Important Instructions to examiners:

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

Q.1

a)(Definition 01 mark each, factors 02 marks (any two 01 mark each)

SensitivityDrift: - If there is proportional change in the indication all along the upward scale the drift is called sensitivity drift

Zero Drift: - If the whole calibration gradually shifts due to slippage, permanent set , or due to undue warming up of electronic tube circuits, zero drift sets.

Factor causing Sensitivity drift and zero drift :-

1) Stray electric and magnetic fields.
2) Thermal emfs.
3) Change in temperature.
4) Mechanical vibrations.
5) Wear and tear.

b)(Advantages 01 mark each (any two), and disadvantages 01 mark each (any two))

Advantage of capacitive transducers:-

1) They require extremely small forces to operate them and hence are very useful for use in small systems.
2) They are extremely sensitive.
3) They have good frequency response.
4) They have high input impedance and therefore the loading effects are minimum.
5) Required small power to operate.

Disadvantages:-

1) the metallic parts of the capacitive transducers must be insulated from each other in order to reduce the effects of stray capacitances, the frames must be earthed.
2) The capacitive transducer show non – linear behavior many a time on account of edge effects.
3) The output impedance of capacitive transducer tends to be high on account of their small capacitive value.
4) They are temperature sensitive.

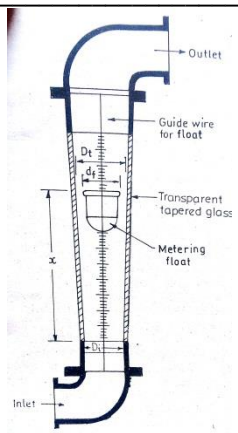
5) The instrumentation circuit used with these transducers is very complex.
6) The capacitance may change on account of presence of dust particles and moisture.

c) (01 mark for each difference)

Parameters	Diaphragm gauge	Bellows Gauge
Construction	Diaphragm element is a flexible disc which may be either flat or corrugated.	Bellow is a series of circular parts resembling the folds
Material	Phosphor bronze, stainless steel ,beryllium copper, Monel and nickel, nylon, Teflon, Buna N rubber ect.	Brass, bronze, beryllium copper, alloys of nickel and copper, steel and monel.
Pressure range	0 – 50 N/m^2 to 0 – 200 N/m^2	Vaccum and low pressure measurement
Application	Used for pressure measurement including vacuum	Used for measurement of low , medium, and high pressure. They use in measurement of absolute, gauge and differential pressure.

d)(Sketch 02 marks, Explanation 02 marks)

A Rotameter is a constant pressure drop variable area flow meter. It consists of a vertical tapered tube with a float which is free to move within the tube. The fluid flows through the tube from bottom to the top. When no fluid is flowing the float rests at the bottom of the tube. The float is made of such a diameter that it completely blocks the inlet (small end of the tube). When the flow starts in the pipe line and the fluid reaches the float , the buoyant effect of fluid makes the float lighter. Usually float has a density greater than that of the flowing material so that the buoyant effect alone is not sufficient to lift the float. The float passage remains closed until the pressure of the flowing material, plus the fluid buoyancy effect exceeds the downward pressure due to the weight of the float. The float then rises and floats within the flowing medium is proportion to the flow at the given pressure. As the float moves upward towards the larger end(outlet) of the tapered tube an annular passage is opened between the inner wall of the glass tube and the periphery of the float. This forms a concentric opening through which the flowing material passes. The float continues to rise until the annular passage is large enough to pass all the material coming through the pipe. The fluid or gas velocity pressure falls until this plus the fluid or gas buoyant effect exactly equals the weight of the float (or the gravitational force exerted by float). The float then comes to a dynamic equilibrium.



e)(01 mark each any four points)

1) Type of insulation used

2) The atmospheric conditions

3) Construction (i.e strength, rugged construction)

4) Sensitivity

f) (02 for construction and 02 marks for bonding technique.)

Wire type bonded strain gauge consists of thin seat of insulating material such as paper or Bakelite. A strain gauge wire having uniform cross sectional area and diameter about 0.025 mm is uniformly cemented on the seat of insulating material. The spreading of wire permits a uniform distribution of stress. Two terminals are taken out are called as connecting leads or terminal leads. Another thin seat of insulating material is placed on the strain gauge wire to prevent it from mechanical damage.The when such type of strain gauge is used for measurement it forms one arm of wheatstone bridge network. When quantity being measured is zero the resistance of other arm is adjusted such that bridge shows null position. When strain is applied the resistance of strain gauge wire changes causing unbalance condition in bridge. The deflection shown by detector is calibrated in terms of quantity being measured.

Bonding Techniques :-

Bonded metal foil gauge , Rosette, Helical Gauge, Torque gauge, linear strain gauge

g) (Sketch 02 marks, Explanation 02 marks)

Feedback control system

- fig. shows the basic elements of a feedback control system . The block diagram represents flow paths of control signals , but does not represent flow of energy through the system or process.

- The plant is the system or process through which a particular quantity or condition is controlled.

- The control elements are components needed to generate the appropriate control signal applied to the plant. These elements are also called the controller.

- The feedback elements are components needed to identify the functional relationship between the feedback signal and the controller output.

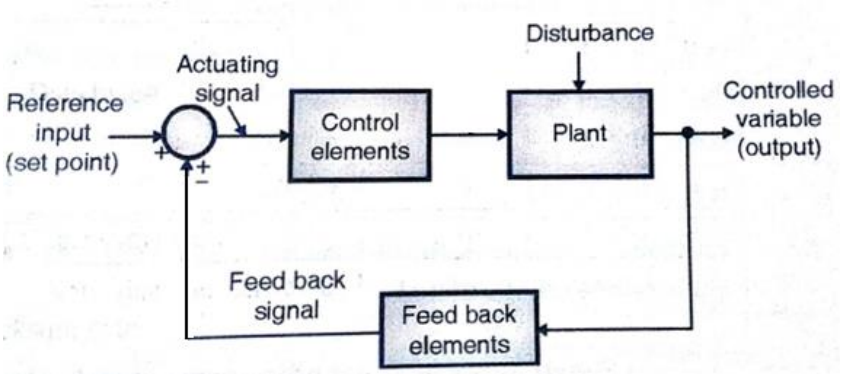
- The reference point is an external signal applied to the summing point of the control system to cause the plant to produce a specific action.

- The controller output is the quantity or condition of the plant which is controlled.

-the feedback signal is a function of the output signal. It is sent to the summing point and algebraically added to the reference input signal to obtain the actuating signal.

- The actuating signal represents the control action of the control loop and is equal to the algebraic sum of the reference input signal and feedback signal. This is also called the error signal.

- The disturbance is an undesirable input signal that upsets the value of the controlled output of the plant.



Feedback control system block diagram

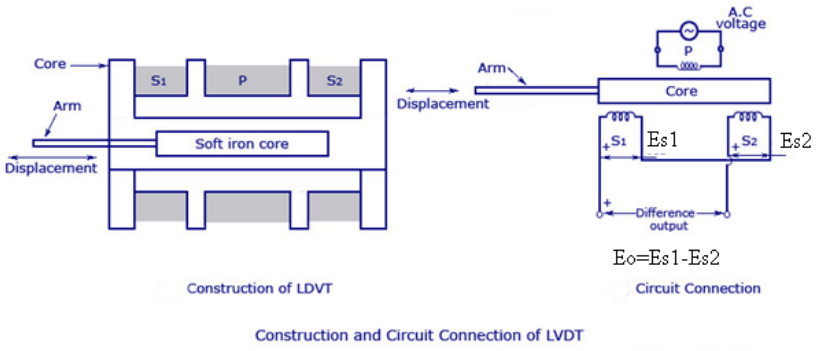
Q. 2

a) (Sketch 02 marks, Explanation 02 marks)

The construction of LVDT is shown in fig. it consists of single primary winding P and two secondary windings S1 and S2 wound on a cylindrical former. The secondary windings have equal number of turns and are identically placed on either on the primary winding. The primary winding is connected to an alternating current source. Since the primary winding is excited by an alternating current source , it produces an alternating magnetic field which in turns induces alternating current voltage in the two secondary windings. The output voltage of secondary S1 is E_{s1} ,that of secondary S2 is E_{s2} . the differential output voltage of the two voltages is $E_0 = E_{s1} - E_{s2}$.

