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C037512(037)

B. Tech. (Fifth Semester) Examination, Nov.-Dec. 2021

AICTE

(New Scheme)

(Mech. Engg. Branch)

SOLID MECHANICS

(BT3037)

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

Note : *Attempt all questions. Part (a) is compulsory and carries 4 marks. Attempt any two parts from (b), (c) and (d) of each carries 8 marks.*

Unit-I

1. (a) Define the following : 4

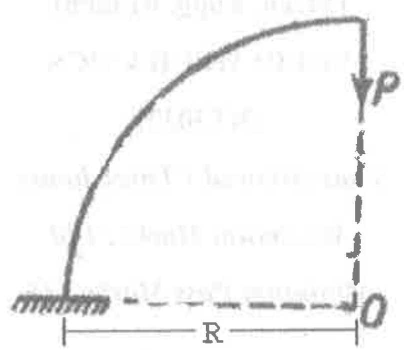
(i) Strain Energy

(ii) Resilience

(iii) Proof Resilience

(iv) Modulus of Resilience

(b) One quadrant of a ring of radius r is shown in figure. One end is clamped and the other end is loaded by a vertical force P. Find the vertical and horizontal deflection of point of application of load P in terms of P, R and EI using energy method. 8



(c) Using Castigliano's theorem calculate the vertical deflection at the middle of a simply supported beam which carries an udl of intensity w over the full span. The flexural rigidity EI is constant and only strain energy of bending is to be considered. 8

(d) Explain Maxwell's reciprocal deflection theorem. 8

Unit-II

2. (a) Define : 4

(i) Free B. M. Diagram

(ii) Fixed bending moment diagram

(b) Derive the Clapeyron's theorem of three moments. State clearly the assumptions involved. 8

(c) A fixed beam of 4 m span is acted upon by a uniformly distributed load of 10 kN/m run over 2 m length starting from left end and a concentrated load of 20 kN at a distance of 3 m from the left end. Make calculations for the moments at the supports and deflction at the centre of beam. Use Macaulay's method. Take Flexural rigidity EI of the beam as 16 MNm^2. 8

(d) A continuous beam ABCD has three equal spans of length 2 m each. The beam carries a uniformly distributed load of intensity 3 kN/m over its entire length. If the beam is freely supported at all the supports which remain at the same level, determine moments and reactions at all the supports. Proceed to draw the shear force and bending moment diagram and find the location of the points of contraflexure. 8

Unit-III

3. (a) Make a clear differentiation between thin and thik shell with diagram also. 4

(b) Derive an expression of Lame's equation. State clearly the assumptions involved. 8

(c) A cylindrical shell 2·5 long which is closed at the ends has internal diameter 250 mm and wall thickness 7·5 mm. Determine : 8

(i) circumferential and longitudinal stresses induced in the shell material

(ii) change in length, diameter of the shell if it is subjected to an internal pressure of 1·5 MN/m^2.

The cylinder is built up with riveted joints and the efficiencies of the longitudinal and circumferential joints are 85% and 60% respectively.

Take modulus of elasticity $E = 200$ GPa and Poisson's ratio $\mu = 0 \cdot 3$.

(d) A hollow cylinder has an external diameter of 250 mm and the thickness of the wall is 50 mm. The cylinder is subjected to an internal fluid pressure = 35 MPa and external pressure = 3·5 MPa. Calculate the maximum and minimum circumferential stresses

and plot the variation of the same across the wall thickness. 8

Unit-IV

4. (a) Define different type of end conditions of column. 4

(b) A hollow cylindrical cast iron column of 150 mm external diameter and 15 mm thickness, 3 m long and is hinged at one end and fixed at the other. Find

(a) the ratio of the Euler's and Rankine's load,

(b) for what length, the critical load by Euler's and Rankine's formula will be equal? 8

(c) A beam of T-section (flange : 100 mm × 20 mm; web : 150 mm × 10 mm) is 2·5 meters in length and is simply supported at the ends. It carries a load of 3·2 kN inclined at 200 to the vertical and passing through the centroid of the section. If E = 200 GPa, calculate

(i) Maximum tensile stress;

(ii) Maximum compressive stress;

(iii) Deflection due to the load; and

(iv) Position of the neutral axis. 8

(d) A column of circular section with external diameter

20 cm, thickness 2 cm and of $3 \cdot 5$ m length has both of its ends fixed. The column is acted upon a 250 kN load applied with 2·5 cm eccentricity from its axis. Taking modulus of elasticity $E = 1 \times 10^5$ N/mm^2 for the column material, work out

(i) extreme stresses in the column section

(ii) maximum eccentricity so that there is no tension anywhere in the section. 8

Unit-V

5. (a) Differentiate plane stress and plane strain problem with suitable examples. 4

(b) A thick-walled steel cylinder with radii $a = 5$ cm and $b = 10$ cm is subjected to an internal pressure p. The yield stress in tension for the material is 350 MPa. Using a factor of safety of 1·5, determine the maximum working pressure p according to the major theories of failure. $E = 207 \times 10^6$ kPa, $\mu = 0 \cdot 25$. 8

(c) Derive equation of equilibrium for an axisymmetric problem. 8

(d) Two carbon steel balls, each 25 mm in diameter are pressed together by a force F = 18N. At the centre

of the area of contact, determine the values of the principal stresses, the maximum shear stress, and the octahedral shress. For carbon steel, E = 207 GPa, and $\mu = 0 \cdot 292$. 8