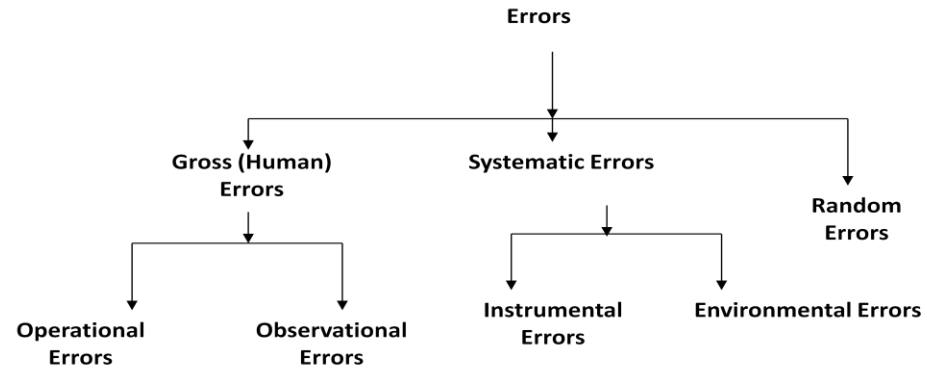
Important Instructions to examiners:

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.

1	**(A)**	**Attempt Any Three**	**12**
	(i)	**Define the term, 'Threshold', 'Resolution', 'Repeatability' and 'Reproducibility'.** *Ans:* **Threshold:** It is defined as the minimum value of input below which no output can be detected. It is instructive to note that the resolution refers to the smallest measurable input above the zero value. **Resolution** It is defined as the smallest increment in the measured value that can be detected with certainty by the instrument. In other words, it is the degree of fineness with which a measurement can be done. Least count of any instrument is taken as resolution of the instrument. **REPEATABILITY:** It can be defined as the ability of the instrument to reproduce a group of measurements of the same measured quantity, made by the same observer, using the same instrument, under the same conditions. **REPRODUCIBILITY:** Reproducibility is the consistency of pattern of variation in measurement i.e. closeness of the agreement between the results of measurements of the same quantity, when individual measurements are carried out: ▪ By different observers, ▪ By differential instruments ▪ Under differential conditions, locations, time, etc. It may also be expressed quantitatively in terms of the dispersion of the results.	*1 Mark for each definition)*
	(ii)	**What are the different types of the errors in measurement system? Give classification.** Ans: Errors arise from different sources and are broadly classified as:	**02**



Gross Error or Human Error

This class of errors mainly covers human mistakes in reading instrument, in recording and calculating measurement results. The responsibility of the mistakes wholly lies with the operator.

Gross errors are further classified in to two types:

- Observational errors
- Operational errors

Observational Errors

There are many sources of observation errors. As an example, the pointer of a voltmeter rests slightly above the surface of the scale. Thus an error on account of parallax will be occurred unless the line of the observer is exactly above the pointer.

Operational Errors

Quite often errors are caused by poor operational techniques. There is an old saying that instruments are better than the people who use them. Too often the errors caused in measurements are due to the fault of the operator than that of the instrument. A good instrument used in a unintelligent way gives erroneous results.

Systematic error

Instrumental errors:

- These errors arise due to the following reasons:
- Due to inherent shortcoming in the instrument
- Zero error
- Calibration error

Environmental errors:

- These errors are due to conditions external to the measuring device, i.e. in the area surrounding it. These may be effects of temperature, pressure, humidity, dust, vibrations or presence of external magnetic or electro static fields.
- Consider mercury-in glass thermometer being used for the measurement of air temperature.

02 (Short description of error)

The instrument will located wrongly if during measurements the sun happens to be shining on the thermometer bulb. Also, if the thermometer is place too close to a window then the bulb would indicate an effect of heat radiation due to window.

- In the above case the thermometer will give a high temperature reading.

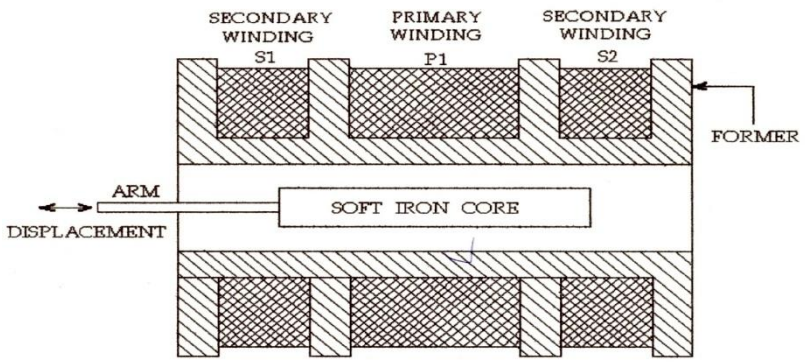
Random Error:

- Even after removing all the systematic errors measurement results show variation from one reading to another.
- The quantity being measured is affected by many factors throughout the universe.
- Out of these much factors we are aware about very few factors.
- The factors about which we are unaware are known as "Random or Residual", and the error occurs due to these factors are called "Random or Residual errors"

iii) Explain with neat sketch working principle of LVDT.

Ans:

The LVDT transformer consists of a single primary winding P_1 and two secondary windings S_1 and S_2, wound on a cylindrical former. The secondary windings have equal number of turns and are identically placed on either sides of the primary winding. The primary winding is connected to an alternating current source.

