BENGAL ENGINEERING AND SCIENCE UNIVERSITY, SHIBPUR

Fourth Semester B. E. Final Examination 2013

Subject: Strength of Materials (AM 405)

Full Marks: 70
Time: 03 hours

Branch: Min. E. & Met. E.

(i) All symbols have their usual meanings unless specified otherwise.
(ii) Use separate answer-scripts for each of the halves.
(iii) Marks will be deducted for unclear writings and figures.

First Half

Answer Question No.1 and any THREE from the rest.

1 Fill in the blanks: (1 x 5)

(a) The slope of bending moment diagram at any section of a loaded beam is equal to the _____ at that section.

(b) For a beam of solid circular cross section of diameter *d*, the section modulus is _____.

(c) A loaded beam has a rectangular cross section. The ratio of maximum to average shear stresses induced on any of its cross sections is _____.

(d) If the diameter of a long column having a solid circular cross section is reduced by 50%, its critical load is reduced by _____%.

(e) According to maximum distortion energy theory, the failure envelope under plane stress condition is elliptical. If a material has the same yield point of σ_{YP} under both uniaxial tension and compression, the length of major axis of this ellipse is _____.

2 (a) Prove that, for a loaded beam, $V_x = \frac{dM_x}{dx}$

(b) A compound beam made of two bars *AC* and *BC* hinged together at *C* is supported and loaded as shown in Fig.1. Draw the shear force and bending moment diagrams of the compound beam. (2+8)

3 Find out the maximum tensile and compressive stresses induced in the loaded beam shown in Fig.2. (10)

4 (a) Prove that, for a loaded beam, $\tau = \frac{VQ}{I_{NA}\, b}$

(b) A laminated wooden beam is made up of three planks glued together to form a rectangular cross section as shown in Fig.3. The allowable shear stress in the glued joints is 35 MPa. If the beam is 2 m long and simply supported at the ends, what is the safe load that it can carry at its mid-span? What is the corresponding maximum flexure stress? Neglect the self weight of the beam. (4+6)

5 Determine the slope and deflection of the free end of a loaded cantilever shown in Fig.4. The cross section of the beam is hollow circular having 30 mm external diameter and 5 mm wall thickness and the Young's modulus of its material is 200 GPa. Neglect self weight. (10)

6 In the structure shown in Fig.5, the member *AB* is a steel wire of 20 mm diameter while the member *BC* is a steel bar of square cross section (60 mm x 60 mm). If the material is isotropic having the stresses corresponding to proportional limit and yield point as 200 MPa and 400 MPa respectively, determine the safe value of the vertical load *P* applied at *B*. Neglect self weight and take Young's modulus of steel as 200 GPa. (10)

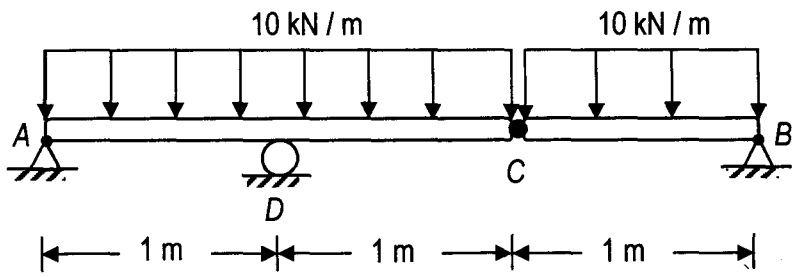
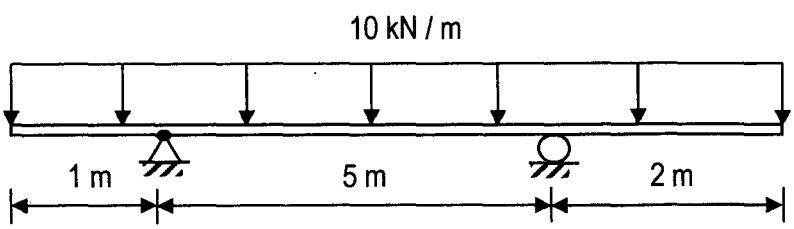
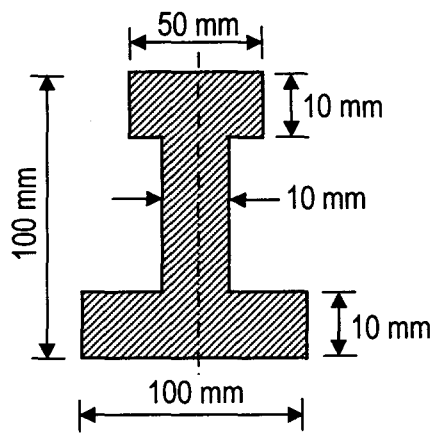


