Code : 102405

B.Tech 4th Semester Exam., 2022

(New Course)

STRENGTH OF MATERIALS

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 of the following (any *seven*) :   2×7=14

   (a) Two parallel, equal and opposite forces acting tangentially to the surface of the body is called

      (i) complementary stress

      (ii) compressive stress

      (iii) shear stress

      (iv) tensile stress

   (b) Maximum shear stress is

      (i) average sum of principal stresses

      (ii) average difference of principal stresses

      (iii) average sum as well as difference of principal stresses

      (iv) None of the above

   (c) What will be the radius of gyration of a circular plate of diameter 10 cm?

      (i) 2·5 cm

      (ii) 2·0 cm

      (iii) 1·5 cm

      (iv) 3 cm

   (d) Which of the following are statically determinate beams?

      (i) Only simply supported beams

      (ii) Continuous beams

      (iii) Fixed beams

      (iv) Cantilever, overhanging and simply supported beams

(3)

(e) In a cantilever carrying a uniformly varying load starting from zero at the free end, the bending moment diagram

   (i) is a horizontal line parallel to x-axis

   (ii) is a line inclined to x-axis

   (iii) follows a parabolic law

   (iv) follows a cubic law

(f) Calculate the deflection if the slope is 0·0225 radians. Take the distance of centre of gravity of bending moment to free end as 2 metres

   (i) 45 mm

   (ii) 35 mm

   (iii) 28 mm

   (iv) 49 mm

(g) Hoop stress in a thin vessel is

   (i) pD/4t

   (ii) pD/2t

   (iii) pD/3t

   (iv) None of the above

(4)

(h) Hoop shrinking in thick cylinders is done to achieve

   (i) increased stresses

   (ii) decreased stresses

   (iii) uniform stresses

   (iv) None of the above

(i) Two shafts in torsion will have equal strength if

   (i) only diameter of the shafts is same

   (ii) only angle of twist of the shaft is same

   (iii) only material of the shaft is same

   (iv) only torque transmitting capacity of the shaft is same

(j) What is the maximum principal stress induced in a solid shaft of 40 mm diameter which is subjected to both bending moment and torque of 300 kN-mm and 150 kN-mm respectively?

   (i) 50·57 N/mm^2

   (ii) 28·1 N/mm^2

   (iii) 21·69 N/mm^2

   (iv) 52·32 N/mm^2

2. *(a)* Derive the relation between E and K. A bar of 30 mm diameter is subjected to a pull of 60 kN. The measurement extension on gauge length of 200 mm is 0·1 mm and change in diameter is 0·004 mm. Calculate E, Poisson ratio and K.   6

(b) Three bars made of copper, zinc and aluminium are of equal length and have cross-section 500, 700 and 1000 mm² respectively. They are rigidly connected at their ends. Of this compound member is subjected to a longitudinal pull of 250 kN. Estimate the proportional of the load carried on each rod and the induced stresses. Take the values of E for copper = $1·3 \times 10^5$ N/mm² and for zinc = $1·0 \times 10^5$ N/mm² and for aluminium = $0·8 \times 10^5$ N/mm².   8

3. A material is subjected to two mutually perpendicular tensile direct stresses of 40 MPa and 30 MPa together with a shear stress of 20 MPa, shear stress being clockwise on the face carrying the 40 MPa tensile stress. Determine—

(a) the stresses on a plane making an angle of 40° counter-clockwise to the plane of the 40 MPa stress;

(b) the principal stresses and their planes;

(c) the maximum shear stress and its plane.   14

4. *(a)* With the help of mathematical proof, show that the torque transmitted by the hollow shaft is greater than the solid shaft.   7

(b) A hollow shaft with diameter ratio 3/5 is required to transmit 450 kW at 120 r.p.m. The shearing stress in the shaft must not exceed 60 N/mm² and the twist in a length of 2·5 m is not to exceed 1°. Calculate the minimum external diameter of the shaft. Take $C = 80$ kN/mm².   7

5. A simply supported beam is subjected to a combination of loads as shown in Fig. 1. Sketch the shear force and bending moment diagrams and find the position and magnitude of maximum bending moment.   14
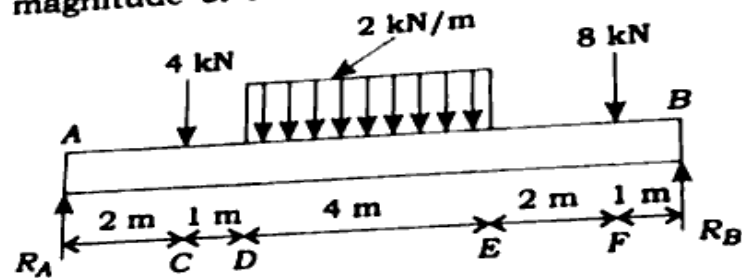

Fig. 1 (Beam)

6. *(a)* Derive expression for moment of inertia for circular lamina and thin ring.   6

(b) Determine the moment of inertia of the beam cross-section about the x centroidal axis shown in Fig. 2 : 8
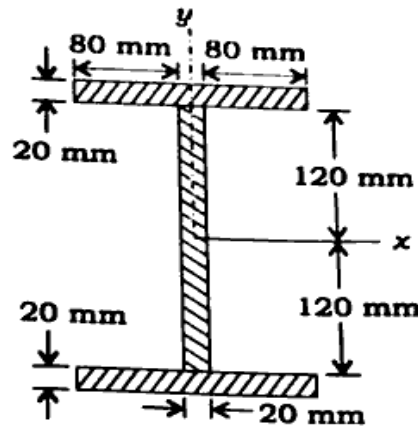

Fig. 2

7. (a) Derive the expression for the change in diameter and for the change in volume of a thin spherical shell when it is subjected to an internal pressure. 7

(b) A thin cylinder is 3·5 m long, 90 cm in diameter, and the thickness of the metal is 12 mm. It is subjected to an internal pressure of 2·8 N/mm². Calculate the change in dimensions of the cylinder and the maximum intensity of shear stress induced. $E = 200$ GPa and Poisson's ratio = 0·3. 7

8. (a) Calculate circumferential and radial stress in a thick cylinder assuming internal pressure = p_t and internal pressure = zero. 6

(b) An external pressure of 10 MN/m² is applied to a thick cylinder of internal diameter 160 mm and external diameter 320 mm. If the maximum hoop stress permitted on the inside wall of the cylinder is limited to 30 MN/m², what maximum internal pressure can be applied assuming the cylinder has closed ends? What will be the change in outside diameter when this pressure is applied? $E = 207$ GN/m², $\nu = 0.29$. 8

9. (a) Deduce the expression for bending equation. What is section moduli of hollow circular section and solid circular section? 6

(b) A simply supported beam is subjected to uniformly distributed load in combination with couple M. It is required to determine the deflection shown in Fig. 3. 8
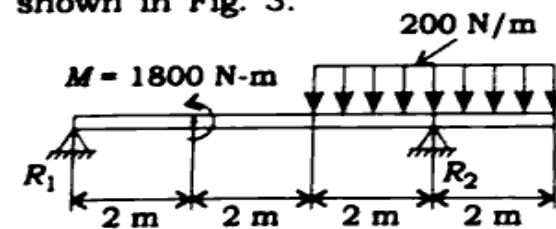

Fig. 3

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