Code : 011406

B.Tech 4th Semester Exam., 2014

MECHANICS OF SOLIDS—I

Time : 3 hours *Full Marks* : 70

Instructions :

(i) The marks are indicated in the right-hand margin.

(ii) There are ***NINE*** *questions in this paper.*

(iii) Attempt any ***FIVE*** *questions.*

(iv) Question No. ***1*** *is compulsory.*

1. Choose the correct option of the following (any *seven*) : 2×7=14

(a) For a linear elastic isotropic material, the number of independent elastic constant(s) is

(i) 1

(ii) 2

(iii) 3

(iv) 4

(b) Strain energy in torsion of a shaft/unit volume is given by

(i) $q^2/2G$

(ii) $q^2/4G$

(iii) $q^2/2E$

(iv) $q^2/4E$

where G = mod. of rigidity, E = mod. of elasticity and q = shear stress.

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(c) A mild steel bar of uniform cross-section A and length L is subjected to an axial load W. The strain energy stored in the bar should be

(i) $WL/2AE$

(ii) $W^2L/4AE$

(iii) $WL/4RE$

(iv) $W^2L/2AE$

(d) For a given material $E = 2G$. Then the bulk modulus (K) of the material will be

(i) $E/3$

(ii) E/L

(iii) E/A

(iv) E

(e) Maximum stress theory is applicable to

(i) brittle material

(ii) ductile material

(iii) brittle and ductile material

(iv) structural material

(f) The ratio of Young's modulus to modulus of rigidity for a material having Poisson's ratio 0·2 is

(i) 12/5

(ii) 5/14

(iii) 5/12

(iv) 14/5

(g) When the strain in a material increases with time under sustained constant stress, the phenomenon is known as

(i) creep

(ii) hysteresis

(iii) strain hardening

(iv) viscoelasticity

(h) The critical bending moment caused in a fixed-ended beam loaded with a total uniformly distributed load w is

(i) $wL/2$

(ii) $wL/4$

(iii) $wL/8$

(iv) $wL/12$

(i) The variation of bending moment in a beam, where load is UDL, is

(i) linear

(ii) parabolic

(iii) cubic

(iv) zero

(j) The variation of bending stress on a transverse plane of a beam is

(i) linear

(ii) nonlinear

(iii) parabolic

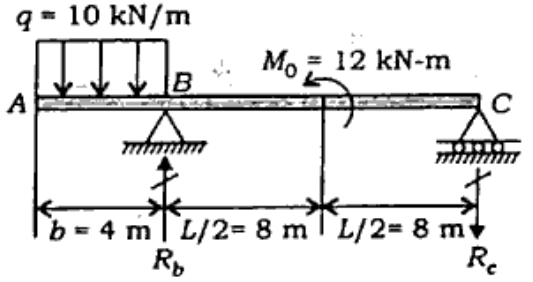
(iv) linear and nonlinear

2. A slightly tapered bar AB of circular cross-section and length L is supported at the end B and subjected to a load P at the free end. The diameters of the bar at the ends A and B are d_1 and d_2 respectively. Derive a formula for the elongation δ at the bar due to the load P. 14

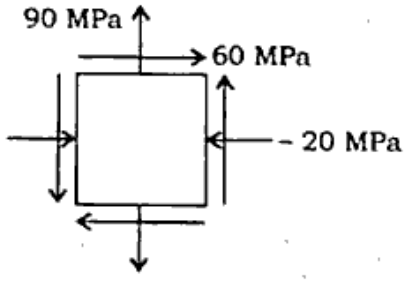
3. A cylindrical piece of steel, 80 mm diameter and 120 mm long, is subjected to an axial compressive force of 5000 kg. Calculate the change in volume of the piece if bulk odulus is $1{\cdot}7 \times 10^6$ kg/cm^2 and $\mu = 0{\cdot}3$. 14

4. A hollow cylindrical steel shaft is 1·5 m long and has inner and outer diameters respectively equal to 40 mm and 60 mm. What is the largest torque that can be applied to the shaft if the shearing stress is not to exceed 120 MPa? Further, what is the corresponding minimum value of shearing stress in the shaft? 14

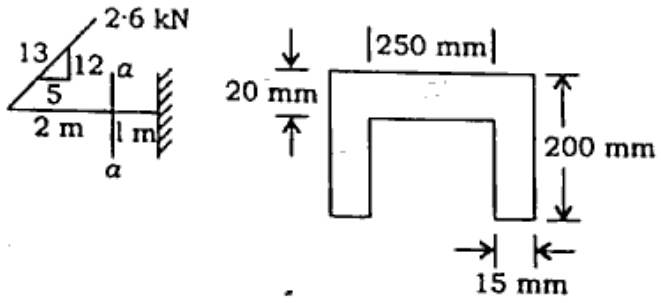
5. Construct shear force and bending moment diagrams for the beam with an overhang shown in the figure below. The beam is subjected to a uniform load of constant intensity $q = 10$ kN/m on the overhang and a counterclockwise couple $M_0 = 12$ kN-m acting midway between the supports. 14



6. An element in plane stress is subjected to stresses $\sigma_x = -20$ MPa, $\sigma_y = 90$ MPa and $\tau_{xy} = 60$ MPa as shown in the figure below. Represent this stress state in terms of principal stresses. 14



7. The beam shown in the figure below has a cross-sectional area in the shape of a channel. Determine the maximum bending stress that occurs in the beam at section $a-a$. 14



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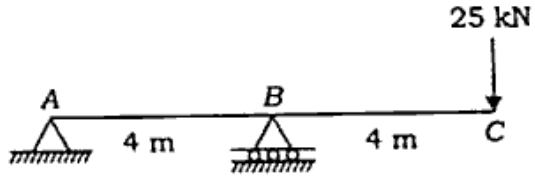
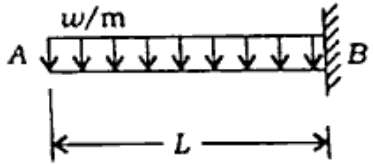
8. With the help of moment area method, determine the displacement at C for the steel overhanging beam as shown in the figure below. [Assume E_{ST} = 200 GPa and $I = 50 \times 106$ mm^4] 14



9. Determine the elastic strain energy due to bending of the cantilevered beam fixed at the end B as shown in the figure below if the beam is subjected to uniformly distributed load w and if EI is constant. 14



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