CBCS SCHEME

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18MT33

# Third Semester B.E. Degree Examination, Jan./Feb. 2023
## Mechanics of Materials

Time: 3 hrs. Max. Marks: 100

***Note: 1. Answer any FIVE full questions, choosing ONE full question from each module.***
***2. Write neat sketches, mention units wherever necessary.***



### Module-1

1 a. Define the following and mention their units:
i) Modulus of Elasticity
ii) Modulus of Rigidity
iii) Bulk modulus
iv) Factor of safety
v) Poisson's ratio. **(10 Marks)**

b. Draw stress strain curve of a mild steel specimen subjected to tension test. Mention all salient points on the curve. Briefly explain. **(04 Marks)**

c. A circular rod of 100mm diameter and 500mm length is subjected to tensile load of 1000kN. Determine:
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. Derive relation between modulus of elasticity and modulus of rigidity. **(08 Marks)**

b. Derive an expression for the extension of uniformly tapering circular bar. **(06 Marks)**

c. Obtain relation between E, G, K. **(06 Marks)**

### Module-2

3 Derive an expression for normal stress, shear stress and resultant stress on an oblique plane inclined at an angle $\theta$ with vertical axis (X-plane) in a biaxial stress system subjected to $\sigma_x$, $\sigma_y$ and $\tau_{xy}$ also find angle of obliquity $\phi$ for Fig.Q.3 shown.

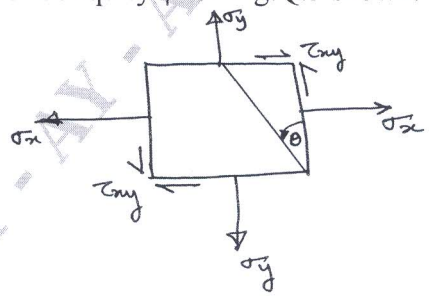


Fig.Q.3

If $\sigma_x = 60MPa$, $\sigma_y = 40MPa$, $\tau_{xy} = 20MPa$, $\theta = 30°$. Find $\sigma_\theta$, $\tau_\theta$, $\sigma_R$ and $\phi$. **(20 Marks)**

**OR**

4 The state of stress in 2 dimensionally stressed body is as shown in Fig.Q.4. Determine the principal stresses, principal planes, maximum shear stress and its planes, average normal stress.

Also find normal, tangential and resultant stress ($\sigma_\theta$, $\tau_\theta$ and $\sigma_R$) on inclined plane. Solve the problem either analytically or graphically by drawing Mohr's circle.

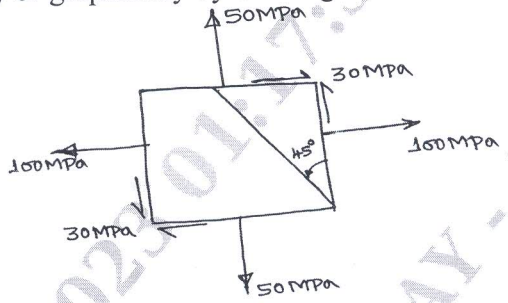


Fig.Q.4

**(20 Marks)**

## Module-3

5 a. What are Hogging bending moment and sagging bending moment? Explain with neat sketch. **(04 Marks)**

b. For the beam shown in Fig.Q.5(b) draw the SFD and BMD.

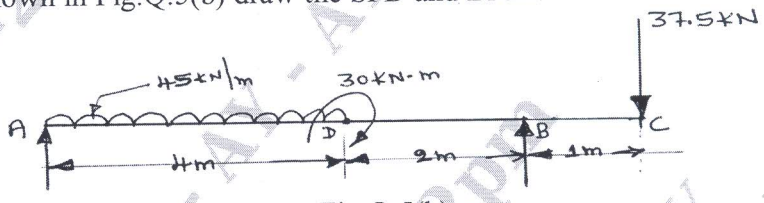


Fig.Q.5(b)

**(16 Marks)**

**OR**

6 a. Derive relation between load, shear force and bending moment with usual notations. **(04 Marks)**

b. Define a beam and list the types of beams with sketches. **(04 Marks)**

c. Draw SFD and BMD for a simply supported beam shown in Fig.Q.6(c). **(12 Marks)**

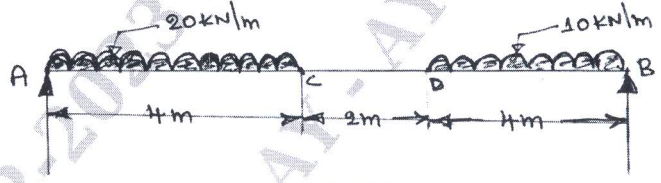


Fig.Q.6(c)

## Module-4

7 a. Derive bending equation $\frac{M}{I} = \frac{\sigma}{y} = \frac{E}{R}$ with usual notations. Also list all the assumptions. **(10 Marks)**

b. What is section modulus? Explain. Obtain section modulus for the following with neat sketches.

i) Rectangular section
ii) Hollow rectangular section
iii) Circular section
iv) Hollow circular section. **(10 Marks)**

**OR**

8 a. Derive deflection equation for a simply supported beam subjected to uniformly distributed load. Also find an equation for its maximum deflection. **(10 Marks)**

b. For the beam loaded as shown in Fig.Q.8(b) find equation of slope and deflection. Using this equation find deflection at C and D. Take E = 200GPa and I = $3 \times 10^8 mm^4$. **(10 Marks)**

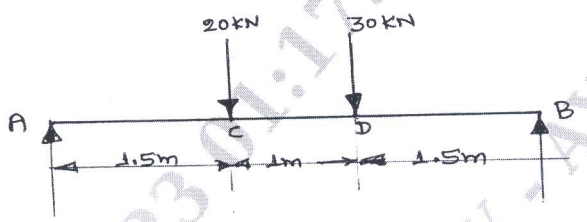


Fig.Q.8(b)

## Module-5

9 a. Derive the torsion formula, in the standard form $\frac{T}{J_p} = \frac{G\theta}{L} = \frac{\tau_{max}}{R}$ and list all the assumptions made while driving. **(10 Marks)**

b. Find the diameter of the shaft required to transmit 60kW at 150rpm, if the maximum torque is 25% greater than the mean torque for a maximum permissible shear stress of 60MPa. Find also the angle of twist for a length of 4m. Take G = 80Gpa. **(10 Marks)**

**OR**

10 a. List the assumptions made in Euler's column theory. Derive Euler's expression for buckling load when both the ends are hinged. **(10 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 factor of safety as 3, calculate safe load using

i) Rankine's formula taking yield stress 560MPa and $\alpha = 1/1600$.

ii) Euler's formula taking $E = 1.2 \times 10^5 N/mm^2$. **(10 Marks)**

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