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.

Q1 Solve any TEN of the following:- **20M**

(a)Define: Repeatability & Reproducibility

Ans} {1 mark each definition}

Definition:-

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

Reproducibility: Reproducibility is a conditions is when the replicate measurements are made by different analysts, working in different laboratories, using different equipment over an extended time period.

NOTE:- (consider any related definition)

(b)Define :i) Point accuracy ii) Resolution.

Ans}{1 mark each definition}

Definition-

Point accuracy : Precise exactness of measurement.

Resolution:-Resolution is the term used to describe the number of dots, or pixels, used to display an image.The smallest to be distinguished magnitude from the measured value.

c)List the preliminary steps of periodic calibration of instruments.

Ans}

Step of calibration of instrument:- **02M**

i)Depressurizing the system, and turning the screw, if necessary, to ensure that the needle reads zero,

(ii) fully pressurizing the system and ensuring that the needle reads maximum, within acceptable tolerances,

(iii) replacing the gauge if the error in the calibration process is beyond tolerance, as this may indicate signs of failure such as corrosion or material fatigue

(d)State any two factors on which precision of instrument depends.

Ans}

NOTE: - [student can write any 2]

Factor deciding precision of instrument:- **02M**

a) Reproducibility
b) Type of instrument
c) Environmental condition
d) Age of instrument.
e) Position
f) Handling of instrument

(e) List any four undesirable characteristics of instrument.

Ans} {1/2 mark each}

Characteristics of instruments:- (any four)

- Error
- noise
- Hysteresis
- Instrument Drift
- Death Space : Threshold
- Uncertainty
- Backlash

f) Define:- i)Settling time ii) Tolerance.

Ans} 01 M each definition

Definition:-

Settling Time: Time require to reach 0 to its 98%

Tolerance: Allowable variation in actual measured value and desire value

(g) Compare active and passive transducers.

Ans}

Comparison:- {any 2} 02M

Parameters	Active	Passive
Definition	Based on the electrical phenomenon or parameter that may be changed due to the whole process. Some of the most commonly electrical quantities in a transducer are Voltage or current	Based on the electrical phenomenon or parameter that may be changed due to the whole process. Some of the most commonly electrical quantities in a transducer are resistance, capacitance
Example	Thermocouple. Piezo electrical	LDR, thermister
circuit	simple	comlicated
Active Bridge	Not Require	Require

h) Give any two advantages of LVDT.

Ans} Advantages :- (any two) 02M

Very basic transducer which is always useful in the field of instrumentation,

Infinite resolution is present in LVDT
* High output

* LVDT gives High sensitivity
* Very good linearity
* Ruggedness
* LVDT Provides Less friction
* Low hysteresis
* LVDT gives Low power consumption

(i) Compare primary transducer & secondary transducer. (any two points.)

Ans} For any 1 comparison point 01M

Primary transducer:-

- Bourdon tube acting as a primary transducer, senses the pressure and convert the pressure into displacement.
- No output is given to the input of the bourdon tube.
- So it is called primary transducer. Mechanical device can act as a primary transducer.

Secondary transducer:-

- The output of the Bourdon tube is given to the input of the LVDT.
- There are two stages of transduction, firstly the pressure is converted into a displacement by the Bourdon tube then the displacement is converted into analog voltage by LVDT.
- Here LVDT is called secondary transducer. Electrical device can act as a secondary transducer.

(j) Seebeck effect and Peltier effect .

Ans}Definition:-

Seebeck effect :- **01M**

The Seebeck effect is a phenomenon in which a temperature difference between two dissimilar electrical conductors or semiconductors produces a voltage difference between the two substances. If the two conductors or semiconductors are connected together through an electrical circuit, direct current (DC) flows through that circuit.

Peltier effect :- **01M**

The Peltier effect is a temperature difference created by applying a voltage between two electrodes connected to a sample of semiconductor material. This phenomenon can be useful when it is necessary to transfer heat from one medium to another on a small scale..

k)State any two characteristics of ideal OP-Amp .

Ans}

Characteristics of ideal OP-Amp. (any two) **02M**

- An ideal op-amp is usually considered to have the following properties:
- Infinite open-loop gain G = v_{out} / 'v. ...
- Infinite input impedance R_{in}, and so zero input current.
- Zero input offset voltage.
- Infinite voltage range available at the output.
- Infinite bandwidth with zero phase shift and infinite slew rate.

l) Define: -i) Slew rate ii) CMMR

Ans} 01 for each definition

Definition:-

i) Slew rate: -The maximum rate at which an amplifier can respond to an abrupt change of input level.

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.

Q2. Attempt any FOUR of the following:-

a) Draw block diagram of instrumentation system. State function of each block.

Ans}NOTE:- (Any other Logical block diagram mark may be given)

Diagram:- **02M**

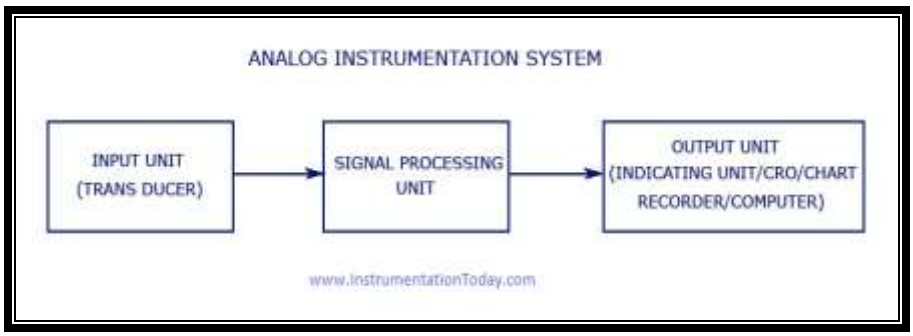


Figure:- Block diagram of instrumentation system

Functions:- **02M**

- **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.

