MECHANICS OF DEFORMABLE BODIES
(MEC2201)

Time Allotted : 2½ hrs **Full Marks : 60**

Figures out of the right margin indicate full marks.

Candidates are required to answer Group A and any 4 (four) from Group B to E, taking one from each group.

Candidates are required to give answer in their own words as far as practicable.

Group – A

1. Answer any twelve: **12 × 1 = 12**

Choose the correct alternative for the following

(i) True stress represents the ratio of
(a) average load and average area
(b) average load and maximum area
(c) maximum load and maximum area
(d) instantaneous load and instantaneous area.

(ii) The stress at which elongation of a material is quite large as compared to the increase in load is known as
(a) ultimate point
(b) yield point
(c) elastic point
(d) rupture point

(iii) Temperature stress is a function of
(a) modulus of elasticity
(b) coefficient of linear expansion
(c) change in temperature
(d) all of these

(iv) The angle between planes of principal stresses and principal strains is
(a) zero
(b) 45°
(c) 90°
(d) 135°

(v) In a rectangular strain rosette, the strain gauges are set at
(a) 45°
(b) 60°
(c) 75°
(d) 90°

(vi) The point of contraflexure lies where
(a) shear force changes sign
(b) bending moment is zero or changes sign
(c) shear force is zero
(d) bending moment is maximum

(vii) At the point of application of a point load on a beam there is
(a) maximum bending moment
(b) sudden change of shape of bending moment diagram
(c) maximum deflection
(d) point of contraflexure

(viii) Maximum torque T that can be transmitted by a solid shaft of diameter D, when subjected to a shear stress τ is equal to:
(a) $(\pi/16)\ \tau D^2$
(b) $(\pi/16)\ \tau D^3$
(c) $(\pi/32)\ \tau D^2$
(d) $(\pi/32)\ \tau D^3$

(ix) Polar modulus of a shaft is equal to
(a) product of polar moment of inertia and maximum radius of the shaft
(b) ratio of polar moment of inertia to maximum radius of the shaft
(c) sum of polar moment of inertia and maximum radius of the shaft
(d) difference of polar moment of inertia and maximum radius of the shaft.

(x) The buckling load for a given material depends upon
(a) Poisson's ratio and slenderness ratio
(b) Poisson's ratio and modulus of elasticity
(c) Slenderness ratio and cross-sectional area
(d) Slenderness ratio and modulus of elasticity.

Fill in the blanks with the correct word

(xi) For a material to be incompressible, it's _____ must be infinite.

(xii) A strain rosette consists of at least _____ strain gauges.

(xiii) Under uniaxial loading, the maximum shear stress is _____ times the uniaxial stress.

(xiv) Ratio of maximum shear stress to average shear stress in beams is 4/3 in a _____ section.

(xv) Ratio of diameters of two shafts joined in series is 2. If the two shafts have the same material and the same length, the ratio of their angle of twist is _____.

Group - B

2. (a) Explain the terms: Young's modulus and modulus of rigidity. *[(CO1)(Remember/LOCQ)]*

(b) A round steel rod supported in a recess is surrounded by a co-axial brass tube as shown in Fig 1. The level of the upper end of the rod is 0.08 mm below that of the tube. Determine (i) the magnitude of the maximum permissible axial load which can be applied to a rigid plate resting on the top of the tube, the permissible values of the compressive stresses are 105 MPa for steel and 75 MPa for brass. (ii) the amount by which the tube is shortened by a load if the compressive stresses in the steel and the brass are the same.

