Institute of Engineering &Technology
Sitapur Road, Lucknow-226021
Subject: Transducer Sensor and Measurement System
Semester: 5th (Session 2021-2022)
Subject code: KIC 051

Assignment 1_KIC 051

1. What do you know about transducer? Classify the transducer.
2. What are the static and dynamic characteristics of instruments?
3. What is limiting error?
4. A 0-150V voltmeter has guaranteed accuracy of 1% of full scale reading. The voltage measured by this instrument is 75V. Calculate the limiting error in percentage.(Ans 2%)
5. A 0-250V voltmeter has guaranteed accuracy of 2% of full scale reading. The voltage measured by this instrument is 150 V. Calculate the limiting error. (Ans 3.33%)
6. Explain input out configuration of measuring instruments and measurement system. Explain desired inputs, interfacing inputs, and modifying inputs with example.

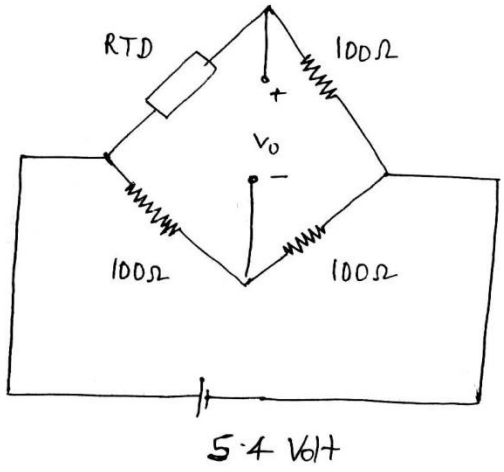
Assignment 2_KIC 051

1. Explain the construction and working of piezoelectric transducer. Derive the expression of output voltage. Draw the equivalent circuit of piezoelectric transducer? Why piezoelectric traducer cannot be used for static displacement?
2. What is piezo resistive effect? Derive the expression of gauge factor.
3. Discuss the construction and working of phase sensitive detection type LVDT. What are the advantages of LVDT? Provide the range of LVDT and RVDT. Why is repeatability of LVDT infinite?
4. The output of a potentiometer is to be read by a recorder of 10,000Ω input resistance. Nonlinearity must be held to 1 percent. A family of potentiometers having a thermal rating of 5W and resistance ranging from 100 to 10,000Ω in 100 Ω steps are available. Choose from this family, the potentiometer that has the greatest possible sensitivity and meets the other requirements. What is this sensitivity if the potentiometers are single turn (360^0) units? (Ans=600 ohm, Sensitivity =152mV/^{0}C)

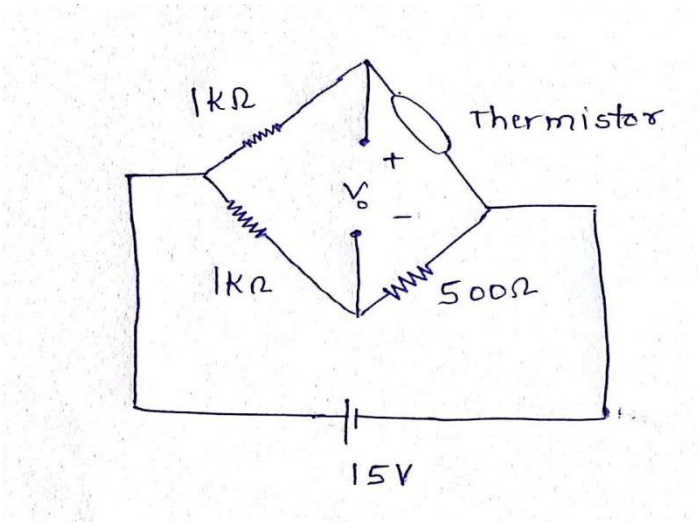
5. Consider a Wheatstone bridge circuit having all resistances equal to 120 Ω. If each strain gage cannot sustain a power dissipation of more than 0.25W, what is the maximum value of input excitation? If this system of strain gages (4 nos), is used for measuring strains on a tensile specimen (mounted for maximum sensitivity and temperature compensation), what is the output voltage per unit of strain (Assume GF=2). (Ans=21.88)
6. What is load cell? How does a load cell work?