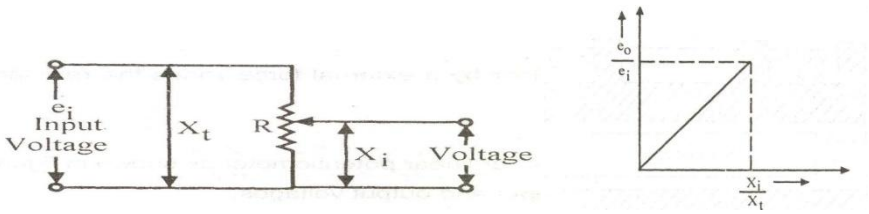


Sketch- 2 M

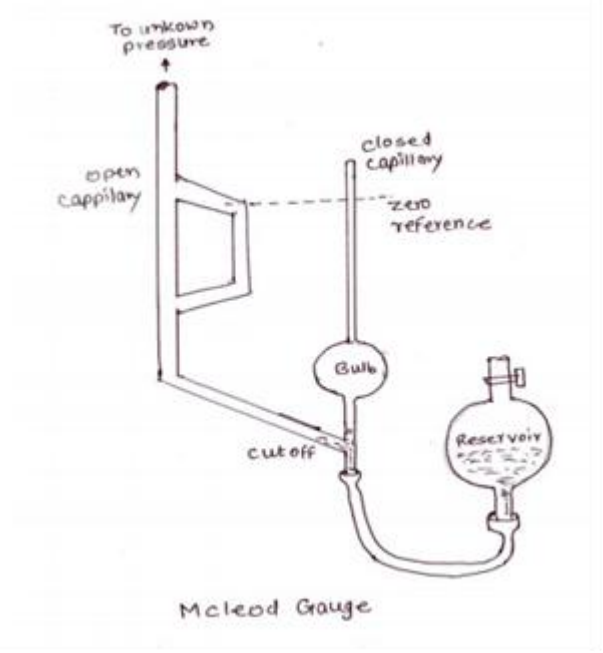
A movable soft iron core is placed inside the former. The displacement to be measured is applied to an arm attached to the soft iron core. In practice, the core is made of Ni-Fe alloy which is slotted longitudinally to reduce eddy current losses. When the core is in its normal (null) position, equal voltages are induced in the two secondary windings. Accordingly, output voltage E_{S1} of the secondary winding S_1 is more than E_{S2}, the output voltage of secondary winding S_2. The magnitude of voltage is thus E_{S1}- E_{S2} and the output voltage is in phase with E_{S1}, the output voltage of secondary winding S_1. Similarly, if a core is moved to the of null position, then the flux linking with winding S_2 becomes larger than that with winding S_1. This results in E_{S2} becoming larger than Es_1. The output voltage in this case is $E_0 = E_{S2}$- E_{S1} and is in phase with E_{S2}; i.e., the output voltage of secondary winding S_2.

Short description of principle working 2 M

The amount of voltage change in either of secondary windings is proportional to the amount of movement of the core. Hence, we have an indication of the amount of linear motion. By nothing which voltage output is increasing or decreasing, we can determine the direction of motion. In other words, any physical displacement of the core causes the voltage of one secondary winding to increase while simultaneously reducing the voltage in the other secondary winding. The difference of two voltages appears across the two output terminals of the transducer and gives a measure of the physical position

		of the core and hence, the displacement. As the core is moved in one direction from the null position, the differential voltage i.e., the difference of 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. By comparing the magnitudes and phase of the output (differential) voltage with that of the source, the amount and direction of the movement of the core and hence, of displacement, may be determined.	
	(iv)	**Draw a neat sketch of linear potentiometer for displacement measurement, explain its working.** Ans: The translatory resistive elements are straight or linear devices used for measurement of liner displacement.  **Working Principle** Positioning of the slider by a external force varies the resistance in potentiometer or a bridge circuit. Consider a traslatory or liner potentiometer as shown in figure. Let e_i and e_o = Input and Output voltages, X_t = Total length of liner pot in meter X_i= Displacement of wiper from its zero position in meter R_p= total resistance of potentiometer. The movement is linear, so resistance per unit length is R_p / X_i Hence, output voltage is , $$e_0 = (\frac{Resistance\ at\ the\ output\ terminal}{Resistance\ at\ the\ input\ terminal}\ x\ (Input\ voltage)$$ $$e_0 = (\frac{R_p \text{ x } \frac{X_i}{X_t}}{R_p} \text{ x } (e_i)$$ $$e_0 = (\frac{\frac{X_i}{X_t}}{R_p} \text{ x } (e_i)$$ $$= \frac{X_i}{X_t} \text{ x } (e_i)$$ Under ideal circumstances, the output voltage varies linearly with displacement as shown in figure.	**Sketch- 2M** **Working 2M**
	(B)	**Attempt any ONE**	**6M**
	(i)	**Define transducer. Explain the classification of transducer with suitable example.**	

