3E1411

Roll No. : _____ Total Printed Pages : 4

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B. Tech. (Sem.III) (Main/Back) Examination, January - 2009
(3ME1) Mechanics of Solids (Mechanical Engg.)
(3PI1) Mechanics of Solids (Prod. & Indus. Engg.)
(3AE1) Mechanics of Solids (Automobile Engg.)

Time : 3 Hours] [Total Marks : 80
[Min. Passing Marks : 24

Attempt five questions in all selecting one question from each Unit.
Schematic diagrams must be shown wherever necessary.
Any data you feel missing may suitably be assumed and stated clearly.
Units of quantities used / calculated must be stated clearly.

Use of following supporting material is permitted during examination. (Mentioned in form No. 205)

1. Nil 2. Nil

UNIT - I

1 (a) Prove that $E=2C(1+\frac{1}{m})$ where (E) is Young modulus of elasticity, (C) is modulus of rigidity and (m) is Poisson ratio. 5

(b) Derive the relation for stress and elongation produced in a bar due to its self weight. 5

(c) A steel wire 2 m long and 3 mm in diameter is extended by 0.75 mm when a weight (w) is suspended from the wire. If the same weight is suspended from a brass wire, 2.5 m long and 2 mm in diameter, it is elongated by 4.64 mm. Determine the modulus of elasticity of brass if that of steel be 2.0×10^5 N/mm^2. 6

OR

1 (a) A beam weighing 450 N is held in a horizontal position by three vertical wires, one attached to each end of the beam and one to the middle of its length. The outer wires are of brass of diameter 1.25 mm and the central wire is of steel of diameter 0.625 mm. If the beam is rigid and wires of the same length and unstressed before the beam is attached, estimate the stresses induced in the wires. Young's modulus for brass : 86 GN/m^2 and for steel 210 GN/m^2. 8

(b) A steel tube 2.4 cm external diameter and 1.8 cm internal diameter encloses a copper rod 1.5 cm diameter to which it is rigidly connected at the two ends. If at a temperature of $10°C$ there is no longitudinal stress, calculate the stresses in the rod and in the tube when the temperature is raised to $200°C$, where :

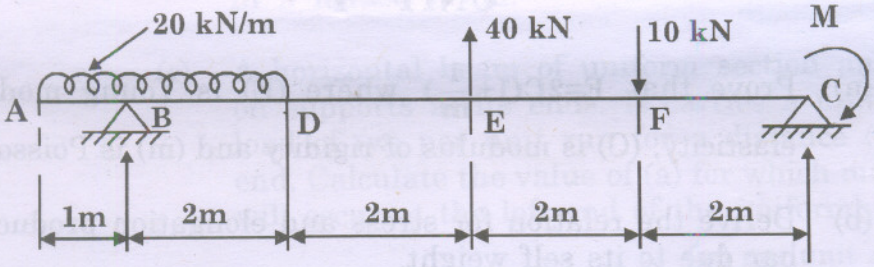
$E_S = 2.1 \times 10^5$ N/mm^2 $\quad$ $E_C = 1.0 \times 10^5$ N/mm^2

$\propto_S = 11 \times 10^{-6}$ /°C $\quad$ $\propto_C = 18 \times 10^{-6}$ /°C

UNIT - II

2 (a) What are the various categories to classify a beam ? 4

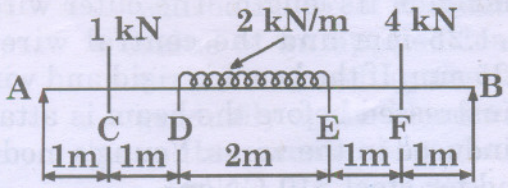
(b) A beam ABC is loaded and supported as shown in Fig. Find the magnitude of the clockwise moment (M) to be applied at (C) so that the reaction at (B) will be 30 kN upward and then draw the shear force and bending moment diagrams for the beam. 12



OR

2 (a) For cantilever carrying load whose intensity varies uniformly from zero at the free end to (w) per unit run at the fixed end; find out bending moment and shear force value at the ends; also draw bending moment and shear force diagram. 8

(b) Draw the shear force and bending moment diagrams for the beam shown in Fig. Mark the position of the maximum bending moment and determine its value.



8

UNIT - III

3 (a) What is torsional rigidity ? Derive torsion equation for a circular shaft. 8

(b) A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 r.p.m, the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MN/m^2 and the twist in a length of 3 m not to exceed 1.4 degree. Calculate the maximum external diameter satisfying these conditions. Take C=84 GN/m^2. 10

OR

3 (a) What is equivalent length ? Give the equivalent length values for different end conditions of columns. 4

(b) What are the limitations for the use of Euler's formula for long columns. 2

(c) Compare the crippling loads given by Rankine's and Euler's formulae for tubular strut 2.25 m long having outer and inner diameters of 37.5 mm and 32.5 mm loaded through pin-joint at both ends. Take yield stress as 315 MN/m^2; $a = 1/7500$ and E=200 GN/m^2.
If the elastic limit for the material is taken as 200 MN/m^2; Then for what length of the strut does the Euler formula cease to apply ? 10

UNIT - IV

4 (a) What is the use of More's circle ? Explain the method of constructing More circle for perpendicular direct stresses with state of simple shear. 8

(b) A short metallic column of 500 mm^2 cross sectional area carries an axial compressive load of 100 kN for a plane inclined at 60° with the direction of load, calculate :
(i) Normal stress
(ii) Tangential stress
(iii) Resultant stress
(iv) Maximum shear stress
(v) Obliquity of the resultant stress. 8

OR

4 (a) Direct stresses of 120 MN/m^2 in tension and 90 MN/m^2 in compression are applied to an elastic material at a certain point on planes at right angles to another. If the maximum principal stress is not to exceed 150 MN/m^2 in tension, to what shearing stress can the material be subjected ? What is then the maximum resulting shearing stress in the material ? Also find the magnitude of the other principal stress and its inclination to 120 MN/m^2 stress. 8

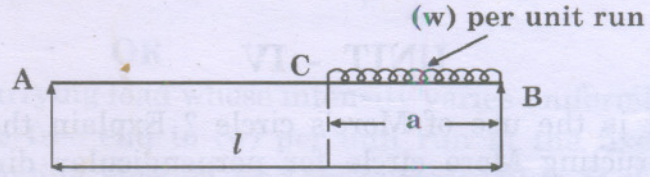
(b) A shaft section 100 mm in diameter is subjected to a bending moment of 4000 Nm and a torque of 6000 Nm. Find (i) The maximum direct stress induced on the section, and specify the position of the plane on which it acts. (ii) What stress acting alone can produce the same maximum strain ? Take Poisson's ratio=03. 8

UNIT - V

5 (a) Discuss the Mohr's theorem used for finding slope and deflection at a section in a loaded beam. 4

(b) Which method is suitable for point and for several load condition to find out the slope and deflection at a section in a loaded beam. 2

(c) 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 maximum deflection will occur at the left end of the uniformly distributed load.



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OR

5 (a) What is load factor and impact factor ? How impact factor can be found ? Give derivation. 8

(b) A uniform metal bar has a cross-sectional area of 7 cm^2 and a length of 1.5 m with an elastic limit of 160 MN/m^2, what will be its proof resielence ? Determine also the maximum value of an applied load which may be suddenly applied without exceeding the elastic limit. Calculate the value of gradually applied load which will produce the same extension as that produced by the suddenly applied load above. 8