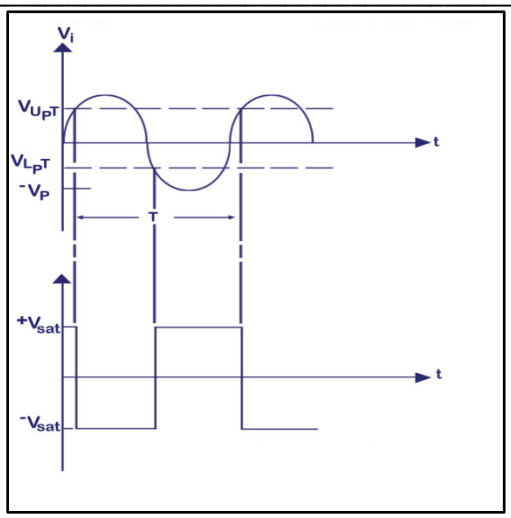
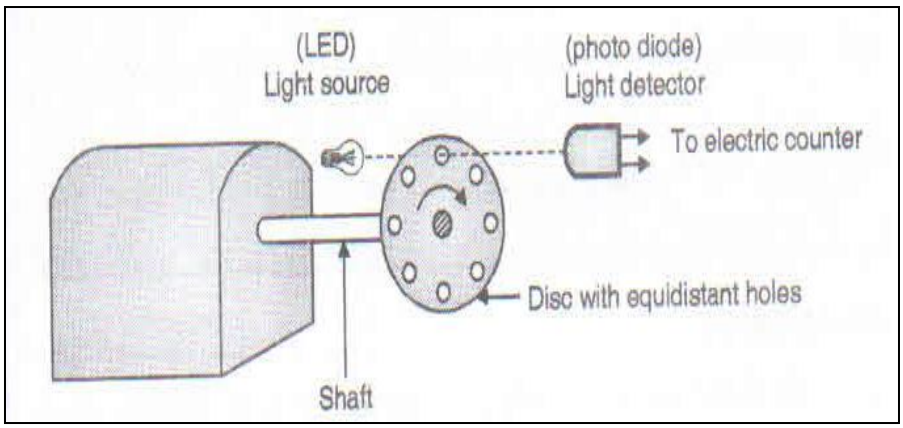


Fig shows an inverting amplifier with positive feedback.
This circuit converts irregular shaped waveform to a square wave or pulse. The circuit is known as Schmitt trigger or squaring circuit. The input voltage Vi triggers (changes the state of) the output Voltage Vo every time it exceeds the certain voltage levels called Upper threshold voltage (V_{UpT}) and Lower threshold voltage (V_{LpT}). These Threshold voltages are obtained by using the voltage divider R_{div1} and R_{div2}, where the voltage across R_{div1} is fed back to the positive input. The voltage across R_{div1} is a variable reference threshold voltage that depends on the value and polarity of output voltage Vo. When $V_o = +V_{sat}$, The voltage across R_{div1} is called upper threshold voltage (V_{UpT}).The input voltage Vi must be slightly more positive than V_{UpT} in order to cause
Output Vo to switch from $+V_{Sat}$ to $-V_{sat}$.

d) Explain the measurement of speed using non-contact type transducer.
Ans : (Diagram: 2M, Explanation:2 M)
Note: Any one type can be considered.
There are two types of non-contact types of tachometer

i) Photoelectric Tachometer:

Constructional diagram:(2M)



Working: (2M)

- Working principle: The light passes through the holes available on the rotating disc with a specific interval, depends on the angular speed of disc having equidistant holes. The frequency of this light pulses is measure of angular speed of the disc.
- It consists of an opaque disc on the rotating shaft. The disc has a number of equidistant holes on its periphery. At one side of the disc a light source is fixed like LED and on other side of the disc, and on the line of the light source, alight sensor like phototube or some photosensitive semiconducting device is placed.
- When a hole appears between two, the light following upon the sensor produces an output pulse.
- The frequency at which the pulses are produced depends on the number of holes in the disc and its speed of rotation. Hence the speed is given by
  N=f/H_S
  N=speed
  f=frequency
  H_s=holes on the disc

OR

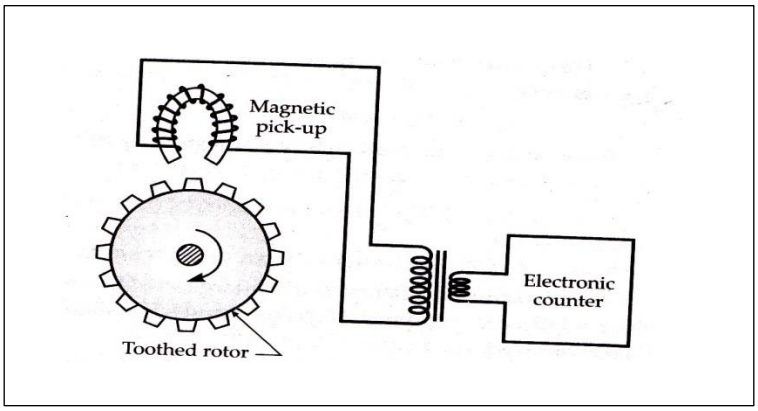
ii) Toothed rotor variable reluctance Tachometer (Magnetic Pick up)

It consists of a housing containing a small permanent magnet with a coil wound round it. When rotor rotates, the reluctance of the air gap between pickup and the toothed rotor changes giving rise to the induced e.m.f in the pickup coil. This output is in the form of pulses, with variety of wave shapes.

