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.	Sub Q. No.	Answers	Marking Scheme
1		**Attempt any FIVE of the following:**	**20**
	a)	**What is measurement? Explain its significance.**	***4M***
	ANS:	***(Definition 01 M and significance 03M)*** **Measurement** is the process of comparing the various characteristic of an object with the various characteristic of standard object. **Significance of Measurement** It is important in various areas of atomization for: indicating function, controlling function, recording function and also in Research and Development activity. The inaccurate measurement leads to the incorrect results and hence the incorrect process control. **Example:** Ships and aeroplanes can navigate confidently without the help of the sight of land, only because of precise angular measurement.	
	b)	**What are the specifications of LVDT?**	***4M***
	ANS:	***(Specifications 1x4 =04 Marks)*** Specifications of LVDT are prescribed as follows:	

Sr. No.	Specifications	Values
1	Measurement Range	0-50 mm
2	Accuracy	± 1% of the FSR
3	Linearity	±2% of the total range
4	Operating Temperature	-20 to 1200C
5	Supply Voltage	5 V
6	Sensitivity	27mV/V

c) Explain Bimetallic thermometer with neat sketch. ***4M***

ANS: ***(Figure 01 M and Explanation 03 M)***

Bimetallic thermometer:

This type of thermometer employs the principle of solid expansion. It consists of a 'bimetal' strip usually in the form of cantilever beam as shown in figure (a). This comprises strips of two metals, having different co-efficient of thermal expansion, welded or riveted together so that relative motion between them is prevented. An increase in temperature causes the deflection of the free end of the strip as shown in figure (b), assuming that metal A has higher coefficient of expansion.

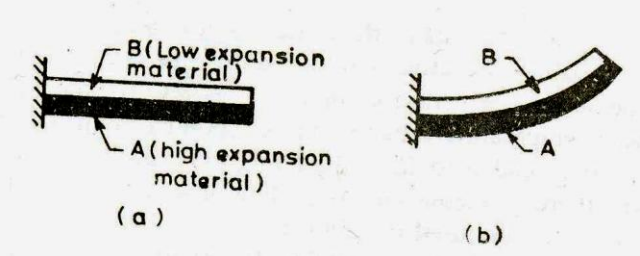
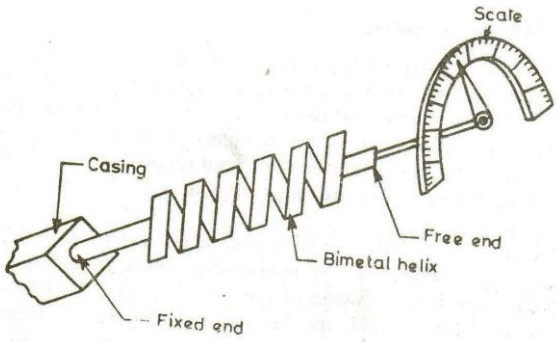
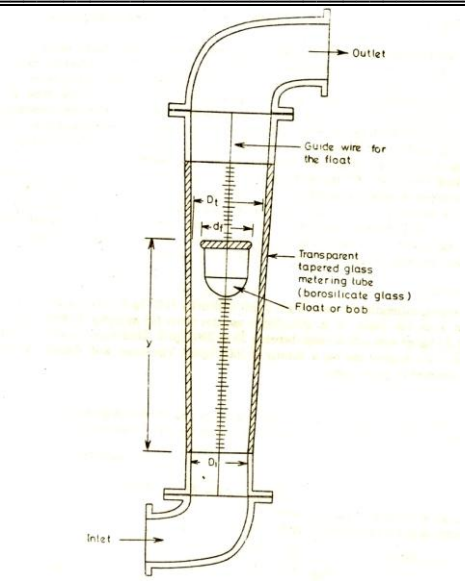
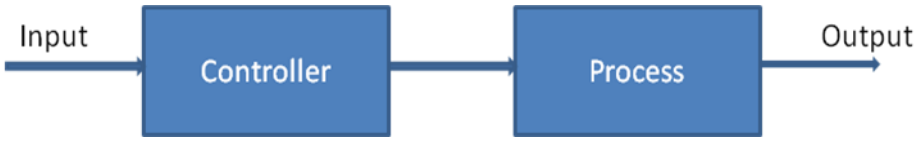


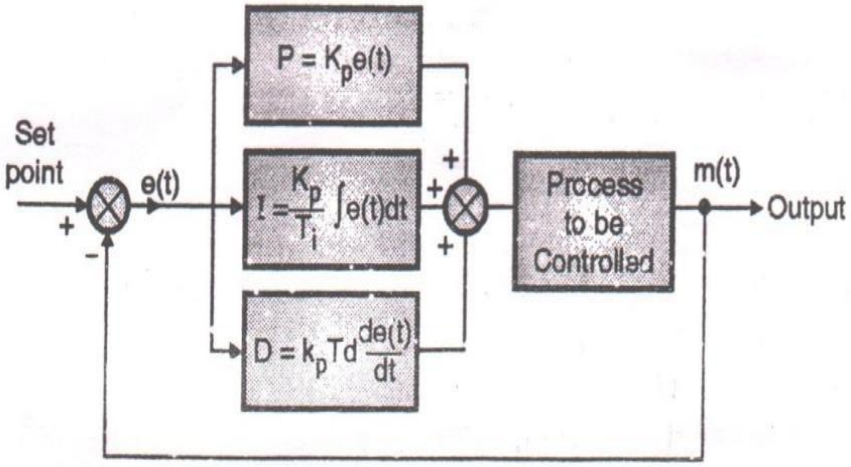
Figure: Bimetal Strip

The deflection with the temperature is nearly linear, depending mainly on the co-efficient linear thermal expansion. Invar is commonly employed as the low expansion metal. This is an iron-nickel alloy containing 36% nickel. Its co-efficient of thermal expansion is around $1/20^{th}$ of ordinary metals. A plain bimetallic strip is somewhat insensitive, but the sensitivity is improved by using a longer strip in a helical form as shown in figure below. One end of the helix is anchored to the casing and the other end which is free is conveniently connected to the pointer which sweeps over a circular dial graduated in degrees of temperature. In response to temperature change, the bimetal expands and the helical bimetal rotates at its free end, thus turning the stem and the