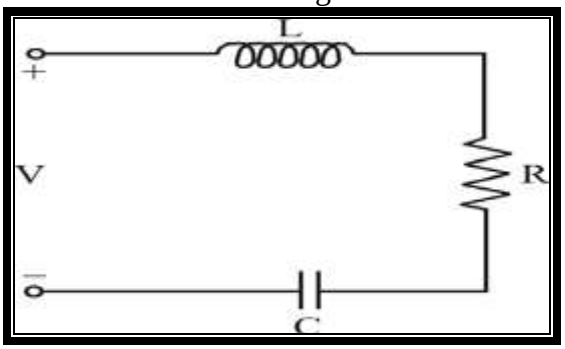
b) Describe dynamic response of second order system . State example of second order instrument.

Ans}[2 mark For Physical system,1mark for graph 1mark for characteristics]

Physical system:-

A second-order dynamic system is one whose response can be described by a second-order ordinary differential equation (ODE). A second-order ODE is one in which the highest-order derivative is a second derivative.

Many electrical circuits, such as the RLC circuit shown in Fig. can also be modeled as second-order systems.



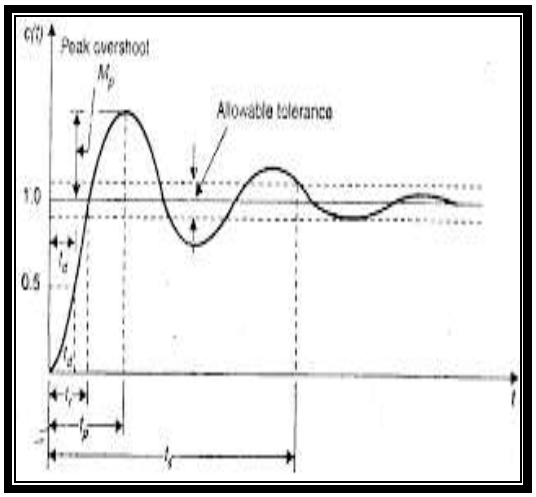


Figure:- Characteristics of second order system

It has characteristics - like decaying oscillations - that you can have in second order systems. Those characteristic decaying oscillations are not to be seen in first order systems. If you see decaying oscillations, you know you don't have a first order system. On the other hand, not every second order system will exhibit those decaying oscillations. Second order systems are more complex than that.

With that in mind, let's look at some basic ideas about second order systems. The simplest second order system satisfies a differential equation of this form.

$$\frac{w_n^2}{s2 + 2\zeta\,\omega_n + \omega_n^2}$$

This is 2nd order system

where:

G(t) = Response of the System,

u(t) = Input to the System,

ζ = Damping Ratio,

ω_n=Undamped Natural Frequency,

G_{dc}= The DC Gain of the System.

The parameters you find in a second order system determine aspects of various kinds of responses. Whether we are talking about impulse response, step response or response to other inputs, we will still find the following relations.

z, the damping ratio, will determine how much the system oscillates as the response decays toward steady state.
$\mathbf{w_n}$,the un damped natural frequency, will determine how fast the system oscillates during any transient response.
G_{dc}, the DC gain of the system, will determine the size of steady state response when the input settles out to a constant value.

c) Distinguish between RTD and thermistor

Ans}

Comparison:- any 4 [1 mark each]

RTD	Thermistor
1. RTD is made up of metals.	Thermistor is made up of semiconductor Materials
2. 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.	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.
3. The resistance temperature characteristics of RTD's are linear.	The resistance temperature characteristics of thermistor are highly nonlinear.
4. It is less sensitive to temperature compared to thermistor.	It has large temperature coefficient of resistance i.e. thermistor highly sensitive to temperature compared toRTD.
5. But, it has-a wide operating temperature range i.e., minus 200 to plus 650°C.	It has low operating temperature range compared to RTD i.e., minus 100 to plus 300°C.
6. RTD's are relatively larger in size.	Size of thermistors are small .
7. They are costlier as compared to thermistor.	They are not costlier as compared to RTD.
8. They have low self resistance.	They have high self resistance. Thus, they require shielding cables to minimize interference problems.
9. RTD's provide high degree of accuracy and long term stability.	Thermistors also provide an accuracy of ± 0.01°C.
10. They are used in laboratory and industrial applications.	

d) State types of bourdon tubes. Describe 'C' type bourdon tube.

