[Total No. of Questions - 9] [Total No. of Printed Pages - 3]
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B. Tech 3rd Semester Examination

Strength of Materials (N.S.)

CE-211

Time : 3 Hours **Max. Marks : 100**

The candidates shall limit their answers precisely within the answer-book (40 pages) issued to them and no supplementary/continuation sheet will be issued.

Note : Attempt five questions in all, select one question from each sections A, B, C and D. Section E (Question-9) is compulsory. Use of non-programmable calculator is allowed.

SECTION - A

1. (a) What are compatibility conditions? **(3)**

   (b) Explain principal stresses and principal planes. How will you represent it on Mohr's circle. **(5)**

   (c) Derive the expression for principal stresses of an element if it is subjected to tensile stresses in x and y direction as σ_x, σ_y and a shear stress τ. **(12)**

2. A rectangular beam of height d, breadth b and length l is supported at the ends and carries a concentrated load P at the middle. Show that the principal stress at a point in the central cross-section and distance d/4 from the top are

$$\frac{3Pl}{8bd^2}\left(1+\sqrt{1+\frac{9d^2}{4l^2}}\right)$$ **(20)**

SECTION - B

3. (a) If the principal stresses at a point in an elastic material are 2f tensile, 1.5f tensile and f compressive, calculate the value of f at failure according to (i) Rankine's theory and (ii) Guest's theory. The elastic limit in simple tension is 210 N/mm^2 and $\mu = 0.3$. **(10)**

   (b) Determine the centroidal principal moment of inertia of an equal angle section 30 mm×30 mm×10 mm. **(10)**

4. For a given stress, compare the moments of resistance of a beam of square section placed (i) with two sides horizontal and (ii) with a diagonal horizontal. **(10+10=20)**

SECTION - C

5. A simply supported beam of uniform cross-section is of length l and is subjected to a clockwise couple M at a distance a from one support and b from the other as shown in Figure-1. Assume EI = Constant and Use Macaulay's method to determine

   (i) Slopes at each end

   (ii) Deflection at the point of application of the couple

   (iii) The maximum deflection **(20)**

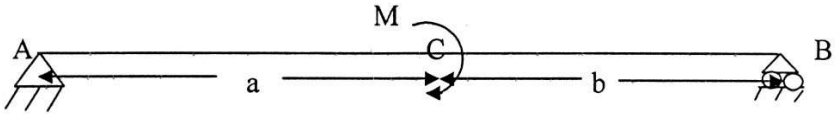

Figure 1

6. A laterally loaded strut of length l is simply supported at its two ends and carries an axial column load of P and uniformly distributed load of intensity w over its span. The flexural rigidity of the strut is EI. Show that the maximum lateral deflection of the strut is

$$\delta = \frac{w}{P}\left[\frac{l^2}{8} - \frac{EI}{P}\left(1 - \sec\frac{l}{2}\sqrt{\frac{P}{EI}}\right)\right]$$ **(20)**

SECTION - D

7. (a) Explain Catigliano's theorem? **(8)**

   (b) Using Catigliano's theorem, find the deflection at the point of application of a point load W acting at 'a' from left end of a simply supported beam, if the span of beam is 'L' and a+b = L. **(12)**

8. (a) A prismatic steel rod of length l and cross sectional area A hangs vertically under its own weight. How much strain energy is stored in the bar if its weight per unit volume is γ. **(10)**

   (b) A hollow circular shaft of 200 mm external diameter and 160 mm internal diameter is subjected to a torque of 24.6×10^6 N-mm and a bending moment of 16.4×10^6 N-mm. Determine the maximum principal stress and maximum shear stress produced in the shaft. **(10)**

SECTION - E

9. (a) Prove that the ratio of maximum and average values of shear stress in a circular section is 1.33

   (b) Derive formula $\frac{\sigma}{y} = \frac{E}{R}$ for pure bending.

   (c) Explain 'Generalized Maxwell theorem'.

   (d) Discuss in brief various prominent theories of failure. Also give the limitations of each theory.

   (e) Discuss briefly about 'shear centre' **(4×5=20)**