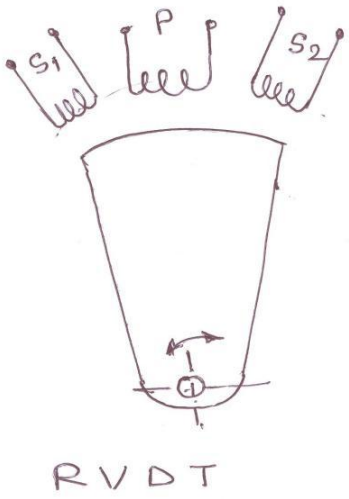
		pointer to new position on the dial.  Figure: Bimetal Helix thermometers Bimetallic thermometers are usually employed in the -30^0C to 550^0C range. Inaccuracies of the order of 0.5 to 1.0% of the full scale deflection are expected in bimetal thermometers of high accuracy.	
	d)	**Explain Rotameter with neat sketch.**	***4M***
	ANS:	**Rotameter:** The rotameter 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 operating, 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.	***(Figure 01 M and Explanation 03 M)***

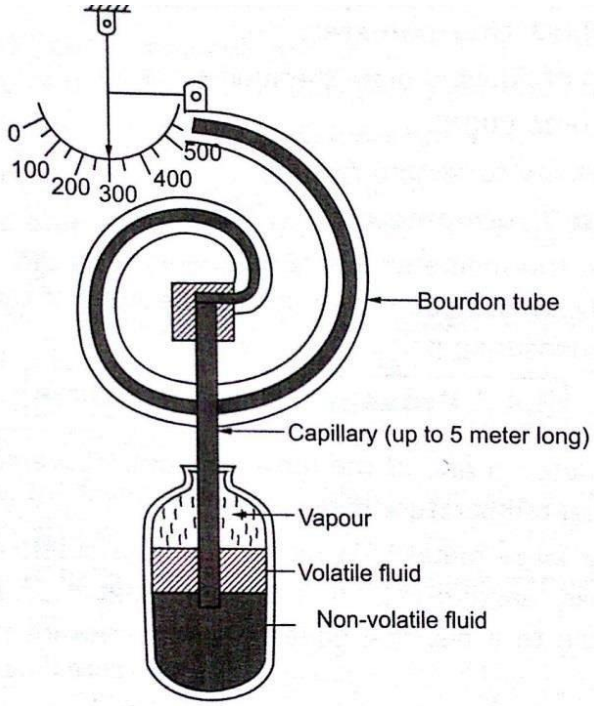
		 Figure : Rotameter	
	e)	**What are the sound characteristics?**	***4M***
	ANS:	Sound is characterized by the following parameters. **Intensity or Loudness:** The intensity (I) of a sound wave at a point is defined as the energy flowing per second per unit area held normally at a point to the direction of the propagation of sound wave. It is expressed in W/m^2 or $J/sec.m^2$. It is purely a measurable quantity. **Frequency or Pitch:** Frequency is defined as the number of vibrations produced per second. The greater is the frequency of a musical notes the higher is the pitch and vice versa. **Sound Pressure Level:** The audible range of human hearing mechanism usually measured at 1 KHz, extends from 0.0002 µbar at a threshold of hearing to 1 mbar at a threshold of pain. This represents an increase of 5×10^6. Because of this very large range, it is more convenient to express the magnitude of sound pressure in logarithmic form, in terms of decibels. **Sound Power Level:** Sound power is the total sound energy radiated by a sound source per unit time. The power in the sound emitted from a source can have an extremely large range.	***(Each Characteristic 01 M 1x4 =04 M)***
	f)	**Explain open loop control system.**	***4M***

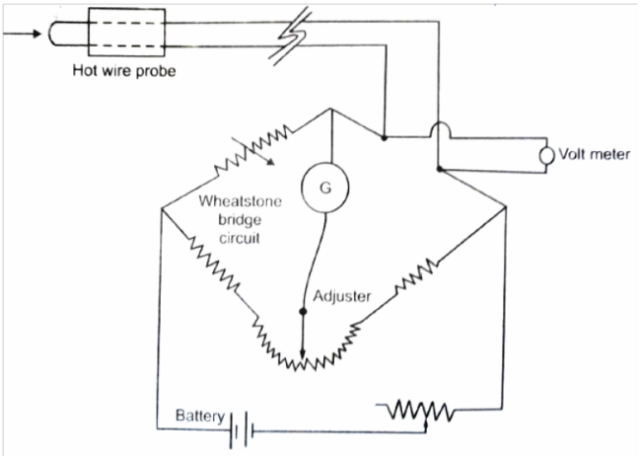
	ANS:	***(Figure 01 M and Explanation 03 M)*** Any physical system which does not automatically correct for variation in its output is called open system. The general block diagram for open loop system is as shown in figure.  In this, system output remains constant for constant input signal provided the external conditions remain unchanged. The output may be changed to any desired value by appropriately changing the input signal. Fluctuations in output may present due to change in external factors. The open loop is therefore satisfactory only if such fluctuations can be tolerated. Applications of open loop system: ➢ The Room Heater ➢ Fan Regulator ➢ Coffee maker ➢ Electric lift ➢ Automatic dryer	
	g)	**Explain with block diagram of PID control.**	***4M***
	ANS:	**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: $$m = K_p e + K_p T_d e + \frac{K_p}{T_i}\int e\,dt + M$$ The PID control mode is best suitable for system where close controls is required because of large and sudden fluctuations.	***(Figure 01 M, Equation 01 M and Explanation 02M)***



2.		**Attempt any FOUR of the following:**	**16**
	a)	**Define Range, Span, Accuracy and Precision.**	***4M***
	ANS:	**RANGE**: It can be defined as the measure of the instrument between the lowest and highest readings it can measure. A thermometer has a scale from −40°C to 100°C. Thus the range varies from −40°C to 100°C. **SPAN:** It can be defined as the difference of reading from the minimum to maximum scale value. In the case of a thermometer, its scale goes from −40°C to 100°C. Thus its span is 140°C. As said before accuracy is defined as a percentage of span. It is actually a deviation from true value expressed as a percentage of the span. **ACCURACY:** Accuracy of measuring system is defined as the closeness of the instrument output to the true value of the measured quantity. However, in usual practice, it is specified as the percentage of deviation or inaccuracy of the measurement from the true value. For example, if a chemical balance reads 1g with an error of 10^{-2} g, the accuracy of the measurement would be specified as 1%. **PRECISION:** Precision is defined as the ability of the instrument to reproduce a certain set of readings	***(Each definition 01 M 1x4= 4 M)***