Ans}

TYPES OF Bourdon Tubes:- **01M**

- Helical
- C type

Diagram:- **01M**

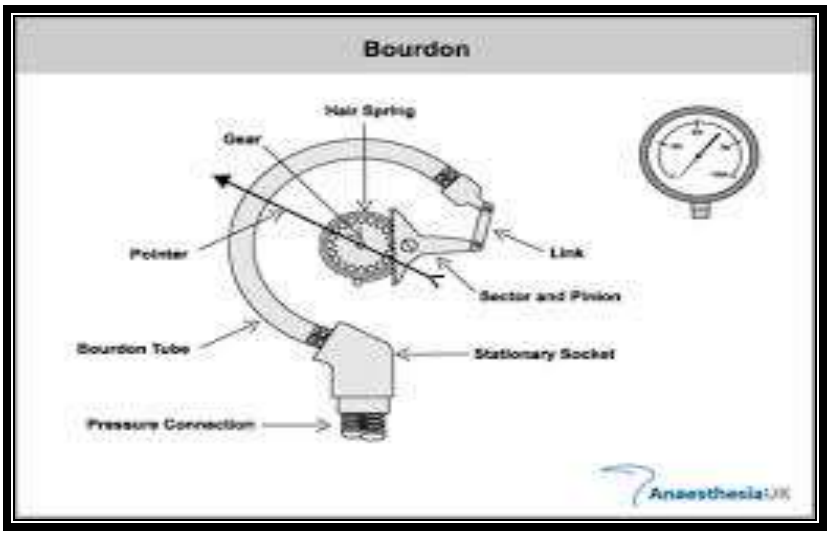


Figure :- C type bourdon tube

Explanation:- **02M**

The C-shaped Bourdon tube has a hollow, elliptical cross section. It is closed at one end and is connected to the fluid pressure at the other end. When pressure is applied, its cross section becomes more circular, causing the tube to straighten out, like a garden hose when the water is first turned on, until the force of the fluid pressure is balanced by the elastic resistance of the tube material. Since the open end of the tubes anchored in a fixed position, changes in pressure move the closed end. A pointer is attached to the closed end of the tube through a linkage arm and gear and pinion assembly, which rotates the pointer around a graduated scale. Bourdon-tube pressure gauges are often classified as simplex or duplex, depending upon whether they measure one pressure or two pressures. A simplex gauge has only one Bourdon tube and measures only one pressure. The pressure gauge shown in figure 8-1 is a simple gauge. A red hand is available on some gauges. This hand is manually positioned at the maximum operating pressure of the system or portion of the system in which the gauge is installed.

e) Describe instrumentation amplifier in three OP-Amp configuration . State its applications.

Ans}{ 01 ½ mark for Diagram 01 ½ mark for explanation)

Explanation:-

It is beneficial to be able to adjust the gain of the amplifier circuit without having to change more than one resistor value, as is necessary with the previous design of differential amplifier. The so-called *instrumentation* builds on the last version of differential amplifier to give us that capability:

Diagram:-

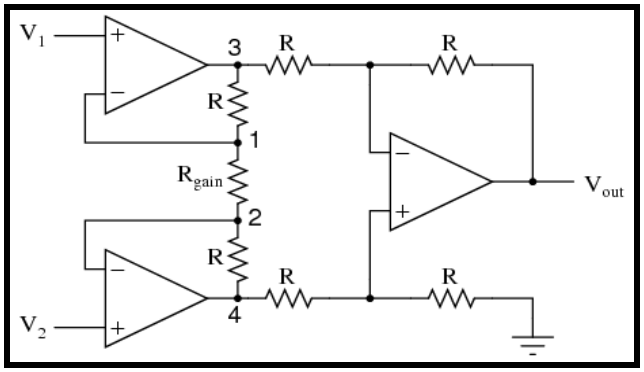


Figure:- Instrumentation amplifier

This intimidating circuit is constructed from a buffered differential amplifier stage with three new resistors linking the two buffer circuits together. Consider all resistors to be of equal value except for R_{gain}. The negative feedback of the upper-left op-amp causes the voltage at point 1 (top of R_{gain}) to be equal to V_1. Likewise, the voltage at point 2 (bottom of R_{gain}) is held to a value equal to V_2. This establishes a voltage drop across R_{gain} equal to the voltage difference between V_1 and V_2. That voltage drop causes a current through R_{gain}, and since the feedback loops of the two input op-amps draw no current, that same amount of current through R_{gain} must be going through the two "R" resistors above and below it. This produces a voltage drop between points 3 and 4 equal to:

$$V_{3\text{-}4} = (V_2 - V_1)(1 + \frac{2R}{R_{gain}})$$

The regular differential amplifier on the right-hand side of the circuit then takes this voltage drop between points 3 and 4, and amplifies it by a gain of 1 (assuming again that all "R" resistors are of equal value). Though this looks like a cumbersome way to build a differential amplifier, it has the distinct advantages of possessing extremely high input impedances on the V_1 and V_2 inputs (because they connect straight into the non-inverting inputs of their respective op-amps), and adjustable gain that can be set by a single resistor. Manipulating the above formula a bit, we have a general expression for overall voltage gain in the instrumentation amplifier:

$$A_V = (1 + \frac{2R}{R_{gain}})$$

Though it may not be obvious by looking at the schematic, we can change the differential gain of the instrumentation amplifier simply by changing the value of one resistor: R_{gain}. Yes, we could still change the overall gain by changing the values of some of the other resistors, but this would necessitate *balanced* resistor value changes for the circuit to

remain symmetrical. Please note that the lowest gain possible with the above circuit is obtained with R_{gain} completely open (infinite resistance), and that gain value is 1.

Application :- (any 1) **01 M**

i)Preamplifier in any measurement system

ii)Noise eliminator in precision DAS

(f) Draw circuit diagram of OP-Amp as integrator with inverting configuration state its output equation.

Ans}

Diagram:- **02M**

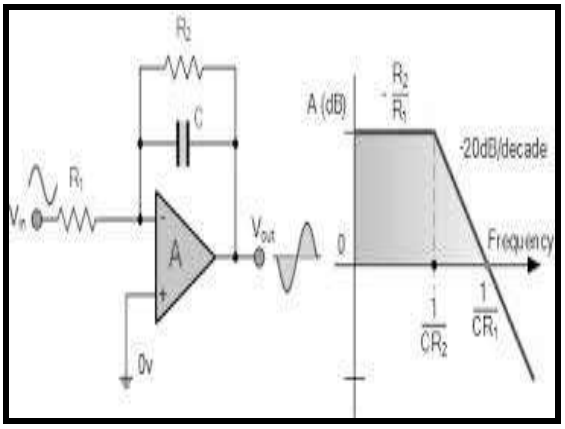


Figure:- OP –Amp as integrator

Equation :- **02M**

$$Vout = -\int_0^t \frac{Vin}{RC}\, dt + c$$

Q 3. Attempt any 4 **(16marks)**

a) Describe the ramp response of first order system in brief.