The frequency of the pulses of induce voltage will depend upon the number of teeth of the rotor and speed of rotation.

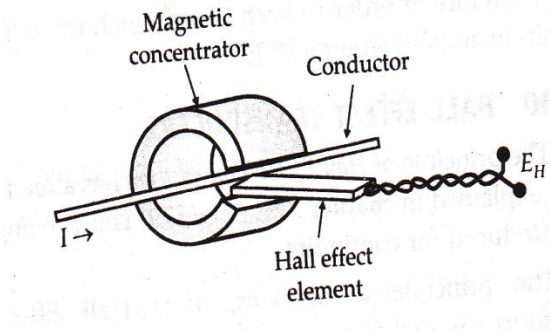
Number of pulses per revolution= T

Thus, Speed = $\frac{pulses\ per\ second}{number\ of\ teeth}=\frac{P}{T}$ rps.



e) Describe the measurement of ac current by hall effect transducer.

Ans: (Diagram-2M,Description: 2M)



Measurement of current using Hall Effect transducer.

Description:

A current (a.c) passes through the conductor and sets up a magnetic field surrounding the conductor. This magnetic field is proportional to the current. A hall effect transducer is placed in a concentrator. The Voltage produced at the output terminals is proportional to the magnetic field strength and hence is proportional to the current flowing in the conductor.

In this way the current is measured using Hall Effect Transducer.

f) Describe with neat labeled diagram measurement of flow using turbine flow meter.
Ans: (Diagram-2M,Explanation: 2M)
Diagram:-

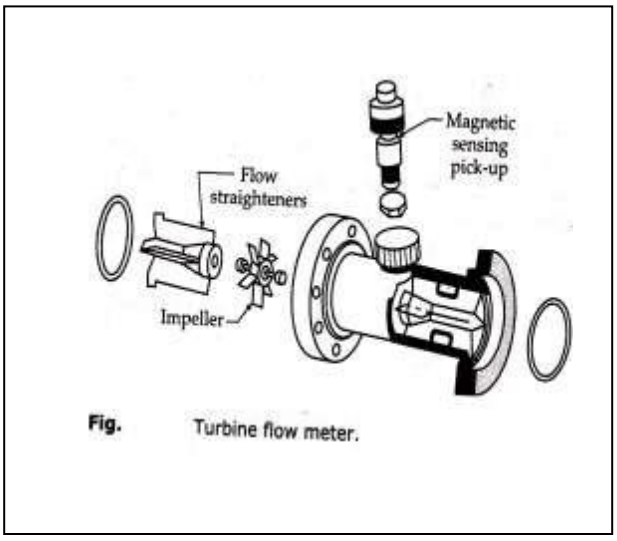


Fig. Turbine flow meter.

Explanation: -

Turbine flow meter s are volumetric flow meters and are available in wide ranges. The output is usually in the form of a digital electrical signal whose frequency is directly proportional to flow rate and whose total count is proportional to flow rate and whose total quantity, as each pulse represents a discrete volume.

A feature of this turbine meter is a hydraulically supported turbine rotor. A permanent magnet sealed inside the rotor body is polarized at 90_0 to the axis of the rotation. As the rotor rotates so does the magnet and therefore rotating magnetic field is produced. This produces an a.c voltage pulse in the pick-up coil located external to the meter housing. The frequency of this voltage is directly proportional to the rate of flow. The pulse can be totalized by a counter to give the value of total flow over a particular interval of time**.**

Q.4 Attempt any FOUR of the following: [16M]

a) Describe the ramp response of first order system in brief.
Ans: (Explanation- 2M, Response-2M)

Input, r(t)=t.1(t),
Laplace transform $R(s)=1/S^2$
Output $C(S)=R(S)/1+TS = I/ S^2 (1+TS)=1/ S^2+T/S+ T/(1+TS)$ where T is the time constant
Taking the inverse Laplace transform gives the response c(t)

$c(t) = t - T + Te^{1/T}$ for t≥0

In the steady-state the output lags the input by a time equal to the time constant

02M

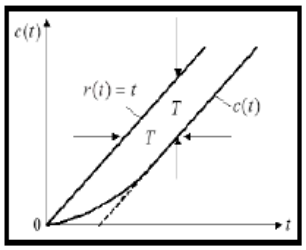


Figure:- Response of ramp

b) Draw and explain the temperature compensation circuit in strain-guage.

Ans:- (Diagram-2M,Explanation-2M)

Note: Any one method can be explained

Temperature compensation in strain gauge. The resistive type strain gauges are sensitive to temperature so compensation is required which is provided by