		Ans: A transducer senses the desired input in one physical form and converts it to an output in another physical form. The transducers may be classified as a) **Active transducer:** These transducers derive the power required for generating output from an external source of power. They may absorb a little energy from the process variable being measured. These are also called as externally powered transducers. e.g. : Resistive Thermometer, Inductive Differential Transducers b) **Passive transducer:** These transducers does not require external source of power to produce their output. e.g. Bourdon Tube, Mercury in Glass Thermometer. The transducers are also classified on the basis of working principles: a) **Resistive Transducer:** This type of transducer converts the input into change in resistance. Ex: Resistance of metallic wire changes by elongation or compression. Strain Gauges positioning of slider varies the resistance in a potentiometer. b) **Inductive Transducer:** These types of transducers convert the input into change in inductance. Ex: The differential voltage of two secondary windings varies linearly with the displacement of magnetic core, the L.V.D.T. c) **Capacitive Transducer:** These types of transducers convert the input into change in capacitance. Ex: Variation in capacitance due to change in distance between two parallel plates. This principle is applied in variable capacitance Gauge. d) **Piezo Electric Transducer:** An Emf is generated when external force is applied on certain crystalline materials such as Quartz. e) **Thermo Resistive:** Resistance of pure metal wire with positive temperature coefficient varies with the temperature. Ex Resistance Thermometer	Definatio n- 1M Classcifi cation with examples - 5M
	(ii)	**Explain with neat sketch working of Mc Leod gauge** The gas enters the gauge through the open capillary tube and fills the tubes down to the level of mercury in the reservoir. The pressure is equal through the tubes and the bulb. Mercury is pumped up from the reservoir. As the mercury raises the cut-off, it traps the gas inside the bulb. The mercury is then pumped higher in the open end capillary tube until all the gas in the bulb is compressed into the bulb. Operator allows the mercury to rise until it reaches zero reference line on the closed capillary tube. The mercury rises faster in the open capillary tube. The compression of gas in closed capillary tube makes the pressure of trapped gas higher than the measured pressure. This pressure difference causes difference in the mercury level in the two tubes.	**Neat sketch- 3M**



The working is based on boyles law

Mathematically $P_1V_1=P_2V_2$

Where P1=Unknown pressure of gas ,V_1= Initial volume of gas ,P_2=Final pressure ,V_2=Final volume of gas

$P_1= P_2V_2/ V_1$

Working - 3M

2 **Attempt Any Two**

(a) Define calibration. Explain the need of calibration of measuring instruments. State calibration procedure you can undertake in your laboratory of bourdon pressure gauge calibration.

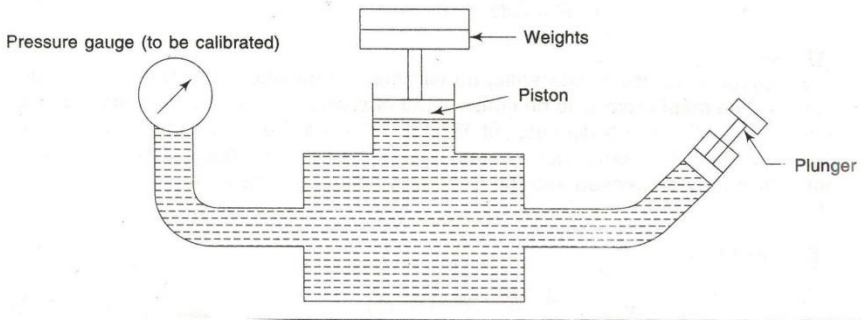
Calibration is the process of framing the scale of the instrument by applying some standardized signals. Calibration is a pre-measurement process, generally carried out by manufacturers. It is carried out by making adjustments such that the read out device produces zero output for zero. **2 M**

Need of calibration **2 M**

The accuracy of all measuring devices degrades over time. This is typically caused by normal wear and tear. However, changes in accuracy can also be caused by electric or mechanical shock or a hazardous manufacturing environment (e.x., oils, metal chips etc.). Depending on the type of the instrument and the environment in which it is being used, it may degrade very quickly or over a long period of time. The bottom line is that, calibration improves the accuracy of the measuring device. Accurate measuring devices improve product quality.

For calibration of bourdon pressure gauge in laboratory, a dead weight tester is commonly used. The bourdon pressure gauge is attached to the dead weight tester as shown in figure. In order to create this accurately known pressure, the following steps are followed. **4 M**
The valve of the apparatus is closed. A known weight is placed on the platform. Now by operating the plunger, fluid pressure is applied to the other side of the piston until enough force is developed to lift the piston-weight combination. When this happens, the piston weight combination floats freely within the cylinder between limit stops.
In this condition of equilibrium, the pressure force of fluid is balanced against the gravitational force of

the weights plus the friction drag.



(b) Write down about specifications, selection and applications of displacement transducer.

Ans:

The following factors should be considered when selecting an displacement transducer:

i)Required Accuracy ii)Resolution required iii)Size of displacement iv)Type of displacement

v)cost of transducer vi)material used for transducer

2M(Any four 1/2 Mark each)

Sample specification of displacement transducer.

Specification	**capacity**	**Non-linearity**	**Rated output**	**other**
Sliding resistance wire type	30,..300mm	0.2	1.5±1%	
L.V.D.T. R.V,D.T.	0 to 50mm + &- 40^0	Linearity over small displacement		Accuracy-0.1% of range,resolution $2X10^{-3}$
Dial-gage type	5,..30mm	0.5	1.5±1%	
Inductance type with spring	2.5,..100mm	0.3	0.75,1.0,1.5 ±20%	

3M

Applications of displacement transducer.

- Acting as device secondary transducer it can be used as device to measure forces weight and pressure etc.
- LVDT can be used in all displacement measurement where displacement ranging from fraction of mm to few centimeter on measured by LVDT. It is also used in CNC machines for displacement measurement
- RVDT used in flight control system
- Potentiometer used in design of many transducer for pressure, force acceleration
- Potentiometer also used as a position feedback in servomechanism
- LVDT can be used for measurement and control of thickness of a metal sheet being roller.
- Used for measurement of tension in channel.

3M(Any three applications 1Mark for each

(c) List the electrical and non electrical methods for temperature measurement. Explain with neat sketch liquid in glass thermometer.

