Exam Date & Time: 20-Dec-2019 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING
III SEMESTER B.TECH. (I & P E) MAKE-UP EXAMINATION DEC 2019
METROLOGY AND MEASUREMENTS [MME 2158]

Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

Instructions to Candidates: Answer ALL questions Missing data may be suitably assumed

1) Write a note on elastic pressure elements with sketch. (5)

A)

B) Explain the different types of errors in measurement. (3)

C) Two pressure gauges (pressure gauge A and B) have a full scale accuracy of ±5%. Sensor A has a range of 0-1 bar and Sensor B 0-10 bar. Which gauge is more suitable to be used if the reading is 0.9 bar? (2)

2) A) A mild shaft is used to connect a motor drive to a constant load torque. To measure this torque, a resistance strain gauge with resistance of 120 Ω and a gauge factor of 2, is mounted on a shaft with its active axis at 45^0 to the shaft axis. Shear modulus of mild steel is 8×10^{10} N/m^2. Shaft diameter is 3 cm and the change in gauge resistance due to load is 0.2 Ω. Find the load torque. (5)

B) What is temperature compensation? With a neat sketch show the temperature compensation by using (i) dummy gauge & (ii) Poisson's gauge. (3)

C) The element of a resistance thermometer is constructed of a 50 cm length and of 0.03 mm diameter nickel wire. The resistivity of nickel wire is 7.8 μΩ-cm. By assuming temperature coefficient of resistance (0.0068^oC^{-1}) is constant over the common range of ambient temperatures, what will be the change in resistance of the element per degree centigrade? (2)

3) A) A load cell is formed of a hollow steel cylinder loaded axially. The four strain gauges with gauge resistance = 1000 Ω and gauge factor = 2 are so bonded as to enhance the signal and compensate for temperature variation. The load cell has a cross-sectional area of 2 cm^2. Young's modulus of steel is 2.07 x 10^{11} N/m^2 and Poisson's ratio 0.3. The current in strain gauge is limited to 20 mA. Calculate (i) the bridge supply voltage and (ii) current in the detector arm if this consists of a micro ammeter of resistance 500 Ω, when the load cell is subjected to a force of 10^5 N. (5)

B) Derive an expression for effective diameter of a Whitworth screw thread by two-wire method, which depends on the diameter of the wires, dimension over the wires, the pitch and angle of the screw thread. (3)

C) Explain with a neat sketch the working of a pressure thermometer. (2)

4) Design the general type of GO and NO GO gauges for a 14 mm shaft and hole pair designated as 14 D7/g8, given that

A) (a) $i = 0.453 (D)^{1/3} + 0.001D$

(b) 14 mm lies in the diameter range of 10–18 mm

(c) IT7 = 16i

(d) IT8 = 25i

(e) FD of shaft = $2.5D^{0.34}$

(f) FD of hole = $16D^{0.44}$

(g) wear allowance assumed to be 10% of gauge tolerance. (5)

B) Explain the phenomenon involved in `wringing` of slip gauges. (3)

C) Differentiate between bilateral and unilateral tolerance. (2)

5) A) An autocollimator and reflecting block were used to measure the departure from straightness of a rectangular-section straight edge 1 m long, which was supported at the points for minimum deflection. The center distance of the feet of the block was 120 mm and the auto-collimator readings (in minutes) were: 0.1, 0.2, 0.4, -0.3, -0.5, 0.2, 0.1, 0.6, -0.3, 0.2. Determine the total straightness error. (5)

B) Derive the expression for the best-size wire in a two-wire method. Calculate the diameter of the best-wire for an M 20 x 25 screw. (3)

C) In the measurement of surface roughness, height of 20 successive peaks and valleys were measured from a datum as follows: 35, 25, 40, 22, 35, 18, 42, 25, 35, 22, 36, 18, 42, 22, 32, 21, 37, 18, 35, 20 microns. If these measurements were obtained over a length of 20 mm, calculate the CLA and RMS values of the surface. (2)

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