CBCS SCHEME

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15AU34

# Third Semester B.E. Degree Examination, Jan./Feb. 2021
## Mechanics of Materials

Time: 3 hrs. Max. Marks: 80

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

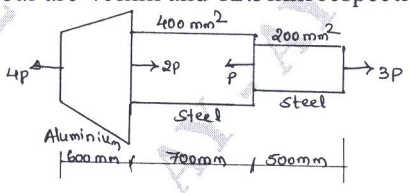


### Module-1

1 a. Derive an expression for analysis of uniform tapering circular bar. **(08 Marks)**

b. A round bar with stepped portion is subjected to the forces as shown in Fig.Q.1(b). Determine the magnitude of force P, such that net deformation in the bar does not exceed 1mm. E for steel is 200GPa and that of aluminium is 70GPa. Big end diameter and small end diameter of the tapering bar are 40mm and 12.5mm respectively. **(08 Marks)**

Fig.Q.1(b)

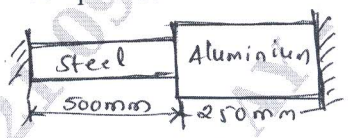



**OR**

2 a. Define: i) Ductility ii) Malleability iii) Toughness iv) Stress v) Strain vi) Poissons Ratio vii) Hooke's law viii) Volumetric strain ix) Bulk modulus. **(08 Marks)**

b. A composite bar made up of aluminium and steel is held between two supports as shown in Fig.Q.2(b). The bars are stress free at temperature 42°C. What will be the stresses in the two bars with the temperature drops to 24°C if i) The supports are unyielding ii) The supports come nearer to each other by 0.1mm. The cross-sectional area of steel bar is $160mm^2$ and that of aluminium bar is $240mm^2$. $E_A = 0.7 \times 10^5 N/mm^2$, $E_s = 2 \times 10^5 N/mm^2$, $\alpha_A = 24 \times 10^{-6}$ per °C, $\alpha_S = 12 \times 10^{-6}$ per °C. **(08 Marks)**

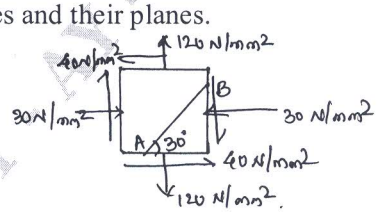
Fig.Q.2(b)




### Module-2

3 At a certain point in a strained material the stress condition shown in Fig.Q.3 exists. Find,
i) Normal and shear stresses on the inclined plane AB
ii) Principal stresses and principal planes
iii) Maximum shear stresses and their planes. **(16 Marks)**

Fig.Q.3




**OR**

4 a. Derive an expression for longitudinal stress in a thin cylinder. **(06 Marks)**

b. A pipe of 500mm internal diameter and 75mm thick is filled with a fluid at a pressure of $6N/mm^2$. Find the maximum and minimum hoop stress across the cross section of the cylinder. Also sketch the radial pressure and hoop stress distribution across the section. **(10 Marks)**

## Module-3

5 a. Explain different types of loads in beam. **(04 Marks)**

b. Draw shear force and bending moment diagrams for the beam shown in Fig.Q.5(b). Locate point of inflexion if any. **(12 Marks)**

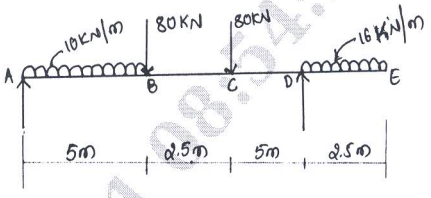



Fig.Q.5(b)

**OR**

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

b. Determine the slope and deflection at the free end of the cantilever shown in Fig.Q.6(b). Take $I = 200 \times 10^{-6} m^4$, $E = 2 \times 10^8 kN/m^2$. **(10 Marks)**

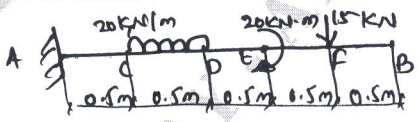



Fig.Q.6(b)

## Module-4

7 a. Derive $\frac{T}{J_p} = \frac{\tau}{R} = \frac{G\theta}{\ell}$ with usual meanings. **(08 Marks)**

b. A solid shaft rotating at 1000rpm transmits 50kW. Maximum torque is 20% more than the mean torque. Materials of the shaft has the allowable shear stress of 50MPa and modulus of rigidity 80GPa. Angle of twist in the shaft should not exceed 1° in one metre length. Determine the diameter of the shaft. **(08 Marks)**

**OR**

8 a. Derive the expression for Euler's critical load for a long column with both end fixed. **(08 Marks)**

b. A 1.5m long column has a 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 the safe load using i) Rankine's formula taking yield stress $560 N/mm^2$ and $\alpha = 1/1600$ ; ii) Euler's formula, taking $E = 1.2 \times 10^5 N/mm^2$. **(08 Marks)**

## Module-5

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

b. A simply supported beam of span '$l$' carries a point load 'P' at mid-span. Determine the strain energy stored by the beam. Also find the deflection at mid-span. **(08 Marks)**

**OR**

10 a. Write a note on:

i) Maximum principal stress theory

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

b. A rod of circular section is to sustain a torsional moment of 300kN-m and bending moment 200kN-m. Selecting 45C8 steel ($\sigma_{y_t} = 353MPa$) and assuming factor of safety = 3, determine the diameter of rod as per following theories of failure.

i) Maximum shear stress theory

ii) Maximum normal stress or maximum principal stress theory. **(08 Marks)**

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