WINTER – 19 EXAMINATION

Subject Name: Measurements and Control **Model Answer** **Subject Code:** 17528

Important Instructions to examiners:

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

Q. No.	Sub Q. N.	Answer	Marking Scheme
1	a)	**Attempt any THREE of the following.**	**4×3=12**
	i)	**Give Classification of Measurements.** **Ans:** a) The direct measurement method b) Indirect measurement method: i) Primary ii) Secondary iii) Tertiary c) Contact type measurement method d) Non-Contact measurement method	**1 Mark each**
	ii)	**Define 1) Range 2) Span. Give one example of each.** **Ans:** **1) Range**: It can be defined as the measure of the instrument between the lowest and highest readings it can measure. OR The region between the limits within which an instrument is designed to operate for measuring, indicating or recording a physical quantity is called the range of the instrument. The range is expressed by stating the lower and upper values.	**Def^n 1 mark Ex. 1 mark**

		Example: A thermometer has a scale from −40°C to 100°C. Thus the range for thermometer is from −40°C to 100°C. **2) 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.	**Def^n 1 mark Ex. 1 mark**
	iii)	**State the advantage and limitations of potentiometer.** **Ans:** **Advantages:** • Cost-effective. • Simple design and simple working. • Can be used for measuring even large displacements. • The device produces a large output and hence can be used for control purposes without further amplification steps. Thus the whole operation is bounded to a single device. • Can produce a high electrical efficiency. • All devices other than wire-wound potentiometer can be used for a large frequency range. • Except wire wound, all other potentiometers can provide excellent resolutions. **Limitations:** • A huge force may be required for the slider movement. Can produce unwanted noise due to alignment problems, wear and tear of the sliding contact. This may affect the total life of the device.	**Advantages 3 marks** **Limit^n 1 mark**
	iv)	**List the devices used for pressure measurements.** **Ans:** **I) Low Pressure Measurement Gauges:** i) Mcleod Gauge ii) Thermal Conductivity Gauge : a) Thermocouple Vacuum Gauge b) Pirani Gauge iii) Ionization gauge **II) High Pressure Measurement Gauges:** i) Elastic Pressure Gauges : a) Diaphragms b) Bourdon tube c) Bellows	**2marks** **2marks**

ii) Electric Pressure Gauges :

a) Electrical resistance

b) Photoelectric

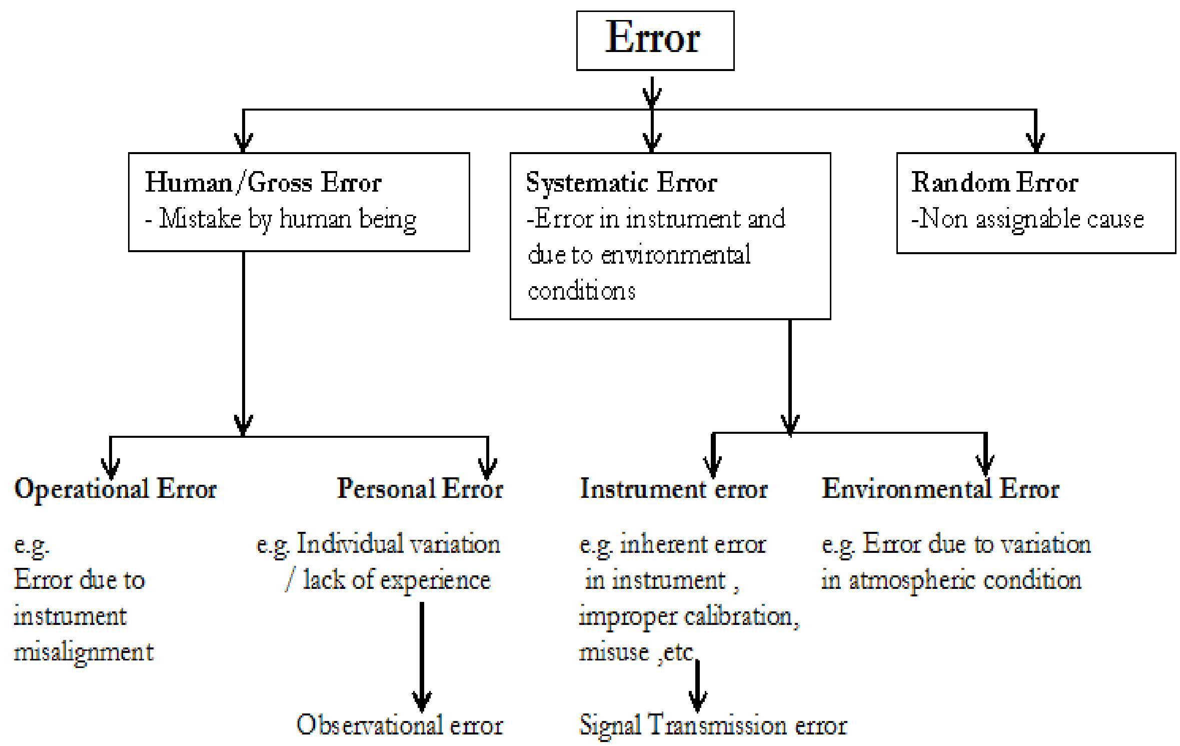
c) Piezoelectric

d) Variable Capacitance

b) Attempt any ONE of the following. **6×1=6**

i) Classify the errors and explain any two types of errors.

