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P.E.S. College of Engineering, Mandya - 571 401

(An Autonomous Institution affiliated to VTU, Belgaum)

Third Semester, B.E. - Mechanical Engineering

Semester End Examination; Dec. - 2015

Mechanics of Materials

Time: 3 hrs *Max. Marks: 100*

***Note**: i) Answer **FIVE** full questions, selecting **ONE** full question from each **unit**.*
ii) Assume suitably missing data if required

UNIT - I

1 a. State and explain Hooke's law with the help of T – E diagram. 6

b. Define Poisson's ratio and proof stress. 4

c. The tensile test was conducted on a M.S. bar. The following data was obtained from the test.

Diameter of steel bar = 16 mm

Gauge length of the bar = 80 mm

Load at proportionality limit = 72 kN

Extension at a load of 60 kN = 0.115 mm

Load at failure = 80 kN

Final Gauge length of bar = 104 mm

Diameter of the rod at failure = 12 mm.

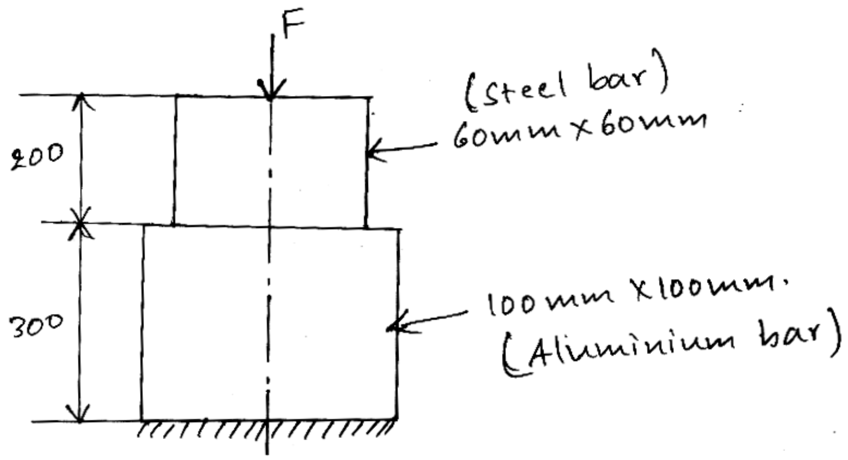
Determine:

i) Young's modulus ii) Proportionality limit iii) % Elongation iv) True breaking stress. 10

2 a. Define Modulus of Rigidity and Bulk modulus. 4

b. Derive an expression to find change in length in a uniformly varying rectangular cross section. 10

c. A member formed by connecting a steel bar to an aluminium bar is as shown in Fig. Assuming that the bars are prevented from buckling sideways, calculate the magnitude of force 'F' that will cause the total length of the member to decrease by 0.3 mm. The values of elastic modulus for steel and Al are 2×10^5 N/mm^2 and 6.5×10^4 N/mm^2 respectively. 6



UNIT - II

3 a. A compound bar is made up of a central steel plate 50 mm wide and 10mm thick to which copper plates 50 mm wide and 5 mm thick are connected rigidly on each side. The length of compound bar at room temperature is 1000 mm. If the temperature is raised by 100º C, determine the stress in each material and the change in length of the compound bar. Assume E_s = 200 GPa, E_c = 100 GPa, $\alpha_s = 12 \times 10^{-6}$/ºC and $\alpha_c = 18 \times 10^{-6}$/ºC. 6

b. At a certain point in a strained material, the stress condition shown in Fig. (1) exists. Find,

i) Normal, shear and resultant stresses on the inclined plane AB

ii) Angle of obliquity

iii) Principal stresses and principal planes 14

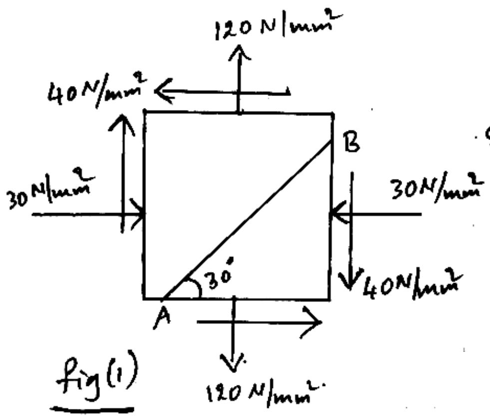
iv) Normal stress on maximum shear stress plane

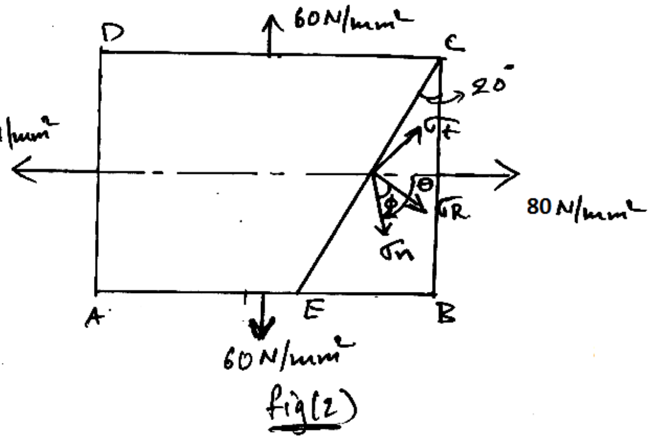
v) Verify the answers by Mohr's circle method.