Take E_s = 210 GPa and E_b = 105 GPa

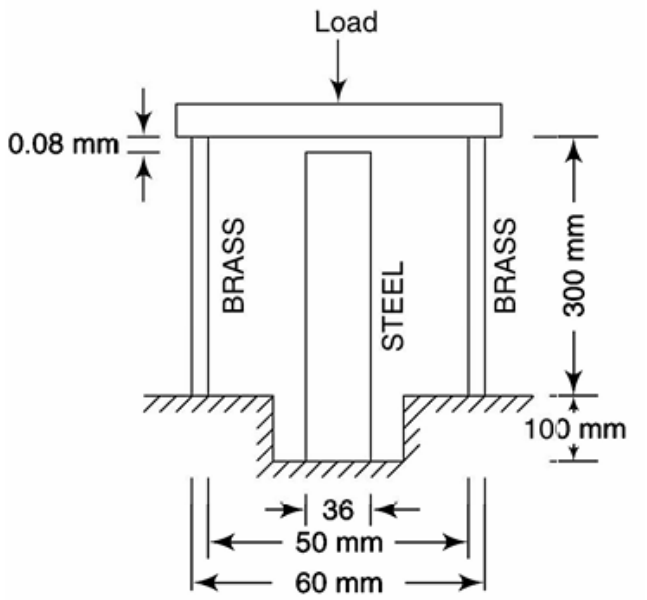

Fig. 1

[(CO2)(Apply/IOCQ)]

4 + 8 = 12

3. (a) A solid uniform metal bar of diameter D and length l is hanging vertically from its upper end. Obtain the total elongation of the bar due to its own weight if γ is the specific weight and E is the Young's Modulus of the material of the bar

[(CO1)(Apply/IOCQ)]

(b) The bar has a cross-sectional area of 325 mm^2 and is made of a material that has a stress–strain diagram that can be approximated by the two-line segments shown in fig 2. Determine the elongation of the bar due to the applied loading.

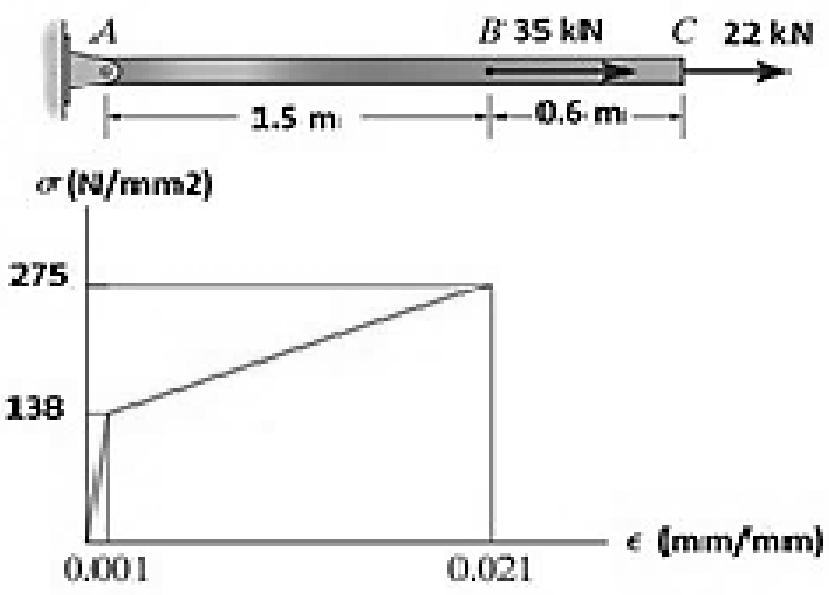

Fig. 2

[(CO2)(Apply/IOCQ)]

5 + 7 = 12

Group - C

4. For the given state of stress shown in Fig. 3, determine (i) principal planes (ii) principal stresses (iii) orientation of planes of maximum in-plane shearing stress (iv) corresponding normal stress. (solve it using method of equilibrium)

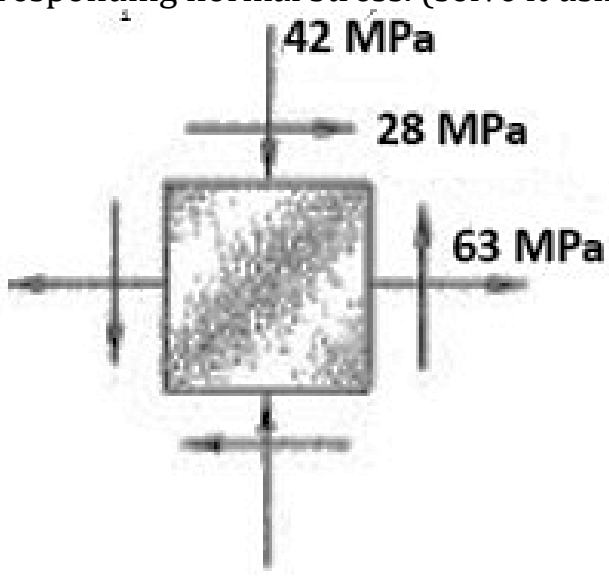

Fig. 3

[(CO4)(Analyse/HOCQ)]