Ans:

Electrical Methods:

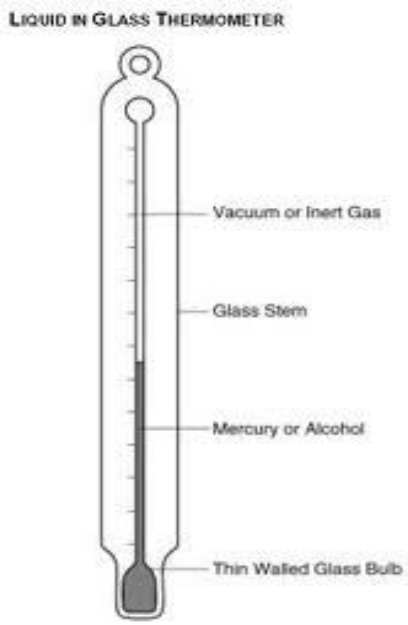
2 M

1. Electrical resistance thermometer
2. Resistance temperature detectors (RTDs)
3. Semiconductor resistance sensors (Thermisters)
4. Thermocouples
5. Quartz thermometers

Non-Electrical Methods:

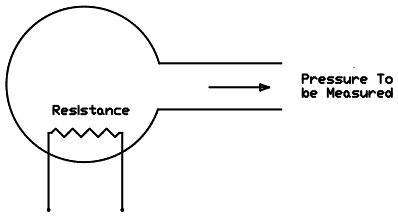
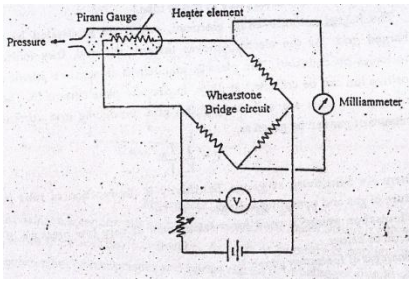
2M

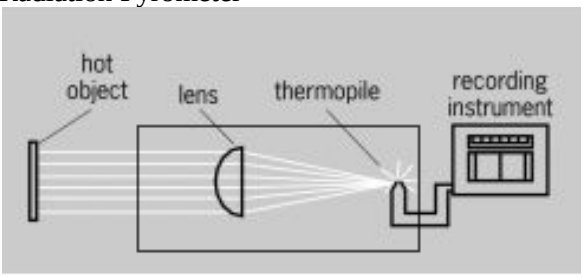
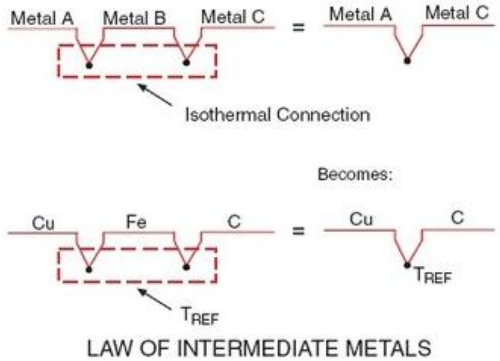
1. Bimetallic thermometer
2. Liquid in Glass thermometer
3. Pressure thermometer
4. Vapour pressure thermometer
5. Constant volume thermometer



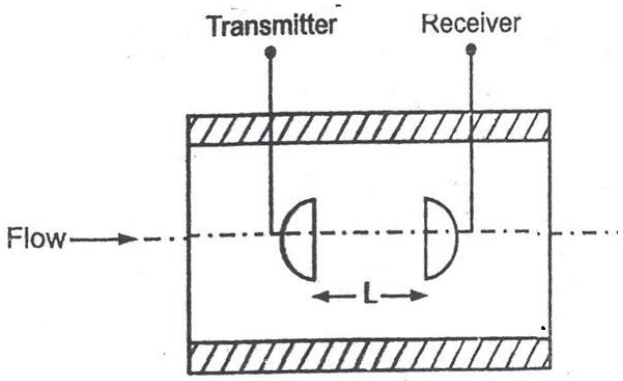
Sketch-2 M

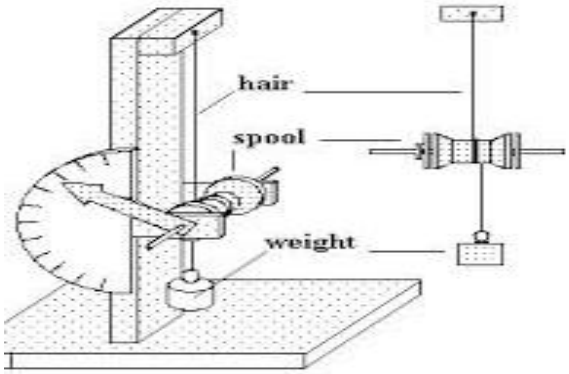
- **Principles and Definitions**
  A liquid in glass thermometer is a temperature-measuring instrument consisting of a thin-walled glass bulb (the reservoir for the thermometer liquid) attached to a glass stem (the capillary tube through which the meniscus of the liquid moves with a change in temperature), with the bulb and stem system sealed against its environment. The portion of the bulb-stem space that is not occupied with the thermometer liquid usually is filled with a dry inert gas under sufficient pressure to prevent separation of the thermometer liquid A scale is provided to indicate the height to which the liquid column rises in the stem, and this reading is made to indicate closely the temperature of the bulb.

