ARYA COLLEGE OF ENGINEERING
GUESS PAPER

(B. Tech. III Semester 2025- 2026)

3ME4-07 Mechanics of Solids

Unit 1:

Short Answers: (2 Marks Each)

1. What is tensile stress? Define it.
2. Define Compressive stress.
3. What is shear stress?
4. Explain hooke's law.
5. Explain stress-strain curve.
6. Define modulus of rigidity, poisson's ratio and modulus of elasticity.

Descriptive Answers: (5 to 20 Marks)

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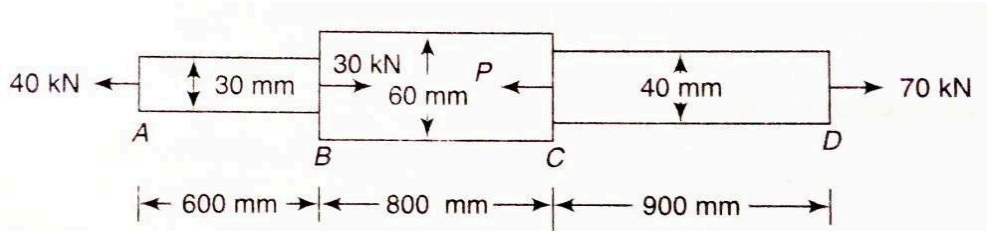
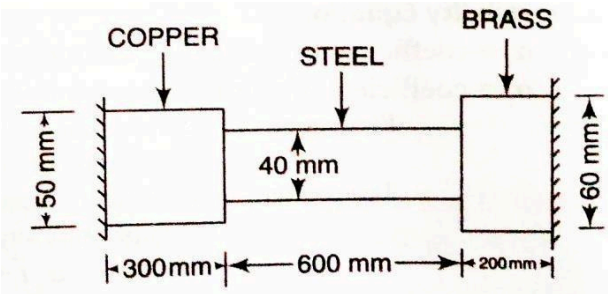
1. A circular steel bar having three segments is subjected to various forces at different cross section as shown in figure below. Determine the necessary force to be applied at section C for the equilibrium of the bar. Also, find the total elongation of the bar.
   Take E= 202 GPa.



2. A composite bar is made up of copper, steel and brass is rigidly attached to the end supports as shown in the figure. Determine the stresses in the three portion of the bar when the temperature of the composite system is raised by 70^0C if,
   (i) The supports are rigid, (ii) The support yield by 0.6 mm.

   E_c= 100 GPa, E_s= 205 GPa, E_b= 95 GPa

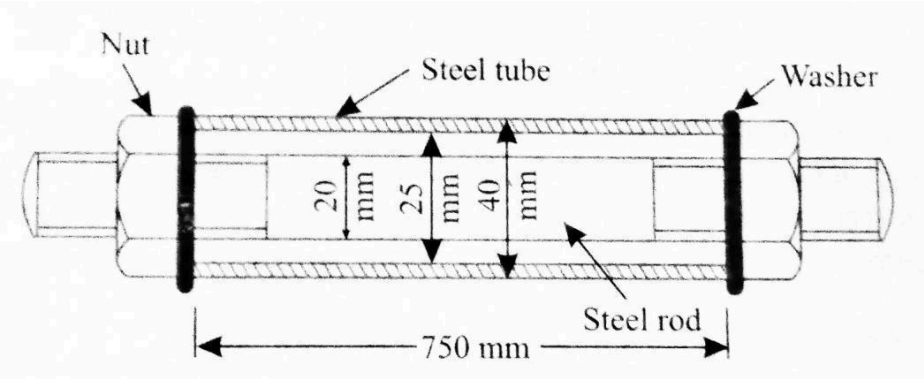
   α_c= 18 x $10^{-6}/^0$C, α_s= 11 x $10^{-6}/^0$C, α_b= 19 x $10^{-6}/^0$C.



