Exam Date & Time: 09-Dec-2023 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH(MECHANICAL) END SEMESTER EXAMINATIONS, NOV/DEC 2023

MECHANICS OF MATERIALS [MIE 2124]

Marks: 50 **Duration: 180 mins.**

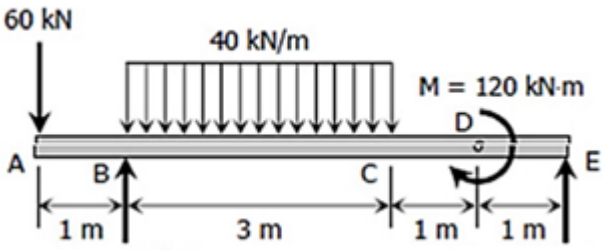
A

Answer all the questions.

Missing data may be suitably assumed

1) Draw SFD and BMD for a beam as shown in the figure by applying the method of sections. Locate the point of contraflexure if any. Also evaluate the maximum bending moment.

A)



(4)

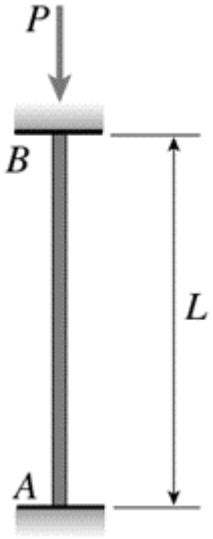
B) A beam of length 10 m is simply supported and carries point loads of 5 kN each at 3 m and 7 m from left support and a UDL of 1 kN/m between the point loads. Evaluate the shear force and bending moments at all the salient points and draw SFD and BMD. (3)

C) A 5 m long beam has rectangular cross-section with dimensions 200 mm x 50 mm. It is used as a cantilever beam with uniformly distributed load of intensity 10 N/mm throughout its span length. Plot the variation of shearing stress of the beam across its cross-section. (3)

2) A simply supported beam 4 m long has an I cross-section. The top and bottom flanges measure 120 mm x 30 mm, overall depth of the cross-section is 200 mm, and the web thickness is 30 mm. If the permissible stress of the beam material is 45 MPa what will be the maximum magnitude of the uniformly distributed load it can carry throughout its span length?.

A) (4)

B) A steel column of cross section 50 mm x 100 mm has 4 m length. The Youngs modulus of the column material is 200 GPa. For the configuration of the column as shown in figure, determine the (a) buckling load, and (b) safe load. Assume factor of safety as 2. What will be the buckling load if the end conditions changed to pinned joints. (3)



C) A steel cantilever beam of length 5 m has a concentrated moment of 10 kN-m at the free end. Determine the deflection and slope at the free end using the double integration method. The elastic modulus of the beam is 200 GPa. Assume the area moment of inertia of the beam as 50 x 10^6 mm^4. (3)

3) A simply supported beam of uniform cross-section and 6 m long is subjected to two vertical concentrated loads of 48 kN and 40 kN acting at 1 m and 3 m respectively from the left-hand support. Evaluate the deflection at loading points by applying Macaulay's

A) method. Take the elastic modulus of beam material as 200 GPa and the moment of inertia as 85 x 10^{-6} m^4. (4)

B) Compare the crippling load as found from Euler's formula and Rankine' formula for mild steel tube of 3 m long and 50 mm internal diameter. Thickness of the metal is 25 mm. One end of the column is fixed while another end is pined. Take crushing stress as 300 MPa, Rankine's constant as 1/7500, and E = 210 GPa. Also, determine the safe load for both cases. Assume factor of safety as 3. (3)

C) A solid shaft of 60 mm diameter is running at 160 rpm. Determine the power transmitted by the shaft if the permissible shear stress is not to exceed 80 MPa. The maximum torque is likely to exceed 20 % of the mean torque. (3)

4) A compound shaft 2 m long is fixed at one end and is subjected to a twisting moment of 150 kN-m at the free end, 200 kN-m at midpoint of the shaft. The direction of application of both torque is the same. The shaft has a diameter of 240 mm for fixed end

A) to the midpoint and 180 mm for the remaining portion. Determine the following:

a. Shearing stress induced in each portion of the shaft. (4)

b. Total angle of twist of the shaft.

Take modulus of rigidity of the shaft material as 82 GPa.

B) A cylindrical vessel whose ends are closed by means of rigid flange plates is made of steel plate 3 mm thick. The internal length and diameter of vessel are 500 mm and 250 mm respectively. Evaluate the longitudinal and circumferential stresses in the cylindrical shell due to an internal fluid pressure of 3 MPa. Also determine the increase in length, diameter, and volume of the vessel. Take E = 200 GPa and Poisson's ratio as 0.3. (3)

C) Explain the concept of principal planes and principal stresses. Sketch the Mohr's circle for a body subjected to only normal stresses that are equal in magnitude but opposite in direction. (3)

5) The principal stresses at a point across two perpendicular planes are 75 MPa (tensile) and 35 MPa (tensile). Find the normal, tangential stresses and the resultant stress and its obliquity on a plane at 20° with the major principal plane. Solve by applying Mohr's circle method. (4)

A)

B) a. Define resilience and creep.

b. Briefly explain Rankine's theory. (3)

C) A bolt is subjected to a tensile load of 18 kN and a shear load of 12 kN. The material has a yield stress of 328.6 MPa. Taking factor of safety as 2.5, determine the core diameter of bolt according to Rankine's theory and maximum shear stress theory. (3)

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