When the core is at its normal (NULL) position , the flux linking with both the secondary windings is equal and hence equal emfs are induced in them. Thus at NULL position $E_{s1} = E_{s2}$.

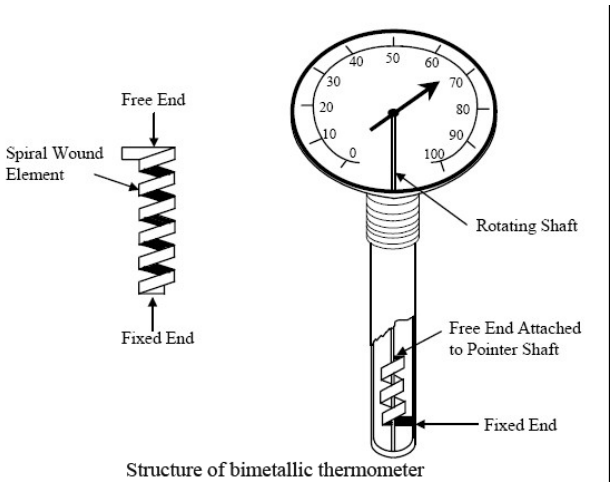
If the core is moved to the left of the null position more flux links with winding S1 and less with windings S2. Output voltage E_{s1} of the secondary winding is greater than E_{s2} . The magnitude of output voltage is $E_0 = E_{s1} - E_{s2}$ and the output voltage is in phase with say the primary voltage. Similarly if the core is moved to the right of the null position, the flux linking with winding S2 becomes greater than that linking with winding S1, this results in E_{s2} becoming larger than $E_{s1.}$ the magnitude of output voltage is $E_0 = E_{s2} - E_{s1}$ and is 180^0 out of phase with the primary. The amount of voltage change in either secondary winding is proportional to the amount of movement of the core. Hence we have an indication of amount of linear motion.



Construction and Circuit Connection of LVDT

b) (Sketch 02 marks, Explanation 02 marks)

Two different materials having different coefficient of thermal expansion rigidly joint together, one on other from a bimetallic strip. When bimetallic strip is fixed at one end and heated from free ends 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 bimetallic strip is wound in the form of helix or in spiral form. Its one end is fastened permanently to outer casing to form stopper and other end is connected to pointer. A pointer moves over a circular dial as helix coils and uncoils with temperature variation. A typical bimetallic thermometer is shown in fig.



Structure of bimetallic thermometer

c) The speed of shaft (n) = $[(f_m \times f_l)/(f_m - f_l)] \times (m-1)$ ----------**01 mark**

where , f_m = Highest flashing frequency = 3600 rpm

f_l = Lowest flashing frequency = 720 rpm ----------**01 mark**

= [(3600 x 720)/ (3600 – 720)] x (5-1) ---------- **01 mark**

n = 3600 rpm ----------**01 mark**

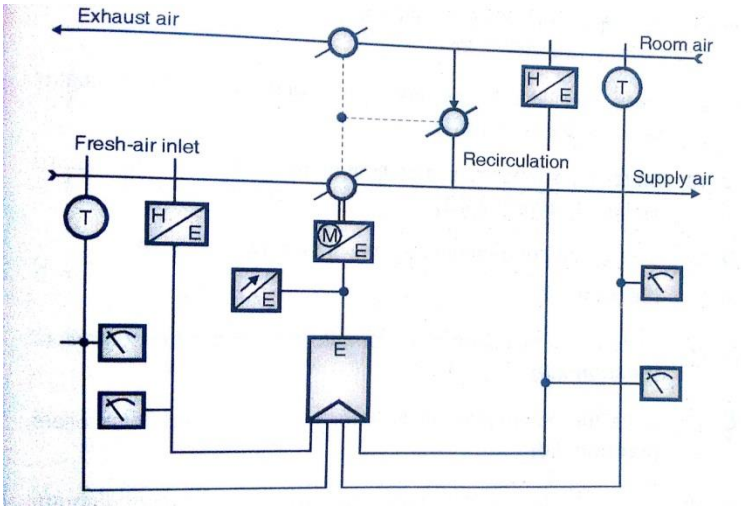
d)(Sketch 02 marks, Explanation 02 marks)

Domestic Air conditioner control system:

Fig shows the automatic control schematic diagram for the variation of outdoor air during the air. when the specific enthalpy of the outdoor airh_0 , exceeds that of the extracted room airh_r , in summer, it is recorded in volume flow. This is to avoid overheating the room or to minimize the cooling plant load. Air temperature and humidity detector are located in the return air duct from the room and in the fresh air inlet duct. Display devices allow manual reading of the data. The enthalpy controller compares the two sets of data. The output signals from the controller is 0-10V.

- A 5V signal corresponds to equal specific enthalpy of the two air streams $h_0/h_r$of 1.

- In winter when $h_0$is much less thanh_r and $h_0/h_r$is 0.25, the controller output signal is 10 V. in summer, when h_0 is much greater than $h_r$and $h_0/h_r$of 2, the controller output signal is 0 V



e) (Explanation 02 marks, advantages 02 marks any two)

PD controller:-

The controller in the forward path which changes the controller input to the proportional plus derivative of error signal is called PD controller. In PD controller, the P controller is augmented with D term to allow the higher proportional gain. In Proportional plus derivative control the derivative (or rate) action causes the controller output to vary as the rate of change of the actuating error signal varies. It is identical to PID controller with Zero I gain. Tuning a PD controller is same as tuning a PID controller.

Advantage:-

1) It eliminates excessive oscillations
2) These controllers are fast in action
3) It has smaller overshoot due to the faster derivative action
4) Damping is increased.

Mathematically it is given by,

$$m = K_p \left(e + T_d \frac{de}{dt} \right)$$

Where T_d is the derivative time – the time interval by which the rate action advances the offset of the proportional control action.

f)(Sketch 01 marks, Explanation 01 marks, advantages 02 marks (any two 01 mark each))

The principal of working of a vortex shedding flow meter is based on the fact that when a bluff is placed in a flow stream, vortices are alternately formed, first on one side of the obstruction and then on the other as shown in fig. the vortices are formed downstream when the flow impinges on the bluff body upstream. When the pipe Reynolds number R_e exceeds about 10^4 , vortex shedding and the shedding frequency is given by f = (N * V) /D where, v= fluid velocity , D= characteristics dimension of bluff body, N= strouhal number.

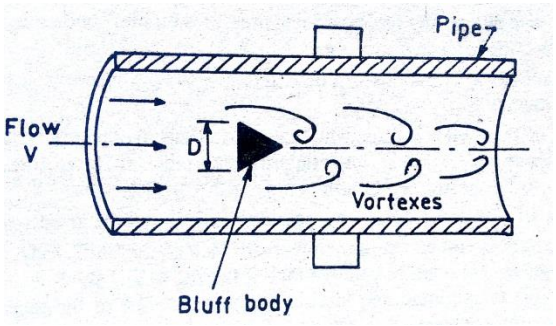
Advantages –

1)the flow meter is of portable type

2) Very low pressure loss.

3)the instrument is very accurate and precise, the accuracy and the precision is in the range of ±5% and ±1% respectively.

4) the calibration constant is same for all fluids which include hazardous or corrosive liquid/ gases



Note: - other type of vortex flow meter (i.e swirlmeter) can be accepted

Q.3. solve any four of the following.