3. A steel rod 20 mm diameter passes centrally through a steel tube of 25 mm internal diameter and 40 mm external diameter. The tube is 750 mm long and is closed by rigid washers of negligible thickness which are fastened by nuts threaded on the rod. The nuts are tightened until the compressive load on the tube is 20 kN. Calculate the stresses in the tube and rod.
   Find the increase in these stresses when one nut is tightened by one quarter of a turn relative of

other. There are 0.4 threads per mm length.

Take E = 200 GN/m^2.



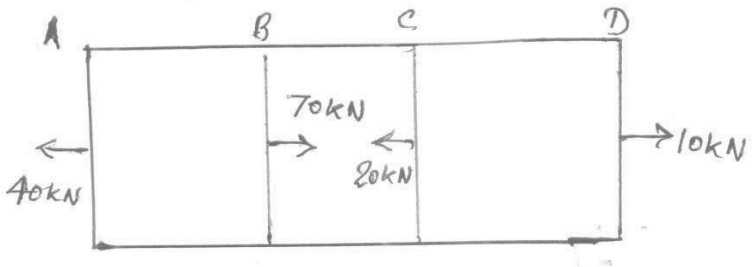
4. Derive an expression between modulus of elasticity and modulus of rigidity.
5. Prove that total expansion of a uniform tapering rod of dia D1 and D2, when the rod is subjected to an axial load P,

$$dL = 4PL/\pi ED1D2,$$

where, L= length of road.

6. A brass bar, having cross sectional area of 900 mm^2 is subjected to axial forces as shown in figure in which AB = 0.6 m, BC = 0.8 m and CD = 1.0 m. Find the elongation of bar.

(Diagram given in the RTU question paper is wrong. Please consider 10 kN on wall D as compressive in nature instead of tensile.)



7. Derive the relation between young modulus , bulk modulus and poissons ratio.
8. Derive the relation for the elongation of bar due to its self weight.

Unit 2:

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Short Answers: (2 Marks Each)

1. What do you understand by the term point of contra-flexure? Explain in brief.
2. What do you mean by trust diagram?
3. What are the various types of load acted on a beam? Explain.
4. What is shear force?
5. What is bending moment?
6. Give sign convention of shear force and bending moment.
7. Hogging and Sagging Bending Moment

Descriptive Answers: (5 to 20 Marks)

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1. Prove that:

   M/I = σ/y = E/R.

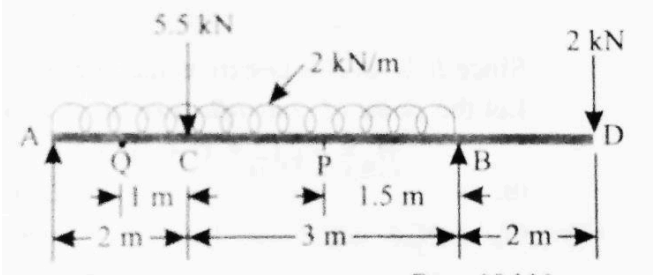
   M = Bending Moment, I = Moment of Inertia, E = Young's Modulus,

   R = Radius of Curvature, σ = Bending Stress

   y = Distance from N.A.

2. A simply supported beam of span L is carrying uniformly distributed load w over its entire span. Calculate S.F. and B.M. Also draw S.F. diagram and B.M. diagram.

3. Draw the shear force and bending moment diagram for the loaded beam as shown in figure.

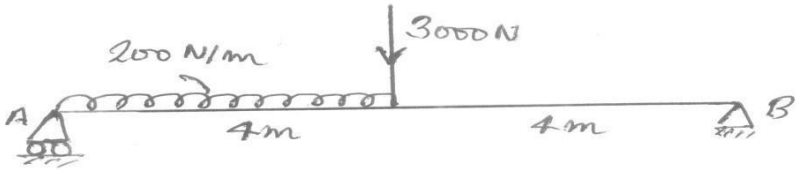


4. Draw and explain the shear stress distribution over the rectangular cross section.

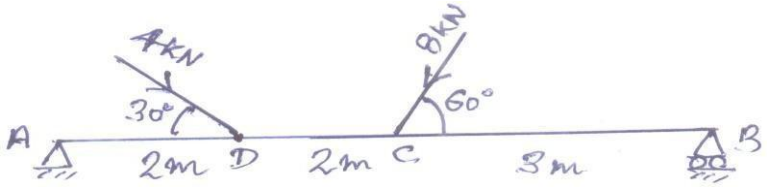
5. A cast iron bracket of I section has its top flange as 200 mm x 40 mm, bottom flange as 120 mm x 40 mm and the web as 300 mm x 40 mm. The overall depth of the section is 380 mm. The bracket is subjected to bending. If the maximum tensile stress in the top flange is not to exceed 15 MPa, determine the bending moment that section can take. If the beam is subjected to a shear force of 150

kN. Sketch the stress distribution over the depth of the section.

