

Code : 011513

B.Tech 5th Semester Exam., 2018

MECHANICS OF SOLID—II

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 **FIVE** questions in all.
- (iv) Question No. 1 is compulsory.

1. Choose the correct answer any seven of the following : 2×7=14

- (a) Flow stress corresponds to
  - (i) fluids in motion
  - (ii) breaking point
  - (iii) plastic deformation of solids
  - (iv) rupture stress
- (b) The total strain energy stored in a body is termed as
  - (i) resilience
  - (ii) proof resilience
  - (iii) modulus of resilience
  - (iv) toughness

- (c) The safe twisting moment for a compound shaft is equal to the

- (i) maximum calculated value
- (ii) minimum calculated value
- (iii) mean value
- (iv) extreme value

- (d) A vertical column has two moments of inertia (i.e.,  $I_{xx}$  and  $I_{yy}$ ). The column will tend to buckle in the direction of the

- (i) axis of load
- (ii) perpendicular to the axis of load
- (iii) maximum moment of inertia
- (iv) minimum moment of inertia

- (e) When a body is subjected to a direct tensile stress ( $\sigma$ ) in one plane, then maximum normal stress occurs at a section inclined at \_\_\_\_\_ to the normal of the section.

- (i)  $0^\circ$
- (ii)  $30^\circ$
- (iii)  $45^\circ$
- (iv)  $90^\circ$

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- (f) The Rankine's formula holds good for
- (i) short columns
  - (ii) long columns
  - (iii) both short and long columns
  - (iv) weak columns
- (g) What is the nature of distribution of shear stress in a rectangular beam?
- (i) Linear
  - (ii) Hyperbolic
  - (iii) Parabolic
  - (iv) Elliptic
- (h) A circular shaft subjected to twisting moment results in maximum shear stress of 60 MPa. Then the maximum compressive stress in the material is
- (i) 30 MPa
  - (ii) 60 MPa
  - (iii) 90 MPa
  - (iv) 120 MPa

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- (i) Shear centre is the point in or outside a section through which the shear force applied produces \_\_\_\_\_ in the beam.
- (i) only twisting
  - (ii) only bending
  - (iii) twisting and bending
  - (iv) no twisting and bending
- (ii) The variation of bending stress in a curved beam is
- (i) cubic
  - (ii) linear
  - (iii) hyperbolic
  - (iv) parabolic
2. (a) What do you understand by complementary shear stresses? 4
- (b) At a point P in a body for the given state of stress

$$[\tau_{xy}] = \begin{bmatrix} 10 & 10 & 10 \\ 10 & -5 & 10 \\ 10 & 10 & -5 \end{bmatrix} \text{ kN/cm}^2$$

determine the normal and shear stresses on a plane that are equally inclined to all the three axes. 10

( 5 )

3. Determine the principal stresses of a given stress at a point in three-dimensional stress system and also check their invariants : 14

$$[\tau_p] = \begin{bmatrix} 20 & 40 & 20 \\ 40 & -40 & -60 \\ 20 & -60 & 80 \end{bmatrix} \text{ N/mm}^2$$

4. (a) Under what conditions unsymmetrical bending occur in a beam? 4
- (b) A beam of rectangular section 150 mm wide and 200 mm deep is used over a simply supported span of 6 m to support the concentrated loads of 4 kN each at 2 m from either support. The plane of loads make an angle of  $30^\circ$  with the vertical plane of symmetry. Find the direction of the neutral axis and the maximum bending stresses in the beam. 10

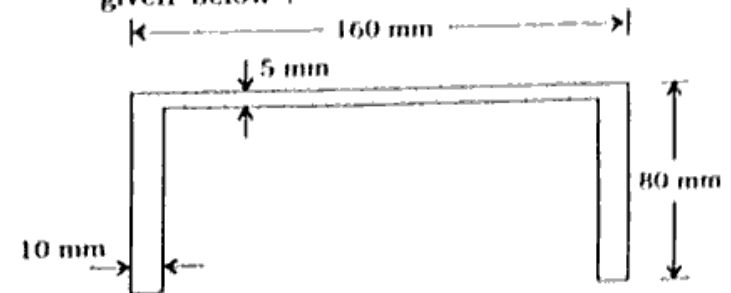
5. A curve bar of rectangular cross-section has a width 50 mm and depth 75 mm is curved in a plane perpendicular to its depth. The mean radius of curvature 100 mm. Find the position of neutral axis and maximum bending stresses at inner and outer faces caused by a moment of 3.75 kN-m tending to reduce the curvature. Also show bending stress distribution across the depth of the beam. 14

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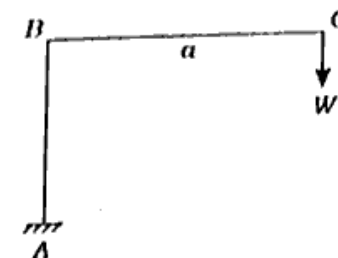
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( 6 )

6. (a) Derive an expression for moment of resistance of a rectangular beam subjected to bending moment in the elastoplastic range, also find the shape factor. 6
- (b) Find the shape factor for the channel shape beam as shown in the figure given below : 8



7. (a) State and prove the Maxwell's reciprocal deflection theorem. 6
- (b) A rigid cantilever frame as shown in the figure given below, carries a load  $W$  at the free end. Assuming a constant value of  $EI$ , determine the vertical and horizontal displacement of the free end  $C$  : 8



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( Continued )

( 7 )

8. (a) What is Euler's curve? What is its importance? 5
- (b) A hollow steel strut hinged at both ends has an outside diameter of 64 mm, an inside diameter of 52 mm and is 2.4 m long. The load is parallel to the axis but is eccentric. Determine the maximum value of eccentricity if the crippling load is 70% of Euler value. The yield stress is 300 MPa and  $E = 205$  GPa. 9
9. (a) Why is hollow shaft preferred to solid shaft? 5
- (b) Calculate the diameter of a solid shaft subjected to a torque of 1.5 kN-m and a bending moment of 1 kN-m, if the maximum shear stress is not to exceed  $60 \text{ N/mm}^2$  and the maximum normal stress is not to exceed  $100 \text{ N/mm}^2$ . 9

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