1) Use of adjacent arm balancing or compensating gauge

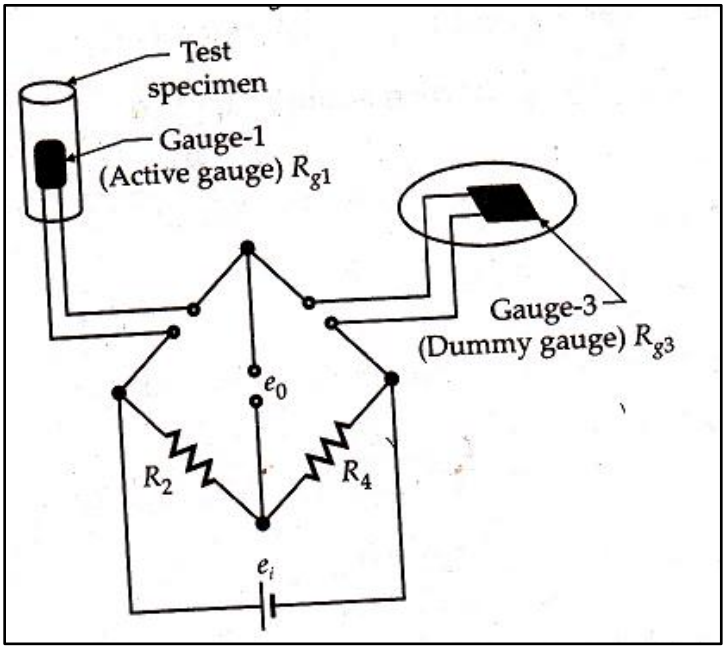
2) Self compensation

3) Use of special circuit

Adjacent arm compensative gauge:-

It is used a dummy gauge in adjacent arm. gauge 1 is installed as active gauge by while gauge 3 is installed as dummy gauge. It is not subjected to any strain. The gauges installed on the test piece and the dummy gauge are at the same temperature. Initially when the bridge is balance $\frac{R_1}{R_3} = \frac{R_2}{R_4}$. Under change in temperature R_1 and R_3 changes unequally to balance the bridge the changes should be equal in amount so as the bridge will be insensitive to temperature variation. So the dummy gauge is introduced in arm 3 which is identical to active gauge.

Diagram:-



c) Explain in brief the concept of active and passive filter.

Ans :(For each concept 2 M)

Passive Filter:

It does not contain any "active components", such as transistors, capable of increasing the signal level of the filter output. They use only what are called "passive components" such as resistors, capacitors, and inductors. Passive filters are circuit sub units often consisting of only two or three components, which reduce (ATTENUATE) the amplitude of signals, They are designed to be frequency selective so that they can reduce the signal amplitude at some frequencies, but do not affect signals at others. The block diagrams indicate the frequency that is attenuated by showing three sine waves with one or two crossed out, the vertical position of the wave indicating high medium or low frequencies.

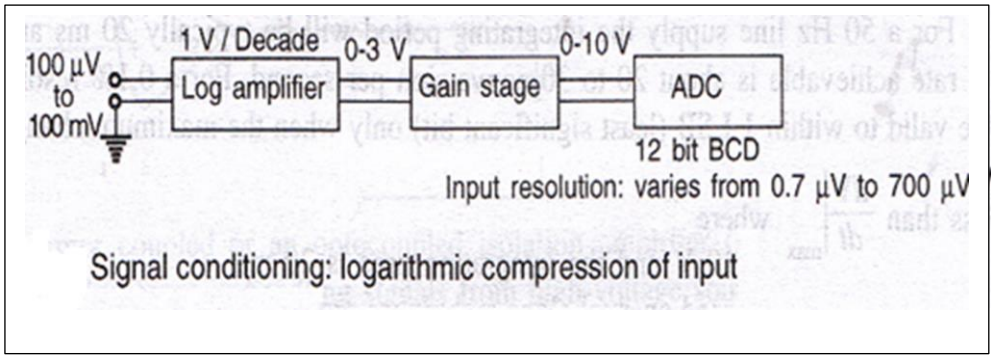
Active Filters:

An active filter is a type of analog electronic filter that uses active components such as an amplifier. Amplifiers included in a filter design can be used to improve the performance and predictability of a filter, while avoiding the need for inductors (which are typically expensive compared to other components). They draw their power from an external power source and use it to boost or amplify the output signal.

d) State the concept of ratio metric conversion and logarithmic conversion in DAS.

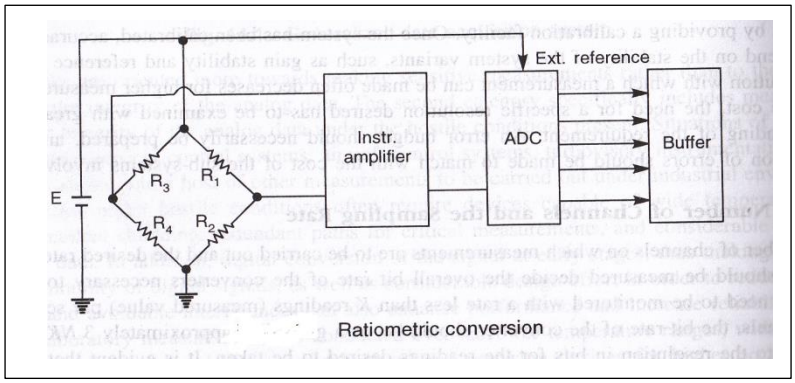
Ans: (For each concept 2 M)

Concept of Logarithmic conversion in DAS :-



It is a signal conditioning method applicable with DAS.
The logarithmic conversion circuit enables the measurement of fractional change in the input as a percentage of the input magnitude rather than a percentage of range. It improves the resolution

Concept of Ratiometric conversion in DAS:-



It is the method of signal conditioning in DAS. It is to feed the bridge excitation voltage as reference voltage for A/D converter. In A/D converter the conversion factor is inversely proportional to the reference voltage. The system sensitivity is independent of fluctuations in the bridge-excitation voltage.

e) List the points to be considered while selecting a transducer for it's applications.