		within a given accuracy. For example, if a particular transducer is subjected to an accurately known input and if the repeated read outs of the instrument lie within say ±1%, then the precision or alternatively the precision error of the instrument would be sated as ±1%.	
	b)	**Explain construction and working of RVDT**	***4M***
	ANS:	**Working of RVDT** This is called as Rotary Variable Differential Transformer (RVDT) and is used for measurement of angular displacement. Iron core is having angular motion and is having windings. Two secondary and one primary winding is used in RVDT. Input supply is given to primary winding and output is taken across secondary winding. Output is the difference of voltage across two secondary windings. This output depends on the movement of central iron cores angular displacement. Fig shows working principle and electrical diagram for RVDT.  **Applications:-** To measure angular position or displacement.	***(Figure 01 M and Explanation 03 M)***
	c)	**Explain working of pressure thermometer with neat sketch.**	***4M***
	ANS:	**Pressure Thermometer** **Principle of working:** In this thermometer, fluid expansion takes place due to an increase in the temperature	***(Figure 02 M and Explanation 02 M)***

		which resulted is increase in volume and ultimately increases the pressure in a given 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.  **Working:** • The liquid in a bulb of vapour –pressure system boils and vaporises until the pressure in the system equals the vapour pressure of boiling liquid. • These vapours create pressure on non-volatile fluid which causes its motion in bourdon tube. • Deflection of bourdon tube is calibrated to measure the temperature. • Volatile liquid works as a spring (Its vaporisation depends on the measurand temperature) • Non-volatile liquid works as a transmitting link.	
	d)	**With neat sketch, explain Hot Wire anemometer.**	***4M***
	ANS:	**Working:**	***(Figure***

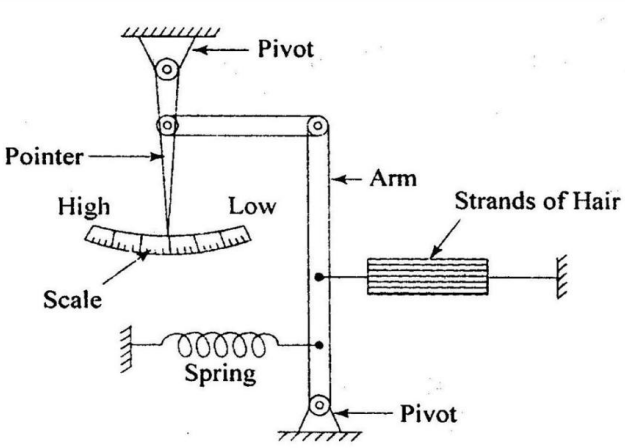
		The hot-wire anemometer measures a fluid velocity by noting the heat convected away by the fluid. The core of the anemometer is an exposed hot wire either heated up by a constant current or maintained at a constant temperature in either case, the heat lost to fluid convection is a function of the fluid 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 temperature type:** In this, operating resistance of wire hence the temperature 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 temperature constant. The bridge voltage is varied to bring the galvanometer reading to zero; the reading of volt meter is recorded and co-related with fluid velocity.  	***01 M and Explanation 03 M)***
	e)	**Explain construction and working of hair hygrometer.**	***4M***

ANS: Hair hygrometer is cheap pocket size instrument used for humidity measurement. Certain materials such as human hair, animal membrane, wood and paper undergo changes in linear dimensions when they absorb moisture from the atmosphere. Human hair becomes longer as the humidity of the surrounding air increases, and shortens when the air becomes drier. This property of hair can be used to operate a pointer or recording pen through a system of mechanical linkage. The indicator scale can be calibrated to give direct indication of the humidity.

(Figure 01 M and Explanation 03 M)

In hair hygrometer, transducer element consists of 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 hair sample under test. For proper functioning the element is maintained under light tension by the spring.

Hair hygrometer is not very precise instrument but can be used between temperature limits 5 to 35°C for humidity range 40 to 90%.

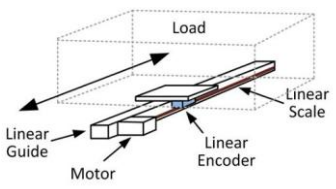


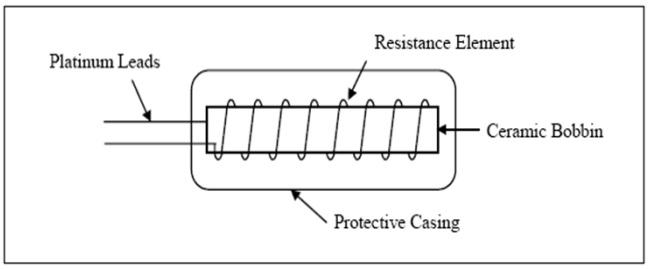
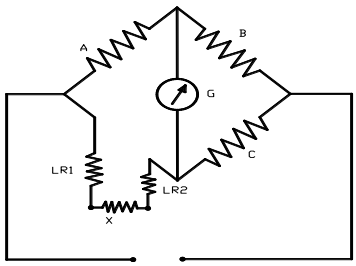
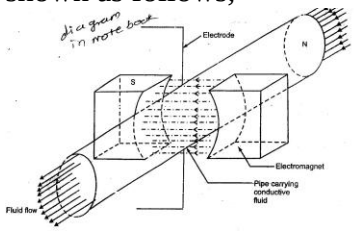
f) Differentiate between open and close loop system. ***4M***

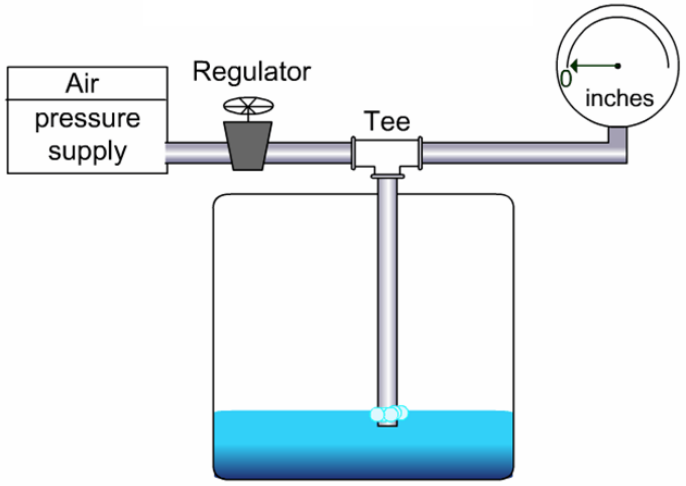
ANS:

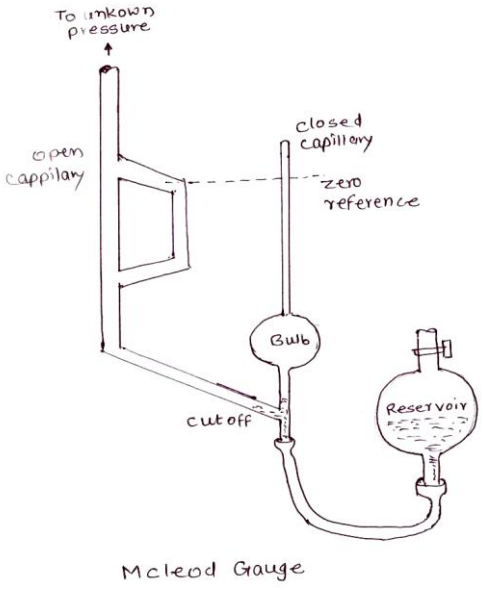
Sr.	Open Loop Control System	Close Loop Control System
1	Feed back is absent, hence no corrective action	Feedback is present, hence corrective action for making processes in control.
2	It is simple in construction and economical	It is complex in construction and costlier
3	It is more stable	It is less Stable
4	It is not reliable	It is reliable
5	Accuracy is less	Accuracy is more

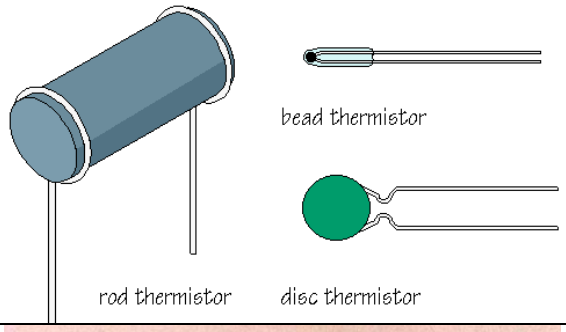
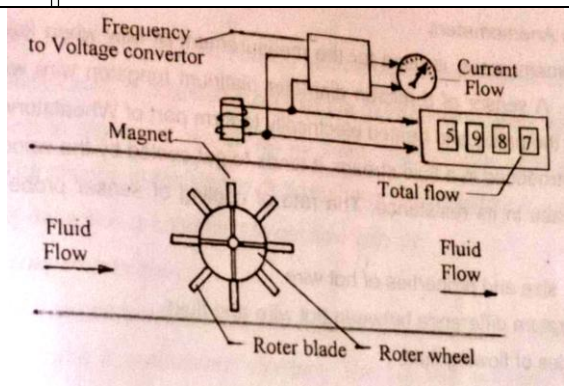
(Each point ½ M ½ x8 = 04M)

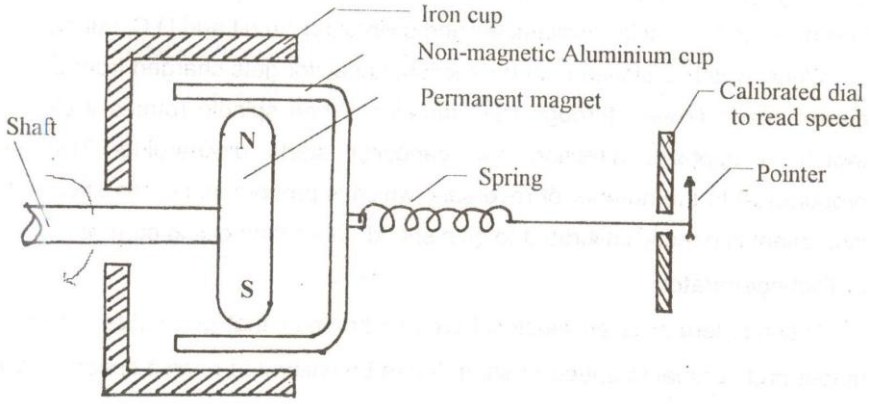
		6	It is cost effective system	It is expensive system	
		7	Easy to built	Difficult to built	
		8	The response system is slow	The response is fast	
		9	Applications: Traffic control, Domestic applications	Applications: Boiler, Industrial automation, Chemicals and Fertilizers manufacturing	
3	a	Define **SPEED OF RESPONSE**: It is defined as the rapidity with which a measurement system responds to the changes in the value of the quantity being measured. **FIDELITY:** It is the degree of closeness with which the system indicates the signal which is imposed upon it. It refers to the ability of the system to reproduce the output in the same form in the input. If the input is a sine wave then for 100% fidelity the output should also be a sine wave. **DYNAMIC ERROR**: The difference between the indicated quantity and the true value of the time varying quantity is the dynamic error; here static error of the instrument is assumed to be zero. **OVERSHOOT**: The overshoot is defined as the maximum amount by which the pointer moves beyond the steady state. Because of mass and inertia, moving parts, i.e. the pointer of the instrument does not immediately come to rest in the final deflection position. The pointer goes beyond the steady state i.e. it overshoots.		01 Each
	b	Scale and Encoder Scales may be broadly defined as Concept, device, or procedure used in arranging, measuring, or quantifying events, objects, or phenomenon in any sequence. Types are Category scale, Interval scale, Sequence scale A linear encoder is a sensor, transducer or read head paired with a scale that encodes position. The sensor reads the scale in order to convert the encoded position into an analog or digital signal, which can then be decoded into position by a digital readout (DRO) or motion controller. Thus encoder is an element that converts mechanical position into digital or analog form. Ex as shown in fig  		02 02