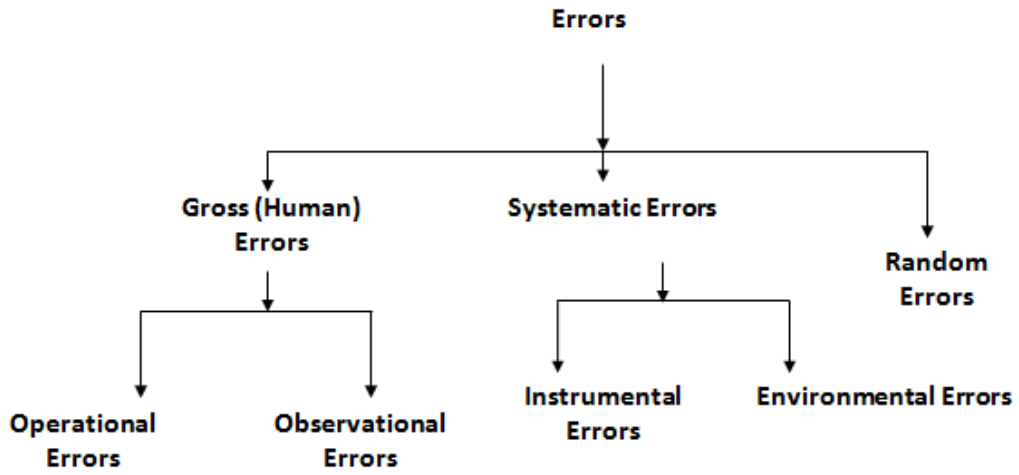
a) Differentiate between deflection and null output type measurement instruments and give its appropriate examples. [Four points, 1 mark each]

Null type instrument	Deflection type instrument
The physical effect caused by the quantity being measured is nullified by generating an equivalent opposing effect.	The physical effect generated by the measuring quantity is noted and correlated to the measurand.
e.g. pan balance or dead weight gauge. In this balanced condition indicated by zero or null position	e.g. platform scale , pressure gauge. In this weight of object is indicated by the relative displacement between pointer and dial.
Null type devices are slow in operation and have poor	Simple in construction and operation and have good

dynamic response.	dynamic response.
More accurate and sensitive.	Comparatively less sensitive.
Do not interfere with the state of quantity being measured.	They interfere with the state of measurand and do not determine its exact state/value/condition.

b) Explain the different sources of errors in measurements and measuring instruments.

[any four, 1 mark each]



Human error or gross errors

A) personal error: human mistakes in reading instrument.recording and calculating. inaccurate conversion of units.inacccurate 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.eg

- 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.

Assembly errors

the assembly errors are the errors in the measuring instrument due to improper manufacturing of the instruments. various components of the instrument are made separately and then they are assembled together. some of the possible assembly errors:

a) displaced scale
b) non-uniform scale
c) the pointer is bent:
d) manufacturing errors in the components:

Environmental errors

The measuring instruments are assembled and calibrated in certain environmental conditions and are designed to be used in within certain restricted conditions, but when they are used in different conditions, there are errors in measurement, which are considered to be the environmental errors.
most of the instruments are designed to be used within certain limits of temperature, pressure, humidity, altitude etc and when the limits are extended there are errors in the measuring instruments.

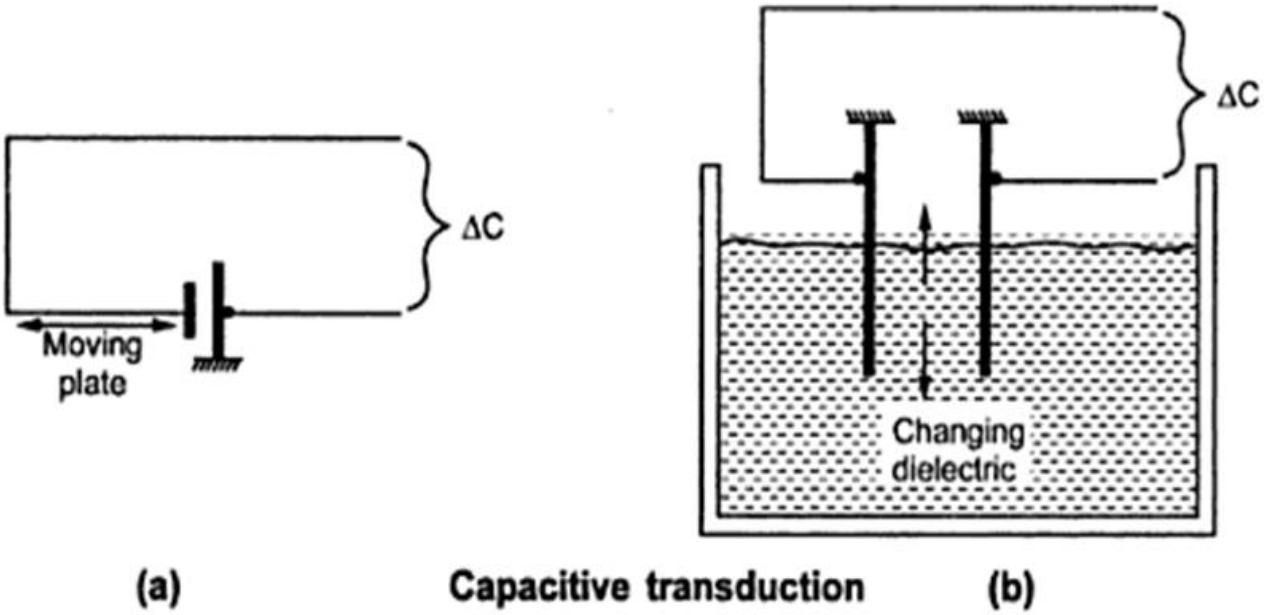
it is quite easier to find the assembly errors in instruments, but the errors due to change in environmental conditions are highly unpredictable.

Random errors

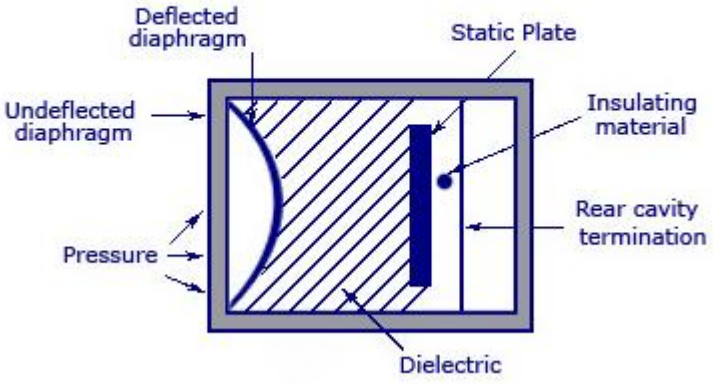
Apart from the assembly and environmental errors there can be many other errors which may be very difficult to trace and predict, these are called as random errors.

a) frictional errors
b) Mechanical vibrations
c) Backlash in the movement
d) Hysteresis of the elastic members.

C) explain the working of variable capacitor pressure transducer with neat sketch and mention its advantages (any two) [sketch 1 mark, description 2 marks]



Capacitive Transducer



It consists of two or more metal plates separated by an insulator. As voltage is applied across the plates , equal and opposite charges are generated on plates.

The capacitance of a parallel plate capacitor is given by,

$C = KA/d\ \varepsilon_0$

Where, A= area of each plate in sq. m

d = distance between two plates in m
K = dielectric constant
$\acute{\varepsilon}_0 = 9.85 \times 10^{-12}$ f/m

Since the capacitance is inversely proportional to the spacing of plates, any variation in distance 'd' causes a corresponding variation in capacitance.

Change in distance between two plates can be measured by resulting change in capacitance with an a.c. bridge.

advantages: [any 2, ½ mark each]

1. excellent frequency response.
2. can measure either static or dynamic phenomenon.
3. Easy to fabricate.
4. Good linearity.
5. Relatively low initial and maintenance cost.

d) List any two advantages and two limitations of resistance thermometer.