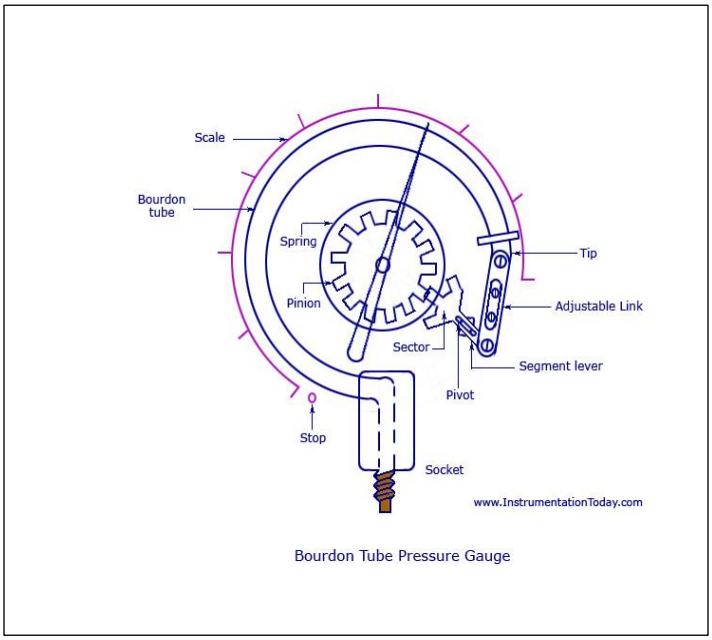
Ans: [Any 8 points- 4M]

Selection criterion of transducers.

1. Operating range
2. Operating principle
3. Sensitivity
4. Accuracy
5. Frequency response and resonant frequency
6. Errors
7. Environmental compatibility
8. Usage and ruggedness.
9. Electrical aspect.
10. Stability and Reliability
11. Loading effect
12. Static characteristics
13. General selection criteria

f) Describe the measurement of pressure using C-type burdon tube with neat labelled diagram.
Ans : (Diagram: 2 M, Explanation: 2 M)

Pressure using C-Type Burdon tube



Bourdon Tube Pressure Gauge

Description: The pressure input is given to a socket which is soldered to the tube at the base. The other end or free end of the device is sealed by a tip. This tip is connected to a segmental lever through an adjustable length link. The lever length may also be adjustable. The segmental lever is suitably pivoted and the spindle holds the pointer as shown in the figure.

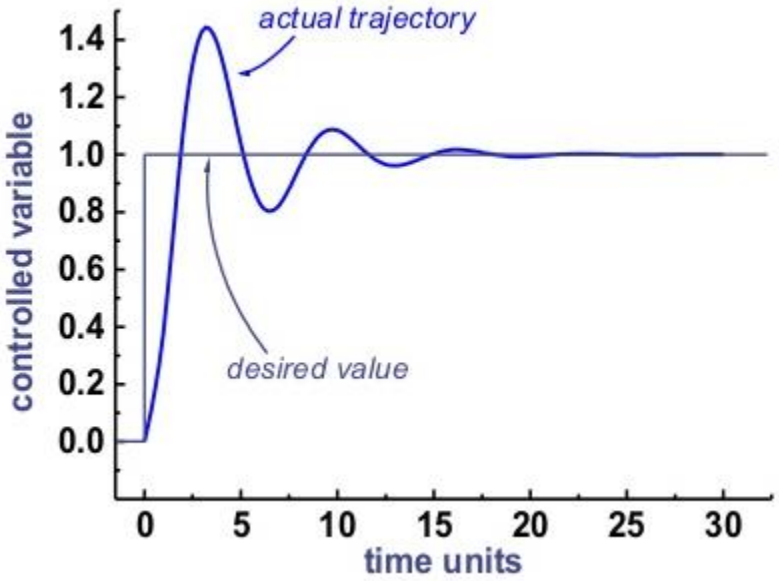
When the fluid whose pressure is to be measured enters the tube, the tube tends to straighten out n account of the pressure applied. This causes a movement of free end is amplified through mechanical linkages. The

amplified displacement of the free end may be used to move a pointer on a scale calibrated in terms of pressure.

Q.5 Attempt any Four: **[16M]**

a) Draw the response of second order instruments for step, Define dynamic error

Ans: (For response diagram-3M,Defination-1M)



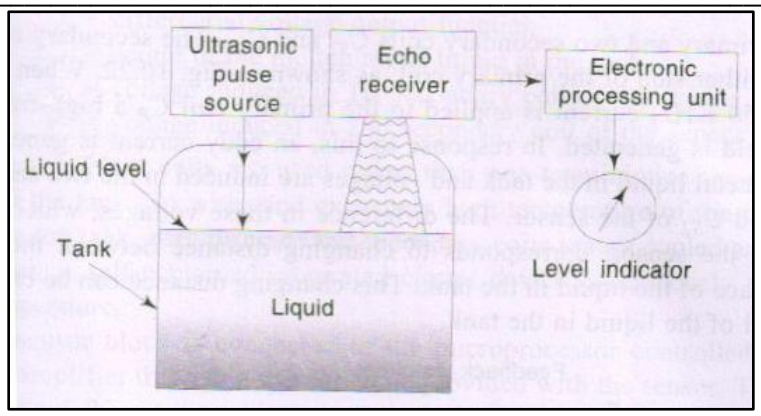
Dynamic error: It is the difference between the true value of a quantity changing with time and the value indicated by the instrument, if no static error is assumed.

b) Describe the ultrasonic level measurement with neat labeled diagram and give its two advantages.

