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320314 (20)

BE (3rd Semester)

Examination, April-May 2021

Branch : Civil

MECHANICS OF SOLIDS

Time Allowed : Three Hours

Maximum Marks : 80

Minimum Pass Marks : 28

Note : Part 'a' of each question is compulsory. Attempt two parts from (b), (c) and (d) of each question.

UNIT-I

Q. 1. (a) Define and explain the following terms : 2

(i) Hooke's law

(ii) Circumferential and longitudinal stress

(iii) Modulus of rigidity

(iv) Bulk modulus

(b) A steel rod of 3 cm diameter is enclosed centrally in a hollow copper tube of external diameter of 4 cm. The composite bar is subjected to an axial pull of 45 kN, if the length of each bar is equal to 15 cm, determine : 7

(i) The stresses in the rod and the tube

(ii) Load carried by each bar

Take E for steel = 2.1×10^5 N/mm^2 and for copper = 1.1×10^5 N/mm^2.

(c) Derive the relationship between modulus of elasticity & modulus of rigidity in terms of Poisson's Ratio. 7

(d) A steel tube 2.5 cm external diameter and 1.9 cm internal diameter encloses a copper rod 1.6 cm diameter to which it is rigidly connected at two ends. If at a temperature of 10°C, there is no longitudinal stress,

calculate, the stresses in each rod and the tube when the temperature is raised to 200°C.

Take : 7

$E_s = 2.1 \times 10^5$ N/mm^2

$E_c = 1.0 \times 10^5$ N/mm^2

$\alpha_s = 11 \times 10^{-6}$/°C

$\alpha_c = 18 \times 10^{-6}$/°C

UNIT-II

Q. 2. (a) Define and explain : 2

(i) Body forces

(ii) Surface forces

(iii) Internal forces

(iv) Plane stresses

(b) An element has a tensile stress of 600 N/mm^2 and a compressive stress of 400 N/mm^2 acting on two mutually perpendicular planes and two equal shear stresses of 100 N/mm^2 on these planes. Find the principal stresses and maximum shear stress. **7**

(c) A flat plate was stretched by tensile forces acting in the direction X and Y at right angles. Strain gauges show that strain in X-direction

was 0.00105 and in Y-direction was 0.00020.

Find,

(i) Stresses acting on X and Y directions

(ii) Direct and shearing strains at a plane at 40° to X-deflection and

(iii) Normal and shearing stresses on that plane. Take $E = 80\ kN/mm^2$ and $\mu = 0.3$. 7

(d) An element in plane stress in subjected to stresses 180 N/mm^2 and 80 N/mm^2 in mutually perpendicular directions and shear

stress of 40 N/mm^2. Using Mohr's circle, determine : 7

(i) Stresses acting on an element rotated through an angle $\theta = 41°$

(ii) Maximum shear stresses

UNIT-III

Q. 3. (a) Explain the relationships between shear force, bending moment and loading on the beams. 2

(b) A simply supported beam of length 8 m rests on supports 6 m apart. The beam carries a

uniformly distributed load of 2000 N/m over the entire length. Draw shear force and bending moment diagrams and find the positions of points of contra-flexure if any. **7**

(c) A timber beam of rectangular section of length 8 m is simply supported. The beam carries a U.D.L. of 12 kN/m run over the entire length and a point load of 10 kN at 3 m from the left support. If the depth is twice the width and the stress in timber is not to exceed 8 N/mm^2; find the suitable dimensions of the section. **7**

(d) Figure (1) shows, R.S.J. 30 cm × 15 cm. At a certain section it has to resist a bending moment of 130 kN-m and a shear force of 280 kN. Find the principal stresses at : 7

(i) At top

(ii) In the flange at 13 cm from Neutral Axis

(iii) In the web at 13 cm from neutral axis

(iv) At the neutral axis

And show the variation of principal stresses along the section.

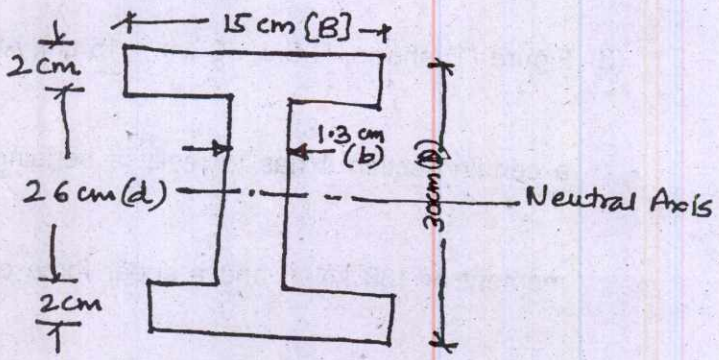

Figure (1)

UNIT-IV

Q. 4. (a) State and explain Euler's theory & assumptions for long columns. 2

(b) A built-up beam shown in figure (2) is simply supported at its ends. Compute its length for a load of 40 kN per meter length, it deflects by 1 cm, use $\left(\delta = \frac{5wl^4}{384EI}\right)$.