Ans:



Classification:- 3marks

I) <u>Gross Error or Human Error</u>

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:

- Personal/Observational errors
- Operational errors

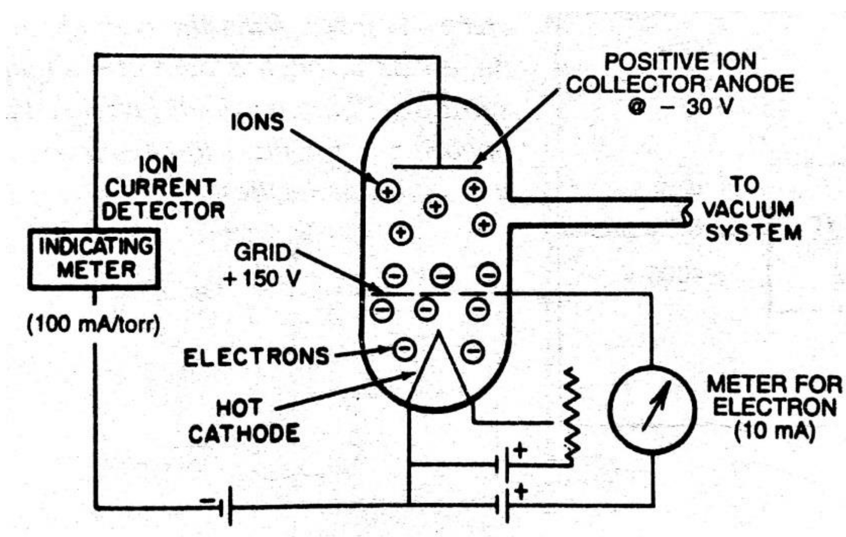
Personal/Observational Errors

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

Explanation:- 1.5 mark each

		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. **II) <u>Systematic error</u>** **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 temp. **III) 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"	
	ii)	**With a neat sketch, explain the working of ionization gauge for the pressure measurement.** **Ans:**  **Figure:** Ionization Gauge **Working:** (**Reference:** Process Measurement and Analysis Handbook by LIPTAK) • Heated cathode emits electrons.	**Figure 3marks** **3 marks**

<table>
<tr><td></td><td></td><td>

- Positive charged grid accelerates these electrons as it passes through the grid.
- Accelerated electrons collide with gas molecules causing ionization.
- Positive ions collect at anode producing plate current i_p.
- Negative ions collect at grid producing grid current i_g.
- Ratio of i_p and i_g gives measurement of vacuum pressure.

$$Pvacuum = \frac{1}{K}\frac{i_p}{i_g}$$

where K = Proportionality constant known as sensitivity of gauge.
</td><td></td></tr>
<tr><td>2</td><td>

a)</td><td>

Attempt any TWO of the following.

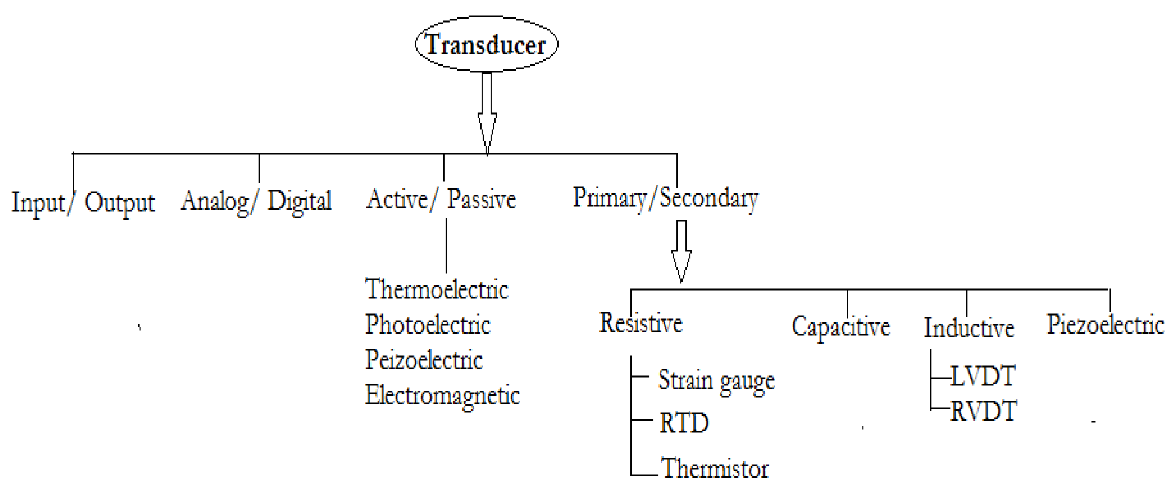
Define transducer. State classification of transducers and explain working of inductive transducer.

Ans:

Defination: A transducer a device that senses 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

Classification of Transducers is shown in figure given below.



Working Principle of Inductive Transducer:

- Work on the principle of the magnetic induction of magnetic material.
- Electromagnetic Induction depends on
  - ➢ Number of turns of the coil on the material,
  - ➢ Size of the magnetic material, and
</td><td>

8×2=16

Def^n
1 mark

Classif.
3marks

1 mark
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- Permeability of the flux path.
- Magnetic materials are used in the flux path
- There are one or more air gaps.

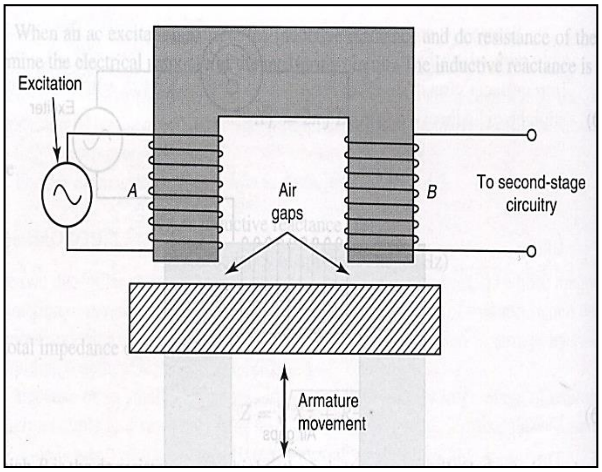


figure 1 mark

<u>Mutual InductanceTransducer (Figure)</u>

Explanation:- 2marks

- Two coils – Energizing coil A and pick up coil B.
- Movement of mechanical element changes the permeance of the flux path generated by the Energizing coil A, changes the mutual inductance of the pick up coil B and output. Change in inductance is calibrated as the displacement or measurand.

b) **With the neat sketch explain LVDT for displacement measurement and state its applications.**

Ans:

<u>Working Principle & constrution:</u>

-Variable Mutual inductance.