Ans}

Explanation:- **02M**

Input r(t)=t.1(t), Laplace transform $R(s)=1/S^2$

Output $C(S)=R(S)/1+TS = I/S^2(1+TS)=1/S^2+T/S+ T^2/1+TS$ where T is the time constant

Taking the inverse Laplace transform gives the response c(t)

$$c(t) = t - T + Te^{-\frac{t}{T}} \quad \text{for } t \geq 0$$

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

Diagram:- **02M**

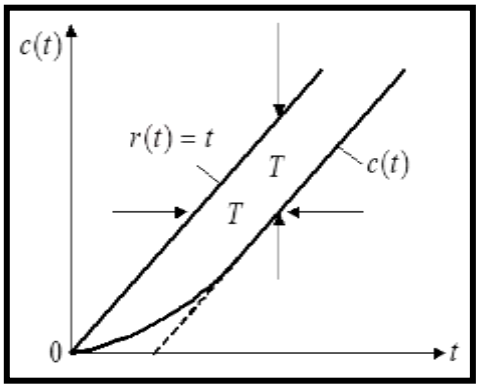


Figure:- Response of ramp

b)) Explain why LVDT gives a residual output at null position. State its two applications.

Ans}

Explanation:- **02M**

Residual output is due to presence of harmonics in the input supply, harmonics produced in the output voltage due to iron core,, temperature effect and stray magnetic field.

Application:- (any 2) 02M

- Displacement measurement.
- Pressure measurement.
- Thickness measurement.
- Weight of liquid in a tank .

c) Define Gauge factor. Describe bonded metal foil strain gauge.

Ans}

Define:- **01M**

Gauge factor is defined as per unit change in resistance to per unit change in length.

$$G_f = \frac{\Delta R / R}{\Delta L / L}$$

Diagram:- **01 ½ M**

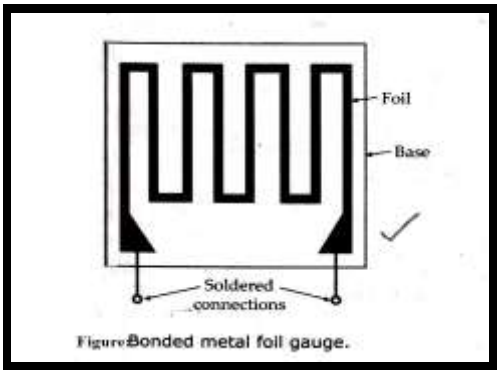


Figure Bonded metal foil gauge.

Explanation:- **01 ½ M**

Metal foil strain gauges use identical or similar materials to wire stain gauges and are used today for most general-purpose stress analysis applications and for many transducers. Foil type gauges have a much greater heat dissipation capacity as compared with wire wound strain gauges on account of their grater surface area for the same volume. For this reason , they can be used for higher operating temperature range. Also the large surface area leads to better bonding.

The sensing elements of foil gauges are formed from sheets less than 0.005mm thick by photo-etching process, which allow greater flexibility with regards to shape.

d) Describe use of Op-amp as current to voltage converter.

Ans}

Diagram:- **02M**

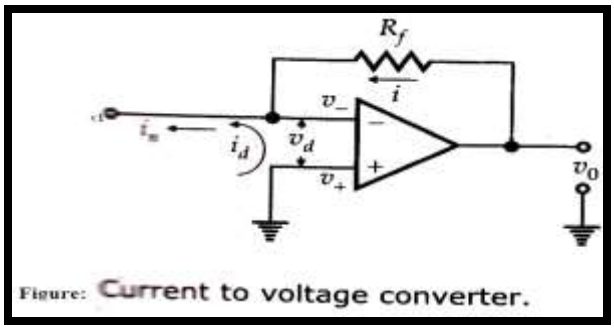


Figure: Current to voltage converter.

Explanation:- **02M**

A current to voltage converter is a circuit the provides an output voltage that is directly proportional to input current. Since the OPAMP input current i_d is essentially zero, the input current directly flows through R_f . Also , since v_- terminal is a virtual ground , the output voltage is

$$Vo=i_n R_f$$

Thus the desired result is obtained

e) Suggest suitable transducers for following measurement as,

(i) Low gauge or vacuum pressure in furnace drafts.

(ii) Water flow in river, streams.

(iii) Level measurement of corrosive materials.

(iv) Speed on any type surface as rotating, vibrating.

Ans} 01M each

NOTE:- (consider any one example)

(**i) Low gauge or vacuum pressure in furnace drafts:-** Vacuum gauge, capsule

(ii) Water flow in river, streams:- Ultrasonic flow meter, vortex flow meter, coriolis mass flow meter.

(iii) Level measurement of corrosive materials:- RADAR, Capacitive level transducer, Radiation Level transducer

(iv) Speed on any type surface as rotating, vibrating:- Eddy current sensor, piezoelectric accelerometer.

f) Describe the operation of turbine flow meter.

Ans}

Diagram:- 02M

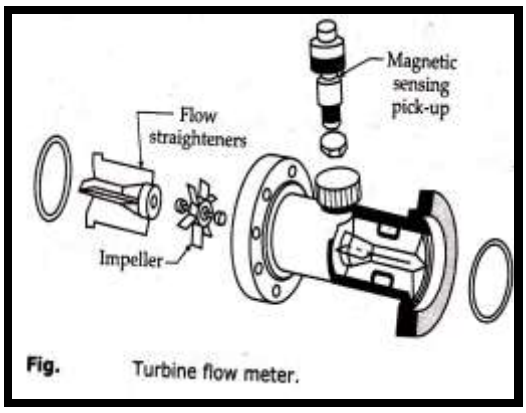


Fig. Turbine flow meter.

Explanation :- **02M**

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**.**

Q4. Attempt any 4 :- **(16marks)**

(a) Describe the operation of electromagnetic flow meter.

