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ME 131302

Roll No. of candidate

2019

B.Tech. (ME) 3rd Semester End-Term Examination

MECHANICS OF MATERIALS

(New Regulation)

(w.e.f. 2017-2018)

Full Marks – 70 Time – Three hours

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

Answer question No. 1 and any *four* from the rest.

1. Fill in the blanks : (10 × 1 = 10)
   (i) The shear stress on the principal plane is ————.
   (ii) In a Mohr's circle, the maximum shear stress is given by the ————.
   (iii) A strain rosette consists of at least ———— strain gauges.
   (iv) The end portion of a beam which is extended beyond the support is called ————.
   (v) Wherever the shear force is zero, the bending moment is ————.

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(vi) In case of pure bending, ———— is directly proportional to the distance from the neutral axis.

(vii) A material is said to be ———— if its physical properties have the same value in all directions.

(viii) Euler's formula is based on the assumption that the columns are initially ————.

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

(x) A bending moment causing convexity upwards is taken as negative bending moment and is called ———— bending moment.

2. (a) What are principal stresses and principal planes? (2)

(b) Deduce expressions for stresses on an inclined plane in a body subjected to a bi-axial stress condition. (5)

(c) A piece of material is subjected to two perpendicular tensile stresses of 300 MPa and 150 MPa. Determine the normal and shear stress components and their resultant on a plane the normal of which makes an angle of 40° with the 300 MPa stress. (8)

3. (a) The stresses on two perpendicular planes through a point in a body 30 MPa and 15 MPa both tensile along with a shear stress of 25 MPa. Using Mohr's circle, find the magnitude and direction of the principal stresses, the planes of maximum shear stress and the normal and shear stresses on the planes of maximum shear stress. (10)

(b) The readings on the gauges of a rectangular strain rosette are 400×10^{-6}, 200×10^{-6} and -100×10^{-6} respectively with the first gauge being along x-axis. Determine the principal strains and principal stresses. $E = 210$ GPa, $\upsilon = 0.3$. (5)

4. (a) Find the expression for shear force and bending moment for a simply supported beam of length L carrying a uniformly distributed load w per unit length. (5)

(b) A simply supported beam of 8 in length carries three point loads of 8 kN, 4 kN and 10 kN at 2 m, 5 in and 6 m respectively from the left end. Draw the shear force and bending moment diagrams. (10)

5. (a) What is pure bending? What are the assumptions made for a beam subjected to pure bending? (1+4=5)

(b) Deduce the relation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with their usual notations for a beam subjected to pure bending. (10)

6. (a) Derive the expression for the maximum slope and deflection for a cantilever of length L carrying a load W at the free end. (5)

(b) A simply supported beam of 8 m length carries two point loads of 64 kN and 48 kN at 1 m and 4 m respectively from the left end. Find the deflection under each load and the maximum deflection. $E = 210$ GPa, $I = 180 \times 10^6$ mm^4. (10)

7. (a) Define strain energy and resilience. (3)

(b) Derive the expression for strain energy for a three dimensional stress system. (5)

(c) A steel rope lowers a load of 9.5 kN with uniform velocity of 750 mm/s. When the length of the rope unwound is 8 m, it suddenly gets jammed and the load is brought to a halt. Determine the stresses developed in the rope due to sudden stoppage and the maximum instantaneous elongation if the diameter of the rope is 20 mm. $E_s = 205$ Gpa. (7)