-Difference in AC voltage induced in two secondary windings is measured against axial displacement of core

-the displacement which is a non-electrical energy is converted into an electrical energy.

<u>Construction:</u>

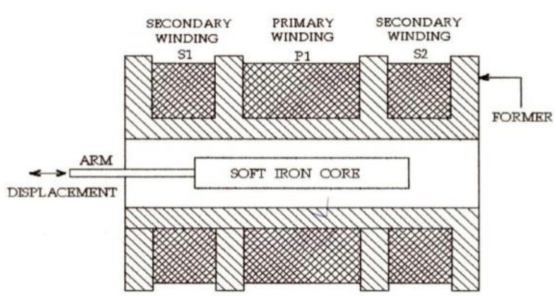


Figure : Construction of LVDT

Figure 2 mark

Consists of single primary winding P and two secondary windings S_1 and S_2 wound on a cylindrical former.

- Secondary windings have equal number of turns and either identically placed.
- An A.C. source is given to primary windings.
- A movable soft iron core is placed inside the former.
- The displacement to be measured is provided to the soft iron core.

Construction: -1 Mark

Core is made up of high permeability, nickel iron which is hydrogen annealed. Core material should be such that it gives low harmonics, low null voltage and high sensitivity.

Core is slotted longitudinally to reduce eddy current losses.

The complete assembly is placed in stainless steel housing.

Working:

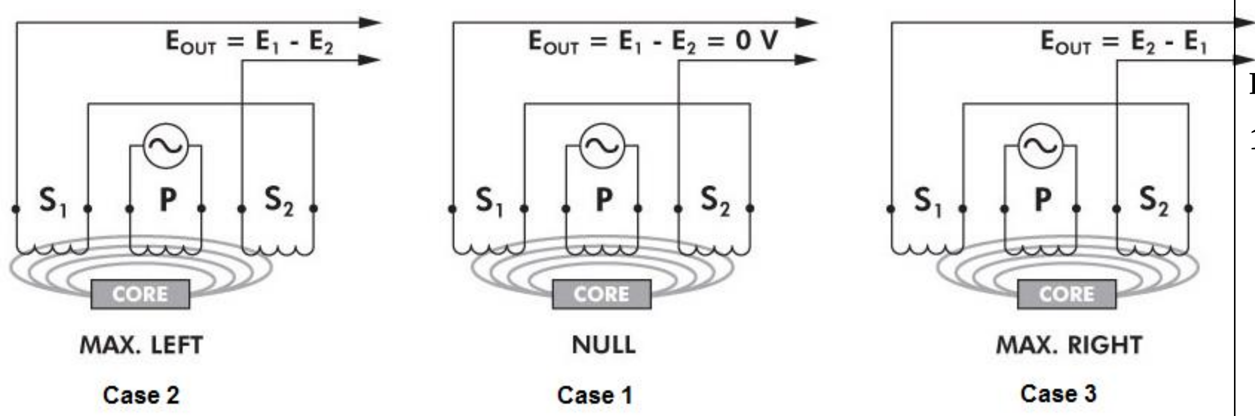


Figure 1mark

Figure: Working of LVDT

An A.C. power source is provided to the primary winding P, and A.C. output voltage is induced in secondary windings S_1 and S_2 depending upon the electromagnetic induction as per position of core. Working of LVDT by splitting the cases into 3 based on the iron core position inside the insulated former.

Working:- 2marks

Case 1: On applying an external force which is the displacement, if the core reminds in the null position itself without providing any movement then the voltage induced in both the secondary windings are equal which results in net output is equal to zero.

i.e., E_1-E_2=0

Case 2: When an external force is applied and if the steel iron core tends to move in the left hand side direction then the emf voltage induced in the secondary coil is greater when compared to the emf induced in the secondary coil 2.

Therefore the net output will be E_1-E_2

Case 3: When an external force is applied and if the steel iron core moves in the right hand side direction then the emf induced in the secondary coil 2 is greater when compared to the emf voltage induced in the secondary coil 1.

Therefore the net output voltage will be E_2-E_1

Change in net output voltage is calibrated as the displacement.

Applicaions of LVDT:-

- This transducer can also work as a secondary transducer.
- LVDT is used to measure the weight, force and also pressure
- Some of these transducers are used to calculate the pressure and load
- LVDT's are mostly used in industries as well as servomechanisms.
- Other applications like power turbines, hydraulics, automation, aircraft, and satellites

Applications:- 2 Mark

c) List the temperature measurement methods and devices. Explain with neat sketch platinum resistance thermometer.

