WINTER– 16 EXAMINATION

Model Answer

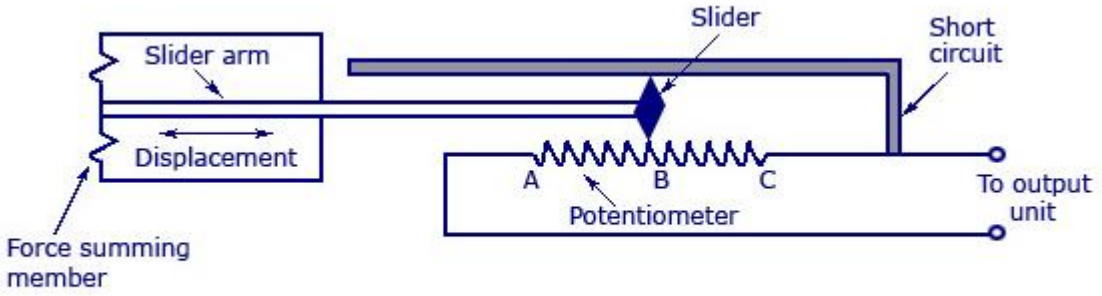
Subject Code: 17528

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. No.	Sub Q. N.	Answer	Marking Scheme
1A		**Attempt any three.**	
	a	**Define: hysteresis, speed of response, fidelity, overshoot.** **Hysteresis :** It is a phenomenon**,** which gives different output effects when loading and unloading, whether it is mechanical or electrical system. It arises due to the fact that all the energy input into the stressed part when loading is not reversible on unloading due to second law of thermodynamics, which rules out any perfectly reversible process. **speed of response :** it is defined as, the rapidity with which a measurement system responds to change in measured quantity. **Fidelity :** fidelity is the degree of closeness with which the measuring instrument indicates or records a changing value of variable input. It is the ability of system to reproduce the output in the same form as input. **Overshoot :** it is the maximum amount by which the pointer moves beyond the steady state. Pointer of an instrument does not come to rest in final deflected position. It happens due to mass and inertia of moving parts.	1m each definition

. No.	Sub Q. N.	Answer	Marking Scheme
1A	b	**What are active and passive transducers? Give two examples of each.** **Active transducer :** they generate equivalent electrical output signal without any external energy or energizing source. Examples : thermoelectric transducer, piezo-electric transducer, photo-voltaic transducer etc. **passive transducer :** the measurand is converted into passive parameter such as resistance, inductance or capacitance, which needs an external electrical supply so as to get an equivalent electrical output. Examples: resistive transducer, inductive transducer, capacitive transducer, piezo- resistive transducer, thermo- resistive transducer.	1m each definition. ½ m each example
1A	c	**Explain working of any one displacement transducer.** *Explanation of any one of the following considered.* *(Linear potentiometer transducer, capacitive transducer, piezoelectric transducer, LVDT , linear motion variable inductance transducer, proximity inductance transducer etc.)* **1. Linear Potentiometer Transducer:** A linear potentiometer **transducer** consists of a potentiometer, which is short circuited by a slider. The other end of the slider is connected to a slider arm. The force summing device on the slider arm causes linear displacement of the slider causing the short circuit of a certain portion of the resistance in the potentiometer. Let the whole resistance positions on the potentiometer be ABC. Let the resistance position caused by the slider movement be BC. As the movement of the slider moves further to the right, the amount of resistance increases. This increase in resistance value can be noted according to the corresponding change in the linear displacement of the slider. The change in resistance can be calculated with the help of a Wheatstone bridge. Another easy method than calculating the resistance with the help of a bridge connection is to connect a constant current source in series with the potentiometer. Thus a voltage will be developed. This voltage can be measured and hence the resistance, R = V/I.	Correct explanation of any one type 4 m.

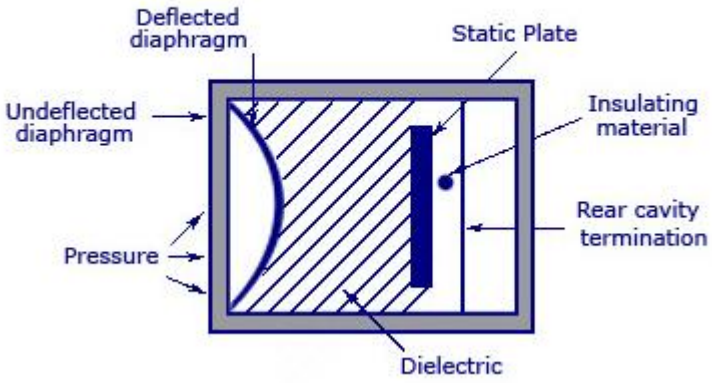


Linear Potentiometer

2. Capacitive Transducers:

As shown in the figure below, a capacitive transducer has a static plate and a deflected flexible diaphragm with a dielectric in between. When a force is exerted to the outer side of the diaphragm the distance between the diaphragm and the static plate changes. This produces a capacitance which is measured using an alternating current bridge or a tank circuit.

Capacitive Transducer



A tank circuit is more preferred because it produces a change in frequency according to the change in capacitance. This value of frequency will be corresponding to the displacement or force given to the input.

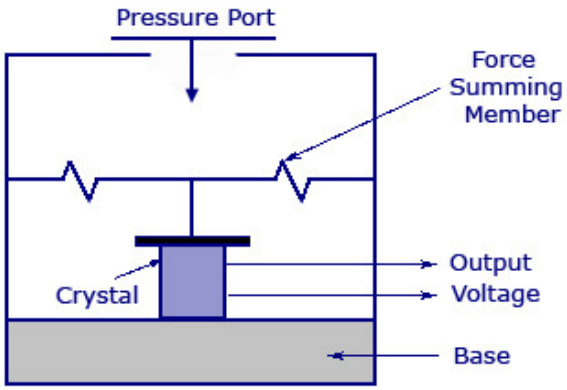
1A d

How pressure is measured by piezoelectric transducer? Explain.

Correct explanation 4 m

The main principle of a piezoelectric transducer is that a force, when applied on the quartz crystal, produces electric charges on the crystal surface. The charge thus produced can be called as piezoelectricity. Piezo electricity can be defined as the electrical polarization produced by mechanical strain on certain class of crystals. The rate of charge produced will be proportional to the rate of change of force applied as input. As the charge produced is very small, a charge amplifier is needed so as to produce an output voltage big enough to be measured. The device is also known to be mechanically stiff. For example, if a force of 15 kiloN is given to the transducer, it may only deflect to a maximum of 0.002mm. But the output response may be as high as 100KiloHz.This proves that the device is best applicable for dynamic measurement.

