Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

I SEMESTER M.TECH (ADVANCED THERMAL POWER & ENERGY SYSTEMS)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: EXPERIMENTAL METHODS IN THERMAL ENGINEERING [MME 551]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ANY FIVE FULL** the questions.
- Missing data may be suitable assumed.

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

1B. In a process industry, to regulate the temperature of fluid, bimetallic thermostat is used. The circuit is completed and hence the cut off takes place when the strip touches the contact point. The gap maintained was based on subtended angle of 11°. The old strip was constituted of yellow brass and invar bonded together at 30°C. The thickness of each strip was 0.30 mm and length 60 mm. During the annual maintenance, by mistake a different strip of same thickness, same length and bonding temperature but made of nickel and invar is fitted. What is the difference in regulated temperature because of this mismatch?

Substance	Expansion Coeff. ($^oC^{-1}$)	Young's modulus (GPa)
Yellow brass	20.2×10^{-6}	96.5
Invar	1.7×10^{-6}	147
Nickel	13.6×10^{-6}	214

(05)

2A. With proper diagram explain the five laws of thermoelectric circuits. **(05)**

2B. A pitot static tube is used to measure the velocity of an aircraft. If the air temperature and pressure are 5°C and 90 kPa, 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. Take Cp = 1.05 kJ/kgK and Cv = 0.765 kJ/kgK. **(05)**

3A. By referring the liquid column balancing method, explain the Boyle's law based instrument to measure vacuum pressure and derive an expression to measure the same with neat sketch. **(05)**

3B. The thermistor response is shown below. Obtain the proper curve fit to get the best index of correlation. Here, 't' is in ^oC and 'R' is in $k\Omega$.

t	0	11.9	28.7	42.0	62.7	83.1	100.0
R	8.80	7.01	5.02	3.54	2.00	1.14	0.67

(05)

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

4B. Horizontal pipe line pressure difference is to be measured using a micromanometer with two enlarged ends (double well type). The diameter of connecting pipe between pressure tappings and wells (diameter, D) is same as limb diameter (d). Lower portion of left and right well is connected by limb. Approximately half of the limb height is filled with Mercury. As a top up fluid, Carbon tetrachloride is filled till the 50 % of well height. If the flowing fluid is water, with sketch derive an expression for finding pressure difference. Modify the equation if D>>>d.

If pressure difference is 100 kN/m^2, A/a = 60, S_{hg} = 13.6 and S_{ccl4} = 1.594, find the difference in mercury level in the limb. **(05)**

5A. With neat sketch, derive an expression for velocity of flow when time of flight Velocimeter is used in case of short length and long length flow line. **(05)**

5B. 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 flow is measured independently and 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 meter. Take Cd = 0.98 and γ = 1.37. **(05)**

6A. 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)**

6B. The discharge coefficient 'C' of an Orifice is given by $C = W/t\rho A\sqrt{2gh}$

Calculate the value of 'C' with its uncertainty for the following data.

W = (400±0.2) kg t = (500±2) s ρ = (10^3±0.1 %) kg/m^3

d = (15±0.02) mm g = (9.81±0.1 %) m/s^2 h = (4±0.05) m **(05)**