Non-Electrical Methods

Sr. No.	**Name of the Method**	**Working Principle**	**Example**
1	Liquid, Vapor pressure and gas thermometers.	Change in volume or pressure.	Glass thermometer with mercury, alcohol, pentane,
2	Differential Expansion Thermometers	Change in dimensions of metal strip due to change temperature i.e contraction or expansion	Bimetal Strip Thermometer
3	Refractory cones, paints and crayons		

2marks

Electrical Methods

Sr. No.	**Name of the Method**	**Working Principle**	**Example**
1	Electrical Resistance Thermometer	Electrical resistance of various materials changes with change in temperature	Metallic Resistance Thermometer
2	Resistance Temperature Detectors		RTD
3	Semiconductor Resistance Thermometer		Thermistors

2marks

4	Thermoelectric Sensors	If two different materials are joined together and two junctions are maintained at two different temperatures, there is emf generation between junctions which is proportional to temperature difference.	Thermocouple
5	Quarts Thermometer	Change in temperature causes change in emf produces of piezoelectric materials.	Piezoelectric Thermometer
6	Pyrometers	Radiation emitted by the hot body is directly proportional to its absolute temperature	Radiation and Optical Pyrometer

- Platinum resistance thermometer is also referred to as (Platinum Resistance Thermometer) PRT (or PT) or Resistance Temperature Detector (RTD).
- The resistance of standard high purity Platinum resistance varies systematically with temperature and it is given as shown in **Figure**

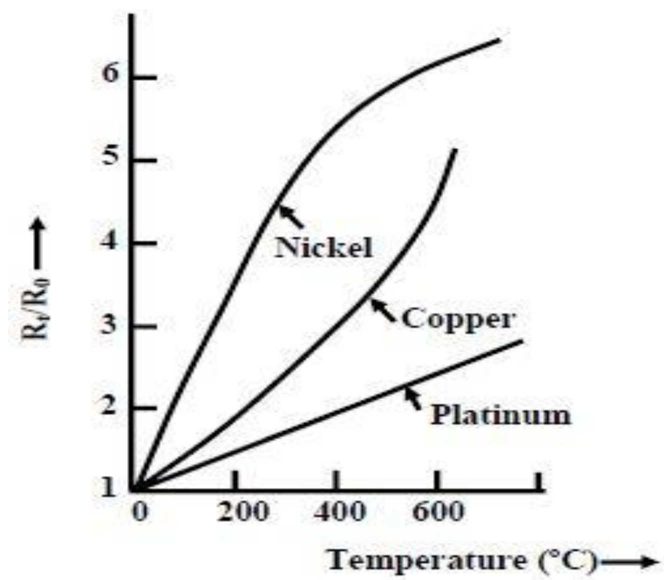


Figure 1 mark

-

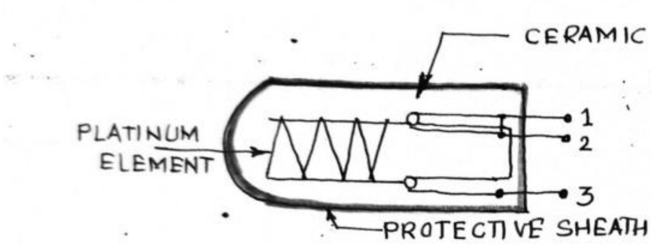


Fig: Constsuction of RTD

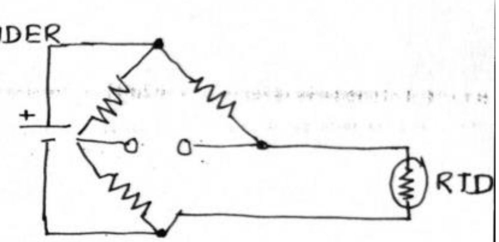


Fig: Working of RTD in Two wire RTD Bridge.

		Construction: **(Figure)** • Coiled Platinum element. • Platinum due to Linearity and Chemical inertness. • Platinum is coiled on ceramic mandrel. • Coiled platinum protected by s.s metal sheath. • Ceramic or mica powder insulates the leads. • The leads connected in Wheatstone bridge. • The lead wires are usually of higher diameter than the diameter of the sensor wire to reduce the lead wire resistance **Working: (Figure)** • Steel protective sheath detects the temperature and transfer it to platinum filament. • Change in resistance value of Platinum coil is very small with respect to the temperature. • So, the RTD value is measured by using a bridge circuit. • Temperature is determined by converting the RTD resistance value using a calibration expression. • Dummy wire reduces impedance effect and so the error. **Advantages:** • Simple in construction. • Most accurate • Highest Reproducibility. • Good Range (-250^{0}C to 899^{0}C) • Linearity is good.(need dummy wires) **Disadvantages:** • Higher cost. • More fragile compared to thermocouples. • Higher response time • I^2R power dissipation by the device itself that causes a slight heating effect which add error after continuous use at elevated temp.	**Construction: -1 Mark** **Working:- 1 mark** **Advantage & Disadvantage: - 1 mark**

3 **Attempt any FOUR of the following** **4x4=16**

a) Compare Active 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 four pts.

1 M each

b) Define Resolution and Noise related to potentiometer

Resolution: it is the smallest measurable input to cause measurable change in output.

The **resolution** of a **potentiometer** is the smallest possible change in resistance ratio. Wire-wound resistors often have a lower **resolution** because the wire turns introduce discrete steps in resistance. Conductive plastic potentiometers have the best **resolution**.

Noise: As the wiper is moved from one turn to the next, the resistance and output voltage change in steps rather than changing in a smooth linear manner. This step-like change is called "resolution **noise**.

2 M each term

c) State any two advantages and two disadvantages of bimetallic thermometer

advantages of bimetallic thermometer:
1)Better ruggedness, 2) Better ease of reading, 3) Low cost 4)High accuracy.
5)useful range of -40 to +50 degree celcious.

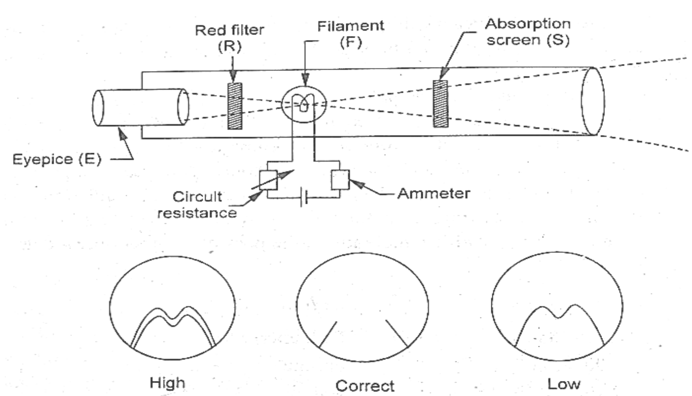
Disadvantages of bimetallic thermometer:
1) Speed of response is comparatively less as compared to infra red thermometer.
2) The metals undergo permanent work distortion
3)It is not suitable for measuring rapidly varing temp of system
4) Not recommended for temp. measurement above 550 degree celcius.

