Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

I SEMESTER M.TECH (TSES) END SEMESTER EXAMINATIONS, NOVEMBER 2018

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. Obtain the expression for the velocity of flow measured by using time of the flight velocimeter, when the transmitter/receiver is inclined 45º to the pipe axis. **4**

1B. With a neat diagram explain the calibration of a gas flow meter by using soap-film burette. **3**

1C. With a neat diagram explain the working of laminar flow element. Where it is used? **3**

2A. Flow of dry air through a pipe is measured by using an orifice plate with β = 0.5. The upstream pressure and temperature are respectively 2 bar and 300 K. The mean velocity of the flow has been measured independently in the pipe and is known to be 35 m/s. The pipe diameter is 0.06 m. Determine the head developed by the orifice plate. Take c_d = 0.585. Is it necessary to take into account expansion factor? **5**

2B. Sketch any two elastic deformation techniques used for pressure measurement. **2**

2C. With a neat diagram explain the construction of Prandtl type micro-manometer. **3**

3A. In an inclined tube sensitive manometer, working fluid 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 120 mm. Determine the differential pressure in mm of water and in Pascals. What is the %age error in pressure, if the density of air is neglected? **3**

3B. Why the electrical resistance of a resistance thermometer increases with increase in temperature, whereas the electrical resistance of a thermistor decreases exponentially with temperature? Explain the physics behind it. **2**

3C. With a neat diagram explain the working of gas thermometer. **3**

3D. Metallic strips of yellow brass ($\alpha = 20.2\times10^{-6}\ ^{\circ}\text{C}^{-1}$ & $E = 96.5$ GPa) and ivar ($\alpha = 1.7\times10^{-6}\ ^{\circ}\text{C}^{-1}$ & $E = 147$ GPa) are bonded at 25°C. Each strip is 0.2 mm thick. The length of the bi-metallic strip is 100 mm. If it is used in the cantilever arrangement, Calculate the deflection sensitivity (deflection per degree centigrade temperature difference). **2**

4A. What is Seebeck effect? State the law of intermediate temperatures for thermocouples. **2**

4B. A thermocouple is calibrated to indicate temperature accurately. Its time constant is to be determined experimentally. The thermocouple initially at 30°C is suddenly dipped into an oil bath at constant temperature of 120°C. The following data is recorded by using a data logger.

Time (s)	0	1	2	3	4	5	6	7	8	9	10
Temperature T (°C)	30	54	72	84	94	101	106	110	113	115	116

Obtain the time constant of the thermocouple by using regression analysis. **4**

4C. A pressure transducer has an un-damped natural frequency of 30 rad/s, damping ratio of 0.1 and static sensitivity $K = 1\mu$V/Pa. Plot the response of the transducer to step function input of 800 kPa. **4**

5A. What is cold junction compensation? How it is done? **2**

5B. Explain the following terms with respect to a measuring instrument; a) Accuracy, b) Precision. **2**

5C. What are the different types of dynamic inputs to a measuring instrument? **2**

5D. The pressure drop in a circular cross-section pipe of diameter D meters, length L meters, carrying Q m^3/s of fluid of viscosity μ Pa.s is given by the well-known Hagen-Poiseuille equation as follows;

$$\Delta p = \frac{128 \mu L Q}{\pi D^4}$$

If μ, Q, L, D are measured with an uncertainty of ±1%, how accurate are the pressure drop and pumping power calculations? **4**