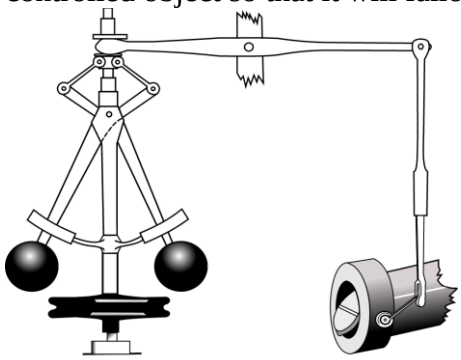
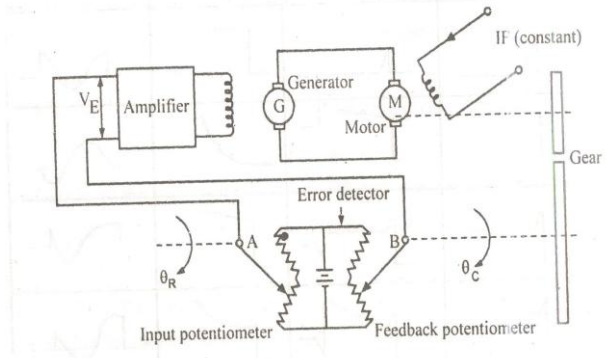
	c.	Resistance Temperature Detector  The certain metals changes with temperature change. Resistance thermometer utilizes this property of the material. With the increase in temperature the electrical resistance of the certain material increases in direct proportion to rise the temperature. Therefore if electrical resistance of wire of known and calibrated material is measured the temperature of the wire can be determined. Platinum, copper and nickel are generally used in resistance thermometers Resistance elements are generally long, spring like wires enclosed in a metal sheath. The resistance element is surrounded by a porcelain insulator which prevents short circuit between wire and the metal sheath. Two leads are attached to each side of platinum wire. When this instrument is placed in liquid or gas whose temperature is to be measured the sheath quickly reaches the temperature of medium. This temperature change causes the platinum wire inside to heat or cool resulting in proportional change in wire resistance. This change in resistance can be directly calibrated to indicate the temperature.  In the balanced condition $A/B = (X + LR_1 + LR_2)/C$ $R_t = Ro (1 + \alpha t)$	Diagram 02 Explanation 02
	d	Electromagnetic flow meter is a kind of inductional instrument designed by Faraday's law of electromagnetic induction to measure flow of conductive media in the tube. Electromagnetic flow meter can realize local indication and output electrical current signal of 4-20mA which can be used to record, adjust and control. The diagram is as shown as follows,  V3 = V1 + V2	Explanation 02 Diagram 02

	e	Bubbler or purge system. Principle : of calculating the hydroststic pressure by allowing the bubbles of air to flow through the liquid & converting this hydrostatic into level of liquid. when the tank is empty, air passed the tube will show zero gauge pressure . When tank is filled with some liquid .air supply is started & valve is slowly opened & air pressuerd is incresed till all the liquid inside tube is forced out & bubbles comes out in the of bubble & presure gauges will show some pressure which can be calibrated in terms of liquid level. As the bubbles continuously comes out of the tube, but the liquid does not entered the tube & hence said to be purged.  	Diagram 02 Explanation 02
	f	<table><tr><th>Hydraulic system</th><th>Pneumatic controller</th></tr><tr><td>Speed of response is high</td><td>Fast in action</td></tr><tr><td>Small size power unit is required</td><td>Not possible to keep actuator at long distance</td></tr><tr><td>Has low inertia/Torque ratio</td><td>Condensate in the instrument air causes choking action of nozzle</td></tr><tr><td>More space is required</td><td>Chances of fire hazards are less</td></tr><tr><td>Two lines are usually required for control</td><td>Cheaper than hydraulic controller</td></tr></table>	01 Each (Total 04)
04	a	A transducer senses the desired input in one physical form and converts it to an output in another physical form. Example: The input variable to the transducer could be a pressure, acceleration. Temperature and the output of transducer may be displacement, voltage or resistance change depending on type of transducer element **Types of Transducers**	1M 2M

		Active Transducer/Passive Transducer Resistive/Capacitive/ Inductive Transducer **Example:** The input variable to the transducer could be a pressure, acceleration. Temperature and the output of transducer may be displacement, voltage or resistance change depending on type of transducer element Piezo Electric Transducer Thermo resistive Transducer	1M
	b	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. Mathematically pressure is calculated as $P = KHHo(1 - KH)$  Mcleod Gauge	Explanation -2M Sketch-2 Mark
	C	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.	02 02

		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  	
	d	 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. The 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 AC voltage pulse in the pick up coil located external to the meter housing. The frequency of this voltage is directly proportional to the rate of flow. 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.	Diagram 02 Explanation 02
	e	Drag cup Tachometers/Eddy Current Tachometer It is electrical type tachometer, which works on eddy current. The shaft whose speed is to be measured is connected to permanent magnet at its end. A nonmagnetic cup generally made of aluminum is provided very close to magnet, which is connected to pointer through spring. Due to rotation of magnet, induced voltage in to cup which thereby produce circulating **eddy current** in cup material. This eddy current interacts with the magnetic fields to produce a torque on the cup in proportion to the relative velocity of magnet and cup. This causes cup to turn through small angle. Low torque measuring transducer is used to measure torque. It can be calibrated to find the speed of shaft	Diagram 02 Explanation 02



4	f.	Servo Motor Mechanism (any one Example) 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.  **D.C. Servomechanism** This controls the position of mechanical load in accordance with the position of reference shaft. Load shaft is driven by a motor through gear system. The driving motor is geared to the load to be moved. The motor develops a torque which is transmitted to the output shaft through a gear train.  	Explanation-02 Diagram 02

5 **Attempt any FOUR** **4X4 =16**

a) **Differentiate between active Transducer and passive transducer.**

Sr.N	Active Transducer	Passive transducer
1	Self-generating type	Externally powered type
2	Absorb the energy from the physical energy from physical variables to be measured	Required energy conversion from an external power source
3	Size comparatively small	Size is comparatively large.
4	Delicate in design	Robust in design
5	e.g: piezoelectric & photovoltaic	e.g: Potentiometer, strain gauge, resistance thermometer

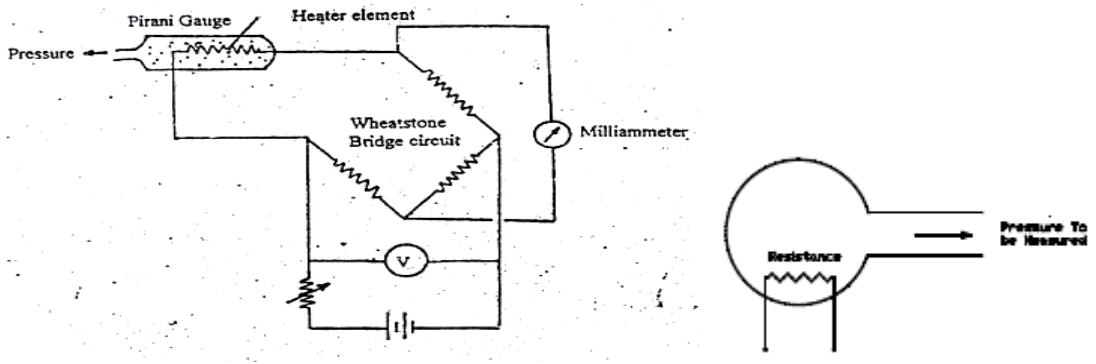
Any 4 Points 1 mark each

b **Thermal conductivity Gauge**:

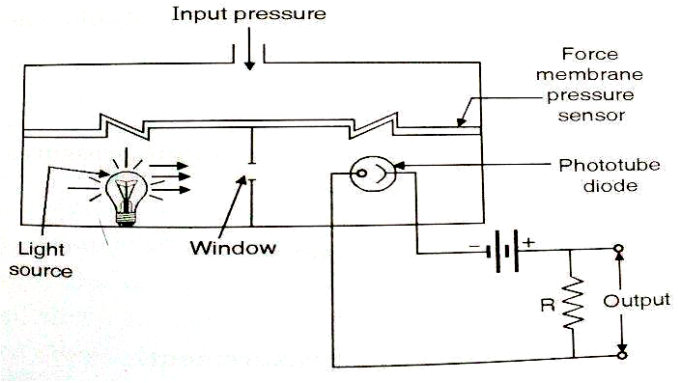
It is a low pressure measuring device. Thermal conductivity is the ability of material to carry heat by conduction. It does not change in pressure takes place until it drops below 1 mm of Hg .In this low pressure, there is direct relationship between pressure and conductivity of gas. This relationship is used to measure the low pressure hence called thermal conductivity gauges.

In a balanced bridge circuit four resistances are connected. 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.

Explanation: 2 M & Diagram 2 M



c) **photoelectric pressure transducer :**



Sketch with labeling :

2 M,

Explanation : 2M

It consist of port for input pressure ,Pressure sensing member like diaphragm ,light source ,a small window, a photo tube with output circuit.
The function of pressure sensing element is to control the aperture of small window. The amount of output is entirely depends upon the amount of incident light falling on phototube. When the pressure to be measured is applied through port to the pressure sensing member, it changes the position of window. As the light source and phototube are separated by a window it changes the amount of light falling on phototube, causing change in the current. This change in current is approximately linear with displacement of window i.e applied pressure. The current in phototube is amplified by a suitable output circuit.
A meter connected across output terminal can directly calibrate in terms of pressure measurement. An A.C Modulated light or stable source of light can be used for incident light.

Advantages:

1. It can measure both static & dynamic pressure.
2. It is highly efficient
3. Easy portability
4. Compact size.

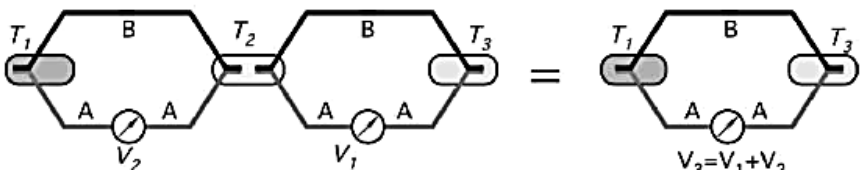
d) **law of intermediate temperature & metal:**

2M

Law of Intermediate Temperature

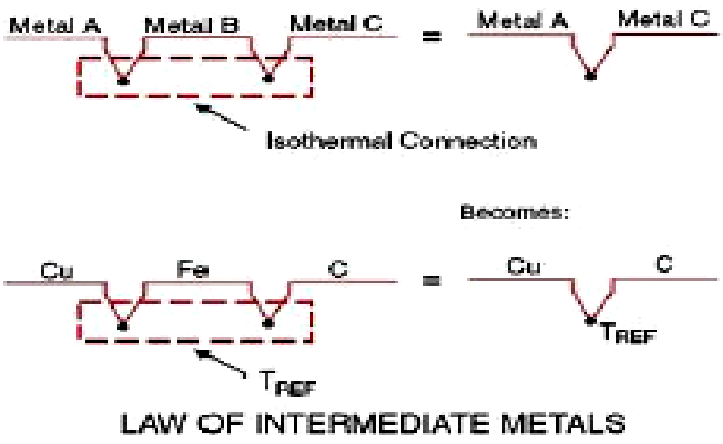
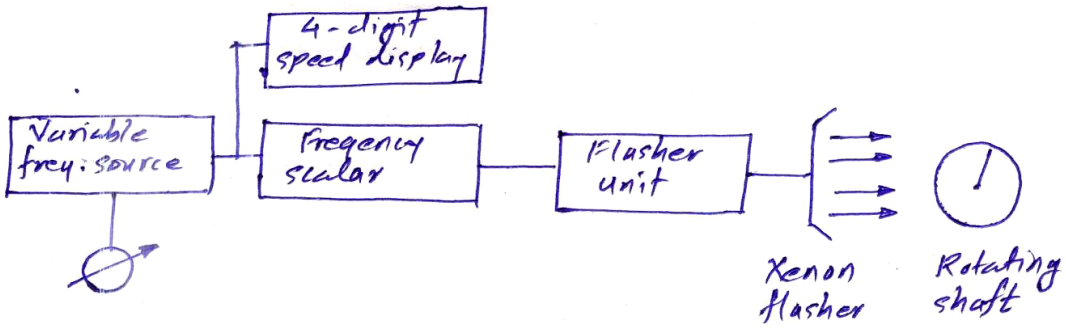
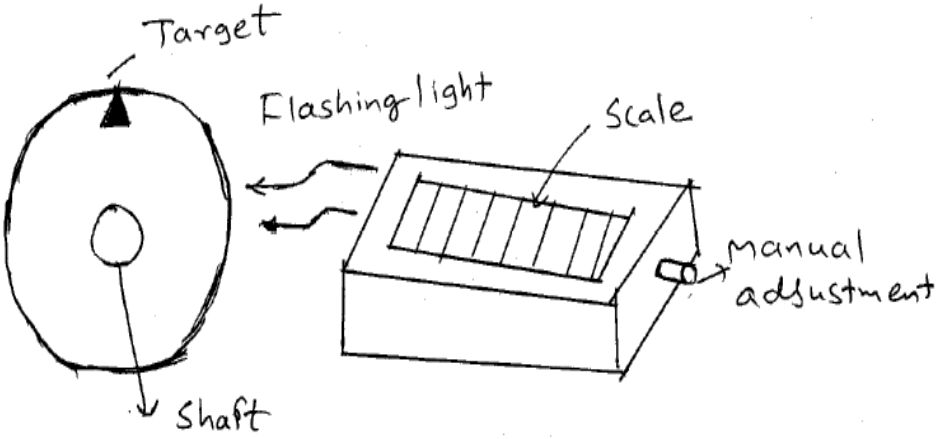
Consider thermocouple in which their junctions are at temperature T1 and T3 which produces the emf V3 . If other two thermocouples junctions are at temperature T1 and T2 producing emf V1, other at T2 and T3 producing emf V2 where T1<T2<T3 then V3 is algebraic sum of two emf V1 and V2

