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B037413(037)

B. Tech. (Fourth Semester) Examination, April-May 2022

(AICTE Scheme)

(Mechanical Engg. Branch)

STRENGTH of MATERIALS

Time Allowed : Three hours

Maximum Marks : 100

Minimum Pass Marks : 35

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

Unit-I

1. (a) Explain the following : 1+1+1+1=4

(i) Hooke's law

(ii) Elastic limit

(iii) Toughness

(iv) Poisson's ratio

(b) A stepped steel bar is suspended vertically. The diameter in the upper half portion is 10 mm, while the diameter in the lower half portion is 6 mm. What are the stresses due to self-weight in sections B and A as shown in fig. 1 E = 200 kN/mm^2. Weight density, W = 0·7644 N/mm^3. What is the change in its length.

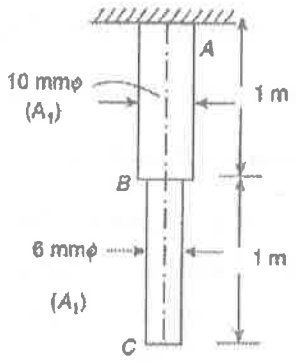

Fig.-1

(c) The modulus of rigidity of a material is 39 kN/mm^2. A 10 mm diameter rod of the material is subjected to an axial tensile force of 5 kN and the change in

its diameter is observed to the 0·002 mm. Calculate the Poisson's ratio and modulus of elasticity of the material.

(d) Figure 2 shows a composite bar of steel and copper. The temperature of the bar is raised by 80°C. Determine the compressive force developed in the bars after the rise in temperature and the change in length of the copper bar. The area of the copper bar is 600 mm^2 and that of the steel bar is 1,000 mm^2.

E_{cu} = 1,05,000 N/mm^2, E_s = 2,10,000 N/mm^2.

- $s = 11\times10^{-6}/°C$
- cu $= 18\times10^{-6}/°C$,

Clearance between support and composite bar is 0·5 mm.

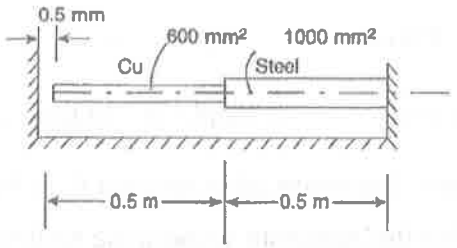

Fig.-2

Unit-II

2. (a) What is the point of contraflexure? Explain with neat sketch. 2+2

(b) A 6-m-long beam AB, which is roller supported at C hinged at B as shown in fig.-3, carries a udl of 5 kN/m over ACD = 3 m and an inclined load of 10 kN at E, at angle of 60° as shown in the figure. Determine support reactions and draw SF and BM diagrams

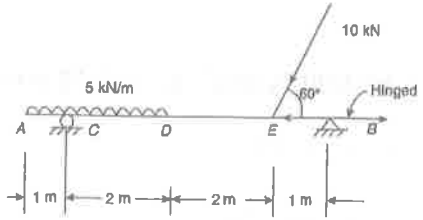

Fig.-3

(c) Dimensions of a T-section are : $B = 110\,\text{mm}$, $D = 150\,\text{mm}$ $t_f = 20\,\text{mm}$ and $t_w = 10\,\text{mm}$. Determine z_1, z_2. A cantilever 4 m long is of this T-section. Determine the point load W at the free end so that the maximum stress in the section does not exceed 90 MPa.

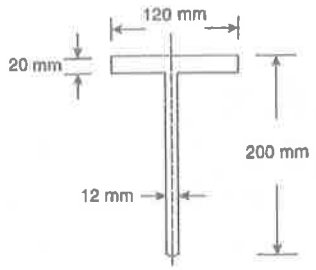

Fig.-4

(d) A rolled steel section is shown in Fig.-5. It is subjected to a vertical force of 20 kN. Determine shear stress at points *A*, *B* and *C* of the section.

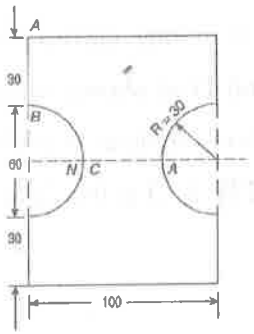

Fig.-5

Unit-III

3. (a) What is a conjugate beam? How reactions at ends give the slope at ends of the beam? 2+2

(b) Derive the expression

$$\frac{1}{R}=\frac{dy^2/dx^2}{\left[1+\left(\frac{dy}{dx}\right)^2\right]^{1.5}}$$

(c) A steel beam of circular section with diameter of 50 mm is used as a cantilever of length 3 m. How much load can be safely applied at the free end of the cantileverif $E = 200$ GPa, and deflection is not to exceed 1 mm and slope is not to exceed 0·2°.