Ans: -(Description -1 ½, Diagram-1 ½ M,Advantages-1M)

Ultrasonic level detectors operate either by the absorption of acoustic energy as it travels from source to receiver or by the attenuation (frequency change) of a vibrating diaphragm face, oscillating at 35 to 40 KHz. It operates by generating an ultrasonic pulse and measuring the time it takes for the echo to return. When an ultrasonic transmitter is mounted at the top of the tank, the pulse travels in air at a speed of 331 meter/second at 0ºC. The time of travel is an indication of the depth of the vapour space above the liquid in the tank. If an ultrasonic transmitter is mounted on the bottom of the tank, the time of travel reflects the depth of liquid in the tank and the speed of travel is a function of what that liquid is.

In order to measure the time of travel of the echo of an ultrasonic pulse, it is essential that some of the sonic energy by reflected. Liquids and solids with large and hard particles are good reflectors. Loose dirt have poor reflecting characteristic as they tend to absorb the sonic pulse. Since the angle of reflection is equal to the angle of incidence, it is important that the reflecting surface be flat. If the sonic pulse is reflected from a sloping surface, its echo will not be directed back to the source and the round-trip travel time will not accurately reflect the vertical distance. Irregular surfaces result in diffuse reflection where only small portions of the total echo travels vertically back to the source.



Advantages:-NOTE:-Any relevant advantage can be considered.

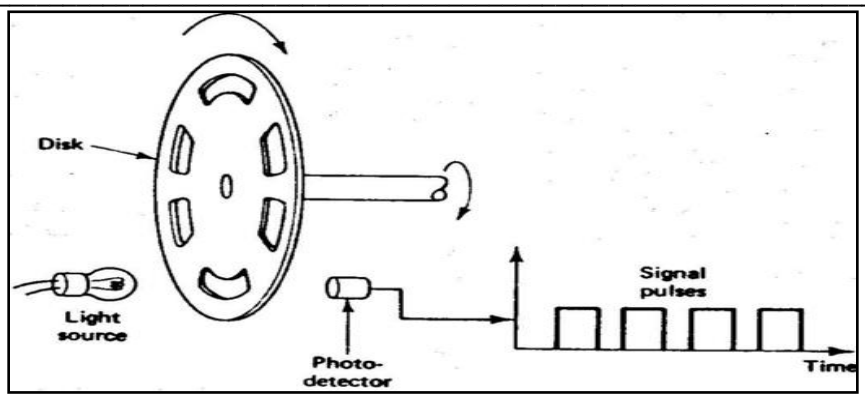
1. Ultrasonic level detectors are non-contact type measurement techniques. They have the ability to measure level without making physical contact with the process material.
2. They have no moving parts.

c) State working principle of analog to digital and digital to analog conversion.
Ans: (Each-2M)

i) **Analog-to-digital Converters:** In a digital computer control system, the plant output (or controlled variable) is usually an analog signal, which is measured by sensors (or instruments). This analog signal has to be converted into digital signal before it is fed to the computer. The conversion of analog measurements to digital measurements involves three operations, namely sampling, quantization and encoding.

ii) **Digital-to-analog Converters:** In computer-controlled processes, the output of the digital controller (manipulated variable) is in digital form and must be converted to analog form before it can be communicated to the analog plant. The device that accomplishes this is called digital-to-analog converters. DAC provides reconstruction of discrete-time digital signals into continuous-time analog signals for computer interfacing output data recovery purposes such as actuators, displays, and signals synthesizers. DAC is considered prior to ADC because some ADC circuits require DACs in their implementation. A DAC may be considered a digitally controlled potentiometer that provides an output voltage or current normalized to a full-scale (FS) reference value.

d) Describe rotary motion measurement using optical encoder.
Ans: (Diagram-2M, Explanation-2M)



An optical encoder is an electromechanical device which has an electrical output in digital form proportional to the angular position of the input shaft. Optical encoders enable an angular displacement to be converted directly into a digital form.

An optical encoder is an angular position sensor

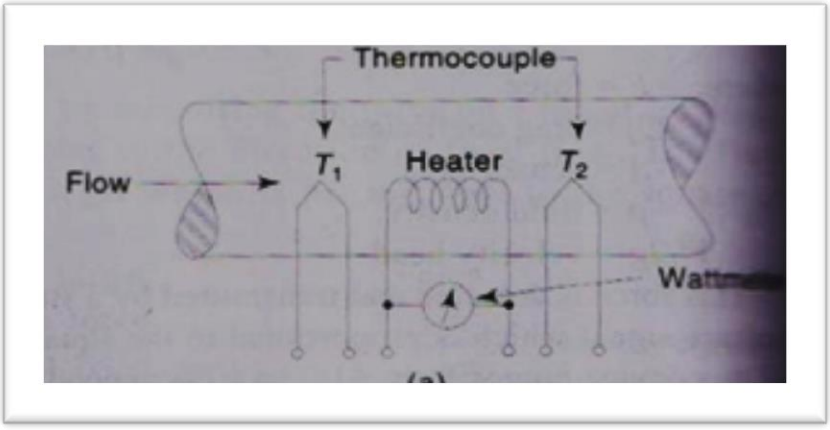
It has a shaft mechanically coupled to an input driver which rotates a disc rigidly fixed to it. A succession of opaque and clear segments are marked on the surface of the disc.

Light from infrared emitting diodes reaches the infrared receivers through the transparent slits of the rotating disc. An analogue signal is created.

Then electronically, the signal is amplified and converted into digital form. This signal is then transmitted to the data processor.

e) Which type of flow is measured by hot wire anemometer and describe its working principle with suitable diagram.