The figure shows a conventional piezoelectric transducer with a piezoelectric crystal inserted between a solid base and the force summing member. If a force is applied on the pressure port, the same force will fall on the force summing member. Thus a potential difference will be generated on the crystal due to its property. The voltage produced will be proportional to the magnitude of the applied force.



Piezo-Electric Transducer

1B a **Explain: observation and instrument error. Any three** — 02 marks each

Observation error:

A) personal error

human mistakes in reading instrument.
recording and calculating.
inaccurate conversion of units.
inaccurate estimate of average reading.
due to

- individual limitation/skill
- lack of experience
- observational error such as parallax error

b) operational error:

Error associated due to improper alignment or assembly.
Improper method of operation.

e.g.

- thermometer will not show proper reading if its thermal bulb not installed properly.
- in ultrasonic test , error due to improper use of probe with body.
- flow meter give wrong readings if it is installed near bend of pipe or immediate after valves.

instrument error:

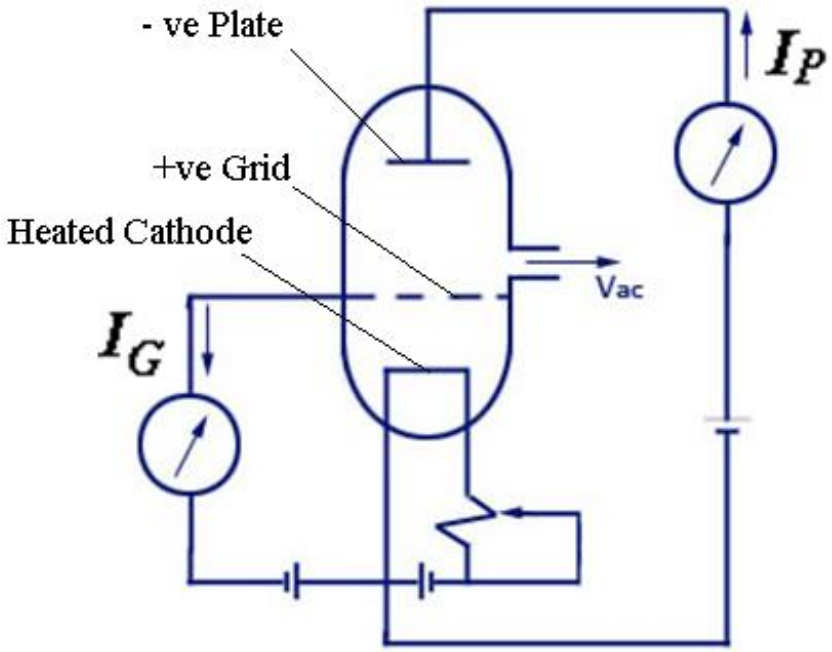
Classified as

- **assembly errors**
- **random errors.**

Assembly errors-

the assembly errors are the errors in the measuring instrument due to improper manufacturing of the instruments.

		Some of the possible assembly errors: A)Displaced scale: this is the incorrect fitting of the measuring scale. For instance the zero of pointer may not coincide with actual zero on the scale. Sometimes the scale gets cracked, thus showing the faulty readings. B) non-uniform scale: sometimes the scale of the measuring instrument is not divided uniformly. In some part of the scale the markings may be too close and in other parts too far. C)The pointer is bent: this happens in many cases. The pointer may get bent in either horizontal direction or the vertical direction, in either case, is shows erroneous reading. D) manufacturing errors in the components: the instruments are made up of a number of small components, which may be manufactured in different places. Sometimes there are manufacturing errors in some of these components like gear, lever, links, hinges etc. **Random errors-** apart from the assembly errors there can be many other errors which may be very difficult to trace and predict, these are called as random errors. A) frictional errors: there are number of moving mechanical parts in the analogue measuring instruments. the friction between these components leads to errors. due to friction some of the parts wear and tear, which further adds to the error of the instrument. hence, one should not use the analogue measuring instruments for long periods of time and replace with the good quality ones from time-to-time. mechanical vibrations: when the instrument is used in vibrating place the parts of the instrument start vibrating giving faulty readings. B) backlash in the movement: this is the error due to time lag between the application of the parameter and the instrument actually showing reading. even though some value of the parameter changes, there is no indication. C) hysteresis of the elastic members: over the period of time the elastic members tend to loose some elasticity leading to errors in the indicated value of the instrument. D) finite scale divisions: the scale marking can be made only up to certain limits and they not be hundred percent accurate.	
1B	b	**With a neat sketch explain working of ionization gauge for pressure measurement.** The construction of a hot cathode type ionization gauge consists of a basic vacuum triode. It is useful to measure pressure ranging from 10^{-3} to 10^{-8} mm of Hg .	Sketch 2m, explanation 4m.



ionization gauge

Ionization is the process of removing electron from an atom producing a free electron and positively charged ion.
It may be produced by the collision of high speed electrons from the atom.
Pressure of gas is proportional

$$P = \frac{1}{S} \frac{I_P}{I_G}$$

where,
Ip-Plate current
I_G –Grid current
S – sensitivity of the gauge. Depends upon tube geometry, nature of gas and operating voltage.