Fig. 1



Loaded beam



Beam cross section

Fig. 2

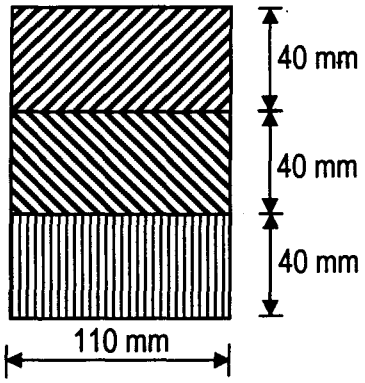


Fig. 3

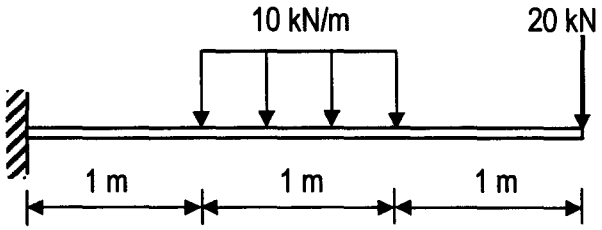


Fig. 4

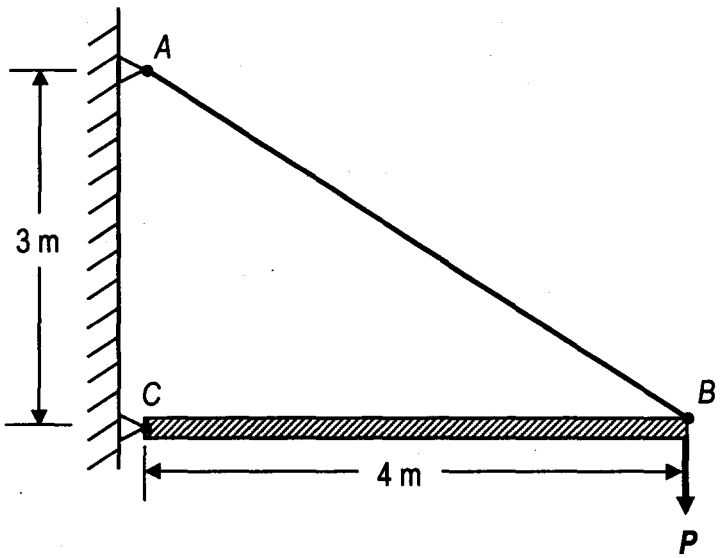


Fig.5

SECOND HALF

(Answer Question No. 7and ANY THREE from rest)

7. Fill in the blanks : [5×1]

   a) The elongation δ of a prismatic bar of length L, cross sectional area A, modulus of elasticity E subjected to an axial tensile force P is given by_____.

   b) In simple tension test the mild steel specimen fails at a load _____ than the ultimate load.

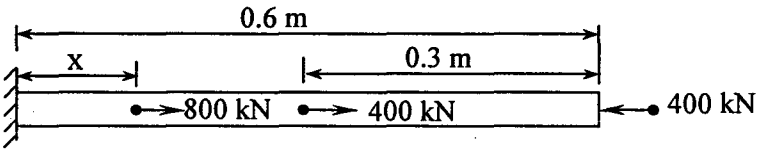
   c) Increase of temperature induces _____ in restrained structural members.

   d) In bi-axial state of stress, principal planes are those in which _____ vanish.

   e) The total angle of twist ϕ for a circular shaft of length l subjected to a torque T is given by _____.

8. A hollow steel shaft is to have outside diameter 1.5 times of its inside diameter. Calculate the proper outside diameter of the shaft if it has to transmit a power of 180 hp at 100 rpm with working stress in shear is 45 Mpa. [*10*]

9. A prismatic steel bar having cross sectional area A = 500 mm^2 is subjected to axial loads as shown in figure. Neglecting localized irregularities in stress distribution find out at what distance 'x' from the fixed support the 800 kN load should be applied to maintain no change in the length of the bar. (E_S = 200 GPa.). (1Pa = 1N/m^2). [*10*]



10. Two bars A and B are made up of same material. The bar A is prismatic with uniform diameter d over its entire length whereas bar B is of diameter $d/3$ for half of its length and rest of the bar is with diameter $2d$. Determine the ratio of the strain energy stored in bars A and B if both are subjected to same axial tensile force and are of same length. [*10*]

11. A two dimensional rectangular element is subjected to a compressive stress of 60 MPa on its shorter side and a tensile stress of 100 MPa on its longer side. Find out the normal and shear stress in a plane which makes an angle of 60° with longer side. [*10*]

12. A brass rod 90 cm long has a cross-sectional area of 10 cm^2 over 50 cm of its length and 15 cm^2 over the remaining length. At a temperature T = 20 °C the rod fits exactly between unyielding walls at its two ends. Compute the maximum compressive stress that will exist in the rod at T = 60 °C. Take $\alpha_b = 18\times10^6$ /°C and E_b = 100 GPa. [*10*]