Ans: (Which Type-1M, Diagram-1 ½ M, Principal-1 ½ M)



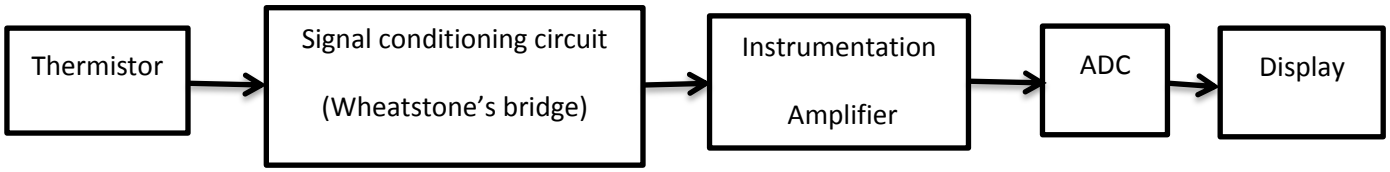
Heat transfer flowmeters this type of flowmeter measures the rise in temperature of the fluid after a known amount of heat has been added to it. Its theory is based upon the specific heat equation which is given as.

$$Q = W C_p (T_2 - T_1)$$

$$W = \frac{Q}{C_P (T_2 - T_1)}$$

When Q = heat transfer
W = mass flow rate of liquid
C_P = specific heat of fluid
T_1 = initial temperature of the fluid after heat has been transferred
T_2 = final temperature after heating the fluid
A schematic diagram of a heat transfer flowmeter, which consist of an electric immersion heater for the heating of flowing fluid. Two thermocouples (or resistance thermometers) T1 and T2 are placed at each side of the heater. The thermocouple T1 measures the temperature of fluid before it is heated, while the thermocouple T2 measures the temperature so after. The power supply to the heater equals the heat transferred to the fluid, i.e. Q, and is measured by a wattmeter. Thus by measuring the values of Q, T1 and T2 the flow rate W of liquid is determined
Principle: The basic principle principle of operation operation of the system is the heat transfer transfer from the heated wire to the cold surrounding fluid, heat transfer which is function of the fluid velocity. Thus a relationship between the fluid velocity velocity and the electrical electrical output can be established established. The purpose of the electronic circuit is to provide to the wire a controlled amount of electrical current, and in the constant temperature method, to vary such a supply so as to maintain the wire temperature constant, when the amount of heat transfer varies

f) Describe the instrumentation system used for temperature measurement using thermistor.
Ans: (Diagram-2M, Explanation:2M)



A **thermistor** is a type of resistor whose resistance is dependent on temperature.
Thermistors are of two opposite fundamental types:

- With **NTC**, resistance ***Decreases*** with temperature to protect against inrush *overcurrent* conditions. Installed **series**in a circuit.
- With **PTC**, resistance ***Increases*** with temperature to protect against *overvoltage* conditions. Installed **parallel** in a circuit.

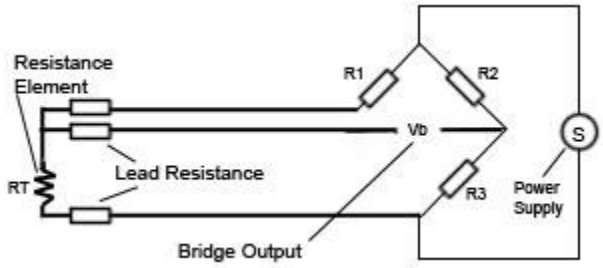
The Sensing Temperature sensor is Thermistor. The output of Thermistor is given to signal conditioning circuit Wheatstone bridge. The output of wheatstone bridge is amplified. The analog signal is converted to Digital by ADC further given to multiplexer, then output is displayed on computer.

Q.6 Attempt any Four:

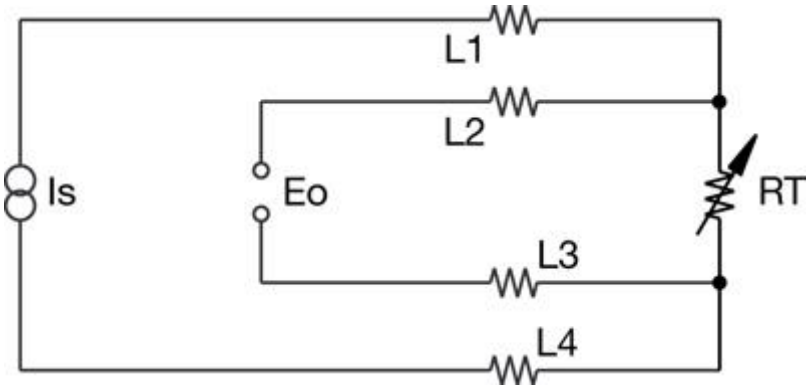
a) Describe the importance of three wire and four wire configuration for RTD with suitable circuit diagram.

Ans:- (Diagram-2M,Importance-2M)

Three wire RTD:



Four wire RTD:

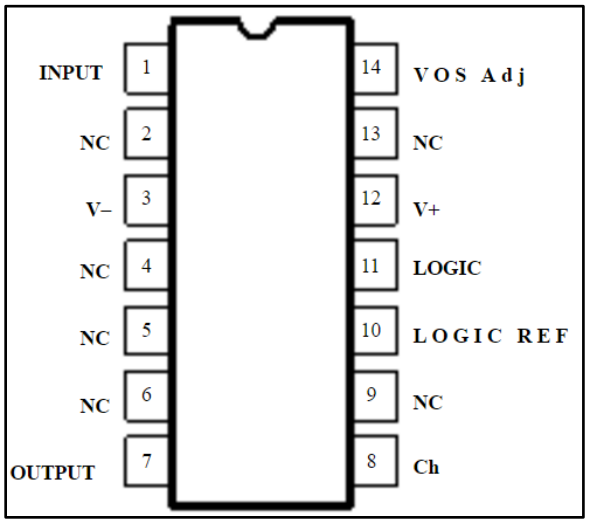


Three wire configurations is used to help the circuit compensate for lead wire resistance, and thus provide a truer indication of the measured temperature.