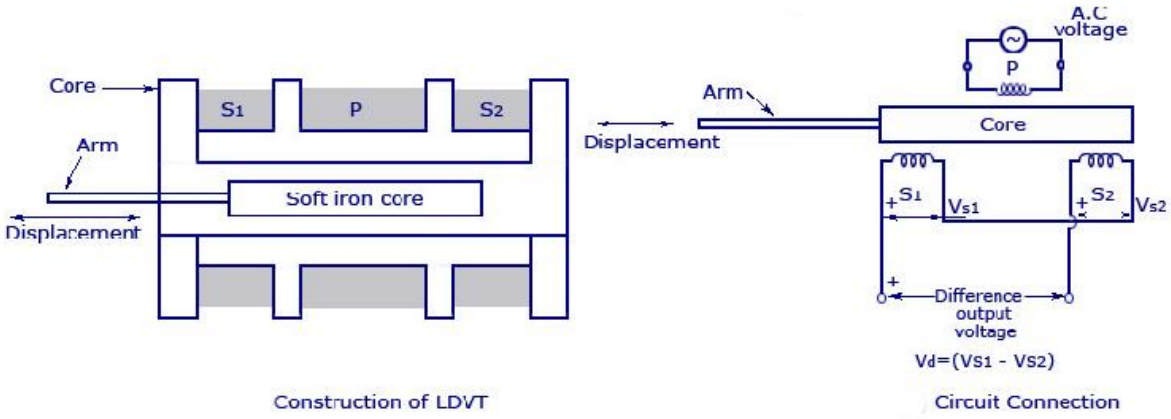
Any four

04 marks

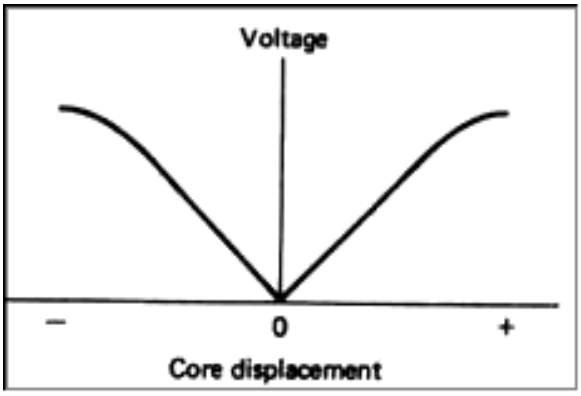
the grid is maintained at a large positive potential with respect to the cathode and the plate.
the plate is at a negative potential with respect to the cathode.
this method is also known as the external control type ionization gauge as the positive ion collector is external to the electron collector grid with reference to the cathode.
the positive ions available between the grid and the cathode will be drawn by the cathode, and those between the grid and the plate will be collected by the plate.

2	a	**Attempt any two.** **State and define four desirable and four undesirable characteristics of measuring instruments.** **Desirable characteristics:** accuracy, precision, sensitivity, reproducibility, repeatability, resolution etc. **Accuracy**: it is the closeness or agreement of measurement value with true value. **Precision**: the difference between two consecutive reading measured by instrumentation system is known as Precision. High precision means tight cluster of repeated results and low precision means broad scattering of results. **Sensitivity**: it is the ratio of the magnitude of the output signal to the magnitude of the input signal or quantity being measured. **Reproducibility**: the closeness or agreement between independent results is obtained with the same method on identical test material but under different conditions. **Resolution**: it is the smallest measurable input to cause measurable change in output. **Undesirable characteristics:** drift, measuring lag, dead zone, dead time, hysteresis, overshoot, backlash etc. **Drift**: drift is the undesirable change or a gradual variation in output over a period of time that is unrelated to change in input, operating conditioning, or load. **measuring lag**: it is the retardation or delay in the response of a measuring system to change in measured quantity. **dead zone**: it is range of values of a measured variable to which instrument does not respond. E.g. the input applied to the measurement may not be sufficient to overcome friction. **dead time:** it is the time required by the measurement system to begin to respond to a change in the measurand. **Backlash**: the maximum distance or angle through which any part of of a mechanical system may be moved in one direction without applying appreciable force or motion to the next part in a mechanical system is called backlash.	Any four desirable 04 marks Any four undesirable 04 marks
2	b	**Explain working LVDT with the help of neat sketch and state its application and working range.** WORKING: as shown in the figure above, an ac voltage with a frequency between (50-400) hz is supplied to the primary winding. thus, two voltages vs1 and vs2 are obtained at the two secondary windings s1 and s2 respectively. the output voltage will be the difference between the two voltages (vs1-vs2) as they are combined in series. let us consider three different positions of the soft iron core inside the former. Null Position – This is also called the central position as the soft iron core will remain in the	Sketch 2m, explanation 4m, application 1m, range 1m

exact center of the former. Thus the linking magnetic flux produced in the two secondary windings will be equal. The voltage induced because of them will also be equal. Thus the resulting voltage VS1-VS2 = 0.
Right of Null Position – In this position, the linking flux at the winding S2 has a value more than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS2.
Left of Null Position – In this position, the linking flux at the winding S2 has a value less than the linking flux at the winding S1. Thus, the resulting voltage VS1-VS2 will be in phase with VS1.



Construction and Circuit Connection of LVDT



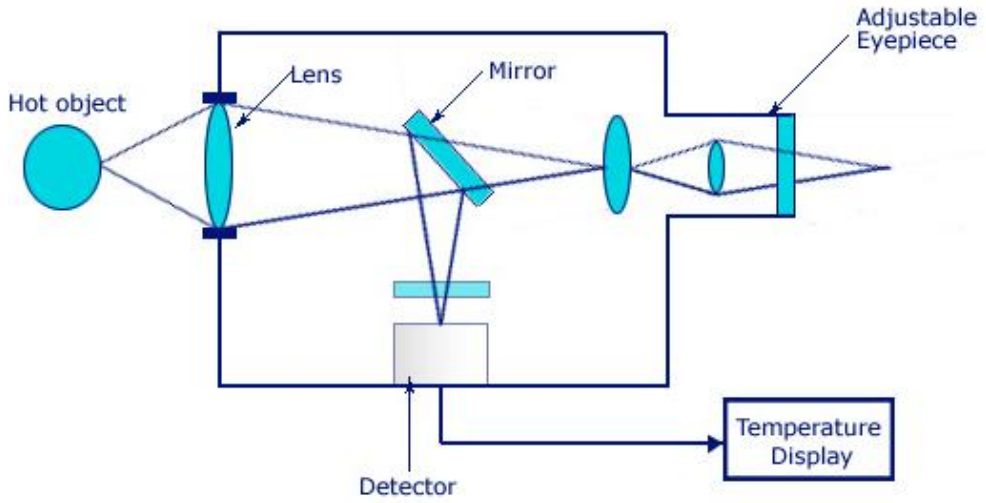
Applications of LVDT:

Crankshaft balancer, soil strength testing machine, pill making machine assembly , automation assembly equipment, robotic cleaner, bore hole extensometer, bottle height inspection, weighing m/c, hydraulic cylinder displacement.

Working range: 1.2 mm to 25 mm displacement.

Explain working of a total radiation pyrometer with the help of a neat sketch. State its temp. range. And application.

Total radiation pyrometer – in this method, the total heat emitted from the hot source is measured at all wavelengths.
as shown in the figure below, the radiation pyrometer has an optical system, including a lens, a mirror and an adjustable eye piece.

