B.E. Mechanical Engineering (Model Curriculum) Semester - IV

# PCCME204 - Strength of Materials

P. Pages : 3 **GUG/S/23/14064**

Time : Three Hours * 2 8 0 1 * Max. Marks : 80

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Notes : 1. All questions carry equal marks.
2. Due credit will be given to neatness and adequate dimensions.
3. Assume suitable data wherever necessary.
4. I.S. Hand Book for structural steel section, I.S. Code 8000/1962 or 1964, I.S. 456 (Revised), I.S. 875 may be consulted.
5. Solve Q. 1 or Q. 2, Q. 3 or Q. 4, Q. 5 or Q. 6, Q. 7 or Q. 8, Q. 9 or Q. 10

**1.** a) Derive the relationship between young's modulus of elasticity (E), modulus of rigidity (G) and Poisson's ratio ($\mu$) . **6**

b) A specimen of steel 20 mm diameter with a gauge length of 200 mm is tested to destruction. It has an extension of 0.25 mm under a load of 80kN and the load at the elastic limit 102kN. The maximum load is 130kN. The total extension at fracture is 56mm and diameter at neck is 15mm find **10**

i) The stress at elastic limit
ii) Young's modulus
iii) Percentage elongation
iv) Percentage reduction in area
v) Ultimate tensile stress

**OR**

**2.** a) An element in a stressed component is subjected to normal stresses and shear stress as shown in fig. (2-a) Determine Analytically **8**

i) Maximum principal stress ($\sigma 1$)
ii) Minimum principal stress ($\sigma 2$)
iii) Maximum shear stress ($z_{mix}$)
iv) Position of principal planes

Also verify the results by Mohr's Circle method.

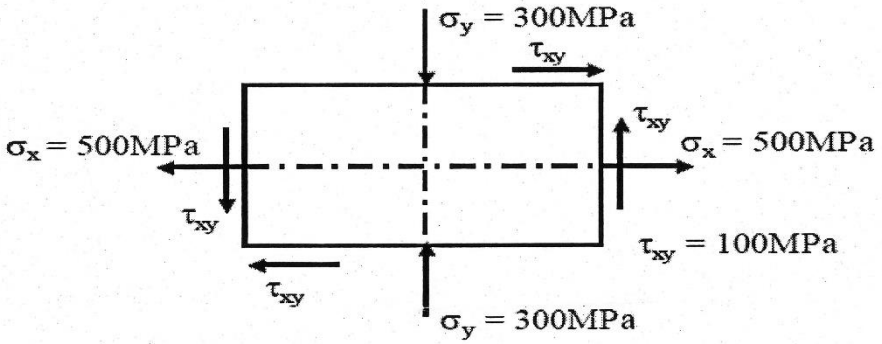


fig. (2-a)

b) A circular bar of dia. 50mm and length 250mm is fixed at one end and free at other. It is subjected to Bending load $P_b$ of 3.5kN and Torque T of 2kN.m as shown in fig. (2-b) Determine **8**

i) Maximum principal stress and
ii) Maximum shear stress at the critical points A and B.

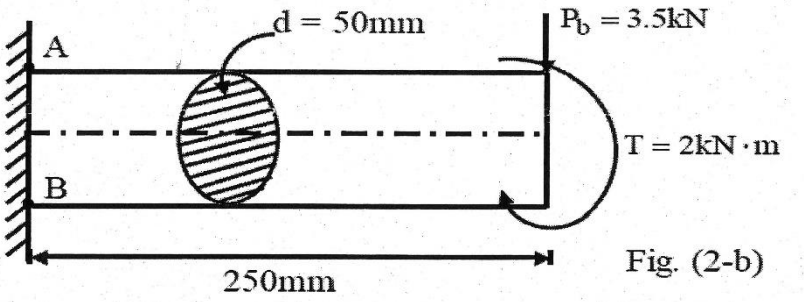

Fig. (2-b)