Ans}

Diagram:- 02M

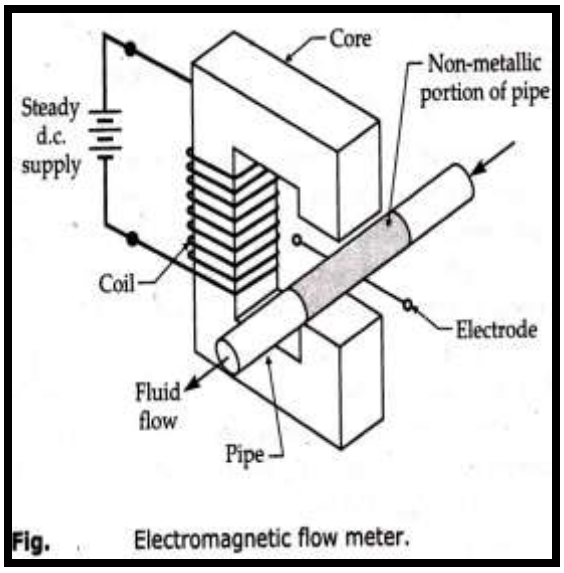


Fig. Electromagnetic flow meter.

Explanation:- 02M

It consist basically of a pair of insulated electrodes buried flush in the opposite pair of insulated electrodes buried flush in the opposite sides of a non- conducting , non- magnetic pipe carrying the liquid whose flow is to be measured.

The pipe is surrounded by an electromagnet which produces a magnetic field. The arrangement is analogous to a conductor moving across a magnetic field. Therefore , voltage is included across the electrodes . This voltage is given by :-

$$E = Blv \text{ volt}$$

Where B= flux x density; Wb/m^2,

l = length of conductor = diameter of pipe; m,

and v = Velocity of conductor (flow); m/s

Thus , assuming a constant magnetic field , the magnitude of the voltage appearing across the electrode will be directly proportional to velocity

(b) What is Hall effect ? State its applicability in parameter measurement.

Ans}Explanation 02M , Applicability 02M

Explanation:-

The principle of working of a Hall Effect Transducer is that if a strip of conducting material carries' a current in the presence of a transverse magnetic field, a difference of potential is produced between the opposite edges of the conductor. The magnitude of the voltage depends upon the current , the strength of magnetic field and the property of the conductor called Hall Effect.

Applicability:- (any two) 02M

- Measurement of displacement
- Measurement of current
- Measurement of power.
- It is used as magnetic to electric transducer.

(c) State advantages of active filter over passive filter. Hence draw frequency response of major active filters.

Ans} Advantages of active filter:- (any four) **02 M**

- Produces high gain
- Easier to design
- High input impedance and low output impedance for minimal loading
- No inductors
- Easier to tune
- Small in size and weight

Diagram:- **02M**

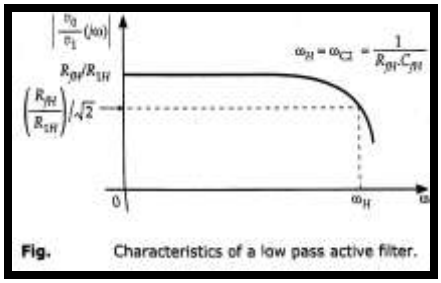


Figure 1:- Frequency response of low pass active filter

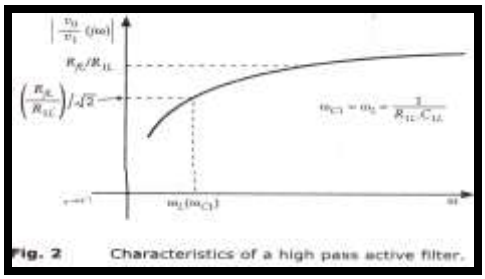


Figure 2:- Frequency response of high pass active filter

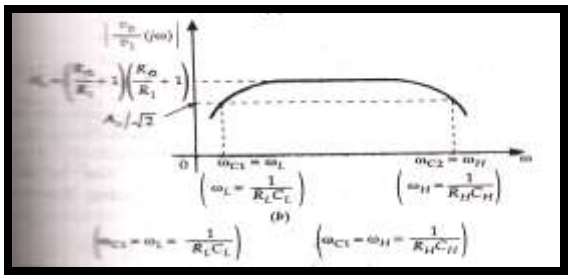
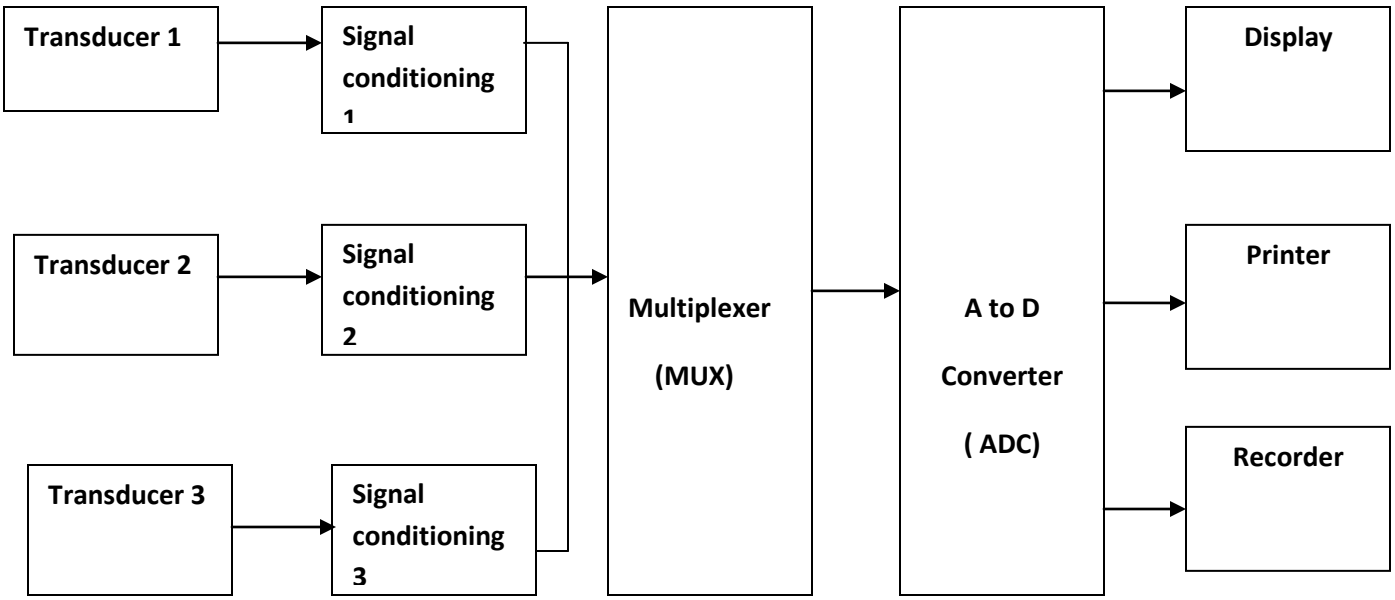