2 M each for Adv. & Disadv.

d) Explain with neat sketch optical pyrometer

Optical Pyrometer

2 M sketch



Disappearing –filament optical pyrometer

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.

2 marks Explain

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 equal 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 becomes 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- 700°C to 4,000°C

e) **Explain the thermometers most suitable for measurement of following temp.**

1 M each

i) -35 to 510⁰ ii) -65 to 430⁰ iii) -100 to 315⁰ iv)- 15 to 3870⁰

Sr.No	Temp Range	Suitable Thermometer
1	-35 to 510⁰ :	Mercury filled pressure thermometer
2	-65 to 430⁰	Bimetallic Thermometer
3	-100 to 315⁰	Metal oxide type thermistor
4	- 15 to 3870⁰	Total radiation pyrometer

4 **a)** **Attempt any THREE of the following**

4x3=12

i) **State law of intermediate temp and intermediate metal with neat sketch**

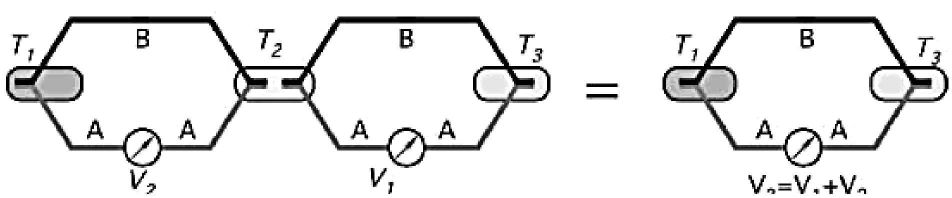
law of intermediate temperature & metal:

2 M Law

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



2 M for Sketch

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.

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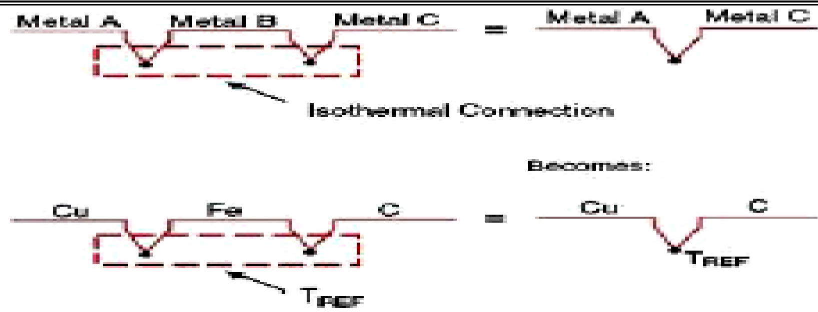
<tr><td></td><td></td><td>

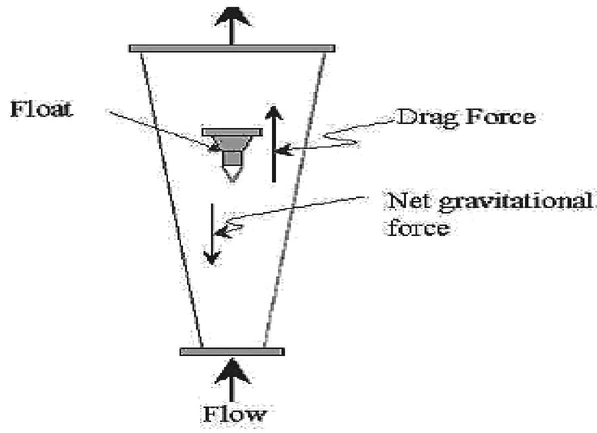
LAW OF INTERMEDIATE METALS</td><td></td></tr>
<tr><td></td><td>ii)</td><td>Draw neat sketch of rotameter and state the material used for float


Fig. Rotameter
Material for float: stainless steel , mild steel,aluminium etc.</td><td>2 M sketch

2 M material</td></tr>
<tr><td></td><td>iii)</td><td>Define Sound power and sound pressure:

Sound power:-It is the total energy radiated by sound source per unit time.It is abbreviated as PWL and is given by
PWL=[10 log10 W/Wref]dB
Where ,W=Acoustic power of the source
Wref=Reference acoustic power

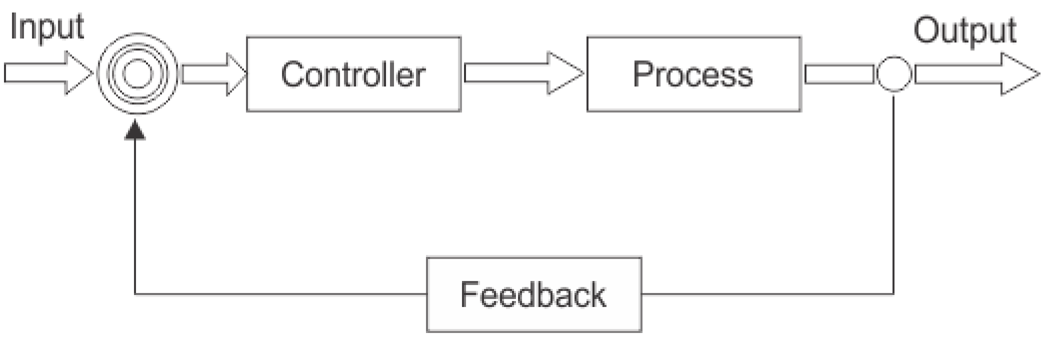
Sound pressure:-The logarithmic measure of the effective sound pressure of a sound to reference value is called sound pressure level. It is denoted by SPL
SPL=[20 log10 P/Pref]dB
Where ,P=sound pressure
Pref=Reference pressure</td><td>2 M each term</td></tr>
<tr><td></td><td>iv)</td><td>Enlist direct and indirect liquid level measurement devices.
Direct liquid level measurement devices:
1) Dip stick method
2) Sight glass method
3) Manometer Tube connected to the container
4) Float and tape gauge
indirect liquid level measurement devices:</td><td>2 M for direct & 2 M for Indirect</td></tr>
</table>