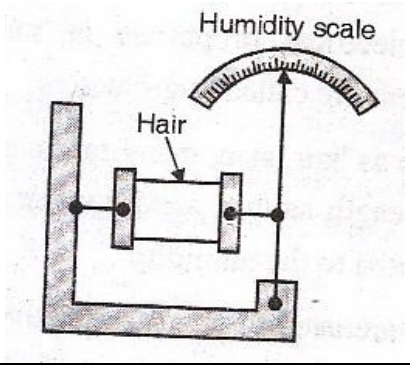
		• An expansion chamber an enlargement of the capillary often is provided above the main capillary to protect the thermometer in case of overheating. A reference point usually marking the height of the thermometer fluid in the stem when the bulb is at the ice point is provided as a check against changes in the bulb volume. • The operation of a liquid-in-glass thermometer thus depends on the coefficient of expansion of the liquid being greater than that of the containing glass bulb. Any increase in the bulb temperature causes the liquid to expand and rise in the stem, with the difference in volume between the bulb and the stem serving to magnify the change in volume of the liquid. • Commonly used in the range -12 to 320 ^{o}C . For Mercury it freezes at -39^{o}C. Hence it is used at high temperature. For low temperature measurement Alcohol is uses as liquid	Explanation- 2 M
3	a	Thermal conductivity Gauge; It is a low pressure measuring device. In a balanced bridge circuit four resistances are connect. One resistance is connecting to source of which pressure is to be measured. At low pressure density of gas changes and hence its ability to carry away heat is also reduced. At low pressure thermal conductivity is proportional to density hence temperature of sensing arm resistance is changed and circuit is imbalanced resulting in deflection. Any one diagram  	02 02
	b	Significance of Measurement It is important in various areas of atomization In indicating function controlling function, recording function also in research and development activity. Linearity Output signal is proportional to the change in input signal In commercial instruments, the maximum departure from the linearity is often specified in the following ways: Independent of the input: if the deviations of the output of the instrument from best fitting straight line does not vary with the input, then non-linearity is specified in the terms of higher value of the maximum deviation that occurs on the positive and negative sides of the best fitting or idealized straight line. Propositional to input: If the deviation of the output of the instrument from the idealized straight line varies with the input, then non-linearity is specified as the function of the input. In such a cases, the maximum deviation of points on the positive and negative sides of the idealized straight line is joined	02 02

	with the origin and their slopes determined. Most of the instrument requires linear behavior as it gives linear scale which is desirable. This is because the conversion from a scale reading to the corresponding measured value of input quantity is most convenient if one merely has to multiply by a fixed constant rather than consult a non linear calibration curve.	
C	Radiation Pyrometer  Principle of radiation pyrometer is based on the measurement of radiant energy by the hot body. It consists of a lens to focus radiated energy from the body, whose temperature is to be measured. This receiving element may have Varity of forms such as resistance thermometer , thermocouple or a thermopile. A thermopile consists of several thermocouples connected in seris. A temperature indicator , recorder or controller is attached with receiving element to indicate the temperature.	02 02
d	Law of intermeediate temperature Consider thermocouple in which their junctions are at temperature T1 and T3 which produces the emf V3 . If other two thermocouples junctions are at temperature T1 and T2 producing emf V1, other at T2 and T3 producing emf V2 where T1<T2<T3 then V3 is algebraic sum of two emf V1 and V2 V3 = V1 + V2 Law of Intermediate Metals This law states that third metal inserted between two dissimilar metals of a thermocouple junction will have no effect on the output voltage as long as two junction formed by additional material are at same temperature.  LAW OF INTERMEDIATE METALS V3 = V1 + V2	02 02
e	Temperature Measurement	04

Non Electrical Methods	Electrical Methods
Does not require electrical power	Require external source to operate the instrument
Output signal is analog form	Output is in digital form
Temperature range is limited to 600^{o} C	Higher Temperature range i limited to 600^{o} C to 2000^{o}
Example Bimetallic Thermometer, Liquid in glass etc	Example RTD, Thermocouple, Thermistor, Pyrometers

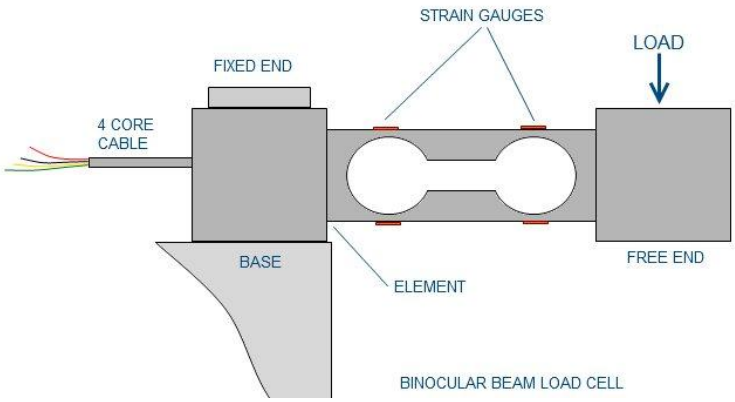
4 A	a	Thermistor and its Types Thermistor are semiconductors made from a specific mixture of pure oxides of nickel, manganese, copper, cobalt, iron, magnesium, titanium and other metals sintered at temperature above 982oC. Their special characteristics are a high temperature coefficient usually negative although it can be positive as well and the fact that their resistance is a function of absolute temperature. Thermistor are available in number of configurations, most familiar is bead type, usually glass coated. They can also be made into washers, discs or rods. They can be made in capsule form in plastic, cemented soldered in bolt, encased in glass tube, needles or variety of other forms. To measure the temperature with a thermistor it is placed in the environment whose temperature is to be measured. Bridge circuit is used to sense the small change in resistance of thermistor	02 02
	b	 Ultrasonic Flow measurement Ultrasonic flow meters measure the difference of the transit time of ultrasonic pulses propagating in and against flow direction. This time difference is a measure for the average velocity of the fluid along the path of the ultrasonic beam. By using the absolute transit times both the averaged fluid velocity and the speed of sound can be calculated. Using the two transit times and the distance between receiving and transmitting transducers. An **ultrasonic flow meter** is a type of that measures the velocity of a fluid with ultrasonic flow meter to calculate volume flow. Using ultrasonic transducers, the flow meter can measure the average velocity along the path of an emitted beam of ultrasound, by averaging the difference in measured transit time between the pulses of ultrasound propagating into and against the direction of the flow or by measuring the frequency shift from the Doppler effect. Ultrasonic flow meters are affected by the acoustic properties of the fluid and can be impacted by temperature, density, viscosity and suspended particulates depending on the exact flow meter.	02 02
	C	Hair Hygrometer Hair hygrometer is cheap pocket size instrument used for humidity measurement. 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. (Any one diagram)	02