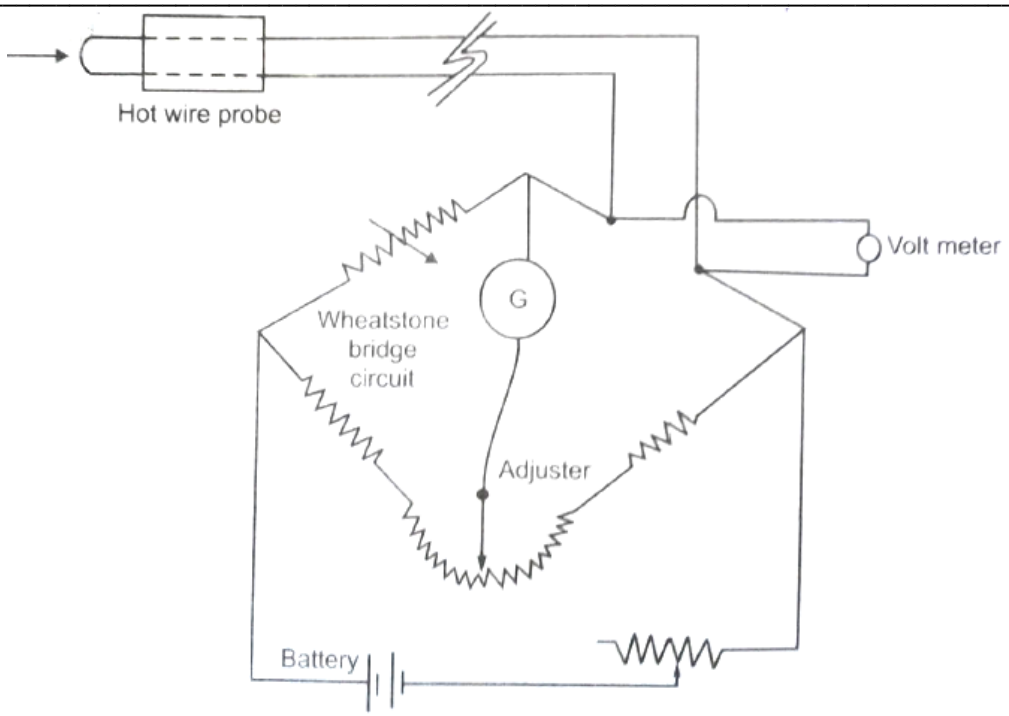
Advantages : [any two, 1 mark each]

1. it can be used for wide range of temperature from -200^0 C to 1000^0 C.
2. it has linear characteristics.
3. It has + and - 0.15 % accuracy.
4. Installation is easy.

Limitations : [any two, 1 mark each]

1. Response is slow
2. Balancing of bridge takes time
3. Possibility of current leakage between resistance element and ground.
4. Affected by shock and vibrations.
5. It does not give temp. of a point but gives temp. of small area.

e) Explain the working of hot wire anemometer for the measurement of rate of fluid flow also mention its limitations. [sketch 1 mark, description 2 mark, limitations 1 mark]



Hot wire anemometer.

RESISTANCE OF PLATINUM OR TUNGSTEN WIRE VHANGES AS PER CHANGE IN TEMP. OF WIRE. IT FORMS ONE OF THE ARM OF WHEATSTONE'S BRIDGE.

The hot-wire anemometer measures a fluid velocity by noting the heat convected away by the fluid.

The core of the anemometer is an exposed hot wire either heated up by a constant current or maintained at a constant temperature in either case, the heat lost to fluid convection is a function of the fluid velocity.

By measuring the change in wire temperature under constant current or the current required to maintain a constant wire temperature, the heat lost can be obtained. the heat lost can then be converted into a fluid velocity.

methods of measuring fluid flow:

1. constant current type
2. constant temp. type.

constant current type:

in constant current type, the heating current i.e. voltage across the bridge maintained constant.
initially circuit is adjusted such that the galvanometer reads zero when probe wire lies on stationary air.when air flows, the hot wire cools and changes its resistance. hence deflects galvanometer. which is already calibrated to get flow velocity.

constant temp. type.

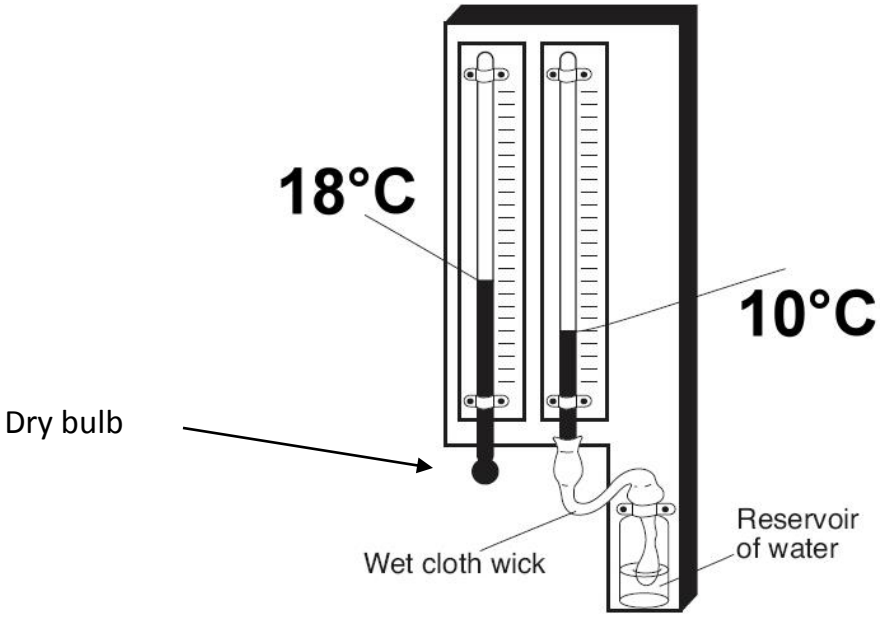
in this operating resistance of wire hence the temp. of the wire is maintained constant.
the hot wire will be cooled when it comes in contact with moving air, the external voltage is applied to keep temp. constant.
the bridge voltage is varied to bring the galvanometer reading to zero; the reading of volt meter is recorded and corelated with fluid velocity.

Limitations :

1. fine wire has limited physical strength.
2. due to dirt accumulation calibration of insrument changes.

f) what is psychrometer? Explain its use for measuring humidity with neat sketch.

[sketch 1 mark, description 3 mark]



PSYCHROMETER.

A psychrometer is simple type of hygrometer, an instrument that is used to measure the amount of humidity that is present in the atmosphere.

A psychrometer measures the relative humidity in the atmosphere through the use of two thermometers. The first, a dry bulb thermometer, is used to measure the temperature by being exposed to the air. The second, a wet bulb thermometer, measures temperature by having the bulb dipped in a liquid. Through the comparison of both temperatures, individuals determine the relative humidity of the surrounding area by calculating the difference between the temperatures.

A psychrometer chart makes it easy to find the relative humidity once a reading has been taken. This reduces the need for on-the-fly calculations which may be difficult to perform.

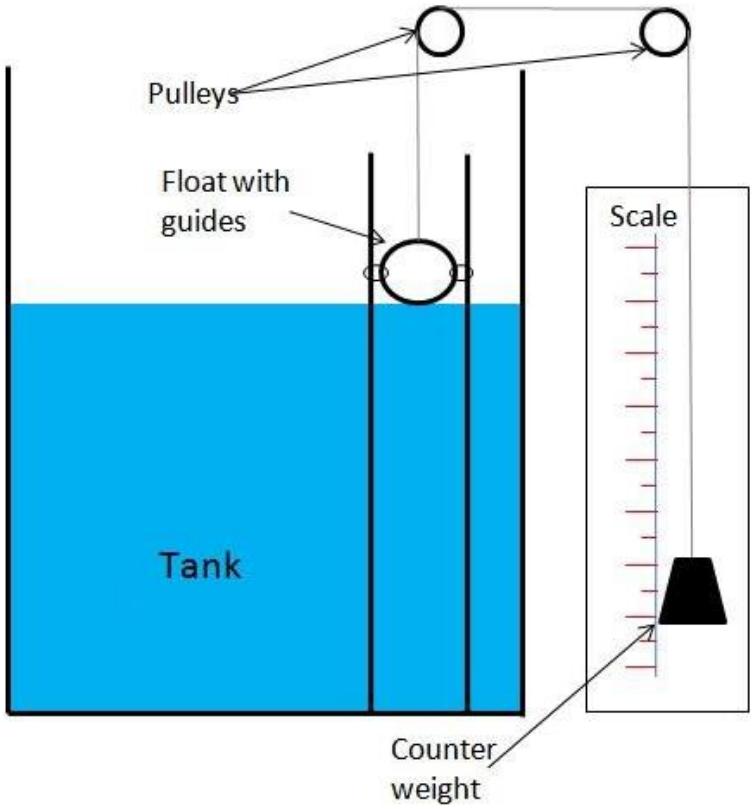
ventilated and aspirated psychromters, which are designed to work with fans that ventilate the wet bulb thermometer. The process also increased evaporation rates evenly, which produces a more accurate reading.

