B. £. 4[tn] Semester Examination, 2010

Solid Mechanics - II (AM - 401)

Branch: Civil

3 hours **Full Marks: 70**

Answer any Six questions takins Three from each half

Each question carries equal marks

2 marks kept reserved for neatness in each half

Assume suitable data, if required

Notations used carry their conventional senses

First half

(a) The principal stresses at a point in a strained material are *o* and CT$_2$. Show, by analytical method, that the resultant stress on the plane carrying maximum shear stress is $\sqrt{(\sigma_1^2 + \sigma_2^2)/2}$.

(b) The three readings on a 45° strain rossette in micrometer per metre are e_a = 232 at 0°, s_b = 123 at 45° and e< = -80 at 90°. Construct a Mohr's circle for strain. If E = 210 GPa and p. =0.3, determine the principal stresses.

Determine the necessary diameter for the uniform shaft (refer to Fig, Q2) carrying two equal pulleys, 300 mm weighing 2 kN each. Belt pulleys on the left pulley are horizontal and those on the right are vertical. Assume allowable shearing stress to be 60 MPa.

Two wood beams cut from the same timber are arranged as shown in Fig. Q3. Both beams are horizontal and at right angles to each other. Find the force transmitted at the middle of the lower beam. Flexural rigidity of both the beams may be assumed as EI. Also find the vertical deflection at point C.

A beam AB of span 8.0 m is simply supported at the ends A and B and is loaded as shown in Fig. Q4. Determine, by Macaulay's method, the deflection at the mid-span and slope at end A. Take E = 200x10^6 kN/m^2,1 = 120xl0"^{6}

(a) State Castigliano's second theorem. Explain the term 'Complementary Strain Energy'.

(b) A portal frame ABCD is subjected to a horizontal force H as shown in Fig. Q5. Determine the horizontal deflection of roller support at D by using Castigliano's theorem.

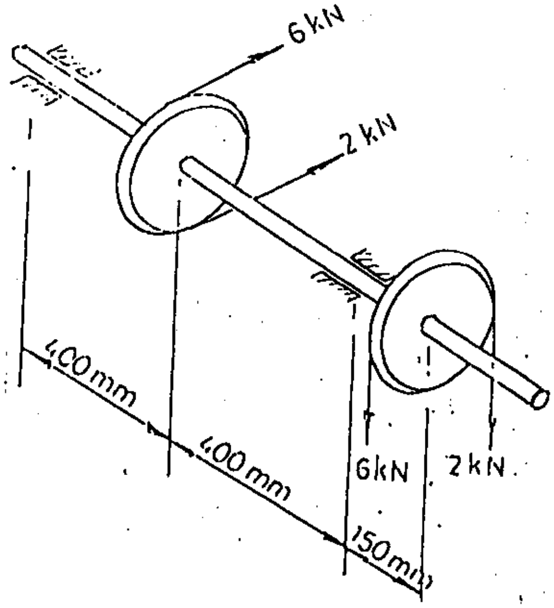


Fig. Q2

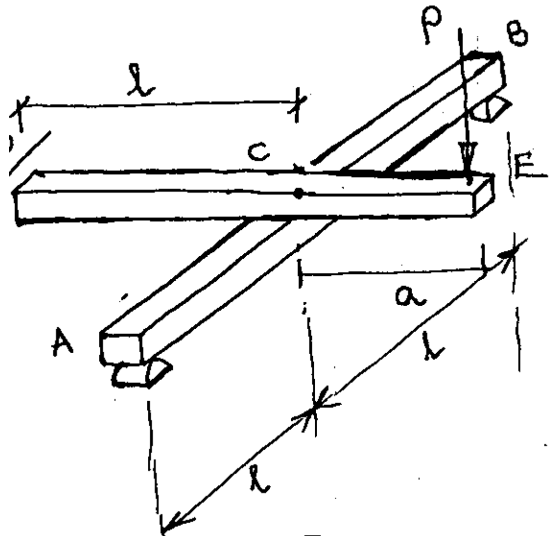


Fig. Q3

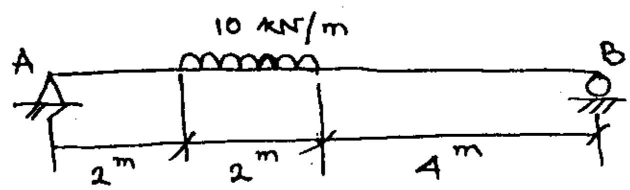
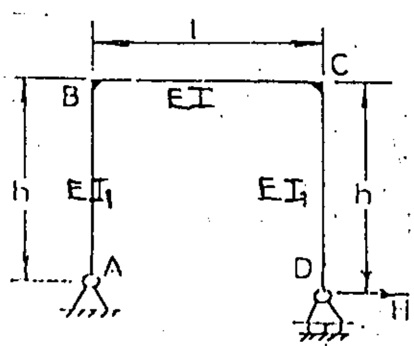


Fig. Q4



Second Half

6(a) Starting from fundamentals, deduce an expression for the critical load of a long column having both ends fixed.

(b) A long column 1.5 m long has a circular cross-section of 5 cm diameter and is used for testing purpose in a strength of materials laboratory. One end of the column is fixed while the other end is free. Using a factor of safety of 3 , calculate the safe load using Rankine-Gordon formula. Given : yield stress of the material = 560 MN / m^2 and $a = \frac{1}{1600}$.

7(a) Starting from first principles, deduce an expression to find the bending stress for a beam hpving an initial curvature and subjected to a pure moment tending to decrease the curvature. Draw a neat sketch explaining the symbols used.

(b) The section of a curved beam, as shown in Figure Q 7, is an inverted T - section having a circular centre line with a pure bending in its plane of symmetry. The distances of the extreme fibres from the centre of curvature are 18 cm and 8 cm. Find the dimension b so that the tensile and the compressive stresses may be the same in the extreme fibres of the section. Also sketch the stress variation diagram across the section.

8. A cantilever beam of I - section and 2.4 meters long is subjected to a load of 200 N at the free end as shown in Figure Q 8. Determine the resultant bending stresses at the corners A and B . Also find the position of the neutral axis. Express the stresses in N / mm^2.

9(a) Explain the following theories of failure and write down the associated expressions.
(i) Maximum principal stress theory (ii) Maximum shearing stress theory
(iii) Maximum shearing distortion energy theory.

(b) A cylindrical shell made of mild steel plate is 1.2 m in diameter. The internal pressure is 1.5 MN / m^2. If the yield point of the material is 200 MN / m^2, calculate the thickness of the plate on the basis of the above theories of failure. Assume a factor of safety of 3 in each case.

10(a) Explain the following terms : (i) Degrees of freedom, (ii) Periodic motion,
(iii) Natural frequency, (iv) Damping

(b) A simply supported beam of 6 m length is supporting a load of 20 N at its centre through a spring of stiffness 30 N / m as shown in Figure Q 10. The cross section of the beam is rectangular with 100 mm width and 150 mm depth. Calculate the natural frequency of the system.. Young's modulus for the material of the beam is 2.0×10^5 N / mm^2.

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(Figure &?)