1) Hydrostatic pressure type liquid level
2) Bubbler system
3) Capacitance gauge
4) Ultrasonic liquid level gauge
5) Gamma ray liquid level sensor

b) **Attempt Any ONE of the following** — **6x1=6**

i) **Draw the block diagram of closed loop control system and explain it. state its application**

2 M Sketch



Explanation: 1) A system in which the controlling action is somehow dependent on output is called closed loop system
2) such system uses a feedback that is a part of the output is feedback to the point and is compared with ref. point.
3) Feedback of the system which allows the output to be compared with the ref. Input so that appropriate controlling action can be executed.
4) it is then compared to with the ref point giving error signal .This error is then manipulated by the controller generating manipulated actuating signal for the process to be controlled. This manipulation is such that to make error in the system exactly zero. Then the process give controlled output.

2 M explain

Application: 1) Refrigerator 2) servo motor 3) Governor 4) motor speed control 5) temp control system.

2 M Applica tions

ii) **Differentiate between hydraulic and pneumatic controllers (Any six Points)**

Any Six pts
1 m each pt

	Hydraulic Controllers	**pneumatic controllers**
1	Operating media for transmission is liquid	Operating media for transmission is Air/gas
2	Chances of fire hazards are more	Chances of fire hazards are less
3	Actuator system is simple	Actuator system is simple
4	Very high maintenance	Less maintenance
5	Used for high power transmission	Used for low power transmission
6	Accuracy of control is high	Accuracy of control is very large
7	Very high initial cost	Low cost

8	Start up period is small	Start up period is longer.

5 **Attempt any FOUR of the following** **4×4=16**

a) **Explain with neat sketch slipping clutch tachometer.**

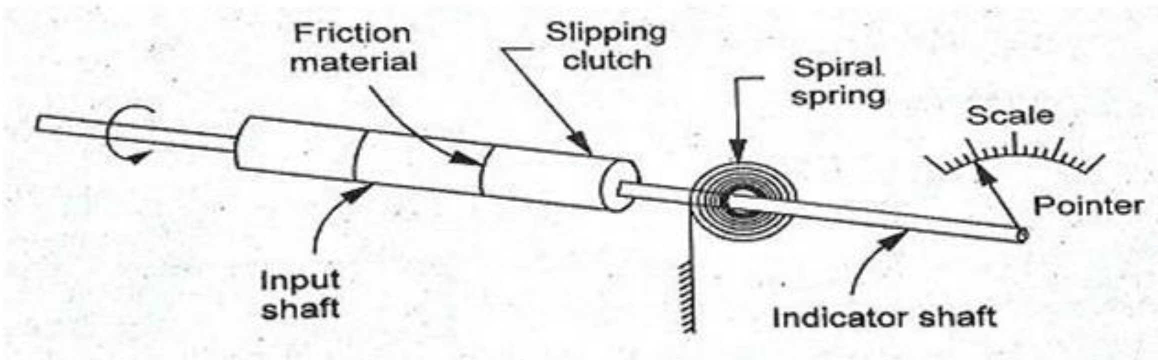


Figure 02 Marks

Fig. Slipping Clutch tachometer

Explanation 02 Marks

1. In this type clutch is used to connect the driving shaft with indicating shaft.
2. The rotating shaft drives and indicating shaft through a slipping clutch.
3. 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

b) **Draw and Explain strain gauge transmission dynamometer.**

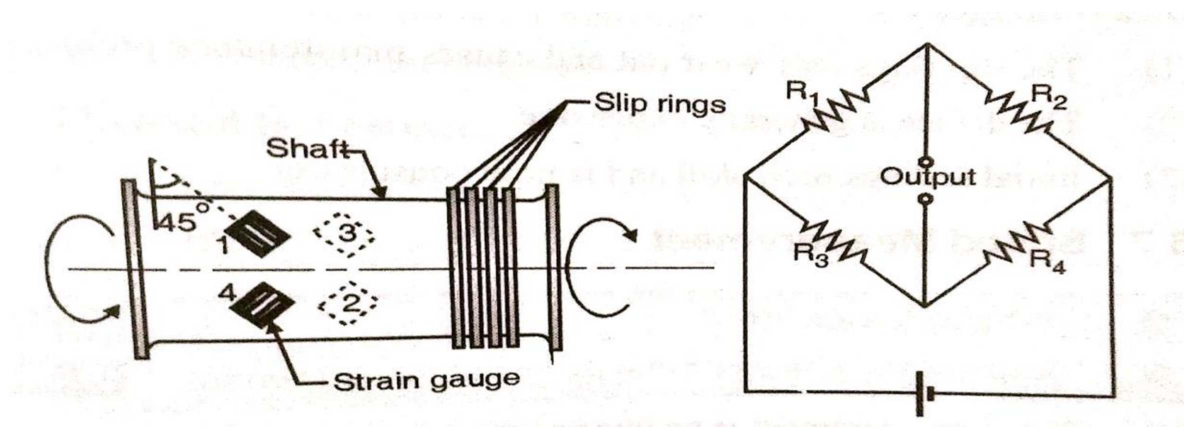


Figure 02 Marks

Fig. Strain gauge transmission dynamometer

1. This is rotating torque sensor which measures torque.
2. This dynamometer is used as a coupling between driving machine and driven machine or between any two portions of the machine.
3. Here strain gauges are fitted at 45˚ to shaft axis as shown in fig.
4. In this type of arrangement, 2 strain gauges are subjected to tensile stress and while