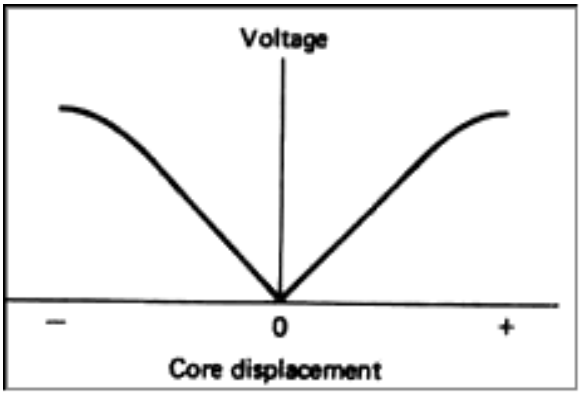
		the heat energy emitted from the hot body is passed on to the optical lens, which collects it and is focused on to the detector with the help of the mirror and eye piece arrangement. the detector may either be a thermistor or photomultiplier tubes. though the latter is known for faster detection of fast moving objects, the former may be used for small scale applications. thus, the heat energy is converted to its corresponding electrical signal by the detector and is sent to the output temperature display device.	
2	c	Block Diagram of Radiation Pyrometer  **Temperature range:** measure temp. above 400 degree celcius. **Application** : • it measures temp. of moving object. • Temp. of furnace interiors, which are not easily accessible. • Average temp. of large surface area. • Can be used in the environment which contaminate or limit the life of thermocouple. • Measures the temperatures that is above the limit of thermocouple.	Sketch 2m, explanation 3m, range 1m, application 2m.
3	a	**What is calibration of instruments? Why it is done?** Calibration is the operation of making an adjustment or making a scale so that readings of an instrument conform to an accepted and a certified standard. It creates confidence of using instruments in users mind. It is a process of establishing reliability of a measuring instrument. It involves visual inspection for obvious physical defects, proper installation according to manufacturer's specifications, zero settings, leveling etc.This involves the comparison of the instrument to be calibrated with either primary standard, secondary standard or a known input source. It is done for the following purpose i) It gives the opportunity to check the instrument against a known standard there by helping in evaluation of errors and accuracy	02

ii) To establish reliability of instrument
iii) To offer specified accuracy to instrument
iv) To improve performance of instrument
v) To minimize errors of measuring instrument
vi) To conform linearity, hysteresis and repeatability of instrument

02

b

Draw the characteristics of LVDT & state its significance



02

Significance:-

As the core is moved in one direction from the null position, the differential voltage i.e. the difference of the two secondary voltages will increase while maintaining an in phase relationship with the voltage from the input source. In the other direction from the null position, the differential voltage will also increase, but will be 180^0 out of phase with the voltage from the source

The output voltage of an LVDT is a linear function of core displacement within a limited range of motion says about 5mm from the null position. Fig shows the variation of output voltage against displacement for various positions of core. The curve is practically linear for small displacements. Beyond this range of displacement, the curve starts to deviate from a straight line.

02

Explain the working of pressure thermometer with a neat sketch

c

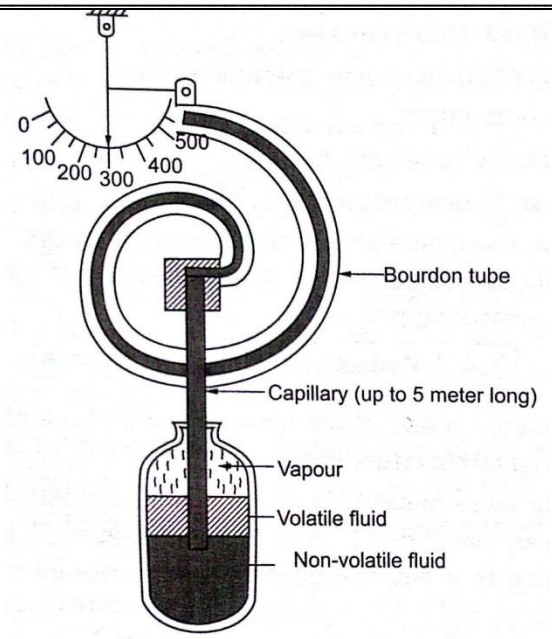
Principle of Woking: Fluid expansion due to an increase in the pressure in a given volume of the temperature measuring system. The bulb of thermometer is filled with either a liquid or gas or liquid- vapour mixture.

Different pressure thermometers depending upon type of fluid are,

(i) Mercury –in-steel thermometer
(ii) Constant volume gas thermometer, or
(iii) Vapour pressure thermometer

Figure below shows the vapour pressure thermometer

02



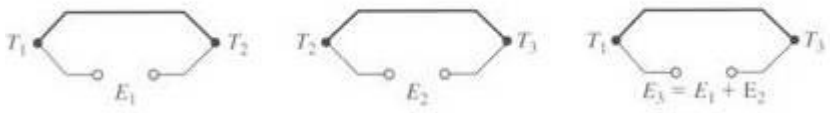
02

Working:

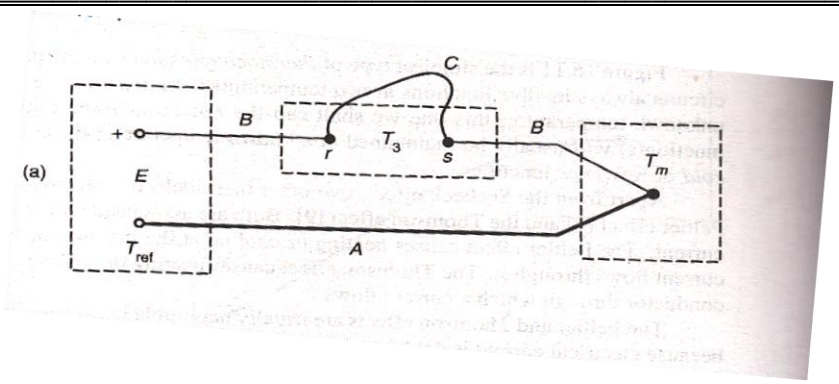
- The liquid in a bulb of vapour –pressure system boils and vapourises until the pressure in the system equals the vapour pressure of boiling liquid.
- These vapours creats pressure on nonvolatile fluid which causes its motion in bourdon tube.
- Deflection of bourdon tube is caliberated to measure the temperature.
- Volatile liquid works as a spring (Its vapourisation depends on the measurand temperature)
- Non-volatile liquid works as a transmitting link.

d **State the laws of intermediate temperature & law of intermediate metals with their practical relevance for a thermocouple**

02



laws of intermediate temperature:-If a simple thermocouple ckt developes an emf E1,when its junctions are at temperature T1 & T2 an emf E2 when its junctions are at temperature T2 & T3.It will develop an emf E1+E2 when its junctions are at temperature T1 & T3 **(Diagram not essential but preferred)**



02

law of intermediate metals:-The law of intermediate metal states that the net emf in the ckt remains unaltered if a third metal is introduced provided that the two junctions of the third metal are at the same temperature

