Total No. of printed pages = 6

ME 131302

Roll No. of candidate | | | | | | | | | | |

2017

B.Tech. 3rd Semester End-Term Examination

Mechanical

MECHANICS OF MATERIALS

Full Marks – 100 Time – Three hours

The figures in the margin indicate full marks for the questions.

Answer Q. No. 1 and any *six* from the rest.

All parts of a question are to be answered in the same place.

1. Answer the following : (10 × 1 = 10)

   (a) The normal stresses acting in two perpendicular directions at a point are called ———— stresses.

   (b) The angle between a normal stress and a shear stress on a plane at a point is ————.

   (c) The state of stress in a plane at a point is defined by ———— stress components.

   (d) The magnitude of shear stress in a principal plane is ————.

   (e) The ratio of lateral strain to longitudinal strain is called ———— ratio.

[Turn over

(f) Principal planes are ———— degrees apart.

(g) At the point of ———— of a beam, bending moment is zero.

(h) For simply supported beam loaded with symmetrical loading, maximum slope occurs at the

(i) Euler's formula for critical load holds good only for ———— columns.

(j) The deformation of a body caused by external loading is stored as ———— energy in the body.

2. (a) A short metallic column of 500 mm^2 cross sectional area carries an axial tensile load of 100 kN. For a plane inclined at 60° with the direction of load, calculate (i) Normal stress; (ii) Tangential stress. (2 + 1 = 3)

(b) Define :

(i) Principal stress;

(ii) Average stress; (1 + 1 = 2)

(c) At a point in a strained material, the principal stresses are 140N/mm^2 (tensile) and 60N/mm^2 (compressive). Determine the resultant stress in magnitude and direction on a plane inclined at 45° to the axis of major principal stress. What is the magnitude of maximum shear stress in the material at that point? (4 + 4 + 2 =10)

3. (a) A point in a strained material is subjected to stresses shown in Fig. 1. Using Mohr's circle method, determine the normal and tangential stresses across the oblique plane. (4 + 3 + 3 = 10)

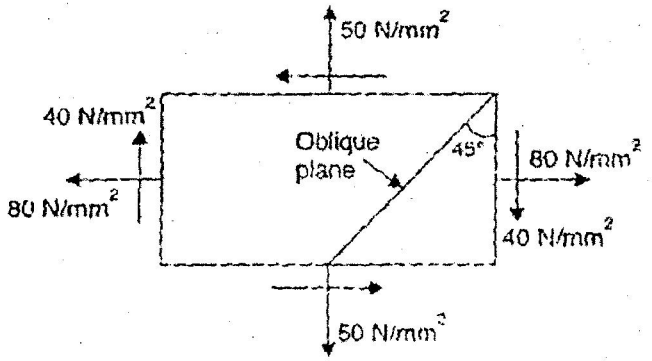

Fig. 1

(b) Derive the normal and shear strains of 60° strain rosette with reference to the equation :

$\epsilon_\theta = \epsilon_x \cos^2\theta + \epsilon_y \sin^2\theta + \gamma \cos\theta \sin\theta$; where ϵ and γ represent normal and shear strain respectively at a point. (5)

4. (a) The readings of a strain gauge rosette inclined at 45° with each other are 4×10^{-6}, 3×10^{-6} and 1.6×10^{-6}, the first gauge being along x-axis. Determine principal strains and their planes. (3 + 3 +2 + 2 =10)

(b) Find the expression for the shear force and bending moment of a simply supported beam of length 'L' subjected to a uniformly distributed load of w' over the entire span and sketch the shear force and bending moment diagrams. (2 + 3 = 5)

5. (a) Define shear force and bending moment at a section in a beam. (2)

(b) Draw bending moment and shear force diagrams for the simply supported beam at A and B with loads as shown in the following Fig. 2 (5)

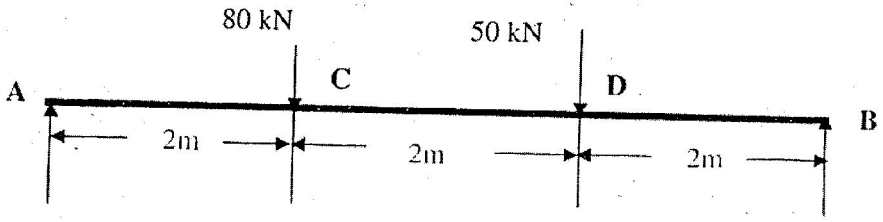

Fig. 2

(c) A simply supported beam of 10m length freely supported at its end carries a concentrated load of 5kN each at a distance 3m and 7m from the left support and also a uniformly distributed load of 2kN/m over a distance 3m from the left support. Draw shear force and bending moment diagrams for the beam. (4 + 4 =8)

6. (a) Draw shear force and bending moment diagrams for the cantilever shown in Fig.3 (3 + 4 = 7)

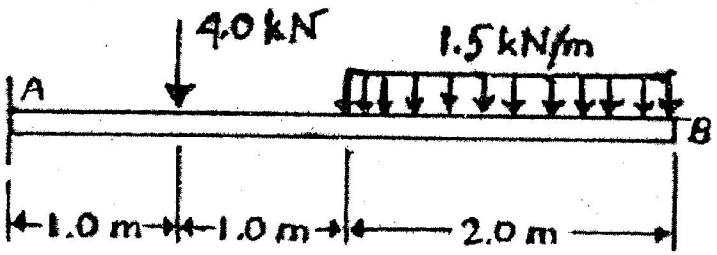

Fig. 3

(b) Derive the expression for the maximum slope and maximum deflection for a simply supported beam of length 'L' carrying a concentrated load of 'W' at the mid-span.

If W= 50 kN; L = 10m; M.I about the neutral axis = $8\times10^{8}\,mm^{4}$ and E = 200GPa, find the maximum slope and maximum deflection of the beam. (6 + 1 + 1 = 8)

7. (a) Define critical load of a column. (2)

(b) What are the differences between a column and a strut? What do you mean by equivalent length of a column'? (3 + 3 = 6)

(c) A hollow steel tube 20cm external diameter and 1cm thick is 4m long. If E for the tube material be $2\times10^{4}\,kN/cm^{2}$, determine the safe buckling load on the hollow tube, if :

(i) Both ends of the tube are fixed

(ii) One end fixed and the other end free

Take factor of safety = 4 (4 + 3 = 7)

8. (a) What is strain energy? Derive the expression for the energy stored in a body due to pure bending. (1 + 6 = 7)

(b) Find the thickness of a thick metal cylinder of internal diameter 160mm to withstand an internal pressure of $60N/mm^{2}$. The Hoop's stress is not to exceed $145\ N/mm^{2}$. (8)

9. Write short notes on (any *three*) $(3 \times 5 = 15)$

(a) Section modulus of a beam;

(b) Equiangular strain rosette

(c) Rakine's formula

(d) Elastic curve

(e) Lame's equation

(f) Shrunk fit cylinder

(g) Castigliano's theorem.