USN | | | | | | | | | | |

10ME/IP/IM/MA/AU/PM/TL/AE34

Third Semester B.E. Degree Examination, December 2011
Mechanics of Materials

Time: 3 hrs. Max. Marks:100

Note: ***1. Answer any FIVE full questions, selecting at least TWO questions from each part.***
2. Missing data, if any, may be assumed suitably.

PART – A

1 a. State the Hooke's law. Neatly draw the stress-strain diagram for steel indicating all salient points and zones on it. **(05 Marks)**

b. A compound bar consisting of Bronze, Aluminium and Steel segments is loaded axially as shown in Fig.Q1(b). Determine the maximum allowable value of 'P', if the change in length of the bar is not to exceed 2mm and the working stresses in each material of the bar, indicated in table below is not to be exceeded. **(15 Marks)**

Material	Area $A(mm^2)$	Elastic modulus E(MPa)	Working stress σ_w (MPa)
Bronze	450	0.83×10^5	120
Aluminium	600	0.70×10^5	80
Steel	300	2×10^5	140

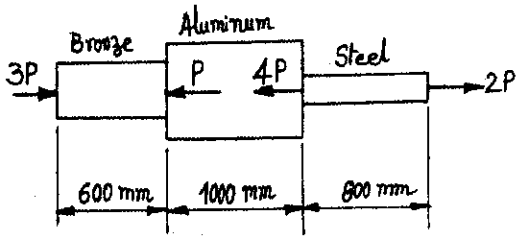

Fig.Q1(b)

2 a. With standard notations, derive an expression to relate the Modulus of Elasticity E, Bulk Modulus K and the Poisson's ratio μ. **(05 Marks)**

b. When a bar of 25mm diameter is subjected to a pull of 61 kN, the extension on a 50mm gauge length is 0.1mm and decrease in diameter is 0.013mm. Calculate the value of elastic constants E, G, K and μ. **(08 Marks)**

c. The bronze bar 3m long with $320mm^2$ cross sectional area is placed between two rigid walls. At –20°C there is a gap Δ = 2.5mm as shown in Fig.Q2(c). Find the magnitude and the type of stress induced in the bar when it is heated to a temperature 50.6°C. For bronze bar, take $\alpha_B = 18.0\times10^{-6}$/°C and E = 80 GPa. **(07 Marks)**

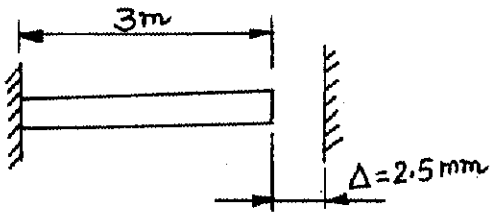

Fig.Q2(c)

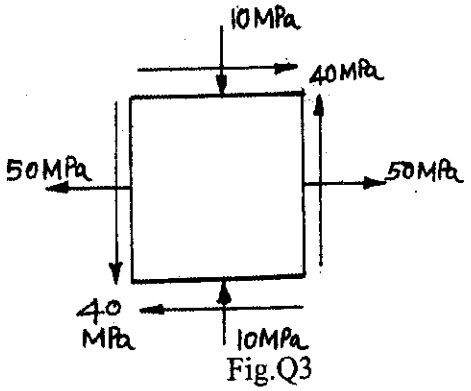

Fig.Q3

3 For the state of stress shown in Fig.Q3, determine:
i) The principal stresses and principal planes.
ii) Maximum inplane shear stress and plane on which it is acting. Also find the normal stress on the maximum shear plane.
iii) Sketch the element aligned with planes of principal stresses and planes of maximum shear.
Also draw the Mohr's circle for the above stress state. **(20 Marks)**

4 a. Define the work and strain energy. **(02 Marks)**

b. A rectangular copper bar 50mm×75mm in cross-section is subjected to an axial energy input of 200 Nm. Determine the minimum length of bar to limit the axial stress in the bar to 80MPa. The modulus of elasticity of bar is 1.15×10^5 N/mm^2. **(06 Marks)**

c. A thin cylinder of 75mm internal diameter and 250mm long has 2.5mm thick walls. The cylinder is subjected to an internal pressure of 7 MN/m^2. Determine the change in internal diameter and change in the length of the cylinder. Also, compute the Hoop stress and Longitudinal stress in the cylinder. Take E = 2×10^5N/mm^2 and $\mu = 0.3$. **(12 Marks)**

PART – B

5 a. Derive an expression to establish a relationship between the intensity of load ω, shear force F and bending moment M in the beam. **(06 Marks)**

b. A beam 25m long is supported at A and B and is loaded as shown in Fig.Q5(b). Draw the shear force and bending moment diagrams for the beam computing shear force and bending moments at A, E, D, B and C. Find the position and magnitude of the maximum bending moment. Also, determine the point of contraflexure. **(14 Marks)**

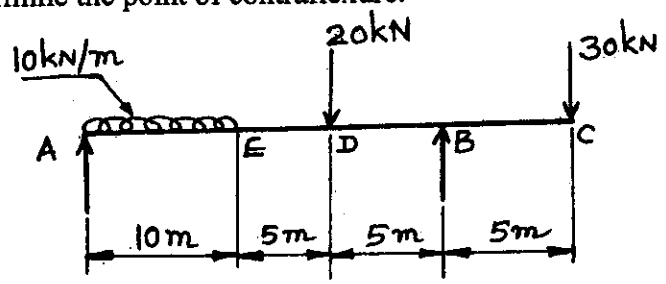

Fig.Q5(b)

6 a. State the assumptions made in the simple bending theory. **(05 Marks)**

b. A uniform I-section beam is 100mm wide and 150mm deep with a flange thickness of 25mm and web thickness of 12mm. The beam is simply supported over a span of 5m. It carries a uniformly distributed load of intensity 83.4 kN/m throughout its length. Determine the bending stress in the beam and plot the stress distribution across its cross-section. **(15 Marks)**

7 a. Using the standard notations, derive an expression for deflection, slope and maximum deflection of a simply supported beam of span 'L' subjected to a concentrated load W at its mid span. **(10 Marks)**

b. A simply supported beam of span 20m carries two concentrated load 4 kN at 8m and 10 kN at 12m from the left end support. Calculate
i) the deflection under each load, and ii) the maximum deflection.
Take E = 2×10^5 N/mm^2 and I = 10^9 mm^4. **(10 Marks)**

8 a. A hallow steel shaft transmits 200 kW of power at 150 rpm. The total angle of twist in a length of 5m of shaft is 3°. Find the inner and outer diameters of the shaft if the permissible shear stress is 60 MPa. Take G = 80 GPa. **(10 Marks)**

b. A circular compression member is of 25mm diameter and 950mm long. Calculate the maximum buckling load. What will be the value of allowable load if a factor of safety of 3 is expected? Take for material of the column, σ_y = 441 MPa, E = 2.07×10^5 N/mm^2. **(10 Marks)**

* * * * *