Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

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

NOVEMBER 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.

1A. Derive an expression for meter constant of variable area orificemeter. **05**

1B. 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

2A. Write operational transfer function for second order instrument. Derive an expression for different parameters involved in it taking appropriate example. **05**

2B. 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 Pascals. 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**

3A. Explain with a neat sketch the working of pressure measuring system which is based on Boyle's law. Also derive an expression to measure unknown pressure. **05**

3B. It has been decided to use bimetallic thermostat for process heat control. The heating and cooling limit of the process chamber is 150º C and 10º C respectively. A single thermostat is expected to monitor the temperature variation. Find the maximum distance between two switch legs, which are located on either side of the thermostat. Sketch the arrangement. The specification is given in the next page:

Thermal coefficient of aluminium:	24×10^{-6} $^oC^{-1}$
Thermal coefficient of invar:	1.7×10^{-6} $^oC^{-1}$
Bonding temperature:	30º C
Thickness of aluminium strip:	0.30 mm
Thickness of invar strip:	0.50 mm
Length of the strip:	100 mm
Young's modulus of aluminium:	69 GPa
Young's modulus of invar:	147 GPa

05

4A. With neat sketch explain:

(a) Unchopped broad band radiation thermometer

(b) Chopped broad band radiation thermometer **05**

4B. 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**

5A. A rectangular steel rod of width '*b*' and depth 'd ' is supported at its ends and loaded at its centre by load '*W* '. If the length of the rod between the supports is '*l* ' and 'y_c' is the deflection at the centre then, $y_c = \frac{Wl^3}{4Ebd^3}$

Where, '*E*' is the modulus of elasticity.

Measurements give:

b = 4.942±0.04 cm *d* = 5.250±0.025 cm *l* = 1.000 m±0.50 cm

W = 15000 N (exact) y_c = 2.622±0.25 % of y_c in mm

(a) Determine the nominal value of *E*.

(b) Determine the % uncertainties in the measured quantities.

(c) Compute the % uncertainty in the *E*. **05**

5B. A pitot static tube is used to measure the velocity of aircraft. The pressure and temperature at that altitude is 0.5 bar and 5°C. The mercury based manometer reading is 1784 mm. Find the precise velocity of aircraft by considering subsonic/supersonic flow condition. **05**