Used in greenhouses and industrial spaces, hygrometers are also used in some incubators (egg), humidors and museums.

Q.4 solve any four of the following.

a) Expalin with neat sketch, working of float gauge for measuring liquid level of tank.

[sketch 2 mark, description 2 mark]



Float type gauge

Working:

There are two types of float type gauges.

1. Float and tape system 2. Wire guided float detectors.
   Common level measuring system uses a tape or servo motor which is connected to a float. The height can be read as float moves with liquid level.
   Float devices use the buoyancy of a float to indicate the liquid level in the tank. The chain is attached to a counter weight which indicates the level as the float moves up and down.
   A magnetic level gauge is used where the liquid is corrosive, toxic or in way hazardous.

b) given : gauge factor, F = 2.1, stress = 100 mN/sq.m , E= 2006 N/ sq.m

calculate % change in gauge resistance.

E = stress/strain , and strain is ΔL/L,

$2006 = 100X10^{-3}/ (\Delta L/L)$

(ΔL/L) = 4.985 x 10 $^{-3}$ …….[2 mark]

gauge factor, F = (ΔR/R)/(ΔL/L)

2.1 = (ΔR/R)/ 4.985 x 10 $^{-3}$

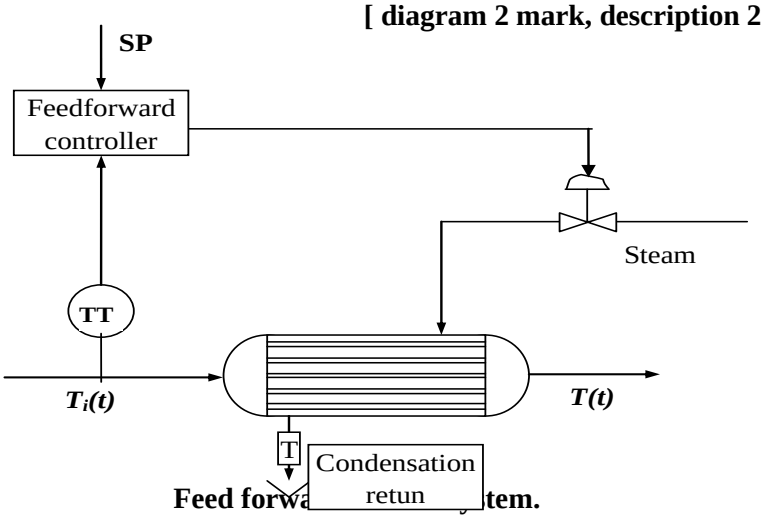
(ΔR/R) = 1.046 x 10 $^{-4}$

Percentage change in gauge resistance = 1.046 x 10 $^{-4}$ x 100

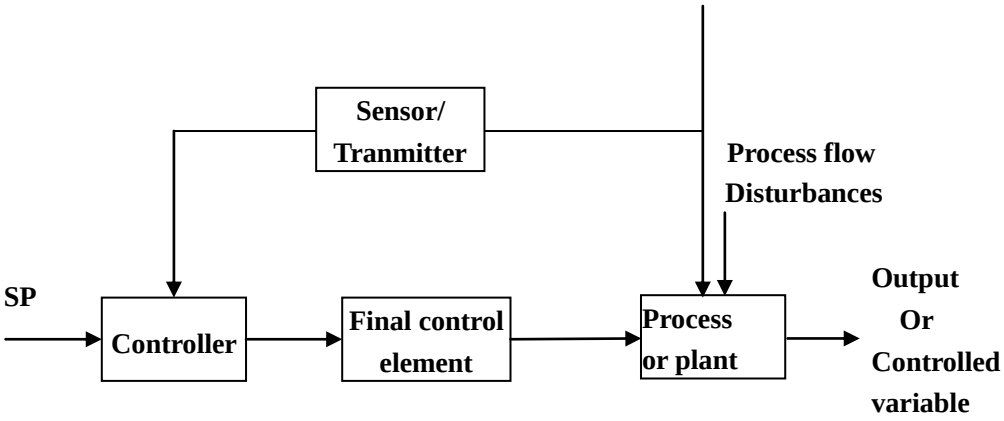
= 0.01046 Ω ……[2 mark]

c). explain feed forward control system with neat sketch.

[diagram 2 mark, description 2 mark]



Feed forwa tem.



Block diagram of feed forward control system

In feed forward control system, disturbances are measured and compensated for them before the controlled variable eviates fron set point.
In control system, it is considered that the disturbance affect the o/p adv
Rsly and considerably. If these disturbances are measurable , then this signal can be added to the controller output to modify the actuating signal. Thus a corrective action s initiated without wating for the effect of the disturbance affect the output is called feed forward control system.

Feed forward controller makes the decision about how to manipulate the actuating element steam valve to maintain the controlled variable at set point.

d) differentiate between active instruments and pssive instruments on the basis of

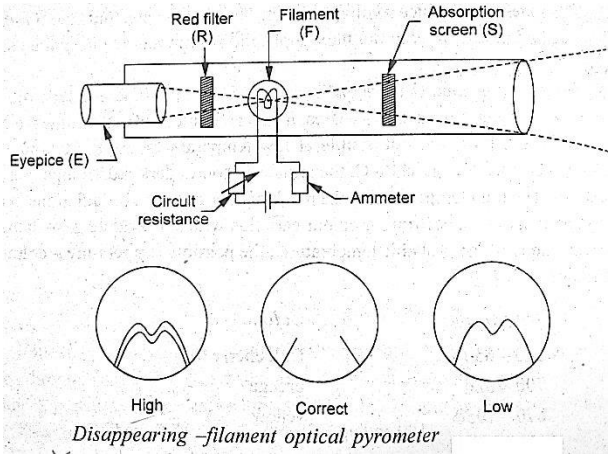
i. Principle ii. Construction iii. Resolution iv. Example.

[four points, 1 mark each]

Active instruments	Passive instruments
Operates under energy conversion principle	Operates under energy controlling principle.
Develop their own voltage or current.	Derive the required power for energy conversion from an external power source.
Energy required is absorbed from the physical quantity being measured.	May absorb a little energy from the process variabel being measured.
Generate equivalent output signal without energizing source.	Measurand is converted into passive parameter such as resistance, inductance, capacitance which needs external energy source so as to get equivalent electrical signal.
e.g.Thermocouples and thermopiles, piezoelectric pickup, photovoltaic cell	e.g. resistance thermometers and thermistors, potentiometric devices, photo emmissive cell

e) explain with neat sketch, working of optical pyrometer for temp. measurement.

Optical Pyrometer



Disappearing –filament optical pyrometer

Labelled sketch -**2 mark**

Principle:

Monocromatic radiation wavelength of a fixed color from a hot surface of body whose temperature is to be measured, is compared with a standard filament light wavelength.

Working:

The current through the lamp filament is made variable so that lamp intensity can be adjusted. The filament is viewed the eyepiece and filter. The current through the filament is so adjusted that filament and image are of euqal brightness. When brightness of source and image produced is same , we can say that both temperatures are same.

If the temperature of filament is higher than that required for equal brightness, filament become too bright as shown in figure. (**High**). And if the temperature of filament is lower , it becomes too dark as shown in figure (**Low**).

Range- 1400^0C, can be incresed upto 3000^0C…….(Correct Explanation-**2 marks**)

(f) List various advantages of Electromagnetic flow meter.