6. Draw the SFD and BMD for the beam shown below:



7. A loaded beam shown below, draw its SF and BM diagram.



8. What is pure bending? What are the assumptions in theory of bending?

Unit 3:

Short Answers: (2 Marks Each)

1. Write short notes on Mohr's circle of stresses.
2. What is principal stress?
3. What is principal plane?
4. What is principal axis?
5. Is there any relation between principal axis and principal plane? Explain.
6. Give name of any five theories of failure.

Descriptive Answers: (5 to 20 Marks)

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1. Derive relation for equivalent bending and twisting for shaft subjected to combined bending and twisting.
2. Explain the theory of failure in detail

3. A point is subjected to perpendicular stresses of 50 MN/m^2 and 30 MN/m^2, both tensile. Calculate the normal, tangential stresses and resultant stress and its obliquity on a plane making an angle of 30^0 with the axis of second stress.
4. The principal tensile stresses at a point across two perpendicular plane are 120 MN/m^2 and 60 MN/m^2. Find;

(i) The normal and tangential stress and resultant stress and its obliquity on a plane at 20^0 with the major principal plane.

(ii) the intensity of stress which acting alone can produce the same maximum strain. Poisson's ratio = 1/4.

5. A mild steel shaft 120 mm diameter is subjected to a maximum torque of 20 kN and maximum bending moment of 12 kNm at a particular section. Find the factor of safety according to the maximum shear stress theory if the elastic limit in simple tension is 20 MN/m^2.
6. At a point with in a body subjected to two mutually perpendicular directions, the stresses are 80 N/mm^2 tensile and 40 N/mm^2 tensile. Each of above stresses is accompanied by a shear stress of 60 N/mm^2. Determine the normal stress, shear stress and resultant stress on an oblique plane inclined at an angle of 45^0 with the axis of minor tensile stress.
7. At a certain point in a strained material, the intensities of stresses on two planes at right angles to each other are 20 N/mm^2 and 10 N/mm^2 (both tensile). They are accompanied by a shear stress of magnitude 10 N/mm^2. Find graphically or otherwise by the location of principle planes and evaluate the principle stresses.

Unit 4:

Short Answers: (2 Marks Each)

1. Explain terms column and strut.
2. What is crippling load?
3. What are the various assumptions for torsion equation?
4. What is torsional rigidity? Explain.
5. Write short notes on power transmitted by the shaft.
6. What is modulus of rupture? Explain.

Descriptive Answers: (5 to 20 Marks)

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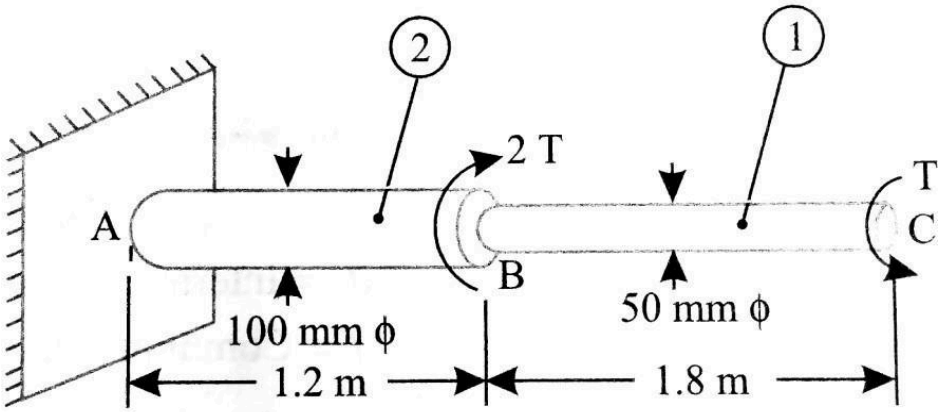
1. Derive the torsion equation for the solid circular shaft.
2. A 1.5 m long C.I. column has a circular cross-section of 5 cm diameter. One end of the column is fixed in direction and position and the other is free. Take factor of safety as 3, calculate the safe load, using:
   (i) Rankine - Gordon formula, take yield stress 560 MN/m^2 and a = 1/1600 for pinned ends,