Find out the safe load if this beam is used as a column with both ends fixed. Assume factor of safety of 4. Use Euler's formula $E = 210\ GN/m^2$. 7

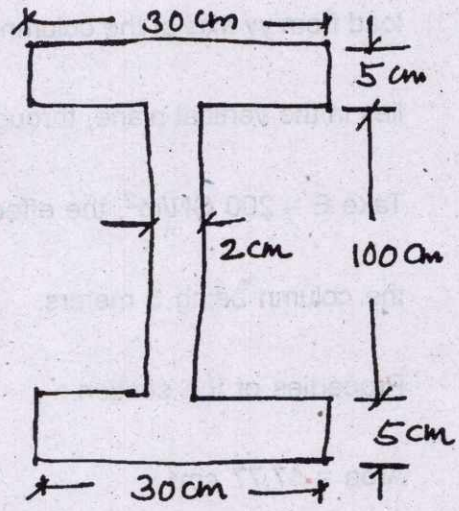

Figure (2)

(c) Figure (3) shows, a compound stanchion made up of two channels ISJC 200 weighing 139 N per meter per channel and two 25 × 1 cm^2 plates, riveted one to each flange, if the maximum permissible stress is 70 MN/m^2, find the maximum eccentricity of a 250 kN load from yy axis of the column. The load line lies in the vertical plane, through the xx axis. Take E = 200 GN/m^2, the effective length of the column being 3 meters. **7**

Properties of the section :

Area = 17.77 cm^2

I_{xx} = 1161.2 cm^4

I_{yy} = 84.2 cm^4

Distance of centroid from back of web = 1.97 cm.

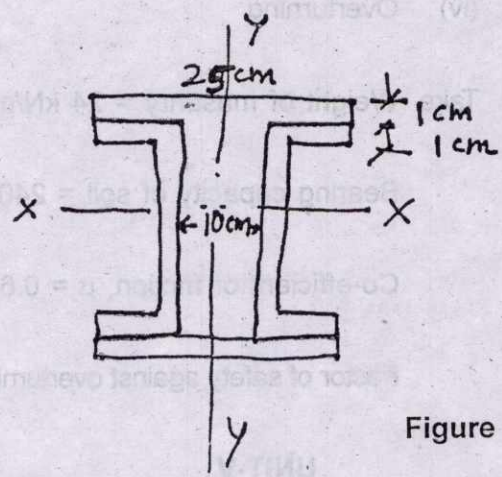

Figure (3)

(d) A masonry retaining wall is 0.8 m wide at the top and 3.8 m at bottom and retains water level at its top. The wall is 4.8 m high, test the stability of wall against : 7

(i) Tension

(ii) Crushing

(iii) Sliding

(iv) Overturning

Take Weight of masonry = 24 kN/m^3

Bearing capacity of soil = 240 kN/m^2

Co-efficient of friction, $\mu = 0.6$

Factor of safety against overturning = 2.5

UNIT-V

Q. 5. (a) State and explain the reasons of unsymmetrical bending. **2**

(b) A cantilever, of I section 2.5 m long is subjected to a load of 210 N at free end as

shown in figure (4). Determine the resulting bending stresses at corners A & B on the fixed section of the contilever. 7

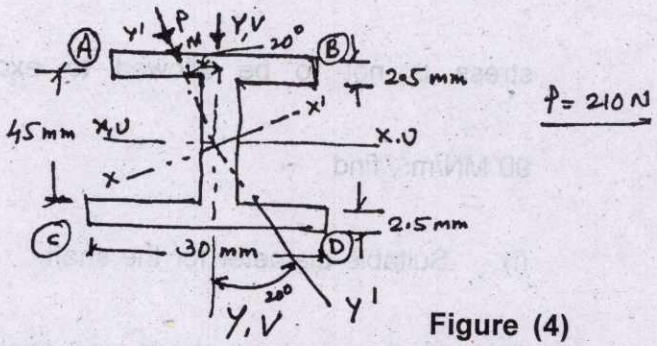

Figure (4)

(c) Determine the position of the shear center of the section of a beam shown in figure (5). 7

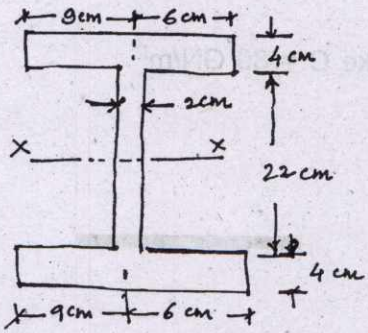

Figure (5)

(d) A solid steel shaft is subjected to a torque of 50 kN-m. If the angle of twist is 0.5° per meter length of the shaft and the shear stress is not to be allowed to exceed 90 MN/m^2, find : 7

(i) Suitable diameter for the shaft

(ii) Maximum shear stress and angle of twist

(iii) Maximum shear strain in the shaft

Take C = 80 GN/m^2