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1-For an inclined manometer measuring pressure difference of $\Delta P=30$ kPa, calculate the uncertainty in ΔP if the followings are given:

Manometer inclination angle is 30° with uncertainty of 1°

      Inclined length L has uncertainty of 1 mm

      Manometer fluid is mercury with density $\rho_{HG} =13600$ kg/m3, and 5% uncertainty.

Which of the three variables θ, L or ρ has dominant effect on the pressure uncertainty.

2-How Diaphragm pressure transducer is used to measure pressure with electrical signal output. Draw a sketch and explain the idea of operation.

3-Draw a sketch for a bellow pressure sensor attached to a potentiometer. Describe with equations how the mechanical movement of the bellow is transformed into electrical signal.

4-Draw a sketch of a capacitive type pressure transducer and give an explanation on idea of operation

5-What is a piezoelectric crystal and how it can be used to measure pressure?

6-In order to measure the flow rate in a 2m by 2m air conditioning duct, an engineer uses a pitot static tube probe with a manometer to measure the dynamic head. The duct is divided into nine equal rectangular areas with the pressure measured at the center of each. Based on the results below, estimate the flow rate for air at 15°C and 1 atm. **[9.40 modified].**

position	1	2	3	4	5	6	7	8	9
H (mm H_2O)	4.9	6.0	6.7	5.5	6	6.6	7.5	6.5	5.5

7-Air velocity is measured using static Pitot tube connected to a U tube manometer. The fluid in the manometer is water. If the manometer deflection at one measurement H is 20 mm H_2O. Take the air density to be 1.2 kg/m^3.

a) Calculate the air velocity
b) If the U tube manometer deflection is measured with resolution of 2 mm, calculate the uncertainty in V and its percentage value
c) If the required percentage uncertainty in measuring the velocity is 1 % how much the required resolution for measuring H

8-What is Doppler shift. How this Doppler effect can be used to measure the flow velocity. Draw a simple sketch, and give explanation.

9-A car is emitting a sound at frequency 800 Hz. A stationary observer detects a frequency of 850 Hz. Assume the air to be ideal gas with T=30°C, utilizing Doppler effect principle what is the velocity of the car?

10-For Constant Temperature Anemometer (CTA) hotwire as shown below, the OP-AM output voltage was calibrated to the hotwire sensor by

$$E^2 = C + DU^n$$

where E is the output voltage from OP-AM, and the constants C, D and n are found from calibration using a Pitot tubed as C=3.0, D=2.2, n=0.45. U is the air velocity (m/s)

Constant temperature hot wire anemometer circuit
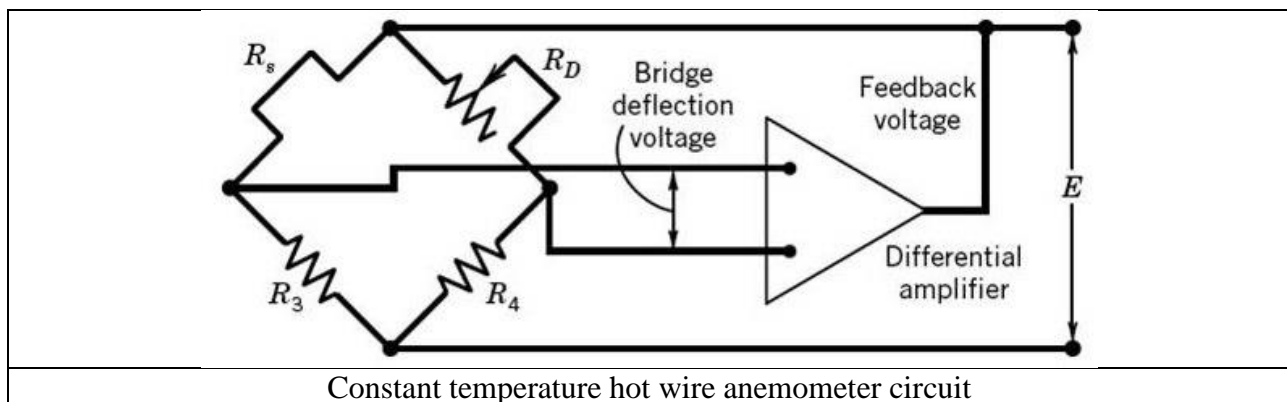
The followings data were found

test #	E (volts)	U (m/s)	dE/dU
1	2.979		
2	3.076		
3	3.249		
4	3.360		
5	3.440		

Calculate the velocity and the sensitivity dE/dU at each test point. If the uncertainty in E is 0.1 Volt, how much is the uncertainty in the velocity U (u_U & $\frac{u_U}{U}$) for each case.