[any four points, 1 mark each]

1. It can handle slurries and greasy materials.
2. It can handle corrosive fluids.
3. It has very low pressure drop.
4. It is totally obstruction less.
5. Available in several construction materials.
6. Available in large pipe size and capacities.
7. Measurement unaffected by change in density, pressure, temperature etc.
8. Capable of handling extremely low flow rates or very high flow rates.
9. Voltage o/p is proportional to average velocity and does not depend on whether flow is laminar or turbulent.

Q5 a)What are thermistors? State its advantages and limitations with its applications. 4M

Thermisteris thermally sensitive variable resistor. These are generally composed of semi-conducting materials. Although positive temperature coefficient of units are available,most thermistors have a negative temperature coefficientie their resistance decrease with increase of temperature. 1M

Advantages:-i)Small and compact having high sensitivity ii)It can be used for low temperature measurement with great accuracy iii)It is physically strong and rugged iv)Low cost

Any two ½ Marks each 1M

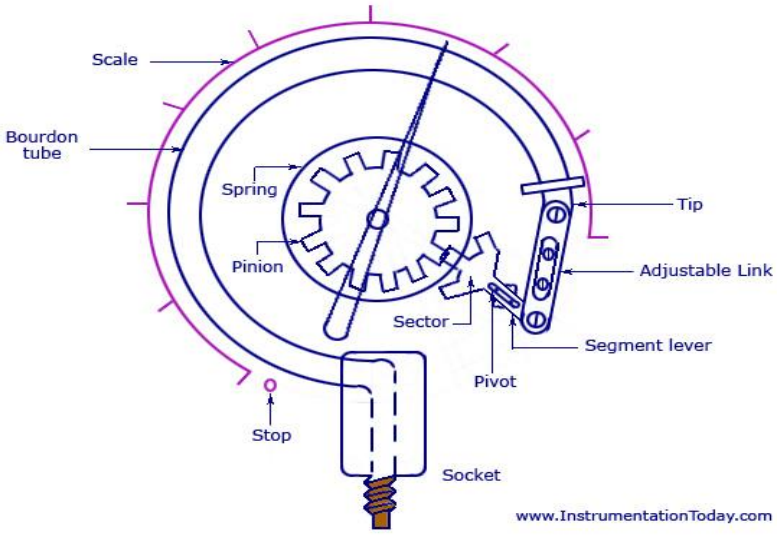
Limitations:-i)It has non linear characteristics ii)Requires external energy source iii)Limited to temperature measurement up to 300 degree Celsius

Any two ½ Marks each 1M

Applications:-i) Temperature measurement ii) Temperature control iii) Temperature compensation iv) Thermal conductivity measurement

Any two ½ Marks each 1M

b) Explain with neat sketch, working of bourdon tube pressure gauge 4M



Bourdon Tube Pressure Gauge

Sketch-2 Marks

An elastic transducer that is bourdon tube which is fixed and open at one end to receive the pressure which is to be measured. The other end of the bourdon tube is free and closed. To the free end of the bourdon tube is attached an adjustable link which in turn connected to a sector and pinion. To the shaft of a pinion is connected a pointer which sweeps over a pressure calibrated scale.

The pressure to be measured is connected to the fixed open end of the bourdon tube. The applied pressure act on the inner walls of the bourdon tube. Due to the applied pressure the bourdon tube tends to change in cross section from elliptical to circular. This tends to straighten the bourdon tube causing a displacement of the free end of the bourdon tube.

This displacement of the free closed end of the bourdon tube is proportional to applied pressure. As the free end of the bourdon tube is connected to a link section pinion arrangement, the displacement is amplified and converted to a rotary motion of the pinion. As the pinion rotates; it makes the pointer to assure a new position on a pressure calibrated scale to indicate the applied pressure directly.

Description of working-2 Marks

c)Given data 4M

i)Tangential force=795N
ii)Axial force=88N
iii)Speed of spindle=300 rpm
iv)Feed rate=0.8 mm per resolution
v)Mean diameter of cut=0.1m and
vi)Power input to 3 phase motor=875 watt/phase
:-
Power absorbed in rotating the work piece is given by

=2πnT
=FXrX2πn **1Mark**
Where F=Tangential force=795N
r=mean diameter of cut/2=100/2=50mm
n=spindle speed=300rpm
Power absorbed in rotating work piece 1Mark
=795X2XπX(300/60)X50
=1248.150W
Power absorbed in feeding the tool along the work piece 1Mark
=FXv(v=feed mm/rev)
$=88X0.8X10^{-3}X(300/60)$
=0.352W
Total power consumed=1248.150+0352=1248.502
Input to the motor=3X875=2625 Watt
Overall efficiency=1249.13/2625=0.4758=47.58% 1Mark

d)Explain proportional control action with a neat diagram 4M

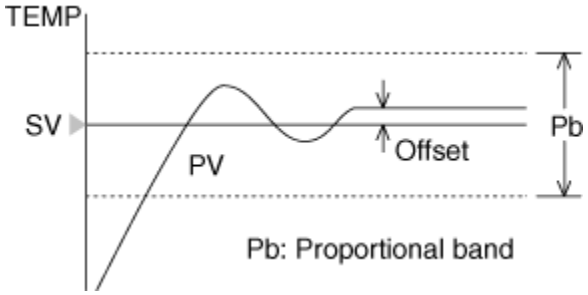


Diagram:-1M

Proportional action is the simplest and most commonly encountered of all continuous control modes. In this type of action, the controller produces an output signal which is proportional to the erroThe gain is often replaced with another parameter, called the proportional band, ***PB***. This quantity is defined as the error required to move the final control element over its whole range and is expressed as a percentage of the total range of the measured variable. r. Hence, the greater the magnitude of the error, the larger is the corrective action applied.

This is a widely used control action. output of controller is a linear function of error signal. Mathematically it can be written as

m(t)=Kp e(t) + Po,where
m(t)=controller output
e(t)=error signal
Kp=gain of controller
Po=output of controller when error is zero

With proportional control, final element can take intermediate position between on &off.For each unit departure of measured variable from set point,there is a particular position for final element.Main disadvantage of proportional action is that it produces offset in the output when load changes occur.departure from set point is called offset.In short it is a steady state error.By adjusting gain of controller offset can be reduced.

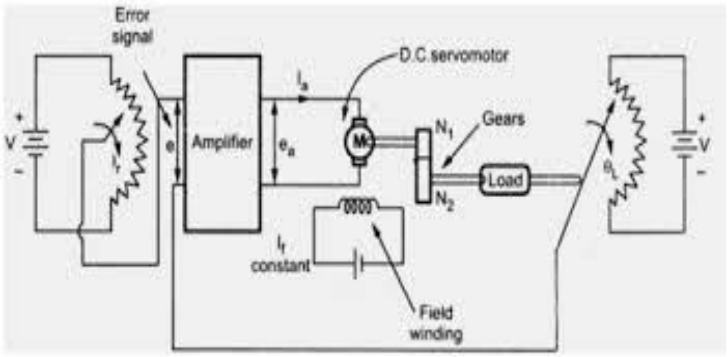
Explanation:-3 Marks

e) Differentiate between hydraulic controller and pneumatic controller 4M

Hydraulic controllers	**Pneumatic controllers**
Are complicated and difficult to maintain	Are simple and easily maintained
Employ a source of oil as a auxiliary power	Compressed air as a source of auxiliary power
Consist of a pilot valve to control oil pressure and flow output and a power cylinder and piston to provide the required displacement of a valve or other final control element	Consist of controller mechanism providing an air pressure output and a final control element which positions the valve according to pressure output
Costly than pneumatic controller	Cheaper than hydraulic controller
More space is required	Less space is required
Speed of response is slow	Speed of response is fast