(Diagram not essential but preferred)

practical relevance of laws for a thermocouple:-

i)The law makes it possible to use extension wires of a different metal from the metals used for thermocouple

ii)The law enables a measuring instrument to be introduced in the ckt

iii)The wires forming the junction can be soldered or brazed together

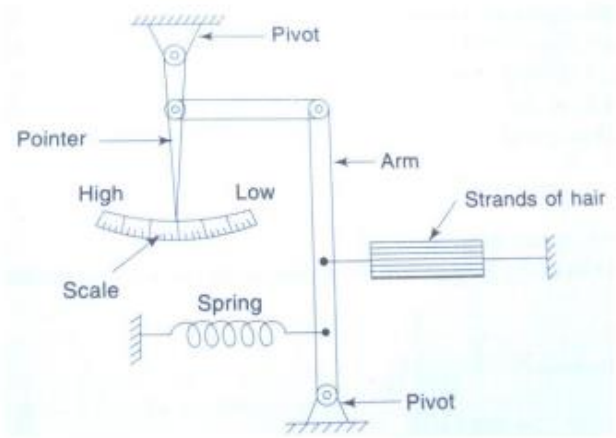
iv)It makes possible the use of thermocouple tables based on a std reference temperature although neither junction may actually be at a std temperature

e

Differentiate between resistance thermometer & thermistor any four

SR NO	Resistance thermometer	thermistor
1	These are made of metals which are good conductor of electricity eg cu,platinum,nickel	These are made of metallic oxides such as cobalt,mangnese,nickel etc
2	Have positive coefficient of resistance(PTC)	Have positive coefficient & negative coefficient of resistance(PTC&NTC)
3	Temperature range -100^{0}C to 650^{0}C	Temperature range -50^{0}C to 300^{0}C
4	Resistance change is small,positive & linear	Resistance change is large & non-linear
5	As they are made of metals,they are more time stable	Made of metal oxides,so less time stable
6	They have better reproducibility & low hysteresis	They have less reproducibility & more hysteresis
7	Relatively bigger in size	Are quiet small in size

Four differences 01 mark each

4	a	**Explain working of hair hygrometer with a neat sketch**  Hair hygrometer is cheap pocket size instrument used for humidity measurement. Its working based on the principle that a change in moisture content causes a change in the physical and chemical characteristics of certain materials .Certain material such as human hair, animal membrane, wood & paper undergo changes in liner dimension when they absorb moisture from the atmosphere. Human hair become longer as the humidity of the surrounding air increases, & shortens when the air becomes dry. It is reflected through a mechanical linkage to a indicator pointer or to a recording pen. The indicator scale is calibrated to give direct indication of humidity. The sensor comprises strands of hair to give it increased mechanical strength. The hair strands are generally arranged parallel to each other with sufficient space between them for giving free access to the air sample under test (atmosphere) .For proper functioning, the element is maintained under light tension by a spring.Here, as the humidity increases, the expansion of hair takes place and thereby the pointer is displaced over the scale, thus giving the reading of RH value directly	02 02
	b	**Define intensity of sound,sound pressure,sound power,sound speed** **Intensity of sound:-**It is the average energy passing through a unit of area per unit of time.It is proportional to the square of electric field amplitude and given by the average value of the pointing vector.Sound intensity is measured in W/m^2 and its frequency in cycles per second or Hz **Sound pressure:**-The logarithmic measure of the effective sound pressure of a sound to reference value,is calle sound pressure level.It is denoted by SPL $$\mathbf{SPL=20\log_{10} P/P_{ref}\ dB}$$ Where ,P=sound pressure P_{ref}=Reference pressure OR Sound presure levels(SPL) are units often used in the measurement of sound levels	01 for each

and are defined as the difference in pressure between the maximum pressure at a point and the average presure at that point

Sound power:-It is the total energy radiated by sound source per unit time.It is abbreviated as PWL and is given by

$$\mathbf{PWL=10log_{10}\ W/W_{ref}\ dB}$$

Where ,W=Acoustic power of the source

W_{ref}=Reference acoustic power

Sound speed:-The speed of sound in a general fluid medium is given by the fluids bulk modulus E (Inverse compressibility) and the fluid density

$$\mathbf{Speed=\frac{\sqrt{E}}{\sigma}}$$

Where E=Bulk modulus

σ=Fluid density

c Write the working of bimetallic temperature measuring instrument

"Bimetallic Thermometer is a device which utilizes the principal of thermal expansion of metals at different temperatures**.**

It consists of two different materials having different coefficient of thermal expansions rigidly joint together, one on other form a bimetallic strip. Various metallic strips of Nickel-steel alloy & brass can be used.

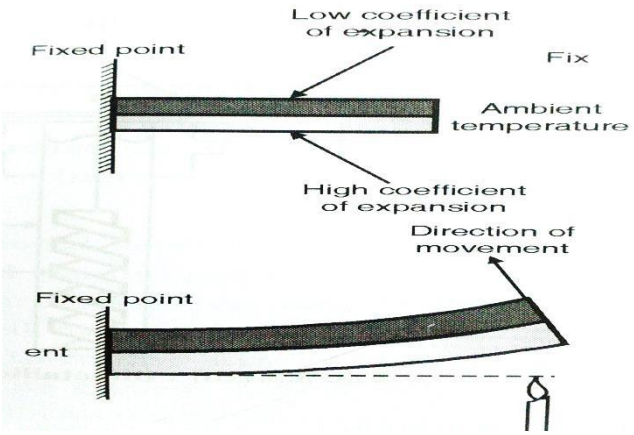


Fig. A bimetallic Strip 02

When two metallic strips of different coefficient of thermal expansions are brazed together and if a temperature change is applied then a free deflection of assembly takes place, since one strip expands more as compared to another strip. The two metals have different coefficient of expansion e.g. brass and invar rigidly joint together. When bimetallic strip is fixed at one end and heated from free end then it bends in the direction of material having low thermal coefficient of expansion. The bending movement of free end is connected to pointer which moves over calibrated scale. Usually the bimetal is wound in the form of helix. Its one end is fastened permanently to the outer casing and the other end is connected to pointer stem. Thermal well is provided for protection against corrosion and breakage. 02

Such bimetallic strips can be used in the thermometers for temperature

measurement or can be used in thermostats for controlling the temperature of furnaces, cooling systems, and refrigeration sans A.C system.