Explanat

		other is subjected to compressive stress. 5. Strain gauge 1 & 3 must be diametrically opposite to strain gauge 2 & 4. 6. Due to torsion, strain gauge senses compressive as well as tensile formation. Further these strain gauges are connected to Wheatstone circuit. the output of Wheatstone bridge is proportional to torsion and hence to applied torque on shaft. The bridge power and output of bridge is connected to the sensor through slip ring and brushes . Advantages: 1) It is sensitive to torque. 2) it gives an instantaneous results. 3) it has full temperature compensation	ion 02 Marks
	c)	**State advantages and disadvantages of Feed Forward control system**. Advantages 1. It prevents disturbances in output. 2. It acts before the effect of disturbance has been felt by the system. 3. It is good for slow systems with significant dead time. Disadvantages 1. Require identification of all possible disturbances and their measurement. 2. Cannot cope with unmeasured. Sensitive to process parameter variations.	**02 Marks** (01 mark for each correct point) **02 Marks** (01 mark for each correct point)
	d)	**Define Control System. State any two examples of control systems**. **Control System-** It is defined as an assemblage of devices and components connected or interrelated so as to command, direct, regulate itself or another system. **Example of control system** 1. An electric switch 2. Air conditioner 3. Refrigerator 4. Boiler Control **5.** Automatic washing machine	**02 Marks** for definiti on **02 Marks** (01 mark for each correct example)
	e)	**Explain with neat sketch PID control action.**	Figure 02

Marks

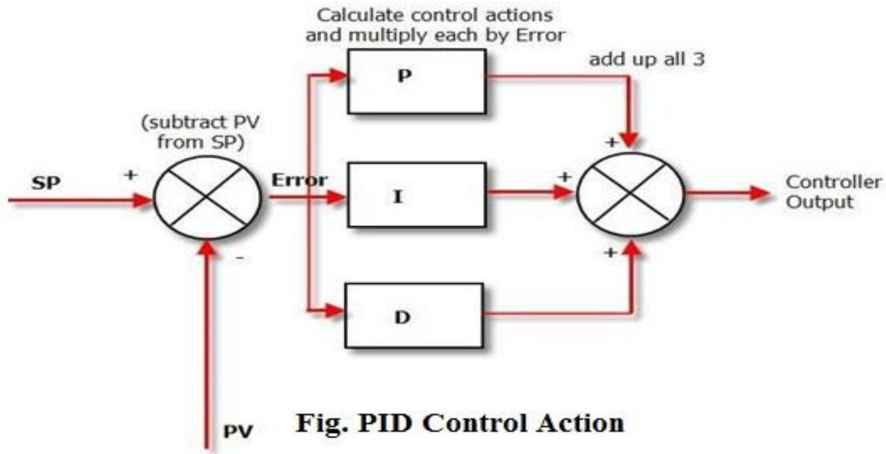


Fig. PID Control Action

1. PID is a control loop feedback mechanism widely used in industrial control system.
2. A PID controller continuously calculate an error value e(t) as the difference between a desired set point (SP) and measured process variable (PV).
3. It is really simple in operation; the process variable is subtracted from the set point to create the error.
4. The error is simply multiplied by one, two or all of the calculated P, I and D actions.
5. Then the resulting error x control actions are added together and sent to the controller output. Mathematical equation of PID controller is as shown below:

$$m(t)=kp*e(t)+ki \int e(t)\,dt + kd * de(t)/dt$$

Explanation:- 02 Marks

f) **State the application of control system for setup of boiler and air conditioner.**