Any four points 1M to each - 4Marks

f) Explain working of D.C. position control system



NeatSketch-2Mark

The remote position system is shown in figure wherein the output shaft rotation is required to follow the input shaft rotation. Two toroidal type potentiometers are coupled to each shaft for measuring the angular position of the two shafts respectively. The wiper arm of potentiometer decides the input position of the input shaft. But the potentiometers are driven through a common power supply. If the output shaft position is same as that of the input shaft, there will be no potential difference between the output voltages of two potentiometers. If there is any misalignment then there will be a potential difference between voltages of two potentiometers. This error signal is amplified by the amplifier and the resultant voltage is fed to the field controlled d.c.motor. Here the armature current Ia is maintained constant. This error signal is applied to field winding of motor. Now the motor will develop a torque of the magnitude and the sign so as to rotate output shaft in the direction as to reduce the error signal to zero

Explanation-3Marks

Q6

a) Explain the working of optical encoder with its neat sketch of construction 4M

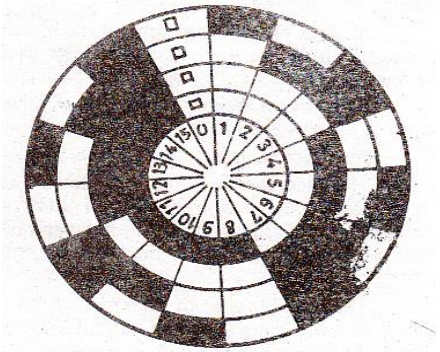
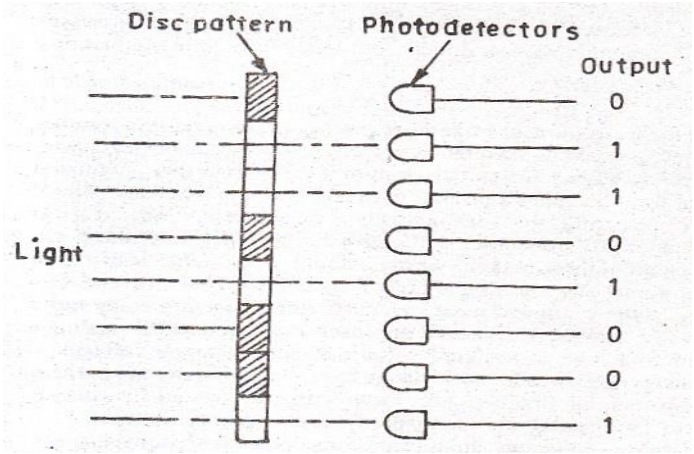


Fig. 5.121. A rotary shaft encoder using four track.



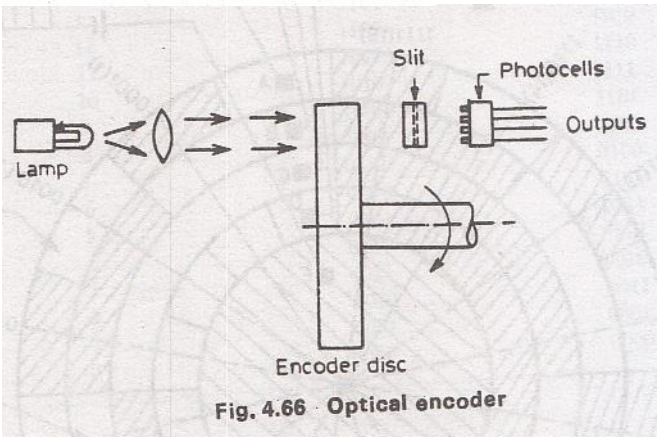


Fig. 4.66 Optical encoder

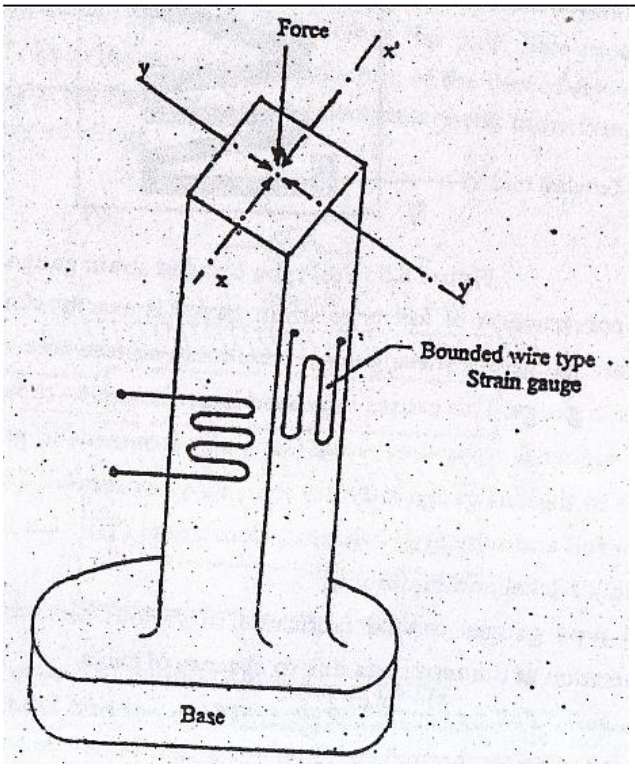
Any one diagram-2Marks

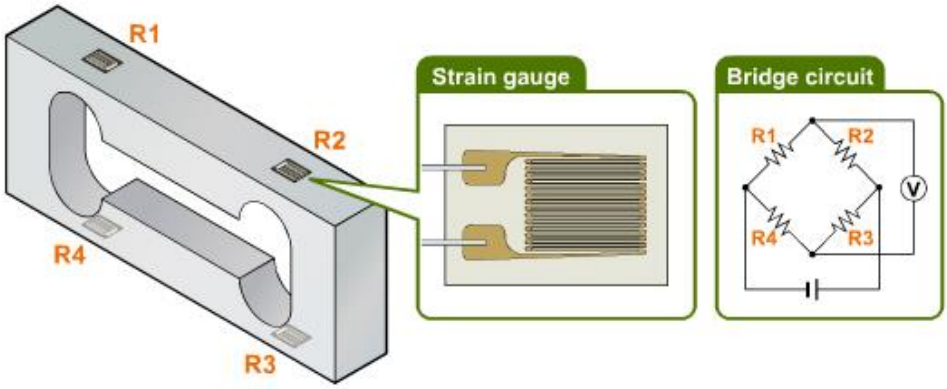
shaft encoder is a digital device used for measurement of angular position. There is a necessity of measuring devices that form a basic part whose output is compatible with digital nature of the computer. The disc is divided into concentric circular tracks & each tack is then divided into segments. For pure binary code the inner track is halfed, the next quartered & the next divided into 8 parts & so on. Each track has twice as many segments as the adjacent one near the center. The alternate segments on each track are made transparent & opaque, if transmitted light and photo cells are used. A eight bit absolute optical shaft encoder is shown. The output is derived from independent tracks on the encoder disc corresponding to individual photo detectors.

The disc has transparent and opaque areas, corresponding to the conducting and non conducting ones respectively.The photo cell corresponding to a particular track,would produce an electrical output if the transparent portion is in front of the slit and light source,giving state ON(or 1) while no electrical output from a cell would corresponds to OFF(or 0)state.

Explanation-2 Marks

b)Explain strain measurement method using load cell with a neat sketch.

