Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

V SEMESTER B.TECH (MECHANICAL/IP ENGG.) END SEMESTER EXAMINATIONS, NOVEMBER 2018

SUBJECT: METROLOGY & MEASUREMENTS [MME 3104]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** the questions.
- Missing data may be suitably assumed.
- Draw neat sketches wherever required.

1A. A diaphragm type of pressure transducer gives a central deflection of 0.2 mm when a pressure of 1.2×10^6 N/m^2 is applied. An electromechanical device, namely, LVDT converts the input displacement of pressure transducer in to voltage and has a sensitivity of 60 V/mm. Indicate the functional elements of the pressure measuring instrument in the form of block diagram and determine the unknown pressure when the output voltage of 2.5 V is observed on the meter. **03**

1B. Differentiate between the terms Accuracy and Precision with suitable example. **02**

1C. Four strain gauges are placed in Poisson`s configuration on a steel bar of 40 mm diameter for a load cell. The load cell is subjected to a load of 500 N. Each strain gauge has a resistance of 120 Ω, and a gauge factor of 2.1. The bridge is excited with 6 V DC.
(i) Show the strain gauge load cell with Wheatstone bridge arrangement.
(ii) Calculate the bridge sensitivity in terms of μV/N. Assume for steel Young`s modulus of elasticity is 200 GN/m$^2$, and Poisson`s ratio is 0.3. **03**

1D. (i) A transducer measures a range of 0-200 N force with a resolution of 0.15% of full scale. What is the smallest change which can be measured by this transducer?
(ii) The calibration range of a certain pyrometer is 300^{0}C to 800^{0}C. If the dead zone in it is 0.11% of span, determine the temperature change which might occur before it is detected. **02**

2A. With a neat sketch show the Bridgman gauge, using a manganin element is to measure a maximum pressure of 10^8 Pa. The wire diameter is 25 μm, length 3 cm. Pressure sensitivity of wire material is 2.5×10^{-11} Ω/Ω-Pa, resistivity 45×10^{-6} Ω-cm. The wire forms one arm of a Wheatstone bridge, with resistance of all arms being equal. If the supply voltage is 12 V, find the output voltage due to maximum pressure. **02**

2B. For a metallic resistance strain gauge prove that the gauge factor should be a function of Poisson's ratio alone. **03**

2C. A strain gauge with gauge factor 2.0 has been applied a tensile strain of 0.00095. The value of the gauge resistance & each of the other three resistances comprising the limbs of a Wheatstone bridge circuit is 100 Ω initial. Calculate the following:

(i) Change in the value of variable resistance R_4 to re-balance the balanced bridge.
(ii) Output voltage of a voltage sensitive bridge if the voltmeter resistance is very high & the input voltage is 6V. **02½**

2D A hollow steel cylinder is used as a torque sensing element with inner radius 2.5 cm, outer radius 3.3 cm and length 15 cm. Calculate the angular deflection for an applied torque of 30 N-m. Also find the strain indicated by a resistance gauge bonded at 45^0 to the axis. The shear modulus of steel is 80 GN/m^2. **02½**

3A. Explain the working principle of hydraulic absorption dynamometer to measure power. **02**

3B. Explain the working of metallic resistance thermometer with neat sketch and derive the equation to measure the source temperature. **03**

3C. A fit is designated as 25 H8/e8. The tolerance value for a nominal diameter of 25 mm in IT8 is 33 microns and fundamental deviation for the shaft is -40 microns (negative). Find the maximum clearance of the fit. **02**

3D Maximum metal limit for the shaft is 100.026 mm. Maximum metal limit for the hole is 100.000 mm. Minimum metal limit for the hole is 100.036 mm. Minimum metal limit for the shaft is 100.003 mm. Sketch the type of fit (i) if hole and shaft are made to maximum metal limits. (ii) if hole and shaft are made to minimum metal limits. **03**

4A. Design the Go and No Go ring gauge for inspecting 30 h6 shaft. Use the following data: Diameter 30 lies in the diameter step of 18 – 30 mm. Fundamental tolerance unit in µm, $i = 0.45\sqrt[3]{D} + 0.001\,D$, where D is geometric mean of the diameter steps in mm. Tolerance value for IT6 = 10i. Also show the disposition of tolerances and allowances on gauge. **04**

4B. A clearance fit has to be provided for a shaft and bearing assembly having a diameter of 40 mm. Tolerances on hole and shaft are 0.006 mm and 0.004 mm, respectively. The tolerances are disposed unilaterally. If an allowance of 0.002 mm is provided, find the limits of size for hole and shaft when (a) hole basis system (b) shaft basis system are used. Also show the disposition of tolerances. **03½**

4C What is wringing? Explain the procedure for wringing of slip gauges with neat sketch. **02½**

5A. (i) Explain with neat sketch the use of an optical square to test the squareness of machine slide ways.
(ii) Explain with the help of a plot how straightness of a machine guide way is assessed using an autocollimator. **04**

5B. Derive an expression for distance over wires in case of metric thread using three wire method of measuring effective diameter of the screw thread. **03**

5C Explain the following method of quantifying surface roughness: (i) R_z Value (ii) RMS Value (iii) R_a Value. **03**