With a neat sketch,explain working of variable area flow meter.

d

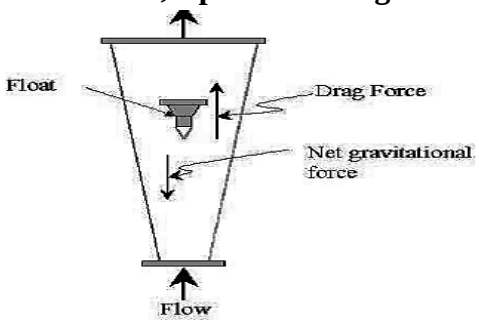


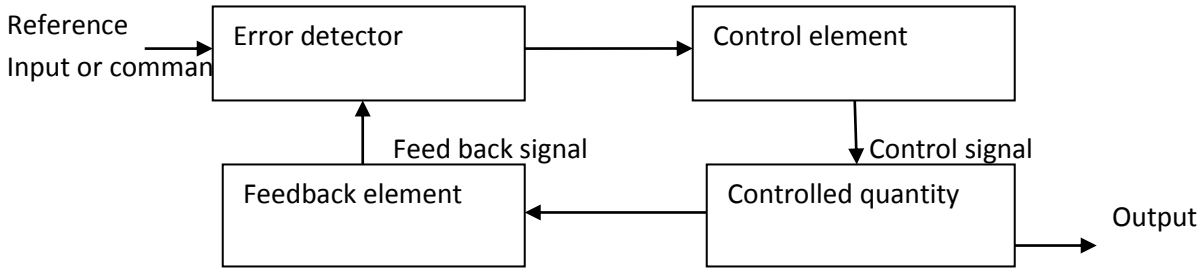
Fig. Rotameter

(variable flow meter) — 02

The rotameter (**variable area flow meter)** consists of three basic elements:
1) A uniformly tapered flow tube, 2) a float, and 3) a measurement scale.
A control valve may be added if flow control is also desired. In operation, the rotameter is positioned vertically in the fluid system with the smallest diameter end of the tapered flow tube at the bottom. This is the fluid inlet. The float, typically spherical, is located inside the flow tube, and is engineered so that its diameter is nearly identical to the flow tube's inlet diameter.
When fluid like gas or liquid is introduced into the tube, the float is lifted from its initial position at the inlet, allowing the fluid to pass between it and the tube wall. As the float rises, more and more fluid flows by the float because the tapered tube's diameter is increasing. Ultimately, a point is reached where the drag force exerted by the fluid is balance by weight of float and gravitational force. The float is now stationary at that level within the tube as its weight is being supported by the fluid forces which caused it to rise. This position corresponds to a point on the tube's measurement scale and provides an indication of the fluid's flow rate. — 02

4B a **Differentiate between electronic & pneumatic control systems Any six** — six marks, 01 each

SR NO	Electronic control system	Pneumatic control system
1	Electricity is operating medium	Operating medium is gas or air
2	Extremely high speed of response	high speed of response
3	Very high accuracy	Fairly good accuracy
4	It has no fire hazards	Chances of fire hazards are more
5	Signal transmission over longer distance	Signal transmission up to 250-300 feet
6	Susceptible to noise pick-ups	Unaffected by electrical noise
7	Application-Automobiles	Application-Earth moving equipments

	b	**with a neat sketch explain working of servo motor mechanism.Write two applications**	
			03
		By servo-mechanism or simply a servo, we mean a system which is used to automatically control the output mechanical position, or time derivative of position, velocity or acceleration of the output member in response to variation of input signal. As such a servo system is used to position a final control element in a generalized instrumentation system. Actuators are used to operate the final control element such as a valve, heater, etc.It is an important element of servomechanism. A servo mechanism is a closed loop system that moves or changes the position of the controlled object so that it agrees with the position of a control device. The error detector compares the feedback signal with the reference input or command. Control element receives and amplifies the actuating signal so that large external power is applied to restore the desired position of the controlled object.	03
		Actuator corrects the system error by causing the right change in controlled quantity. In servo mechanism this actuator must produce motion, either linear or rotary. Therefore some type of thrust device or motor is required so that it can work as an actuator.	
5	a	**Applications:-** i)Tool position control ii)Radar tracking system iii)Missile guidance system iv)Power steering system in automobiles v)Remote control airplanes vi)Antiaircraft-gun control system vii)Control mechanical things such as motors and robots	01
		The stroboscope is a simple portable manually operated device which may be used for measurement of periodic or rotary motions. If strong light is caused to flash on moving object, the object will appear stationary .The stroboscope consists of a source of flashing light whose frequency can be varied and controlled. This source is called a strobotron. Stobotron is hot cathode gaseous discharge tube.It consists of one cathode, one anode and two grids. Conduction starts when potential of outer grid is increased or potential of inner grid is	03

decreased. Once the conduction starts, it can be stopped only by removing the anode potential.The tube has capacity to flash 300 flashes per second.The flashing light is directed on rotating member , which usually has some spoke , gear teeth or some other features.

If the rotating member does not have any of such features, a paper having black and white stripes, which is attached to it or some marketing is done at a target. The frequency of lamp flashing is adjusted until the target appears stationary .

Under this condition, speed is equal to flashing frequency . The scale of stroboscope can be calibrated to read the speed directly .

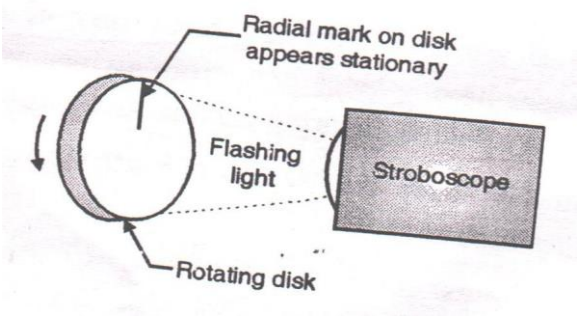
- If there are several marks on shaft, various errors in measurement arise.
- If disc has m number of marks, then disc will appear stationary,

  The speed (n) = $\frac{F}{M}$

  Where F= Number of flashes per sec.
  M = Number of marks on disc.
- Single line image is obtained by flashes.
- The flashing rate is gradually reduced and flashing frequencies are noted for all single line image.
- If single line image are obtained at m different flashing rates say F1,F2……..Fm

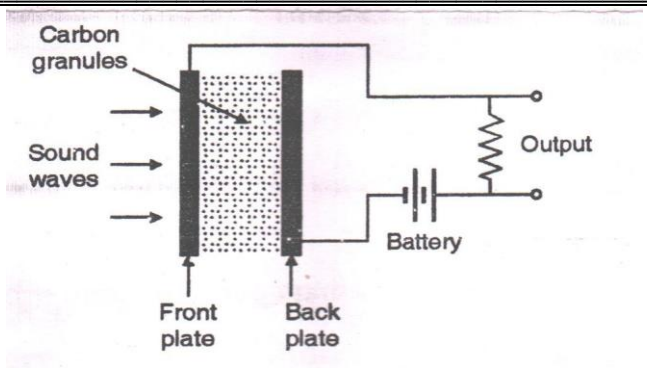
Then, Speed of shaft (n) $= \frac{FmF1(m-1)}{Fm-F1}$

Where , F1 = Lowest flashing frequency
Fm = Highest flashing frequency
M = Number of flashing points or frequencies



Carbon microphone

b It is also referred as button microphone or a carbon transmitter . Fig show carbon microphone .