(d) A beam AB, 10 m long, carries point loads of 6 and 3 kN at C and D as shown in Fig.-6. Determine support reactions, deflection at C and D, and slope at ends A and B, if EI is the flexural rigidity of the beam.

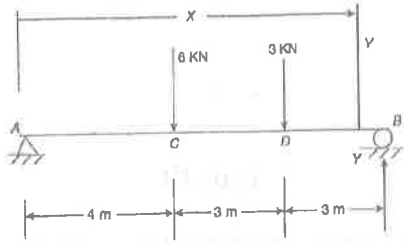

Fig.-6

Unit-IV

4. (a) What are equivalent twisting moment and equivalent bending moment in a shaft? 2+2

(b) A composite shaft is made by joining an 800 mm long solid steel shaft with 800 mm long hollow copper shaft as shown in fig.-7. The diameter of solid shaft is 40 mm, while internal and external diameters of hollow shaft are 25 and 50 mm, respectively. Determine the maximum shear stresses developed in steel and copper shaft, if torque T applied at junction is 4 kN-m. What is the angular twist at the junction? Given $G_{steel} = 2 \times G_{copper} = 82{,}000$ N/mm^2.

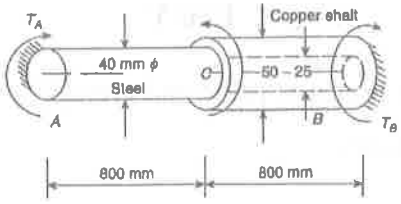

Fig.-7

(c) A solid shaft of diameter d is subjected to a bending moment, $M = 15$ kN m and a twisting moment,

$T = 25\,\text{kN} - \text{m}$. What is the maximum diameter of the shaft if the maximum most shear stress in shaft is not to exceed 160 N/mm^2 and the maximum direct stress is not to exceed 200 N/mm^2.

(d) An open-coded helical spring made from steel wire of circular cross-section is to carry an axial load of 120 N. The wire diameter is 8 mm and mean coil radius is 40 mm. Calculate the (a) axial deflection and (b) angular rotation of the free-end with respect to the fixed-end if helix angle of spring is 25°, and number of turns is 12. Given $G = 84\ \text{kN/mm}^2$, $E = 210\ \text{kN/mm}^2$.

Unit-V

5. (a) Define principal plane and principal stresses with neat sketch.

(b) State of stress on two perpendicular planes AC and BC is given in Fig.-8. Draw Mohr's stress circle, taking BC on reference plane, determine (i) Principal Stresses (ii) Principal angles (iii) Maximum shear

stress (iv) Normal and shear stresses on inclined plane AB, with $\theta = 30°$.

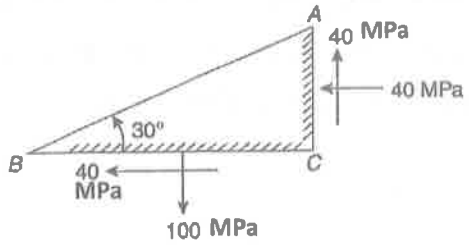

Fig.-8

(c) Stresses at a point are as shown in fig.-9. On plane BC, $\sigma_1 = 100$ MPa, $\tau = 30$ MPa and on plane AC, $\sigma_2 = -60$ MPa, $\tau = 30$ MPa. Determine the normal and shear stresses on the inclined plane AB, $\theta = 30°$. At what angle of plane AB, the shear stress will become zero?

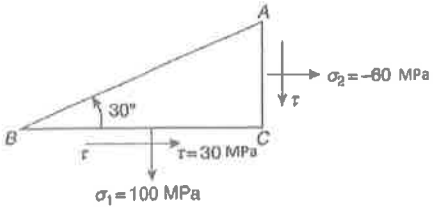

Fig.-9

(d) A cast iron column of a section of 200 mm × 250 mm is subjected to a vertical load of 300 kN acting at a point 40 mm away (along the diagonal) from the centre. Determine the resulting stress at the corners a, b, c and d of the section.

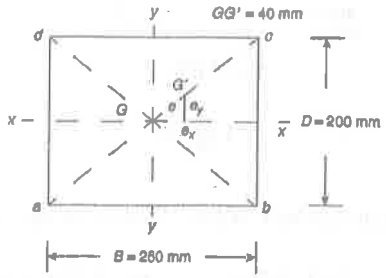

Fig.-10