(3 + 3 + 3 + 3) = 12

5. (a) What do you mean by point of *inflection* or *contraflexture* ? *[(CO3)(Remember/LOCQ)]*

(b) For the beam and loading shown in Fig. 4, (i) draw the shear force and bending moment diagrams, (ii) determine the maximum normal stress due to bending on a transverse section at C.

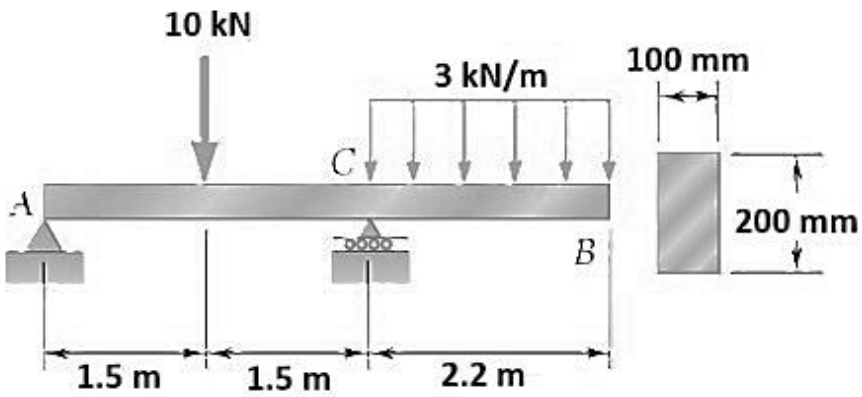

Fig. 4

[(CO3)(Analyse/HOCQ)]

3 + 9 = 12

Group - D

6. Determine the slope and deflection at D for the beam loading shown in Fig. 5. Take flexural rigidity of the beam EI = 100 MN-m^2.

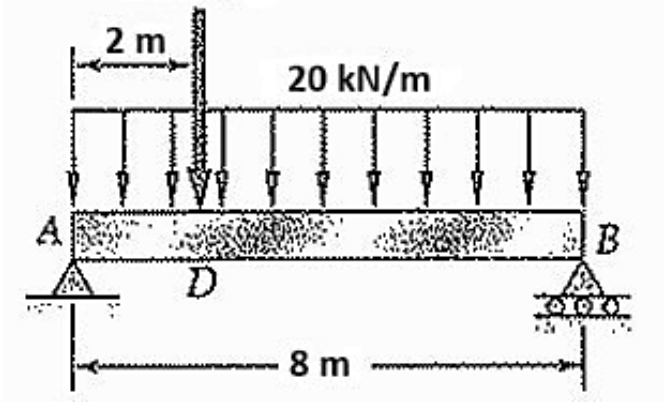

Fig.5

[(CO5)(Apply/IOCQ)]

(6 + 6) = 12

7. Determine the reactions at the supports for the prismatic beam and loading shown in Fig. 6.

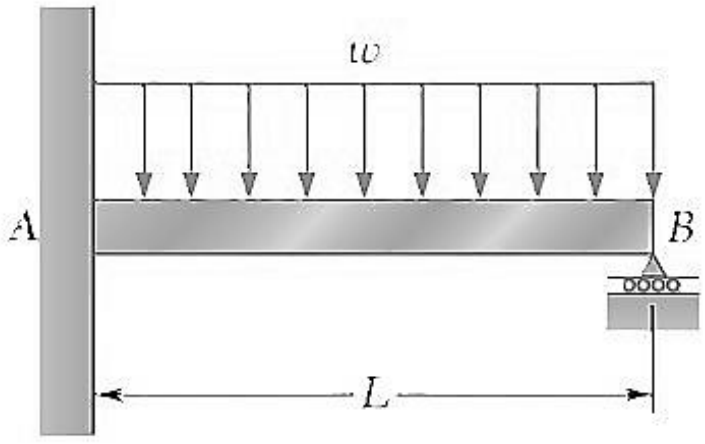

Fig. 6

[(CO5)(Analyse/HOCQ)]