4 a. A steel tube of 25 mm external diameter and 18 mm internal diameter encloses a copper rod of 15 mm diameter. The ends are rigidly fastened to each other. Calculate the stress in the rod and the tube when the, temperature is raised from 15º to 200ºC. 8

Take; $\alpha_{st} = 11\times10^{-6}$/ºC, $\alpha_{En} = 18\times10^{-6}$/ºC, E_{st} = 200 GPa and E_{cn} = 100 GPa.

b. An element is subjected to principal tensile stresses across 2 perpendicular planes as shown in Fig. (2). Determine normal stress, shear stress and resultant stress on the plane EC. Determine also its obliquity. What will be the intensity of stress which is acting alone will produce the same maximum strain if Poisson's ratio is 0.33? 12

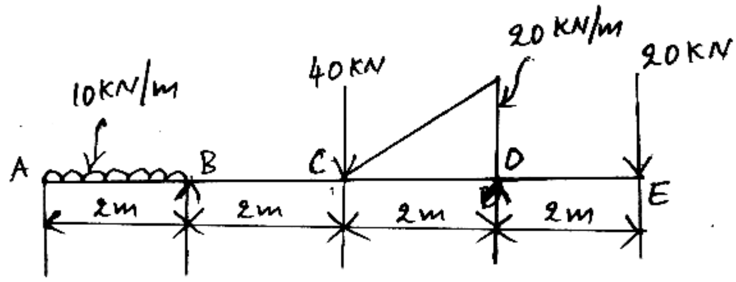




UNIT - III

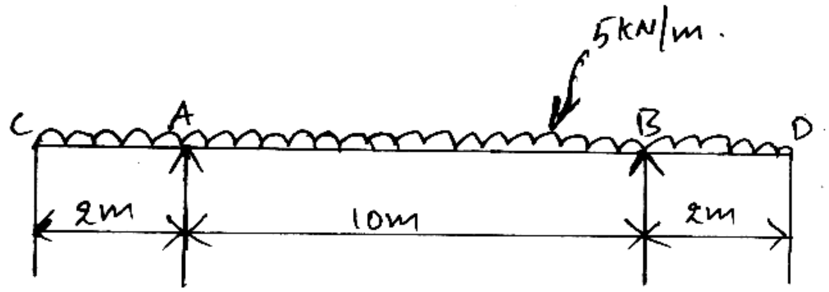
5 a. What are the different types of loads acting on a beam? Explain with sketches. 4

b. Draw the shear force and bending moment diagram for a overhanging beam shown in Fig. and locate the points of contra flexure. 16



6. a. Explain the terms sagging B.M. and Hogging B.M. 4

b. Determine the Bending Moment and Shear force with diagram and compute the point of Contra flexture. 16



UNIT - IV

7 a. Derive the bending equation, $\frac{M}{I} = \frac{E}{R} = \frac{F}{Y}$. 14

b. A cast iron test beam 25 mm x 25 mm cross – section and 1m long, supported at its ends fails when a central load of 800 N is applied on it. What U.D.L will break a cantilever of the same material 50 mm wide, 100 mm deep and 2 m long? 6

8 a. Prove that in case of a rectangular section of a beam, the maximum shear stress is 1.5 times average shear stress. 8

b. A simply supported steel beam having uniform C/S is 14 m span and is simply supported at its ends. It carries a concentrated load of 120 kN and 80 kN at two points 3 m and 4.5 m from the left and right end respectively. If the M.O.I. of the section is 160 x 10^7 mm^4 and E = 210GPa, Calculate the deflection of the beam at load points and mid span. Also find maximum deflection and the point at which it occurs. 12

UNIT - V

9 a. Derive an expression for circumferential stress and longitudinal stress in thin cylinders. 10

b. Find the diameter of the shaft required to transmit 60 kW at 150 rpm, if the maximum torque is 25% greater than the mean torque for a maximum permissible shear stress of 60 MN/m^2. Find also the angle of twist for a length of 4m. Take; G = 80 GPa. 10

10 a. Derive the torsional equation, $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ 10

b. Derive Euler’s crippling load equation for a column when both of its ends are fixed. 10

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