02

It consists of two metal plates separated by carbon granules.

One plates is on the face and acts as a diaphragm. When sound strikes the face plate, a current runs from one plate through the carbon to the other plate . The resistance causing change in the current and a consequent change in voltage which is the output of the microphone.

02

The principle advantage of carbon microphone is that they have the ability to produce high level audio signals from very low d.c. voltage . Its major drawback is low quality of sound reproduction and limited frequency response . They were used in telephone receivers, radio broadcasting etc.

01 for each

c

Advantages : Any two

1) It makes effects of process (plants) disturbances.

2) it makes system insensitive to process variations

3) it stabilizes an unstable system.

4) it creates well-defined relation between output and reference .

5) It is more accurate than open loop systems

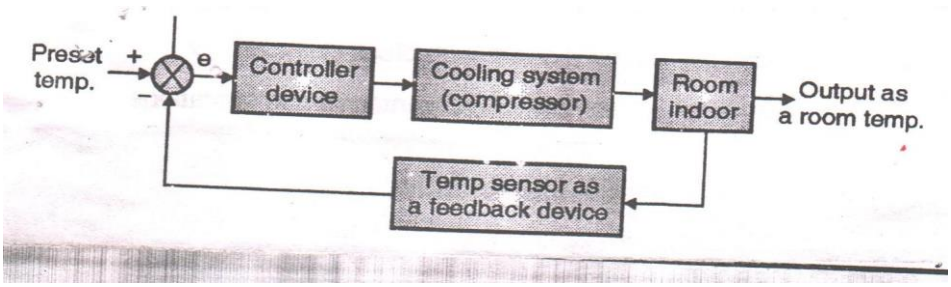
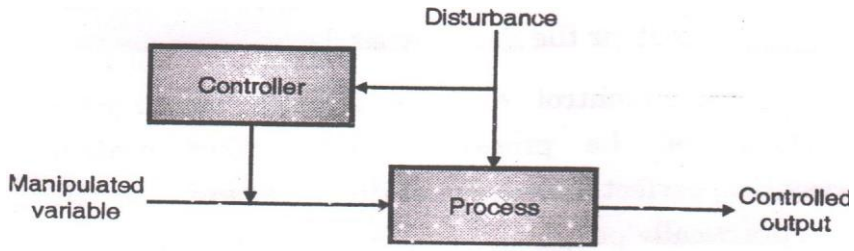
6) It performs job faster than human beings

7) It clear out the errors between input and outputs signals

Disadvantages : Any two

02

1) These are relatively more complex in construction.
2) These are costlier than open loop system.
3) These are less stable than open loop system.

	d	Control system for an air conditioner :  • Today most of the modern appliances are equipped with closed loop control or feedback control. Examples include air conditioners refrigerators, water heaters, oven etc. • An air conditioner uses a thermostat to detect the temperature and control the operation of its compressor to keep room temperature to adjust the extent of cooling. • When the temperature of the cool air is lower than the preset one, controller device will stop the operation of the compressor, hence coolant circulation stops. When temperature inside the room is move than preset, then controller device starts the compressor hence cooling systems. Temperature sensors continuously measures the indoor temperature and send results to the controller for further action. Hence it is closed loop or feedback control system.	02 02
	e	Feed forward control system : Feed controllers have the theoretical potential for perfect control.  The fig show the general form of feed forward control system. It measures the disturbance directly and then changes effect that it will have on the process output . Subsequently, it changes the manipulated variable by such an amount as to eliminate completely the impact of the disturbance on the process output (controlled ariable) Control action starts immediately after a change in the disturbance has been detected . Feedback acts after the fact in a compensatory manner, wheras feed forward acts beforehand in an anticipator manner. The feed forward control system can be developed for more than one disturbance .The controller acts according to which disturbance changed value. With the excepation of	02

the controller, all the other hardware elements in a feed forward loop are the same for a feedback loop

- The feed forward loop retains all the external characteristics of the feedback loop. Thus it has a primary measurement , which is compared to a set point signals , and the result of the comparison is the actuating signals for the main controller .
- Feed forward control depends heavily on a good knowledge of the process model perfect necessities, perfect knowledge of the parameters, which is not practically possible .

02

f

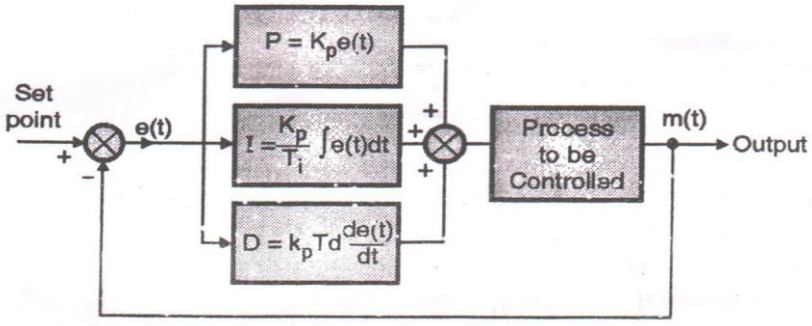
PID Control Action

It is the composite control action of proportional integral and derivative control mode. It combines the advantages of these three control actions. In this system the output (m) is a linear combination of input e, the time rate change of input and the time integral as input . Mathematically it is given by

02

$$m(t) = K_p\, e(t) + \frac{K_P}{T_i} \int e(t) \cdot dt + K_p\, T_d \frac{de(t)}{dt} + M \ldots (IV)$$

The PID control mode is best suitable for system where close controls is required because of large and sudden fluctuations



02

a

Turbine Flow meter

Construction and working

The turbine flow meter consists of a multi blade rotator which is placed at right angle to the axis of flowing fluid. The rotor is supported by ball bearing on a shaft . This is free to rotate about its axis .A magnetic pickup coil is placed near the table . It is used to measure the speed of blade.

The turbine flow meter works on basic principle of turbine .If is losses are kept

6	b	minimum, the turbine speed varies linearly with flow rate i.e. flow rate can be measured by measuring the speed of the turbine . When blade passes by pickup coil it interrupt magnetic field and produces a pulse . The rate of pulse gives flow and total number of pulses gives a measures of the flow . Turbine meter is shown in Fig	02

Turbine Flowmeter :

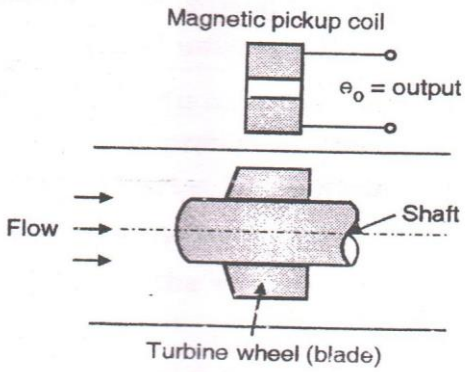


Fig. **Turbine flow meter** 02

Application :

i) It is used for measurement of liquid , gas and very low flow rates.
ii) To measure wind speed/velocity

Hot wire anemometer is used for measurement of flow rate of fluctuating and unsteady flow.