Figure 2:- Frequency response of band pass active filter

(d) Draw generalized block diagram of data acquisition system.

Ans}

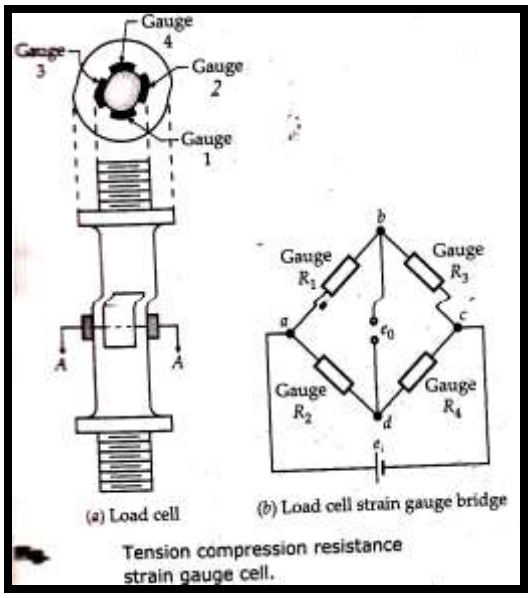
Diagram:- **04M**



e) Describe instrumentation system for force measurement using load cell.

Ans}

Diagram:- 02M



Explanation:- 02M

Load cells utilize an elastic member as the primary transducer and strain gauges as secondary transducers . Strain gauges may be attached to any elastic member , on which there exists a, suitable plane area to accommodate them. This arrangement may then be used to measure loads applied to deform or deflect the member , provided that the resultant strain is large enough to produce detectible outputs. When the strain gauge –elastic member combination is used for weighing it is called a load-cell.

f) Describe logarithmic conversion applicable with advantages to DAS.

Ans}

Explanation:- 04M

It is a signal conditioning method applicable with DAS.

The logarithmic conversion circuit enables the measurement of s fractional change in the input as a percentage of the input magnitude rather than a percentage of range. It improves the resolution

Q5. Attempt any FOUR of the following: 16M

a) Describe the construction of torque cell with a neat diagram.

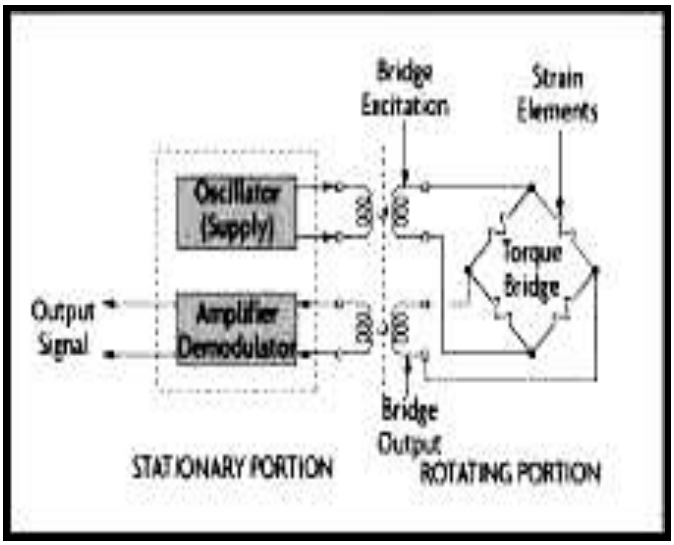
Ans}

Explanation:- 02M

A torque cell is a load transducer that will convert a torsional moment into a proportional electrical signal. Metal foil strain gauges are bounded on to a structural member that deforms when a torsional motion is applied .

Four metal foil strain gauges are used to obtain maximum sensitivity and temperature compensistion. Two of the gauges are in tension, and two in compression, all four strain gauges are wired in a Wheatstone bridge configuration with compensation adjustments that correct for temperature errors.

Diagram:- 02M



(b) Describe the operation of AC analog tachometer.