02

d Load Cell and Strain Measurement



02

Load cell is application of wire type 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 gauge are cemented of the column of the load cell .when it is used for measurement of axial force or strain gauges are connected to form Wheatstone bridge network.

When the axial force to be measured is applied on load cell then its column gets compressed. The compression of the column causes decease in resistance at the strain gauge .this turns the bridge to unbalance condition. The deflection shown by detector can be directly calibrated to read axial force.

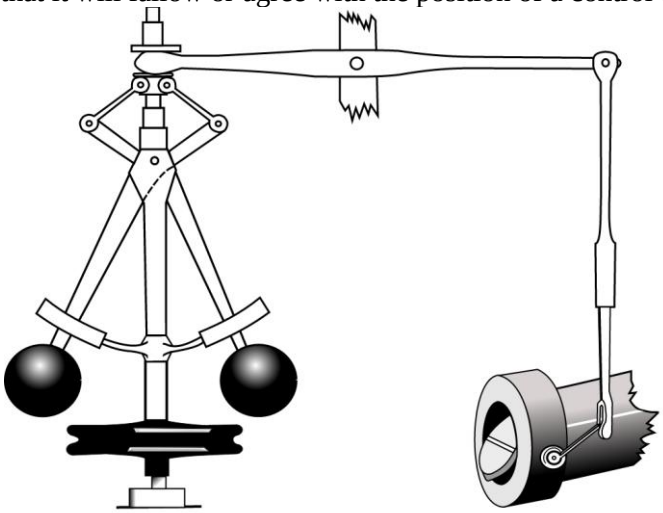
02

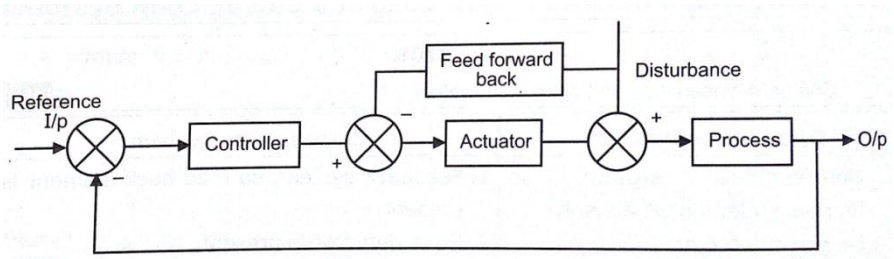
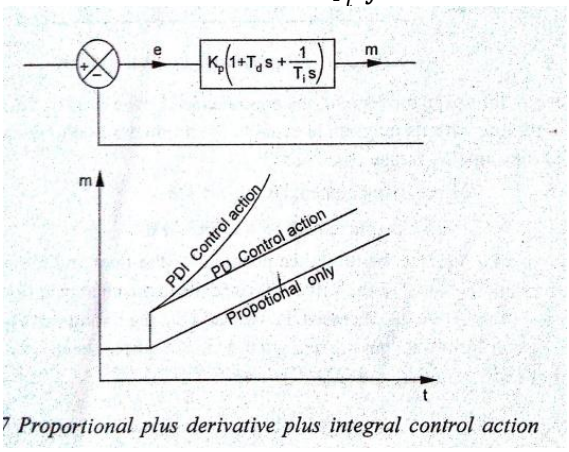
4 B a Hydraulic and Pneumatic Control System

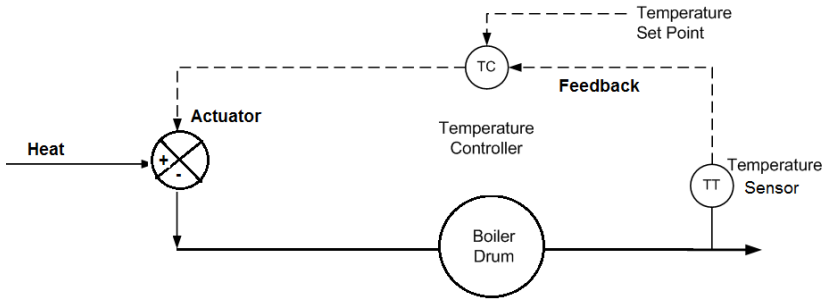
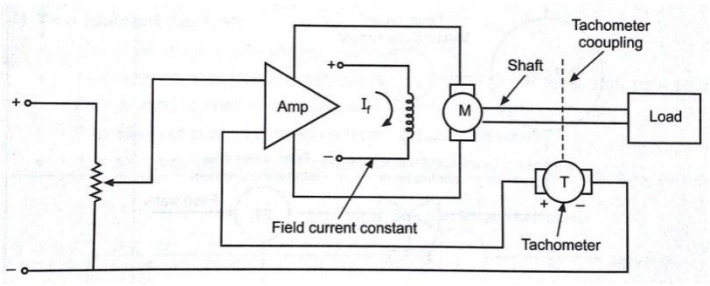
Hydraulic system	Pneumatic controller
Speed of response is high	Fast in action
Uses oil as a working media	Use air as working media
Small size power unit is required	Not possible to keep actuator at long distance
Has low inertia/Torque ratio	Condensate in the instrument air causes choking action of nozzle
More space is required	Chances of fire hazards are less
Difficult to operate	Easy to operate
It is costly	It is economical
Used for heavier application	Used for lighter application

