Reg. No. : | | | | | | | | | | | | |

Question Paper Code : 80844

B.E./B.Tech. DEGREE EXAMINATIONS, NOVEMBER/DECEMBER 2021.

Fourth Semester

Mechanical Engineering

ME 2254/CE 1259/10122 ME 405/080120018/ME 45 — STRENGTH OF MATERIALS

(Common to Production Engineering/Automobile Engineering)

(Regulations 2008/2010)

Time : Three hours Maximum : 100 marks

Answer ALL questions.

PART A — (10 × 2 = 20 marks)

1. Define Hooke's law.

2. Define the term modulus of resilience.

3. Mention and sketch any two supports and beams.

4. Sketch the bending stress distribution and shear stress distribution for the beam of rectangular cross section.

5. What is meant by torsional rigidity?

6. Define spring constant.

7. Write down the boundary conditions for a cantilever beam to find out the equations for deflection and slope

8. Define the term 'equivalent length' of a column.

9. Differentiate stiffness and stability.

10. Mention the advantage of Macaulay method.

PART B — (5 × 16 = 80 marks)

11. (a) A steel rod of 12 mm in diameter passes centrally through a copper tube of internal diameter 36 mm and external diameter 48 mm and of 2.5 m length. The tube is closed at each end by 24 mm thick steel plates which are secured by nuts. The nuts are tightened until the copper tube is reduced in length by 0.50 mm. The whole assembly is then raised temperature by 60°C. Calculate the stresses in copper and steel before and after the rise of temperature, assuming the thickness of the plates remains unchanged. Take $E_s = 210$ GN/m^2, $E_c = 105$ GN/m^2, $\alpha_s = 1.2 \times 10^{-5}$ per° C and $\alpha_c = 1.75 \times 10^{-5}$ per° C. (16)

Or

(b) Two mutually perpendicular planes of an element of material are subjected to direct stresses of 10.5 MN/m^2 (tensile) and 3.5 MN/m^2 (comp.) and shear stress of 7 MN/m^2. Find the magnitude and direction of principal stress. Also find magnitude of normal and shear stresses on a plane on which the shear stress is maximum. (16)

12. (a) A simply supported beam of span 6 m is carrying a uniformly distributed load of 2 kN/m over the entire span. Calculate the magnitude of shear force and bending moment at every section, 2 m from the left support. Also draw shear force and bending moment diagrams.

Or

(b) State the assumptions made in the theory of simple bending and derive the simple bending equation.

13. (a) A hollow shaft having internal dia 0.6 times external dia is to replace a solid shaft of the same material to transmit 500 kW at 200 rpm. The permissible shear stress is 40 N/mm^2. Calculate the diameters of the solid and hollow shafts. Also calculate the percentage saving in material.

(16)

Or

(b) Two close-coiled helical springs of the same length, are wound out of the same wire, circular in cross section and supports a compressive load P. The inner spring consists of 20 turns of mean dia 16 cm and the outer spring has 18 turns of mean dia 20 cm. Calculate the max stress produced in each spring if the dia of wire = 1cm and P 1000 N. (16)

14. (a) A horizontal beam of uniform section and length 'l' rests on supports at its ends. It carries a uniformly distributed load of 'w' per unit run for a distance 'a' from the right end. Calculate the value of 'a' for which the maximum deflection will occur at the left end of the uniformly distributed load. If the maximum deflection is expressed by (wl^4 /kEI), find the value of k. (16)

Or

(b) (i) Derive an expression for the crippling load of a long column when both ends are hinged. (8)

(ii) Find the Euler's critical load for a cast iron hollow column of external diameter 200 mm, 25 mm thick and of length 6 m hinged at both ends. $E = 0.8 \times 10^4$ N/mm^2. Compare Euler's load with Rankine's critical load. Assume $f_c = 550$ N/mm^2 and $\alpha = 1/600$. Find the length of column at which both critical loads are equal. (8)

15. (a) At a certain point in a strained material the horizontal tensile stress is 80 N/mm^2 and the vertical tensile stress is 150 N/mm^2. The shear stress is 50 N/mm^2. Find the magnitude and nature of principal stresses and the directions of principal planes.

Or

(b) A cylindrical shell 5 m long which is closed at the ends has an internal diameter of 2 m and a wall thickness of 20 mm. Calculate the circumferential and longitudinal stresses induced and also change in the dimensions of the shell if it is subjected to an internal pressure of 1 N/mm^2. Assume the modulus of elasticity and Poisson's of the material of the shell as 200 kN/mm^2 and 0.3.

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