Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

I SEMESTER M.TECH (TSES) END SEMESTER MAKE UP EXAMINATIONS,

DECEMBER 2017

SUBJECT: MEASUREMENTS IN THERMAL ENGINEERING [MME 5144]

REVISED CREDIT SYSTEM

Time: 3 Hours

MAX. MARKS: 50

Instructions to Candidates:

- ✤ Answer ALL the questions.
- Missing data may be suitably assumed.
- Sketch and explain the set up to calibrate low gas flow meter and liquid flow meter.
- **1B.** The friction factor Reynolds number product fRe for laminar flow in a rectangular duct is a function of the aspect ratio A = h/w, where *h* is the height and *w* is the width of the rectangle. The following table gives the available data. Make a suitable fit to data. Justify the method used and calculate the standard error.

Α	0	0.05	0.1	0.125	0.167	0.25	0.4	0.5	0.75	1
fRe	96	89.91	84.68	82.34	78.81	72.93	65.47	62.19	57.87	56.91

- **2A.** Write operational transfer function for first order instrument. Derive an expression for different parameters involved in it taking appropriate example.
- **2B.** A mercury-in-glass thermometer employs a Bourdon pressure gauge which has a range of 0 6 MPa for the pointer rotation from 0 270°. In the temperature calibration process, the pointer movement was set to 0° rotation at 0°C and the instrument indicated 250° rotation to 200°C. Determine:
 - (a) The sensitivity of the instrument in rad/°C
 - (b) The error due to ambient temperature rise of 16°C if the thermometer bulb has 8 times that of combined volume of capillary and the bourdon tube, and
 - (c) The error in the observed temperature values if the bulb is raised by 600 mm from calibration elevation.
- **3A.** 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.
- **3B.** A thermistor has a resistance $\text{Ro} = 80000\Omega$ when To = 273.15 K. The resistance of the thermistor has been measured accurately at 3 other temperature as given in the next page:

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T (K)	323.15	373.15	423.15
R (Ω)	10980	2575	858

Using the above data estimate β for this thermistor. Use this β to estimate the resistance of the thermistor at 10°C and 110°C. Compare also the data with the values calculated using the β determined above.

- **4A.** With proper diagram explain the five laws of thermoelectric circuits.
- 4B. A rotameter is to be used to measure air flow at 7 bar and 21°C. The maximum flow rate of 0.0005 kg/s, the inlet diameter of meter is 8 mm and the length of the meter is limited to 100 mm. The bob is constructed such that it has a frontal diameter of 8 mm and a volume of 2.5 ml. Determine the taper Cd = 0.80, $\rho_b = 50 \text{ kg/m}^3$. of the tube.

The discharge coefficient C of an orifice is given by $C = \frac{W}{t \rho A \sqrt{2gh}}$ 5A. Calculate the value of C with its uncertainty for the following data. $d = (15 \pm 0.02) \text{ mm}$ $W = (400 \pm 0.2) \text{ kg}$ $t = (500 \pm 2) s$ $g = (9.81 \pm 0.1\%) \text{ m/s}^2 \rho = (10^3 \pm 0.1\%) \text{ kg/m}^3$ $h = (4 \pm 0.05) m$

5B. A pitot static tube is used to measure the velocity of an aircraft. The air temperature and pressure are 5° 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.

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