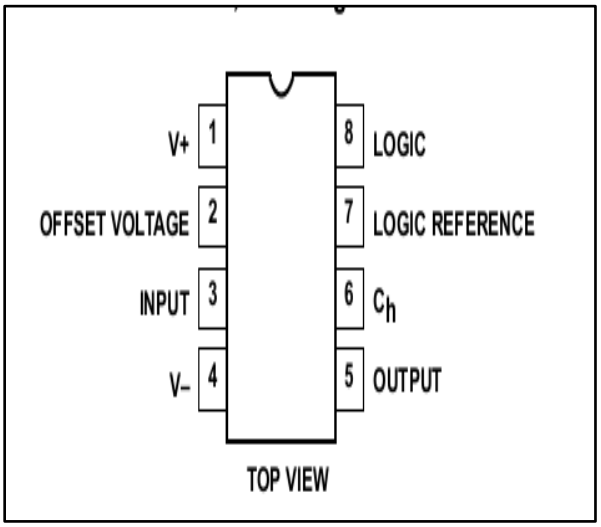
Four wire RTDs provide slightly better compensation, but are generally found only in laboratory equipment and other areas where high accuracy is required.
When used in conjunction with a 3-wire instrument, a 4 wire RTD will not provide any better accuracy. If the fourth wire is not connected, the device is only as good as the 3 wire RTD; if the fourth wire is connected, new errors will be introduced.. A 2 wire RTD can be used with either a 3-4 wire instrument by jumping the appropriate terminals, although this defeats the purpose and reintroduces the uncompensated resistance of the leads. To get the optimum performance, it is generally best to specify the RTD configuration.

b) Draw the pin diagram of IC LF398.List function of each pin.
Ans:-((Pin diagram-2M,Function-2M)

Pin Diagram:-



OR

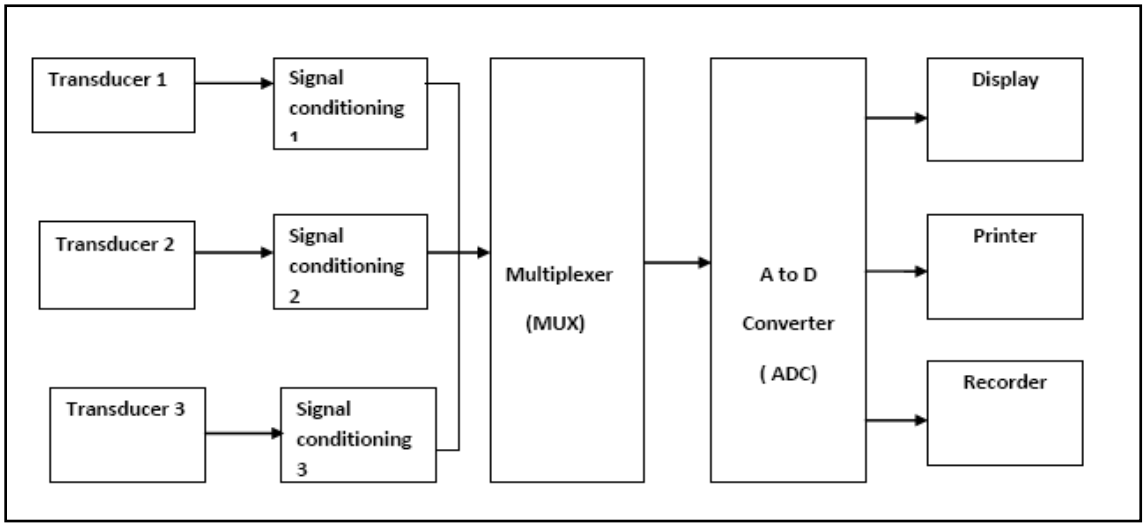


Function:-

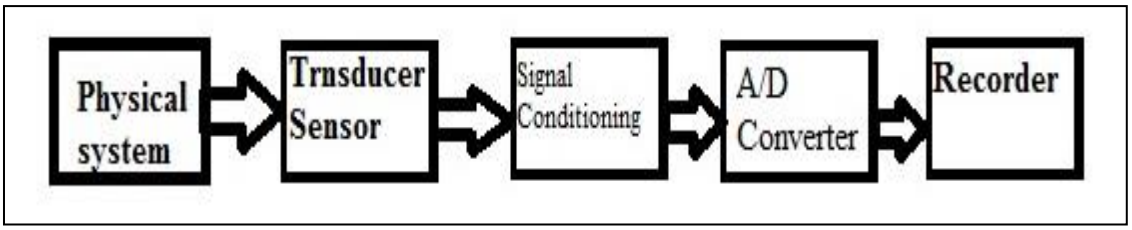
PIN 1 ---- $+V_{cc}$
PIN 2 ---- Offset
PIN 3 ---- $+V_{input}$
PIN 4 ---- $+V_{EE}$
PIN 5 ---- Output
PIN 6 ---- Hold Capacitor
PIN 7 ---- Ground (logic reference)
PIN 1 ---- Hold Signal (Logic Input)

c) Draw generalized block diagram of Data Acquisition System (DAS) and explain the role of each block.

