CBCS Scheme

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15ME/MA34

Third Semester B.E. Degree Examination, Dec.2017/Jan.2018
Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

Note: Answer any FIVE full questions, choosing one full question from each module.

Module-1

1 a. Define :
i) Hooke's law ii) Poisson's ratio iii) Factor of safety
iv) Bulk modulus v) Modulus of elasticity. **(05 Marks)**

b. Draw and explain stress-strain diagram of a mild steel specimen subjected to tension test. **(05 Marks)**

c. A circular rod of 100mm diameter and 500mm length is subjected to a tensile load of 1000kN. Determine the i) Modulus of rigidity ii) Bulk modulus iii) Change in volume. Take Poisson's ratio = 0.30 and E = 200GPa. **(06 Marks)**

OR

2 a. Define :
i) Elasticity ii) Plasticity iii) Resilience iv) Toughness v) Stiffness. **(05 Marks)**

b. Derive a relation between modulus of elasticity and bulk modulus. **(05 Marks)**

c. A bar of brass 25mm diameter is enclosed in a steel tube of 50mm external diameter and 25mm internal diameter. The bar and the tube fastened at the ends and are 1.5m long. Find the stresses in the two materials when the temperature raises from 30°C to 80°C.
Take : $E_{steel} = 200$ GPa ; $E_{brass} = 100$GPa,
$\alpha_{steel} = 11.6 \times 10^{-6}/°C$; $\alpha_{brass} = 18.7 \times 10^{-6}/°C$. **(06 Marks)**

Module-2

3 a Derive an expression for normal stress, shear stress and resultant stress on an oblique plane inclined at an angle θ with vertical axis (x-plane) in a biaxial stress system subjected to σ_x, σ_y and τ_{xy} also find angle of obliquity ϕ. **(10 Marks)**

b. Derive expressions for hoop stress and longitudinal stress for a thin cylinder subjected to internal fluid pressure. **(06 Marks)**

OR

4 a. A point in a strained material in subjected to a tensile stress of 500N/mm^2 and 300N/mm^2 in two mutually perpendicular planes and also these planes carries a shear stress of 100N/mm^2. Calculate the normal, tangential, resultant stresses (σ_θ, τ_θ, σ_r) on a plane making an angle of 30° with the vertical axis (x-plane). Also find principal stresses. **(10 Marks)**

b. A thin cylindrical shell 1.2m in diameter and 3m long has a metal wall thickness of 12mm. It is subjected to an internal pressure of 3.2MPa. Find the circumferential and longitudinal stress in the wall. Also determine change in volume of the cylinder. Assume E = 210 GPA and $\mu = 0.30$. **(06 Marks)**

Module-3

5 For the beam shown in Fig. Q5. Draw shear force and bending moment diagrams. Locate the point of contraflexure if any. **(16 Marks)**

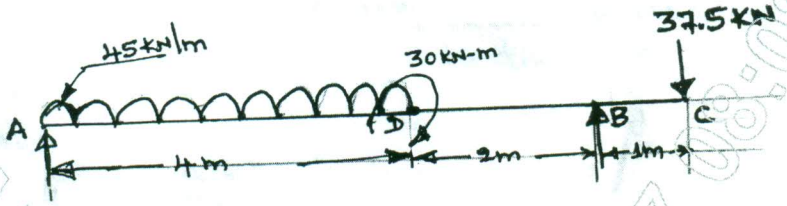

Fig Q5

OR

6 a. Derive the relationship between load shear force and bending moment for UDL. **(04 Marks)**

b. List the assumptions made in theory of pure bending. Write the bending equation with usual notations with their meanings. **(06 Marks)**

c. Derive an expression relating slope, deflection and radius of curvature in a beam in terms of E, I an M with usual notations. **(06 Marks)**

Module-4

7 a. State the assumption made in pure torsion and derive $\frac{T}{J_p} = \frac{G\theta}{L} = \frac{\tau}{R}$ with usual meanings. **(08 Marks)**

b. A 1.5m long column has circular cross section of 50mm diameter. One end of the column is fixed in direction and position and the other end is free. Taking the factor of safety as 3 calculate :

i) Safe load according to Rankine's formula taking $\sigma_c = 560MPa$ and $\alpha = \frac{1}{1600}$

ii) Safe load according to Euler's formula taking $E = 120GPa$. **(08 Marks)**

OR

8 a. State the assumptions made while deriving Euler's column formula. Also derive Euler's expression of buckling load for column with both ends hinged. **(08 Marks)**

b. A solid circular shaft has to transmit a power of 1000 kW at 120rpm. Find the diameter of the shaft if the shear stress of the material must not exceed $80N/mm^2$. The maximum torque is 1.25 times the mean torque. If this solid shaft is replaced by hollow one whose internal diameter is 0.6 times its external diameter, find diameter of hollow shaft. **(08 Marks)**

Module-5

9 a. Explain: i) Castigliano's first theorem ii) Castigliano's second theorem. **(08 Marks)**

b. Write a note on :

i) Maximum principal stress theory ii) Maximum shear stress theory. **(08 Marks)**

OR

10 a. A hollow circular shaft of 2m length has an external diameter of 100mm and a thickness of 10mm. If it is subjected to a torque of 10kN-m, determine the strain energy stored in the shaft. Take G= 80Gpa. **(04 Marks)**

b. The plane state of stress at a point is given $\sigma_x = 70MPa$; $\sigma_y = 140MPa$; $\tau_{xy} = -35MPa$. If the yielding stress in tension in 175MPa, check whether there is failure according to

i) Maximum principal stress theory

ii) Maximum shear stress theory

If the material is safe then find the factor of safety. **(12 Marks)**

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