Ans}

Diagram : **02M**

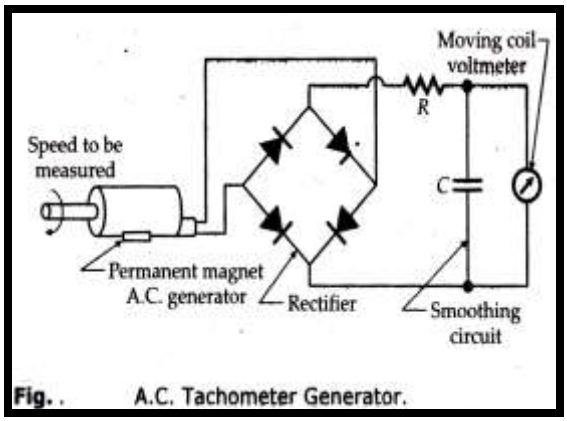


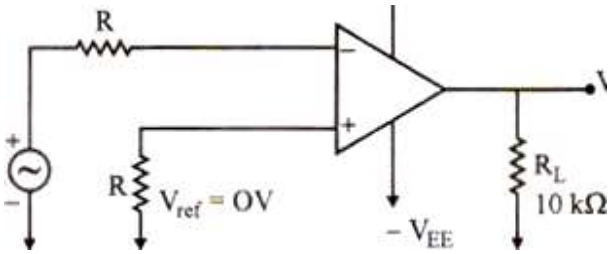
Fig. . A.C. Tachometer Generator.

Explanation:- **02M**

The tachometer generator has rotating magnet which may be either a permanent magnet or an electromagnet . The coil is wound on the stator and therefore the problems associated with commutator (as in d.c tachometers) are absent.

The rotation of the magnet causes an emf to be induced in the stator coil . The amplitude and frequency of this emf are both proportional to the speed of rotation. Thus either amplitude or frequency of induced voltage may be used as a measure of rotational speed.

(c) Identify the application of Op-amp shown in following circuit diagram. Hence draw its typical input- output waveforms.

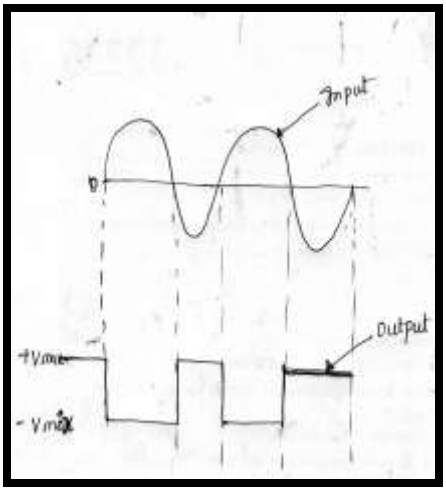


Ans}

Application :- **01M**

- **Inverter**

Input waveform 1 ½ M & output waveform 1 ½ M



(d) Differentiate between single channel and multi-channel DAS.

Ans}

Differentiation:- (any four points) **04M**

Note:- (Diagram of both DAS can be considered.)

Sr.No.	Single channel DAS	Multi channel DAS
1	Only one parameter is acquired	More than one parameters
2	Multiplexer is not required	Multiplexer is required
3.	Less number of transducer & signal conditioning is required	More number of transducer & signal conditioning is required
4.	Simple circuitry	Complicated circuitry

(e) Describe measurement of rotary motion using optical encoder.

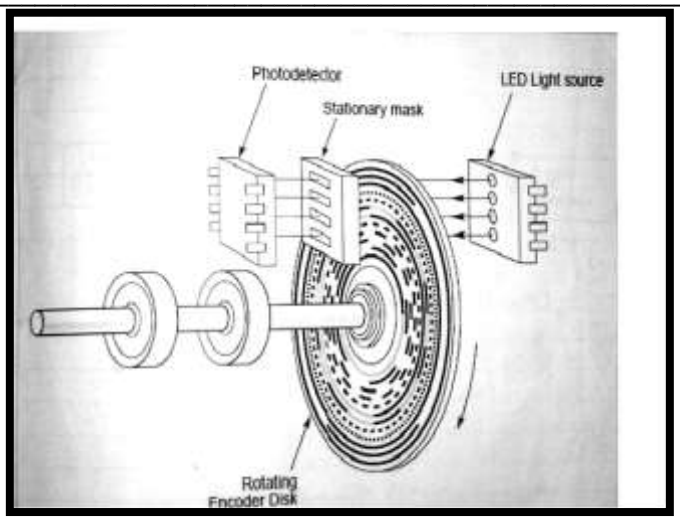
Ans}

Explanation of optical encoder:- **02 marks**

Rotary encoder converts linear or rotary displacements into digital codes or pulse signals. Encoders are of two types. i) Absolute encoder ii) incremental encoder.

All encoders require a sensing system of either contacting type using brushes or no contacting optical type. In rotary encoder, the sensing system is optical type. An optical rotary encoder consists of light source, rotary disc, stationary mask and photo sensor. The load or the motor whose displacement is to be measured is connected to the rotary disc which has transparent and optical parts. The light source and photo sensor are on opposite sides of the disc. Since the low level signals obtained from photo sensor is not adequate for control or signal processing, amplifiers and wave shaping circuits are necessary.

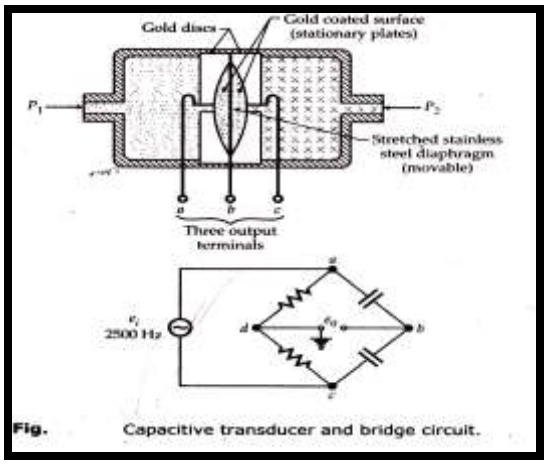
Diagram:- **02 marks**



(f) Describe operation of variable capacitance pressure transducer using diaphragm.

Ans}

Diagram:- **02M**



Explanation:- **02M**

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.*, $P_1=P_{2)}$ the diaphragm is in neutral position and the bridge is balanced. The output voltage e_0, 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 , e_0 from the bridge terminal . This output voltage is proportional

to the differential pressure. For an opposite pressure difference, the output voltage shows a 180^0 phase shift. This voltage may be amplified by an emitter follower amplifier.