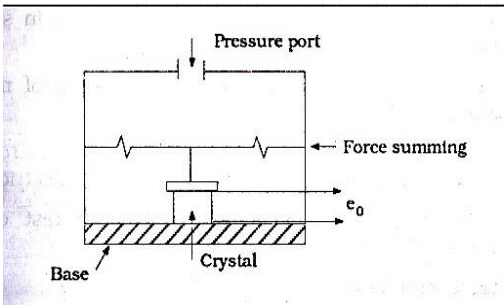




Load cell is application of wire type bonded strain gauge. It works on the principle of the elasticity i.e. when axial force is applied, its column gets compressed and when force is released it regain its original position .Four wire type bonded strain gauges are cemented on the column of load cell as shown in fig such that gauges along x-x are cemented in horizontal position where as along y-y in vertical position. The resistance offered by each gauge is same in magnitude. Gauges are connected to form Wheatstone bridge network. When axial force applied is zero then the resistance of each gauge is equal in magnitude, which keep bridge in balance condition and deflection shown by detector is zero. When the axial force applied is zero then the resistance of each gauge is equal in magnitude, which keep bridge in balance condition and deflection shown by detector is zero. When the axial force to be measured & resulting strain is applied on load cell then its column gets compressed. The compression of column causes decrease in resistance of strain gauge along y-y and remains unaffected along x-x.This turns the bridge to unbalance condition. The

deflection shown by detector can be directly calibrated to read axial force or strain

c) Explain the working of piezoelectric type pressure transducer for pressure transducer with a neat sketch. **4M**



Neat sketch-2 Marks

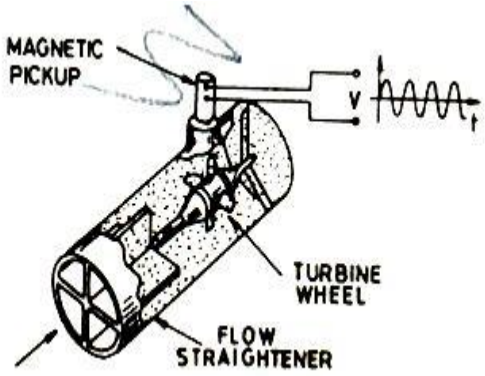
When certain crystalline substances are subjected to pressure or stresses along specific planes, voltage is generated in them. This effect is called as piezoelectric effect. The piezoelectric effect is direction sensitive i.e. if tension is applied definite voltage polarity will be produced while if compression is applied opposite polarity will be produced. Usually a crystal is placed between a solid base and a force summing member. Metal electrodes are plated on to selected faces of piezoelectric material .The electrodes become the plates of a capacitor

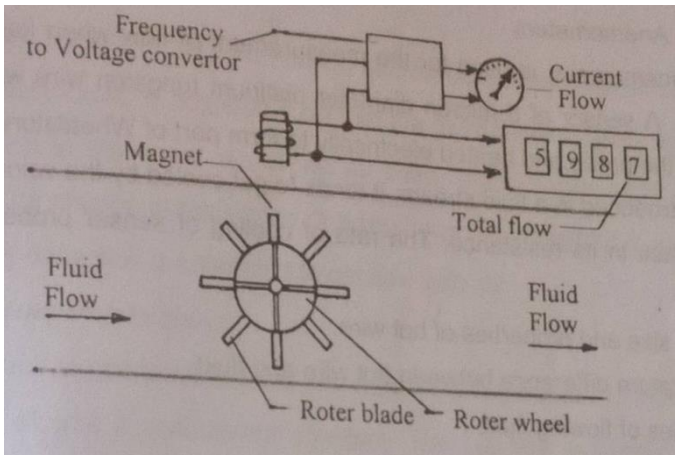
Output v=Q/C

When unknown pressure is applied through the port, voltage is generated across the crystal, which can be directly calibrated in terms of pressure.

Explanation-2 Marks

d) Explain working of turbine meter for flow measurement with a neat sketch.





Any one diagram-2 Marks

Turbine flow meter is suitable for measurement of flow in tubes and pipes. The rotor is placed in path of moving stream directly. The rotor spins freely at the rate proportional to flow velocity. A permanent magnet is sealed inside the rotor body is polarized at 90 degree to the axis of rotation. As rotor rotates, along with it magnet also rotates and produces rotating magnetic field. This produces an A.C. voltage pulse in the pickup coil located external to the meter housing. The frequency of this voltage is directly proportional to the rate of flow. These voltage pulses are counted by means of electronic digital counter to give total flow.Alternatively; the frequency is converted into voltage and is fed to an analog/digital voltmeter to give the rate of flow. In turbine flow meter it is possible to get measurement of total flow as well as rate of flow

Explanation-2 Marks

e) List advantages and disadvantages of inductive type transducer.

advantages

1)Non contact type
2) Maintenance free
3) pnp or npn type

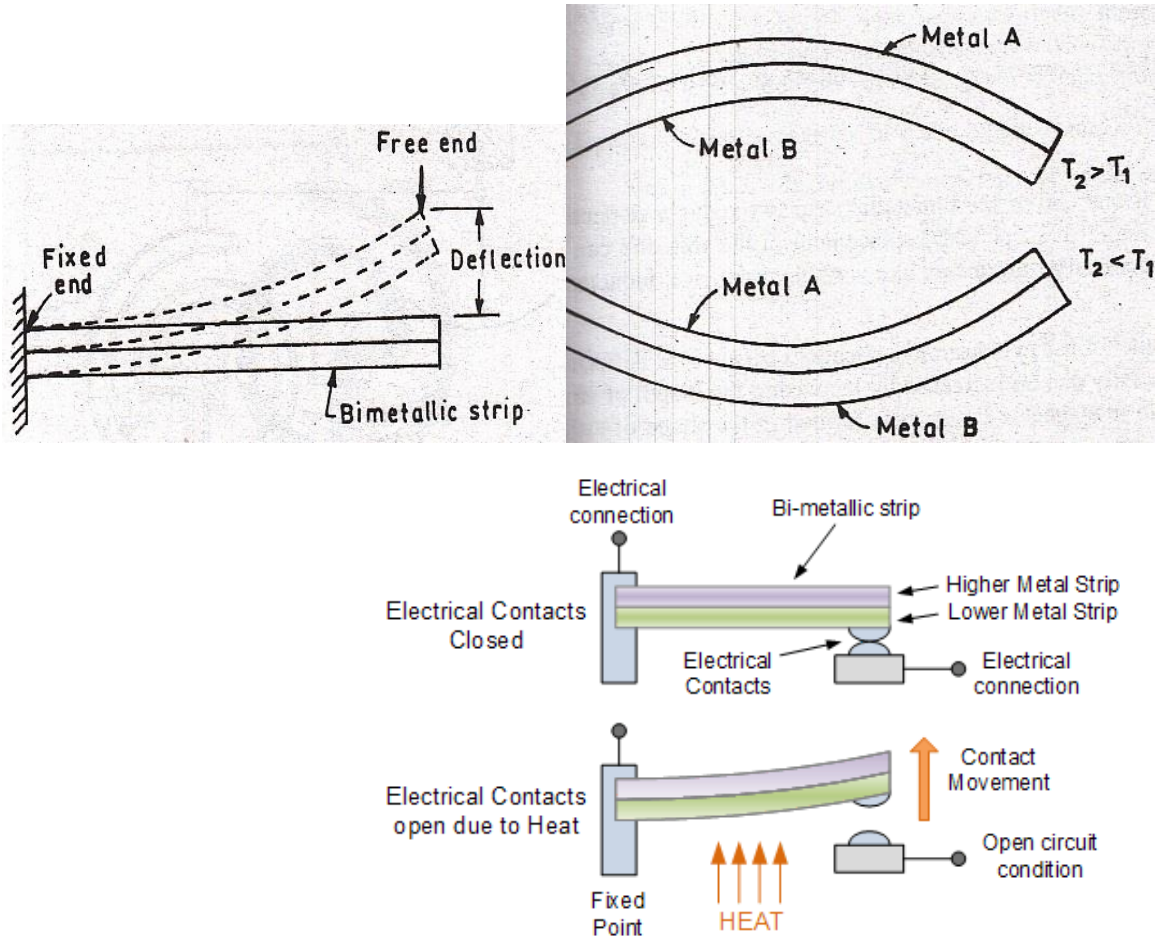
4)360°-viewable output indicators for easy operation and maintenance
5) Electrical protections against short circuits, overload, transient noise, false pulses and reverse polarity (DC models) to help reduce downtime and maintenance costs

Disadvantages

1) Cannot be repaired
2) must be free from oil and dust
3) Cable connections to be checked regularly

Any two advantages and disadvantages 2 Marks each-4 Marks

f) Explain working of bi-metallic thermometers with a neat sketch and state its applications. 4M



Suitable neat sketch-1 Marks

Basically it consists of a bimetallic 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.

Working-2 Marks

Applications-

i) Frequently used in simple On-OFF temperature control devices (Thermostats)
ii) In clocks to compensate temperature changes in clock mechanism
iii)In circuit breakers to protect circuit from excess current
iv)Time delay relays
v)Lamp flashers **Any two applications-1Marks**