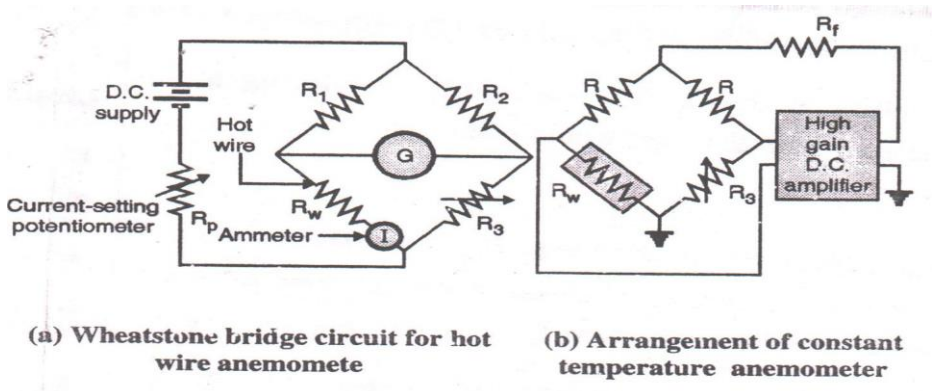
A sensor of 5 micron diameter platinum tungsten wire welded between two prongs of the probe and heated electrically to form part of Wheatstone circuit

When the probe is introduced into the flowing fluid , it tends to be cooled by the velocity and there is decrease in its resistance . 02

The rate of cooling of wire depends upon the :

i) Dimension and physical properties of the wire.
ii) Difference of the temperature between the wire and fluid.

There are two methods of measuring fluid flow. (Anyone method may be considered)



(a) Wheatstone bridge circuit for hot wire anemomete (b) Arrangement of constant temperature anemometer 02

Constant –current mode :

- Fig shows constant-current mode hot wire anemometer in which the voltage across the bridge is kept constant .
- Initially the circuit is adjusted at zero galvanometer reading when the heated wires lies in still air .
- When the fluid flows the hot wire cools the resistance changes and the galvanometer deflects.
- The galvanometer deflections are amplified measured and correlated with fluid velocity by previous calibration.

Constant-temperature mode :

- Fig shows constant –current mode hot wire anemometer in which resistance of the wire and its temperature is maintained constant.
- The interior of the anemometer is an exposed hot wires maintained at a constant temperature. The heat lost to fluid convection is a function of the fluid velocity

Vortex Shedding Flow Meter

The principle of operation of vertex shedding flow meter is based on a phenomenon known as vertex shedding . 02

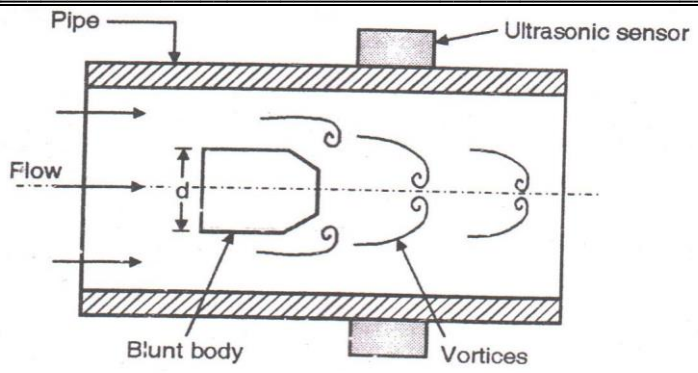
When a blunt or bluff body or obstacle is placed in a flow path , vortices are formed alternately around and downstream of an object. Fig :

c The frequency at which the vortices are formed is directly proportional to the fluid velocity . The frequency is called as vortex shedding frequency . The frequency can be measured by ultrasonic transducer placed in pipe.

It is given by

$$F \alpha v / d$$

02



vortex shedding flow meter

Advantages :

i) A wide variety of fluids may be measured
ii) It has linearity within + 0.5 % and rangability up to 200:1 is possible
iii) It has no moving parts.
iv) It is more acceptable in the market.

01 for each

d

Strain Gauge Material :

Following are some of the popular metal alloys used for strain gauge element :

i) Constantan – Nickel 45 % , Chromium 55 %
ii) Advance – Copper 57 % , Nickel 43 %
iii) Isoelastic – Iron 52 % , Nickel 36 % , Chromium 8 % Molybdinum 0.5%
iv) Nichrome - Nickel 80 % , Chromium 20 %

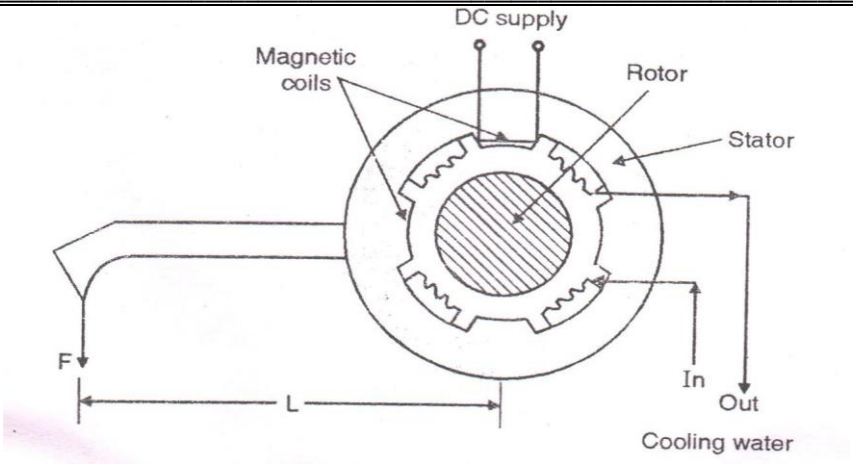
01

e

Eddy current is the type of absorption type dynamometer is used for shaft power measurement

- It consists of non-magnetic solid metallic rotor, which moves in the magnetic field of stator.
- The stator winding is excited by a D.C. supply as shown in fig

03



- When the soild rotor moves in the field produced by stator windings an emf is produced in it resulting in a large loss of power due to eddy current.
- This power is dissipated as heat in the rotor and therefore water is circulated through air gap between stator and rotor .

Torque on the stator casing may be measured