6.Attempt any FOUR of the following : 16

(a) Explain how liquid level is measured by resistive sensor.

Ans}Arrangement of float along with potentiometer can be used for level measurement.

Diagram:- **02M**

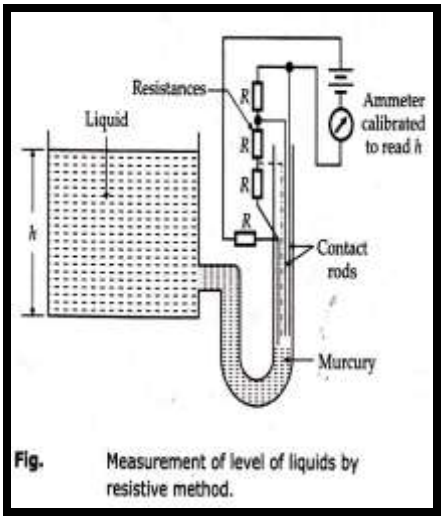


Fig. Measurement of level of liquids by resistive method.

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.

(b) Discuss any four points to be considered while selecting a transducer for its intended applications.

Ans} Any 4, 1 mark each

Explanation:-

Selection criteria of transducer is :-

- Operating principle
- Sensitivity
- operating range

- accuracy
- cross sensitivity
- errors
- transient and frequency response
- loading effect
- static characteristic
- ruggedness

(c) Describe ratio metric conversion in brief.

Ans

Diagram:- **02M**

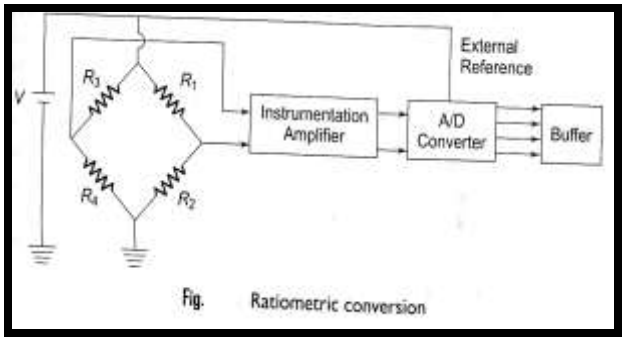


Fig. Ratiometric conversion

Explanation:- **02M**

It is a signal conditioning method applicable with DAS .

It includes an analog voltage divider to which an excitation voltage is given as the input . The output of it is given to an instrumentation amplifier and then to A to D converter. The output voltage of the divider is the ratio of the amplifier output voltage and the excitation voltage. Thus by this method the output of the signal amplifier will be a voltage proportional to the input parameter only and independent of the input excitation voltage. Hence the system accuracy improves since variation in the excitation voltage does not affect the sensitive of the system.

(d) Select suitable RTD with features for following temperature ranges as,

(i) - 240 °C to + 649 °C

(ii) - 196 °C to + 538 °C

(iii) - 212 °C to + 316 °C

(iv) - 73 °C to + 204 °C

Ans} Each range 01M

(i) - 240 °C to + 649 °C……..tungsten RTD

(ii) - 196 °C to + 538 °C…… platinum RTD

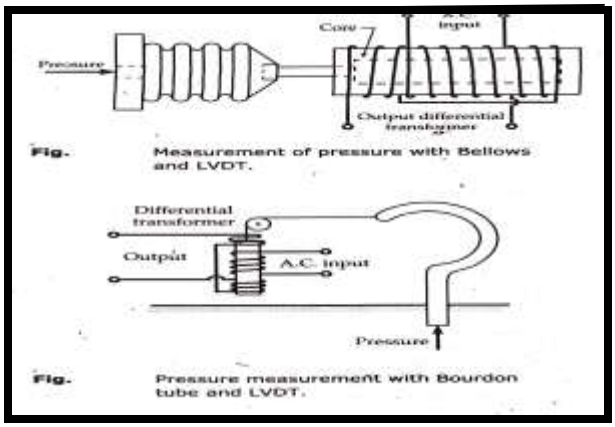
(iii) - 212 °C to + 316 °C……..nickel RTD

(iv) - 73 °C to + 204 °C…….copper RTD

(e) Explain use of LVDT as secondary transducer for pressure measurement.

Ans}

Diagram:- **02M**



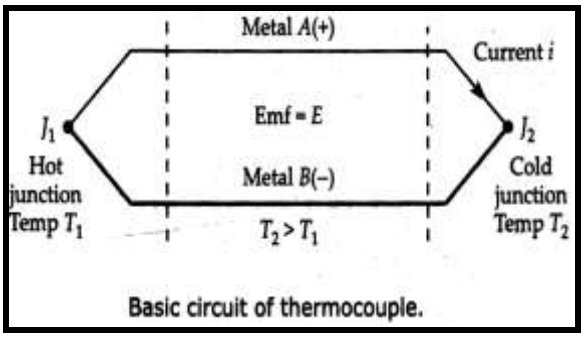
Explanation:- **02M**

The LVDT is used as a secondary transducer for measurement of pressure with Bellows or Bourdon tube acting as the transducer i.e., as a force summing device. The pressure is converted into displacement which is sensed by the LVDT and transuded into a voltage.

(f) Explain the working of thermocouple for temperature measurement.

Ans}

Diagram:- **02M**



Basic circuit of thermocouple.

Explanation:- **02M**

When heat is applied to junction (hot junction) of the two dissimilar metals, an emf is generated which can be measured at the other junction(cold junction). The two dissimilar form an electric circuit , and a current flows as a result of the generated emf. This current will continue to flow as long as T1>T2.