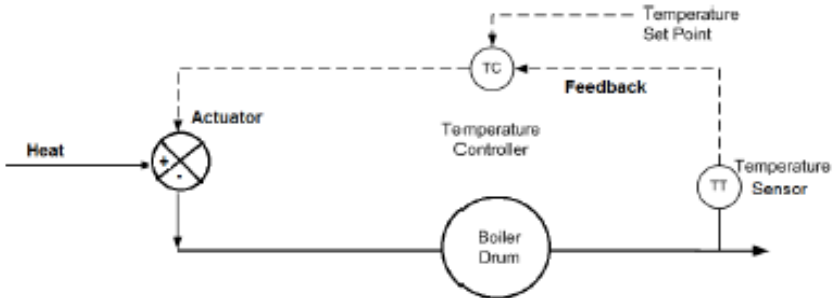
V3 = V1 + V2



Law of Intermediate Metals

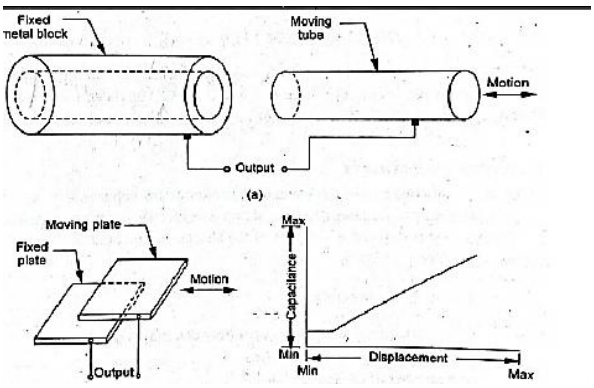
This law states that third metal inserted between two dissimilar metals of a

		thermocouple junction will have no effect on the output voltage as long as two junction formed by additional material are at same temperature.	2M
		 LAW OF INTERMEDIATE METALS	
e)		**Construction & working of stroboscope:**	
			**Diagram 2 M**
		Construction: The stroboscope is simple manually operated portable device which is used for measurement of speed. Stroboscope has variable frequency flashing light. An oscillator is Provided to control flashing frequency. The speed is measured by adjusting frequency so that the Moving object is visible at specific intervals.	**Construction: 1M ,** **WORKING 1 M**
			
		Working Principal: The flashing light is directed on rotating member, which usually has	

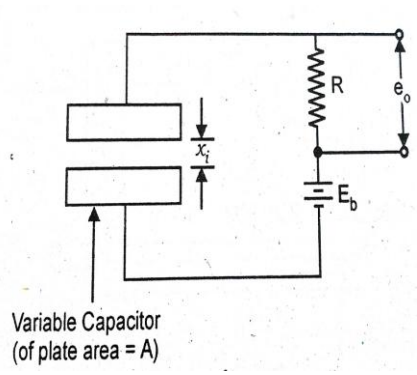
		some spoke, gear teeth or some other feature. If rotating member do not have any of such features, a paper having black and white stripes is attached to it or some marking is done as a target. The frequency of lamp flashing is adjusted until the target appears stationary. Under this condition speed is equal to flashing frequency. The scale of stroboscope can be calibrated to read the speed directly.	
5	**f.**	**Control system used for boiler:**  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	**Explanation: 2 M &** **Diagram** **2 M**
6	**a)**	**Attempt Any Four** **Error** It is the difference between observed value and true value. Errors arise from different sources are classified as **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. • To minimize 0 parallax error, highly accurate meters are provided with mirrored scale. • When the pointers image appeared hidden by the pointer, observer's eye is directly in line with the pointer. Although a mirrored scale minimizes parallax error. An error is necessarily present though it may be very small. • Since, the parallax errors arise on account of pointer and the scale not being in the same plane, we can eliminate this error by having the pointer and the scale in the same plane. • causes: Wrong Reading Taken, Tendency to Read High or to Read Low , Lack of Experience	(4x4) Meaning : 1M **Explanation:** **3 M**
	b)	**Capacitive type transducer :** A rotational or translatory motion may be used in many ways to change the	

capacitance of a variable capacitor.

The resulting capacitance change can be converted into a usable electrical signal by means of a variety of circuitry**.**



or



Explanation:

2 M &

Diagram

2 M

A capacitor comprises two or more metal plate conductors separated by an insulator.
As voltage is applied across the plates, equal and opposite electric charges are generated on the plates.
Capacitance is defined as the ratio of the charges to the applied voltage and for parallel plate capacitor is given by:

$$C = \frac{\in A}{d}$$

Where; C = capacitance between the plates
= dielectric constant for medium between the plates A = overlapping area of plates
d = distance between the plates

A capacitive pick up operates on the principle of a variation in capacitance produced by the physical quantity being measured.
Capacitance can be changes by varying,
= dielectric constant for medium between the plates, or
A = overlapping area of plates or
d = distance between the plates
e.g. Mechanical displacement can be measured by noting the change in capacitance brought about by either change in overlapping area or change in distance between plates as shown in figures. The change in dielectric is used to measure changes in liquid or gas levels...