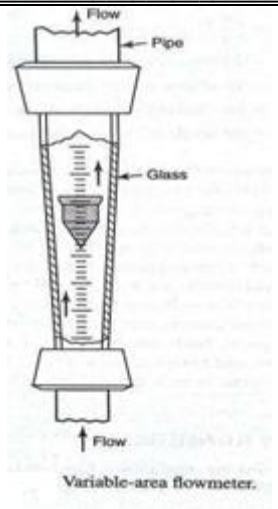
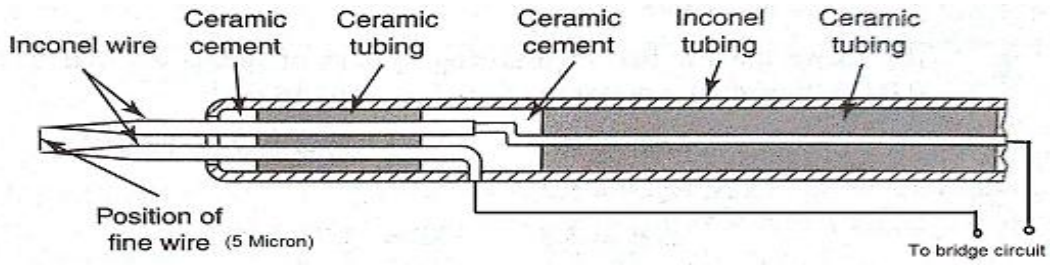
06 One mark each point

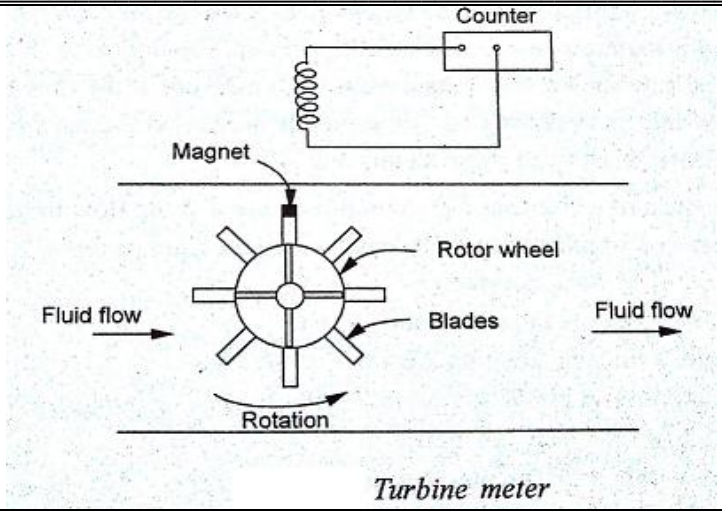
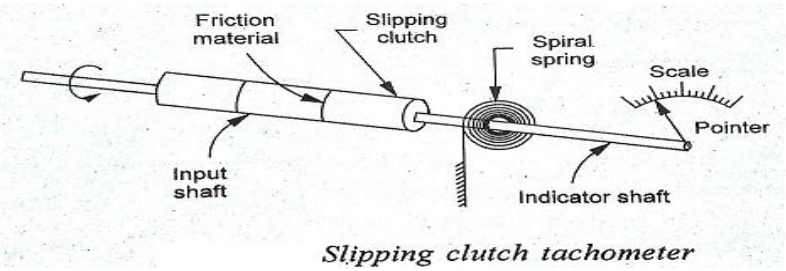
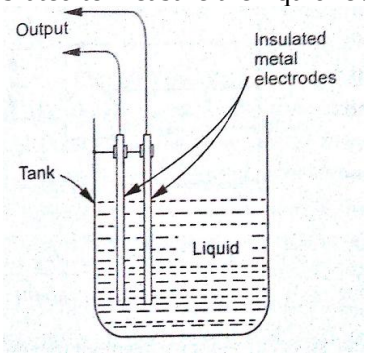
b Servo Motor Mechanism

		It is a complete system that provides automatic position control of an object or quantity as desired. Such a system may include many electrical, mechanical or hydraulic devices. It is a closed loop system that moves or changes the position of the controlled object so that it will fallow or agree with the position of a control device.  Governer Mechanism as Servomotor	03 03
5	**(A)**		
	(i)	**During a test on a I.C. engine fitted with a rope brake, the diameter of brake wheel is 600 mm and rope diameter is 26 mm. the dead load on the brake is 200 N. spring balance reads 30 N. Speed of engine is 450 rpm. Calculate the power in kW.** **Solution:** Effective brake radius, $r_{eff} = \frac{D+d}{2} = \frac{600+26}{2} = \frac{626}{2}$ = 313 mm = 0.313 m Torque T = $(W - S)$ r_{eff} = (200-30) × 0.313 = 53.21 N-m Power = $\frac{2\pi NT}{60\times1000} = \frac{2\pi \times450 \times53.21}{60\times1000} = 2.51kW$	1mark 1mark 2marks
	(ii)	**Explain the importance of humidity measurement in industry. Name some processes which might require humidity control for efficient operation.** **Ans:** Human comfort is highly dependent on the humidity in the surrounding environment. Proper control of critical operations with fabrics, paper and chemicals frequently depend on suitable control of humidity of surrounding environment. Following processes need humidity control for efficient operation. • Maintaining of humidity and temperature for human comfort. • Requirements of low humidity to prevent withering of food products and spoilage of dried eggs or dried milk. • Requirements of low humidity to prevent dryout and cracking of leather, mildewing of canvas and leather. • Protection of cargoes on ships from condensation damage by maintaining the dew point	1 mark 1 mark each process(any three processes)