12

Group - E

8. (a) A vertical compound shaft is made by securely fixing a 500-mm long brass bar to a 500-mm long aluminium bar so that the total length of the shaft is 1 m as shown in Fig. 7. The diameter of each bar is 40 mm. The aluminium bar is rigidly fixed at its upper end. Determine the maximum torque which can be applied at the lower end of the shaft if the maximum angle of twist is not to exceed 3° and the maximum shear stress in aluminium and in the brass 78 MPa and 55 MPa respectively. G_b = 34 GPa and G_a= 28 GPa.

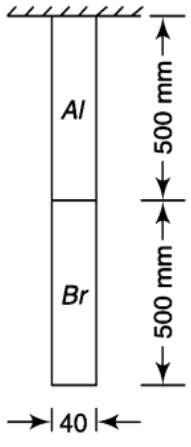

Fig. 7

(b) Define the following term: (i) Torsional rigidity (ii) Crippling load.

[(CO3)(Analyse/HOCQ)]
[(CO3)(Remember/LOCQ)]

8 + 4 = 12

9. (a) Define the following term- (i) Slenderness ratio (ii) Critical or buckling load. *[(CO6)(Remember/LOCQ)]*

(b) Determine Euler's crippling load for an I section joist 40 cm × 20 cm × 1 cm and 5 m long shown in Fig. 8, which is used as a strut with both ends fixed. Assume E for the joist as 2.1×10^5 N/mm^2.

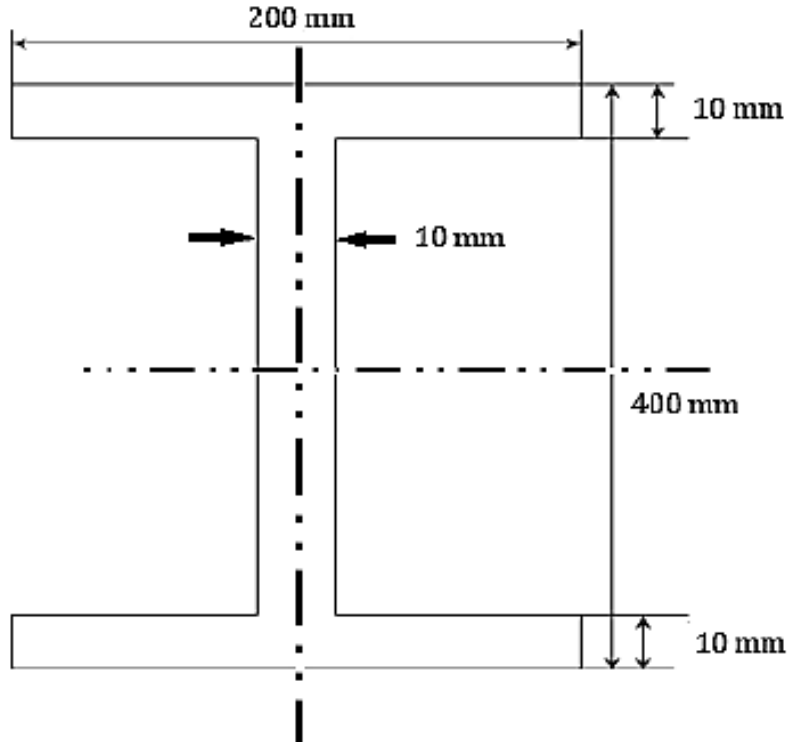

Fig. 8

[(CO3) HOCQ/Evaluate]

4 + 8 = 12

Cognition Level	LOCQ	IOCQ	HOCQ
Percentage distribution	15.63	33.33	51.04