Ans:[Block diagram-2M,Explanation-2M]



OR



d) Describe liquid level measurement by resistive sensor with suitable diagram.

Ans: (Diagram- 2, Explanation- 2M)

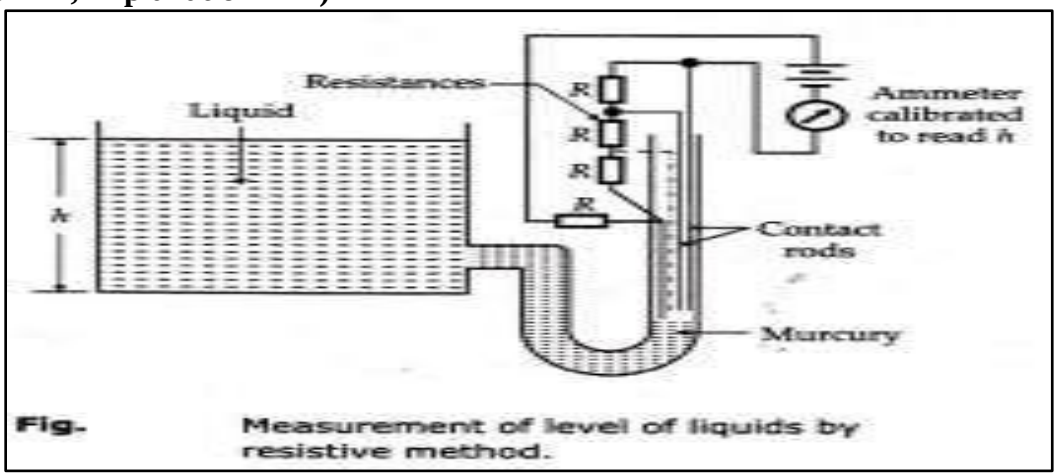


Fig. Measurement of level of liquids by resistive method.

Explanation:- (02M)

This method uses mercury as a conductor. A number of conduct rods are placed at various liquid levels. As head h increases, the rising level of mercury above the datum, shorts successive resistors R and increases the value of h directly.

e) Compare between RTD and thermistor (any four points)

Ans: (Comparison- Any 4, 1 M each)

RTD	Thermistor.
• .RTD is made up of metals. • Metals have Positive Temperature Coefficient (PTC) of resistance. Hence, the resistance of RTD increases with an increase in temperature and decreases with a decrease in temperature. • The resistance temperature characteristics of RTD's are linear. • It is less sensitive to temperature compared to thermistor. • But, it has-a wide operating temperature range i.e., minus 200 to plus 650°C. • RTD's are relatively larger in size	• Thermistor is made up of semiconductor Materials • Semiconductor materials have Negative Temperature Coefficient (NTC) of resistance. • Hence, the resistance of a thermistor decreases with an increase in temperature and increases with a decrease in temperature. • The resistance temperature characteristics of thermistor are highly nonlinear. • It has large temperature coefficient of resistance i.e. thermistor highly sensitive to temperature compared to RTD. • It has low operating temperature range

• They are costlier as compared to thermistor. • They have low self-resistance. • RTD's provide high degree of accuracy and long term stability. • They are used in laboratory and industrial applications.	compared to RTD i.e., minus 100 to plus 300°C. • Size of thermistors is small. • They are not costlier as compared to RTD. • They have high self-resistance. Thus, they require shielding cables to minimize interference problems.

f) Explain pressure measurement using diaphragm with neat diagram.
Ans: (Diagram-2M,Explanation-2M)

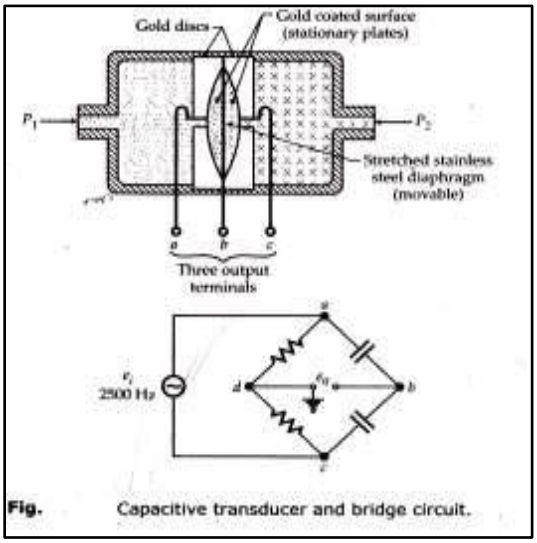


Fig. Capacitive transducer and bridge circuit.

Capacitive transducers are used for the measurement of pressure by converting the pressure into a displacement. The displacement is sensed by a capacitive transducer using a differential arrangement's thin stainless steel diaphragm is clamped between the disc, acts as the moveable plate. . With equal pressures applied (*i.e.*, P1=P2) the diaphragm is in neutral position and the bridge is balanced. The output voltage e0 is zero under the conditions. If one pressure is made greater than the other, the diaphragm deflects in proportion to the differential pressure, giving an output voltage, e0 from the bridge terminal. This output voltage is proportional to the differential pressure. For an opposite pressure difference, the output voltage shows a 1800 phase shift.
This voltage may be amplified by an emitter follower amplifier.