		temperature of air in holds lower than the cargo temperature. • Requisite moisture conditions for a drying process. Drying operation gets retarded if humidity is too high. • Low humidity is important to minimise surface leakages effects in electrical installations. • Humidity controls the nature and characteristics of synthetic fibres and paper pulp. • Proper humidity decides the growth of bacteria in manufacturing of pharmaceuticals.	
	(B)		
	(i)	**Draw block diagram of feed forward control system and state its working principle.** **Ans:**  * In feed forward control the disturbances are measured and the controlled parameter is calculated based on some mathematical (or logical) model. * There is no feedback to see if the system is really in the desired state or "how far" is it form the desired state. * If disturbances not measured cause the systems outputs to differ from the desired one, the controller will not react.	Diagram- 2 marks Working Principle- 2 marks
	(ii)	**State the function of PID controller** **Ans:** In PID control mode the output m(t) is linear combination of input e(t) , the time rate of change of input and the time integral of the input. The control is thus additive combination of proportional action, derivation action and integral action. Figure shows the action of PID controller and its response to a unit ramp mode. The equation of PID control action is given by: $$m = K_p e + K_p T_d e + \frac{K_p}{T_i}\int e\,dt + M$$  *7 Proportional plus derivative plus integral control action* The PID controls are best suited where the situation demand extremely close control on a system that	1 mark 1 mark 1 mark 1 mark

		experiences large and sudden fluctuations, and also on installations where the plant or instruments have large lags.	
	(C)		
	(i)	**How feedback control system is used for temperature control of boilers.** **Ans:**  Figure shows how the feedback control system can be used for temperature control of boilers. • Boiler temperature can be measured or sensed and signal can be fed to thermostat. • Thermostat will calculate the error as per the set temperature value. • Signal by thermostat will actuate heating coil to heat to cool as per the error.	Diagram 2 marks Explanation 2 marks
	(ii)	**Explain the control system of speed control of motor.** **Ans:**  • The D.C. shunt motor is used where the field current is kept constant and armature voltage is changes to obtain desired speed. The feedback is taken by speed tachometers. • This generates voltage proportional to speed which is compared with voltage required to the speed. • This difference is used to change the input to the controller which cumulatively changes the speed of the motor as required.	Diagram 2 marks Explanation 2 marks
6	**(a)**	**Explain the working of Rotameter with the help of neat diagram.** **Ans:** • The basic construction of a rotameter is shown in fig.It consists of a vertical pipe, tapered downward. The flow passes from the bottom to the top. • There is cylindrical type metallic float inside the tube. • The fluid flows upward through the gap between the tube and the float. • As the float moves up or down there is a change in the gap, as a result changing the area of the orifice. • In fact, the float settles down at a position, where the pressure drop across the orifice will create an upward thrust that will balance the downward force due to the gravity. The position of the float is calibrated with the flow rate.	Explanation 2 marks

		 Variable-area flowmeter.	Diagram 2 marks
	(b)	**How flow is measured by hot wire anemometer?** **Ans:**  Figure show the construction of hot wire anemometer. The sensor is a 5 micron diameter platinum-tungsten (Inconel) wire welded between two prongs of the probe and heated electrically as a part of Wheatstone bridge circuit. When probe is introduced into flowing fluid, it tends to be cooled by instantaneous velocity and hence there is change in electrical resistance of fine wire. The rate of cooling depend upon i) Dimensions and physical properties of wire ii) Difference of temperature between the wire and fluid iii) Physical properties of the fluid iv) Stream velocity under measurement. For a simple hot wire anemometer first three conditions are effectively constant and the instrument response is then direct function of the velocity.	Diagram 2 marks Explanation 2 marks
	(c)	**Explain working of turbine flow meter for flow measurement with neat sketch.** **Ans:** • Turbine flow meter consists of a freely rotating wheel (rotor or propeller) with multiple blades. • The rotor is supported by ball or sleeve bearings and is located centrally in the pipe along which the flow occurs. • Flowing fluid impinging on turbine blade imparts a force on blade surfaces and set the rotor in motion with angular speed which is proportional to the fluid velocity. • The rotor speed is measured with mechanical counter or with an electro –magnetic pick up.	Explanation 2marks

		 *Turbine meter*	Diagram 2 marks
	(d)	**Explain with neat sketch the working of slipping clutch tachometer.** **Ans:**  *Slipping clutch tachometer* The rotating shaft drives and indicating shaft through a slipping clutch. A pointer attached to indicator shaft mover over a calibrated scale against the torque of spring. The pointer position gives a measure of the shaft speed.	Diagram 2 marks Explanation 2 marks
	(e)	**Explain with neat sketch the working of capacitive transducer for liquid level measurement.** **Ans:** Figure shows the capacitive liquid level transducer. • Two parallel insulated metal electrodes are firmly at a known fixed distance apart. The dielectric constant between the electrodes varies with the liquid level and so the capacitance of the system. • Change in capacitance is calibrated to measure the liquid level. 	Explanation 2 marks Diagram 2 marks