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# MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
*A Constituent Institution of Manipal University*

**I SEMESTER M.TECH. (TSES)**
**END SEMESTER EXAMINATIONS, NOV/DEC 2016**
SUBJECT: MEASUREMENTS IN THERMAL ENGINEERING (MME 5144)
**REVISED CREDIT SYSTEM**
**(01/12/2016)**

Time: 3 Hours MAX. MARKS: 50

**Instructions to Candidates:**

- Answer ALL the questions.
- Missing data may be suitable assumed.

**1A.** Consider flow of dry air through a venturimeter with β = 0.5. The upstream pressure and temperature are 2 bar and 300 K respectively. The mean velocity of the flow has been measured independently in the pipe and is known to be 56 m/s. The pipe diameter is 0.06 m. Determine the head developed by the meter. Is it necessary to take into account the expansion factor? Explain. If so, determine the correct pressure difference developed by the flow meter, Cd = 0.98, R = 0.287 kJ/kgK and Cv = 0.775 kJ/kgK. **(05)**

**1B.** Write generalized mathematical model and with proper example, refine it for the case of second order instrument. **(05)**

**2A.** A pitot static tube is used to measure the velocity of an aircraft. The air temperature and pressure are 5º C and 90 kPa respectively. What is the aircraft velocity in kmph, if the differential pressure is 1500 mm of water column? Is compressibility factor to be considered? Why? If so find the percentage error in velocity measurement. Assume Cp = 1.05 kJ/kg K and Cv = 0.765 kJ/kg K. **(05)**

**2B.** Explain with a neat sketch an instrument which is based on manometry to measure pressure in the range of 0.01-1000 microns. Also derive an expression to measure unknown pressure. **(05)**

**3A.** The thermocouple response shown below (Copper – material A, Constantan – material B thermocouple with the reference junction at the ice point) follows approximately the relation $Vs = at + b$. Obtain the parameters *a* and *b*. Justify the method used and find the standard error. Here *t* is in °C and *Vs* is in mV.

| *t* | 37.8 | 93.3 | 148.9 | 204.4 | 260 |
|---|---|---|---|---|---|
| *Vs* | 1.518 | 3.967 | 6.647 | 9.523 | 12.572 |

**(05)**

**3B.** Sketch and explain the set up to calibrate the following:
(i) Gas flow meter based on volumetric analysis.
(ii) Liquid flow meter based on gravimetric analysis. **(05)**

**4A.** It has been decided to use bimetallic thermostat for process heat control. The heating and cooling limit of the process chamber is 175°C and 20°C respectively. A single thermostat is expected to monitor the temperature variation. Find the maximum distance between two legs, which are located on either side of the thermostat. Sketch the arrangement.

| | **Yellow brass** | **Invar** |
|---|---|---|
| Thermal coefficient ($°C^{-1}$) | $20.2 \times 10^{-6}$ | $1.7 \times 10^{-6}$ |
| Thickness (mm) | 0.50 | 0.50 |
| Young's modulus (GPa) | 96.5 | 147 |
| Bonding temperature | 40°C | |
| Length | 100 mm | |

**(05)**

**4B.** With a neat sketch, derive an expression for flow rate in case of variable area Orificemeter. **(05)**

**5A.** In an inclined tube manometer the manometer liquid is water at 20°C while the fluid whose pressure is to be measured is air. The angle of the inclined tube is 20°. The well is a cylinder of diameter 0.05 m while the tube has a diameter of 0.001 m. The manometer reading is given to be 150 mm. Determine the pressure differential in mm of Water and Pascal. What is the error in % if the density of air is neglected?
Determine the error in the measured pressure differential if the reading of the manometer is within 0.5 mm and the density of water has an error of 0.2 %. Assume that all other parameters have no errors in them. Neglect air density in this part of the question. **(05)**

**5B.** The resistance of certain length of wire $R = \frac{4\rho l}{\pi d^2}$
Where, '$\rho$' is the resistivity of the wire (Ωcm), '$l$ ' the length of the wire (cm), '$d$ ' the diameter of the wire (cm). Determine the nominal resistance and the uncertainty in resistance of the wire with the following data:
$l = 523.8 \pm 0.2$ cm,
$\rho = 45.6 \times 10^{-6} \pm 0.15 \times 10^{-16}$ Ωcm,
$d = 0.062 \pm 1.2 \times 10^{-3}$ cm.
Recalculate the uncertainty by considering this problem as a complicated one. **(05)**