Assignment 3_KIC 051

1. What are the methods of temperature measurement? What is RTD? Why do we use platinum for construction of RTD?
2. Explain the principle of working of thermocouple. Which material is used in design of type T, J, K, and E.?
3. Explain cold junction compensation.
4. Explain construction and working of total radiation pyrometer.
5. RTD having a sensitivity of 0.4Ω/℃ connected to a dc bridge with 100 Ω fixed resistance in other three arms. The bridge is excited with 5.4 Volt. The bridge is balanced at 0℃. At room temperature the bridge is unbalanced and the output is 0.2 volt. Find the room temperature.(Ans=40^0C)

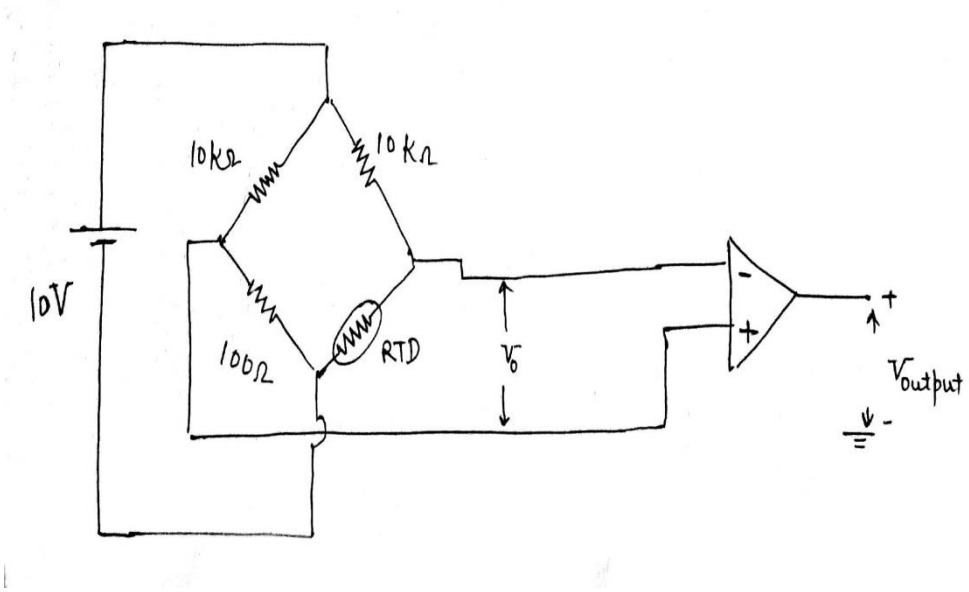


6. Thermistor has a resistance of 500Ω at 30℃ and its temperature coefficient is -5Ω/℃. Thermistor is used to measure the temperature of the system with the following arrangement. If the temperature is increased by 10℃ then calculate the reading of voltmeter.



(Ans= -10/29)

7. A temperature measurement scheme using RTD is shown below. The resistance of RTD at 0°C is 100Ω and temperature coefficient of resistance α=0.00392/°C. Find the differential gain of amplifier to achieve the voltage sensitivity of 10mV/°C at 0°C.

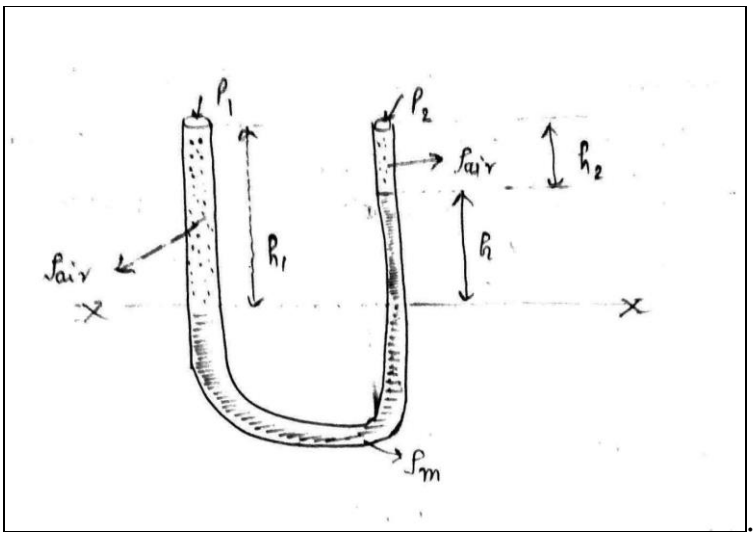


(Ans gain=29.38)

Assignment 4_KIC 051

1. Describe high pressure measurement using Bourdon tube.
2. Explain pressure measurement using bellows.
3. Explain pressure measurement diaphragm and capsule,
4. What are low pressure sensors? Explain Pirani gauge
5. Derive the expression of unknown pressure P_i using McLeod gauge.
6. Explain construction and working of Ionization gauge.
7. Explain Knudsen gauge with neat diagram.