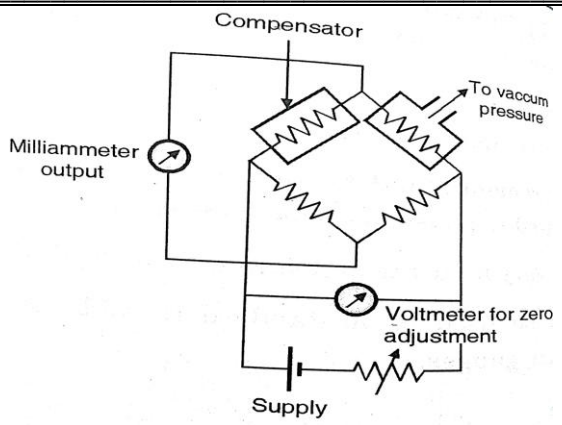
6 **c.** **Construction & working of Pirani gauge:**

Construction:

- -Consists of platinum filament wire enclosed in a chamber connected to unknown pressure source.
- -Filament forms an arm of W-bridge.
- -Compensating resistance is placed in opposite arm.

Sketch

d)



2M

Construction

1 M

WORKING

1 M

Working:

- Due to constant current, filament gets heated.
- -At low pressure, thermal conductivity gets reduces.
- -Temperature variation leads to resistance variation of filament which unbalances the W- bridge.
- -Change in resistance of wire filament gives value of unknown pressure.
- Range is between 10^{-5}mm to 10 mm of Hg.

Compare optical pyrometer with radiation pyrometer

Optical Pyrometer	**Radiation pyrometer**
Temp Range: more than 750^{o} C	Temp Range: more than 550^{o} C
Accuracy is 10^{o} C	Accuracy is 10^{o} C
Stability is very good	Stability is good
Sensitivity is good	Sensitivity is fair
Calibration against standard tungsten strip lamp	Calibration by comparing with standard optical pyrometer.
Monochromatic radiation	All radiations are considered

Compare

Point :

any 4:

1 Mark

each

e)

load cell:

Load cell is a "mechanical type transducer" which converts load applied
On a components into an equivalent "displacement" or electrical signal".
In hydraulic & pneumatic load cell, fluid pressure is used to measure the force.
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.

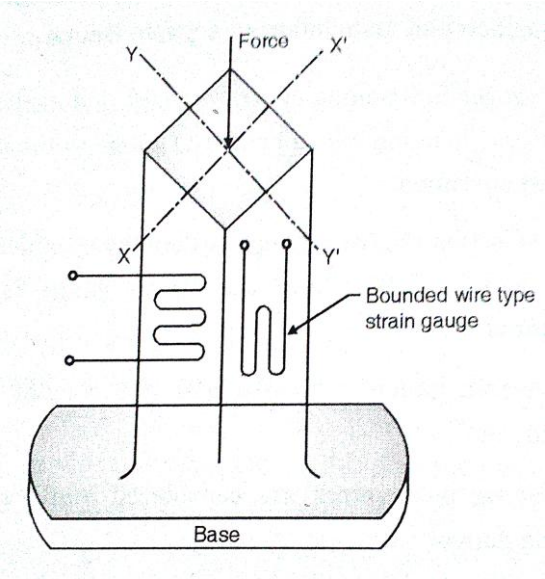
Explanation:

2 M &

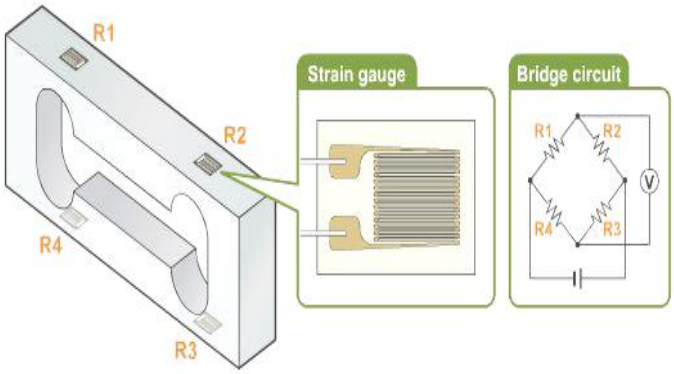
Diagram

(any 1)

2 M



or

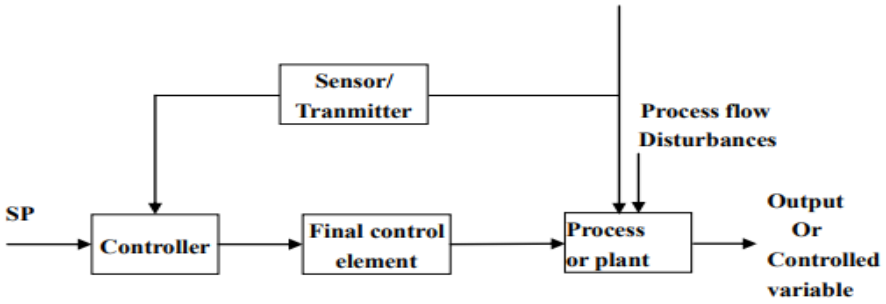
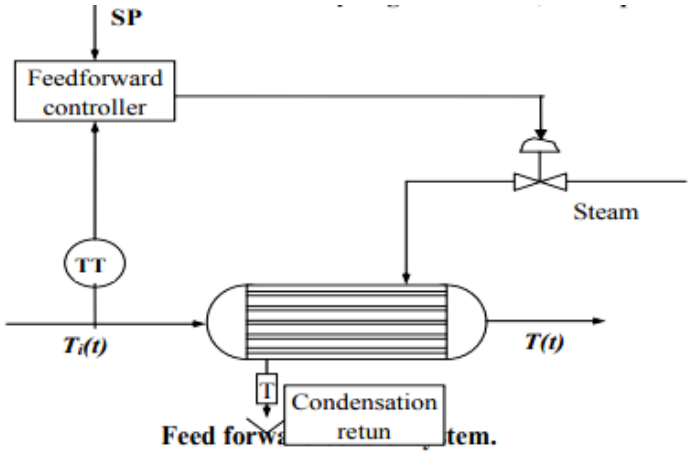


Four wire type bonded strain gauges are cemented on the column of load cell as shown in fig such that gauges along x-x are cemented in horizontal position where as along y-y in vertical position.

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.

	f)	This turns the bridge to unbalance condition. The deflection shown by detector can be directly calibrated to read axial force or strain. Types of mechanical load cell:1) Hydraulic load cell 2) pneumatic load cell 3) strain gauge load cell **feed forward control system with block diagram:**  In feed forward control system, disturbances are measured and compensated for them before the controlled variable deviates from set point. In control system, it is considered that the disturbance affect the o/p adversely 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 waiting 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. Example:  Feed forwa tem.	Block Diagram 2 M & Explanation: 2M