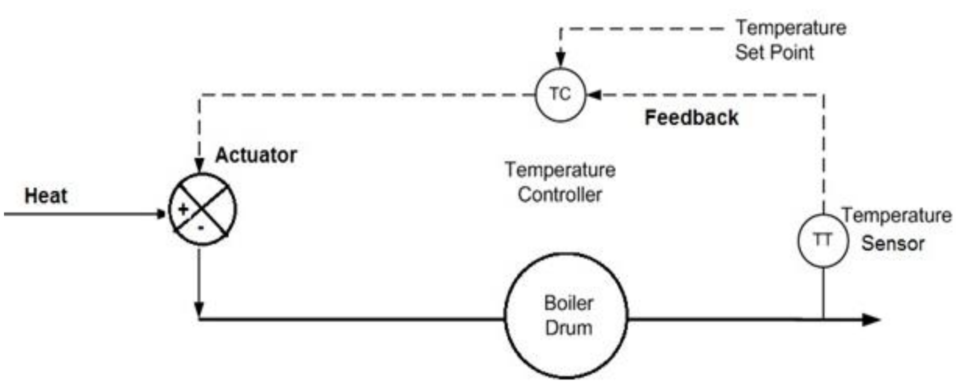
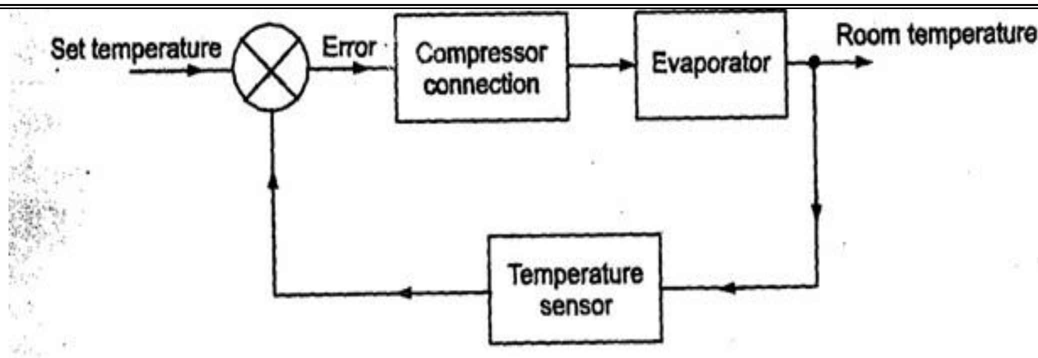
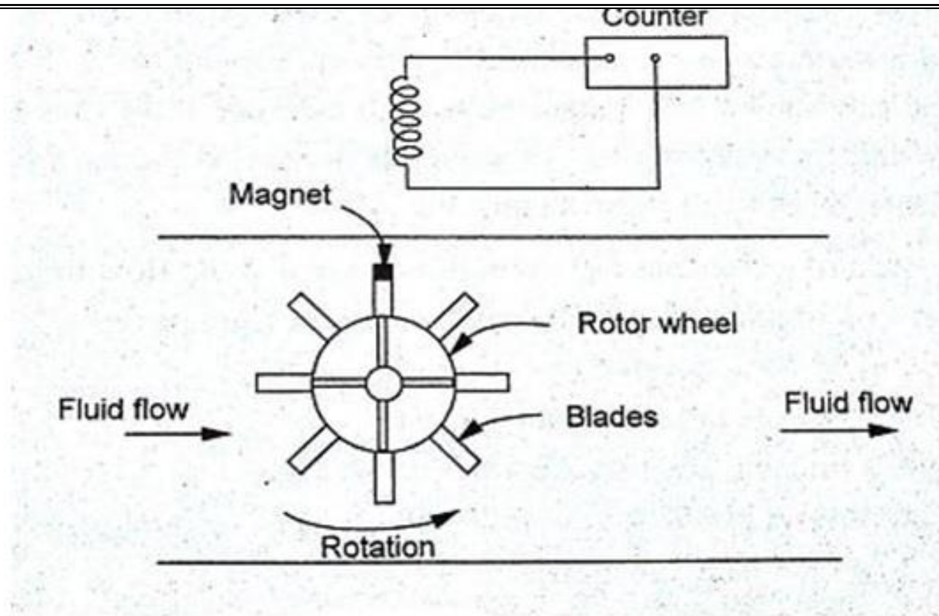


Fig. Control System for Boiler

02 marks

1. Figure shows how the feedback control system can be used for temperature control of boilers.
2. Boiler temperature can be measured or sensed and signal can be fed to thermostat.
3. 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

		 **Fig. Control system for Air Conditioner** There is comparison between the actual temperature (controlled) and the desired value of temperature variable. 1. To accomplish the output signal is fed back and the loop is completed. 2. Air-conditioner maintains the room temperature at some predetermined (Set) value. When room temperature is more than set value it switch ON compressor to start cooling of room. On reaching the set value of temperature in room it disconnects compressor Connections	02 marks
6		**Attempt any FOUR of the following**	**4×4=16**
	a)	**State any four advantages of Electromagnetic flow meter.** **1.** There is no obstruction to flow. **2.** It can handle slurries nd liquid containing suspended particles. **3.** It has high accuracy. **4.** It can measure reverse flow. **5.** It respond rapidly to flow changes.	Any four advantages (01 mark for each correct point) **-04 Marks**
	b)	**Explain with neat sketch turbine flow meter.**	Figure 02 Marks



1. Turbine flow meter consists of a freely rotating wheel (rotor or propeller) with multiple blades, which is placed at right angle to the axis of flowing fluid.
2. The rotor is supported by ball bearing on a shaft . This is free to rotate about its axis .
3. A magnetic pickup coil is placed near the table . It is used to measure the speed of blade.
4. The turbine flow meter works on basic principle of turbine ..
5. 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.
6. The rotor speed is measured with mechanical counter or with an electro –magnetic pick up.

The rate of pulse gives flow and total number of pulses gives a measures of the flow

Explanation 02 Marks

c) **Write Classification of Flow measuring devices.**

04 Marks

Flow measuring devices

A) Variable head type
   1. Venturi 2. Orifice 3. Nozzle
B) Variable area type
   1. Rotameter
C) Electromagnetic type
   1. Electromagnetic Flow meter 2. Turbine flow meter
D) Ultrasonic flow meter
E) Anemometer:-Cup Anemometer, Hot wire Anemometer

	d)	**Write advantage and disadvantage of photoelectric tachometer.** Advantages 1. Simple in construction 2. Output is in digital form 3. Easy to operate 4. Less Maintenance 5. It is contactless type meter Disadvantages- 1. Chances of operational error 2. Limited to low speed	Any two advantages (01 mark for each correct point) Any two disadvantages (01 mark for each correct point) **-04 Marks**
	e)	**Write four metal names used for strain gauge sensing element.** **Strain Gauge materials** **Advance** : It is 55 % copper, 45 % nickel having gauge factor 2. It is most commonly used as it has reasonable gauge factor. It can be easily worked and soldered. **Isoelastic:** It is 36 % nickel, 8 % copper, 4 % Mn, Si and molybdenum and rest of iron, It has gauge factor 3.5. It has high gauge factor. It useful in dynamic measurement. **Nichrome:** It is nickel, chromium alloy having gauge factor 2. **Maganin :** Manganin is a trademarked name for an alloy of typically 86% copper, 12% manganese, and 2% nickel. It has 0.47 gauge factor and low temperature coefficient. **Monel :** It has high temperature coefficient and gauge factor as 1.9. This is alloy of Ni (67 %) and Cu (32 %) with small amount of iron and Mn	Any four Material (01 mark for each correct point) **-04 Marks**

		Nickel : It has negative gauge factor (-12). It exhibits reduced resistance though length increases and diameter decreases.	