8. Explain the construction and working of dead weight gauge.
9. Derive the expression for differential pressure (P_1-P_2) when it is balanced at the level X-X as shown in figure below.



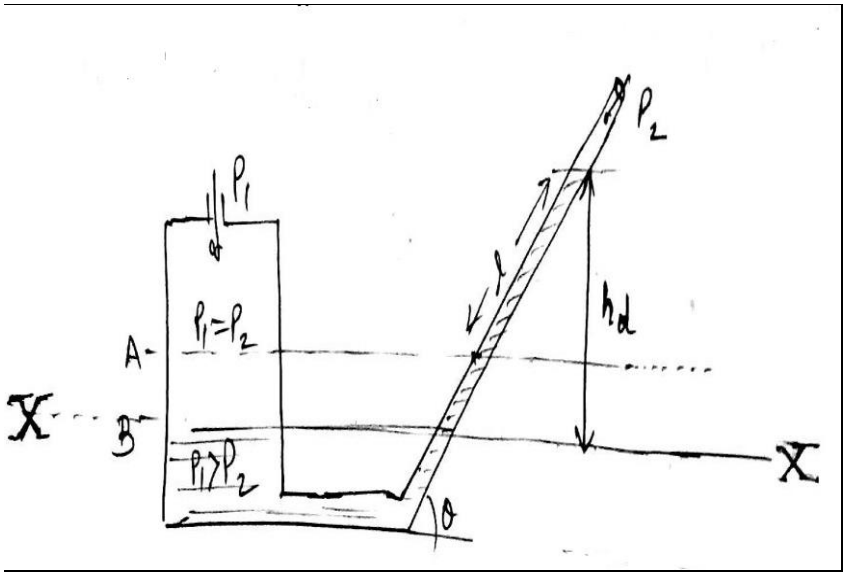
10. A McLeod gauge has a volume of bulb and capillary tube is 90cm^3. Diameter of capillary is equal to 1mm. Calculate the pressure indicated by a reading of 3 cm. [Ans:7.85x10^{-3}mm]

11. A well of cross section area a_w is connected to an inclined tube of cross section area a_t to form a differential pressure gauge as shown in the figure below. When P_1=P_2, the common liquid level is denoted by Level–A. When P_1> P_2, The liquid level in the well is depressed to B, and the level in the tube rises by l along its length such that difference in the tube and well level is h_d.

    a. Prove that: $P_1 = P_2 + \rho\, g \left(\frac{a_t}{a_w} + \sin\theta \right) l$

    b. Prove that angle of inclination θ of the tube with the horizontal is equal to

$$\theta = sin^{-1}\left[\frac{h_d}{l} - \frac{a_t}{a_w}\right]$$


P1
P2
l
hd
A
B
X
X
P1=P2
P1>P2
θ

Assignment-5_KIC 051

1. Let water (incompressible fluid) is flowing through a horizontal pipe. At any point 1 it has pressure P_1, area A_1, and velocity v_1, at any point 2 it has pressure P_2, area A_2, and velocity v_2. Let A_1 is larger than A_2. Derive the expression of flow velocity v_2 (m/s) and theoretical volume flow rate Q (m^3/s).

2. Explain orifice plate, venturi meter and flow nozzle with diagram.

3. Explain the construction and working of Rota meter. Derive the expression of volume flow rate for Rota meter.

4. Explain the construction and working of Ultrasonic flowmeter.

5. Describe constant current type and constant temperature type hot wire hot film anemometer.

6. Describe constant temperature type hot wire hot film anemometer.

7. Determine the flow velocity of water having density of $1000kg/m^3$ at the head of the Pitot tube if it produces a differential pressure of 10KPa between the outlets.

8. A nozzle is fitted in a horizontal pipe having diameter of 15 cm, carrying a gas of density $1.15kg/m^3$, for the purpose of flow measurement. The differential pressure head indicated by a U-tube manometer containing oil of specific gravity 0.8 is 10 cm of oil. If the co-efficient of discharge and diameter of nozzle are 0.8 and 5cm respectively. Determine the volume flow rate (m^3/s or cm^3/s) through the nozzle flow meter. Consider density of water is 1000 kg/m^3. (Ans $Q=58293.957m^3/s$)

9. A mercury manometer is connected to a standard orifice meter with a 30 mm diameter hole that has been placed in an 80 mm diameter pipe. For a manometer reading of 300 mm of mercury, determine the volume flow rate (m^3/s) in the pipe if the fluid is crude oil at 20^0C. Consider the density of crude oil at 20^0C is 870 kg/m^3, density of mercury =13,600 kg/m^3,$C_d=1$(Ans $Q=0.0066m^3/s$)

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