**3.** a) Draw S.F. and B. M. diagram for the beam loaded as shown in fig. 3 a and determine: **10**

i) The position and magnitude of the maximum B. M. and
ii) The position of any point of contraflexure

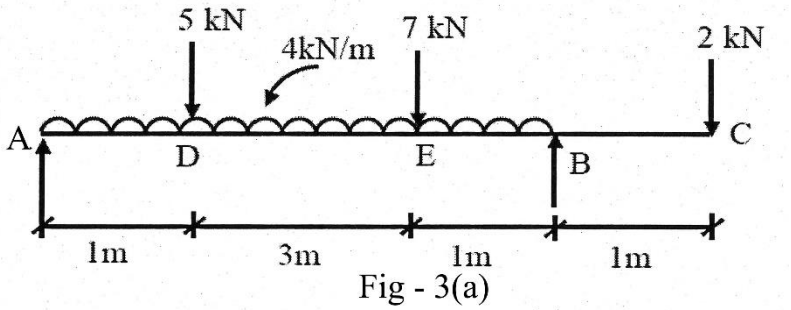

Fig - 3(a)

b) A 0.5 m long cantilever is 20 mm x 40 mm in section is subjected to a load of 250 N at free end. Determine bending stresses- **6**

i) At the top of the beam
ii) At centroid of the beam
iii) At 10 mm from the bottom of the beam and
iv) At the bottom of the beam.

**OR**

**4.** a) A cast iron test beam 20 mm x 20 mm in section and 1m long and supported at the ends fails when a central load of 640N is applied. What uniformly distributed load will break a cantilever of the same material 50mm wide, 100mm deep and 2m long? **6**

b) Derive the bending equation. Also write the assumptions. **10**

$$\frac{M}{I}+\frac{\sigma_b}{y}+\frac{E}{I}$$

**5.** A beam is 10m long and is simply supported at the ends. It carries concentrated loads of 100kN and 60kN at distances of 2m and 5m respectively from the left end. Calculate the deflection under each load. Find also the maximum deflection. **16**

Take $I = 18\times10^8 mm^4$ and $E = 200kN/mm^2$ use Macaulay's method.

**OR**

**6.** a) A simply supported beam carries UDL of intensity wN/m over its entire span 'L' show that the maximum deflection at its center is given by **8**

$$Y_{max} = \frac{5wL^4}{384EI}$$

b) A cantilever of length 2 meters carries a UDL of 2.5kN/m for a length of 1.25m from the fixed end and a point load of 1kN at the free end. If the section is rectangular 120mm side and 240mm deep, find the deflection at the free end. Take $E = 1 \times 10^5 N/mm^2$. **8**

**7.** a) Derive the torsion equation and state the assumptions made in it. **8**

$$\frac{T}{J} + \frac{\tau}{r} + \frac{C\theta}{1}$$

b) A shaft has to transmit 105kW at 160 rpm. If the shear stress is not to exceed $65N/mm^2$ and the twist in a length of 3.5m must not exceed 1º, find a suitable diameter. Take $C = 8 \times 10^4 N/mm^2$. **8**

**OR**

**8.** a) Define the 'column' and 'strut' with example. **3**

b) Explain the failure of 'short column' and 'Long column'. **4**

c) Derive the expression for the crippling load when one end of the column is fixed and the other end free. **9**

**9.** a) A bar 100 cm in length is subjected to an axial pull, such that the maximum stress is equal to 150 MPa. Its area of cross-section is $2cm^2$ over a length of 95cm and for the middle 5cm length, it is only $1cm^2$. If E = 200 GPa Calculate strain energy stored in the bar. **8**

b) Show that the maximum stress inducted in the body due to suddenly applied load is twice the stress induced when the same load is applied gradually. **8**

**OR**

**10.** Write short notes on the following **any four.** **16**

i) Castigliano's theorem.

ii) Modulus of rupture and section modulus.

iii) Limitations of Euler's formula.

iv) Importance BM diagram and S.F. diagram for the beam.

v) Mohr's circle.

vi) Effect of temperature on stress and strain in the bar.

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