   (ii) Euler's formula.

   Young's modulus for C.I. = 120 GN/m^2.
3. A hollow shaft, having an inside diameter 60% of its outer diameter is to replace a solid shaft

transmitting the same power at the same speed. Calculate, the percentage saving in material, if the material to be used is same in both the cases.

4. The stepped steel shaft shown in figure is subjected to a torque T at the free end and a torque of 2T in the opposite direction at the junction of two sides. What is the total angle of twist at the free end, if the maximum shear stress in the shaft is limited to 70 MN/m^2? Assume the modulus of rigidity to be 84 GN/m^2.



5. Find the max. shear stress induced in a solid circular shaft of dia 20 cm. When the shaft transmit 187.5 kW at 200 RPM.

6. Prove that rippling stress by Euler's formula is given by,

$$f_e = \pi^2 E/(L_e/k)^2.$$

Unit 5

Short Answer Questions

1. Define thick and thin cylinders.
2. What do you understand by equivalent length of column?
3. Rankine Formula
4. State Mohrs theoem
5. State Hoops Law
6. State assumption in derivation of beam deflection formula.
7. Explain Euler's crippling load and Eulers formula.

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Unit 5:

Descriptive Answers: (5 to 20 Marks)

1. Derive differential equation for deflection: $EI\, d^2y/dx^2 = M$.

2. A simply supported beam subjected to a uniformly distributed load w over its entire span. Determine the maximum slope and deflection by double integration method and Macaulay method .
3. Prove that the deflection at center of simply supported beam, carrying a point load at the center is given by,
   $y_c = WL^3/48EI$

   where,

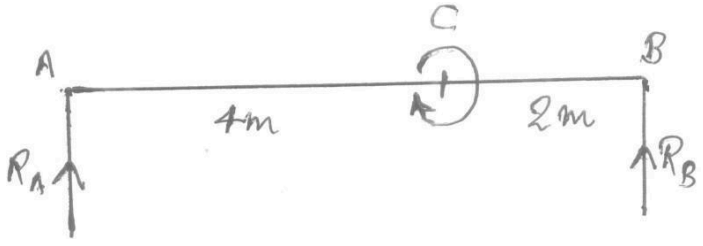
   W= Point load, L= Length of beam, E= Elastic constant, I= Moment of inertia.

4. A steel cantilever of span 2.5 m carries a point load of W kN at its free end. The moment of inertia for the section of the cantilever is 9900 cm^4. If the deflection at the free end is not to exceed 0.75 cm, what must be the value of W? Take E= 210 GN/m^2. Derive the deflection using Area Moment Method.
5. A girder of uniform section and constant depth is freely supported over a span of 3 m. If the point load at the mid span is 30 kN and Ixx = 15.614 x 10^{-6} m^4, Calculate,
   (i) The central deflection,

   (ii) The slopes at the ends of the

   beam. Take E= 200 GN/m^2.

6. A thin cylindrical tube with closed ends is subjected to an internal pressure of 8 MPa. The tube is of 90 mm internal diameter and 6 mm thickness. Determine the maximum principal stress and maximum shear stress if a torque of 4000 Nm is applied to the tube.
7. A horizontal beam is simply supported at A and B, 6 m apart. The beam is subjected to clockwise couple of 300 kNm at a distance of 4m. from the left end as shown in fig. If E=2x10^5 N/mm^2 and I=2x10^8 mm^4.
   (i) Deflection at the point where couple is acting and (ii) The max. deflection.



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