Reg. No.										

Manipal Institute of Technology, Manipal

(A Constituent Institute of Manipal University)

V SEMESTER B.TECH (MECHANICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOV/DEC 2015

SUBJECT: METROLOGY AND INSTRUMENTATION [MME 309]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Design a plug and ring gauge for inspecting the shaft and hole pair size ϕ $50E_7/h_8$ (step size of 30-50 mm).The fundamental deviation for the e shaft is $-11D^{0.41}$. Show the dimensions schematically. Take IT7= 25microns and IT8 = 39 microns **[3]**

1B. List the slip gauges to be wrung together to produce an overall dimension of 62.536 mm using two protection slips of 2.5mm size.(Use M112 Slip gauge set). Also show schematically the sequence of wrung slip gauges **[2]**

1C. Derive the expression for the unknown pressure to be measured by a bulk modulus gauge with a neat sketch. A bulk modulus gauge, using a manganin element is to measure a maximum pressure of 10^8 Pa. The wire diameter is 23 μm, length is 3.3 cm. Pressure sensitivity of wire material is $2.45 \times 10^{-11}\Omega/\Omega$-Pa, resistivity $43 \times 10^{-6}\Omega$-cm. The wire forms one arm of a Wheatstone bridge, with resistance of all arms being equal. If the supply voltage is 12V, find the output voltage due to maximum pressure **[5]**

2A. Write short notes on Systematic/Cumulative errors encountered in the process of measurement. Also state how to eliminate it. **[3]**

2B. With necessary sketches explain the procedure for flatness measurement of a surface table using an autocollimator. **[4]**

2C. A hollow steel cylinder is used as a torque sensing element with r_i = 2.3 cm, r_o = 3.5 cm and L = 25 cm. Calculate the angular deflection for an applied torque of 40 N-m. Also find the strain indicated by a resistance gauge bonded at 45^0 to the axis. Elastic modulus of mild steel is 200GPa and Poisson's ratio is 0.3. **[3]**

3A. With the help of a neat sketch explain the working of Hydraulic load cell and state its advantages, disadvantages and applications. **[4]**

3B. With neat sketch explain the working of Taylor- Hobson "Talysurf". Also show the schematic layout of the circuit. **[4]**

3C. State the two laws of Thermo-Electricity. **[2]**

4A. A measuring machine bed was tested for straightness using an autocollimator and reflector and the following readings in minutes were obtained corresponding to various points a, b, c… etc. One minute of arc increase in angle observed corresponds to a rise of 18μm of the front of the reflector relative to the rear. Determine the straightness error and represent the line graphically (Error Vs position graph). **[5]**

Position	A	A-B	B-C	C-D	D-E	E-F	F-G	G-H	H-I	I-J	J-K
Angle reading θ in minutes		20.68	21.08	21.11	20.75	20.81	20.65	20.72	20.68	20.83	20.85

4B. With neat sketch of Pressure thermometer draw the generalized block diagram to show its functional elements in different stages. Also explain the function of these functional elements. **[5]**

5A. Design and make a drawing of general purpose 'GO' and 'NO-GO' plug gauge for inspecting a hole of Ø22 D_8 (step size of 18 – 30 mm). Fundamental deviation for hole D = $16D^{0.44}$. and IT8 = $32.6\mu m$ **[4]**

5B. In a Wheatstone bridge arm 1 is the active strain gauge made up of Advance alloy of 120Ω. Arm 2 is dummy gauge for temperature compensation. Arm 3 and 4 are of fixed 120 Ω resistors. Excitation voltage for the Wheatstone bridge is 7.2 V. **[4]**

(a) If the active gauge with a gauge factor 2 is bonded to steel member, what is the bridge output voltage for a 35 micro-strain?

(b) Compute the value of the shunt calibrating resistor that would give equivalent strain as 35 micro-strains.

5C. Explain the terms: (i) Primary texture (ii) Secondary texture **[2]**

6A. Calculate the effective diameter if (i) Micrometer reading over standard cylinder with two wires of diameter is15.45 mm (ii) Micrometer reading over the gauge with two wires of diameter is15.22 mm and pitch of the thread is 2.5 mm (iii) Wire of 2 mm diameter and standard cylinder is18 mm. **[2]**

6B. Explain with neat sketch the squareness measurement of a block using indicator method. **[3]**

6C. A rectangular rosette is mounted on a steel plate having a modulus of elasticity E=200GPa and Poisson's ratio υ=0.3. The three strains measured are ε_1= 500 microns, ε_2= 200 microns and ε_3= –200 microns. Calculate the principal strains and stresses, the maximum shear stress and the orientation angle for the principal axis of the stress. **[5]**