Exam Date & Time: 15-Jan-2024 (09:30 AM - 12:30 PM)

MANIPAL ACADEMY OF HIGHER EDUCATION

THIRD SEMESTER B.TECH (MECHANICAL) END SEMESTER (Make up) EXAMINATIONS, JAN-2024

MECHANICS OF MATERIALS [MIE 2124]

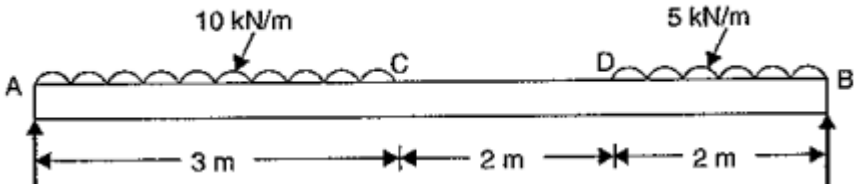
Marks: 50 **Duration: 180 mins.**

A

Answer all the questions.

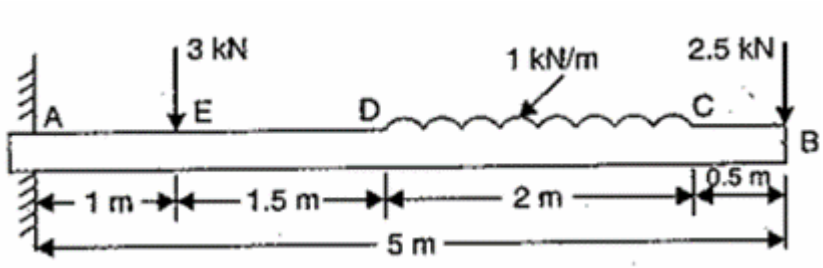
Missing data may be suitably assumed

1) Draw the shear force and bending moment diagrams for the beam shown in figure and locate the position of the maximum bending moment.

A) 

(4)

B) Draw the shear force and bending moment diagrams for the beam shown in figure.



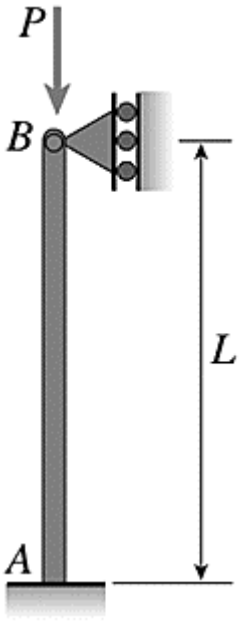
(3)

C) A 5 m long beam 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's thickness is 30 mm. It is used as a simply supported beam with uniformly distributed load of intensity 10 N/mm throughout its span length. Find the maximum shearing stress in the beam. (3)

2) A simply supported beam 4 m long has a T cross-section. The top flanges measure 150 mm x 30 mm, overall depth of the cross-section is 200 mm, and the web's thickness is 30 mm. If the permissible stress of the beam material is 45 MPa what will be the maximum concentrated load the beam can carry at the mid-point? (4)

A)

B) An aluminium column of cross section 150 mm x 100 mm has 5 m length. The Youngs modulus of the column material is 70 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. Also, determine the buckling load if the end conditions are changed to fixed joints. (3)



C) A cast iron cantilever beam of length 6 m has a point 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 200 GPa. Assume the area moment of inertia for the beam as 80 x 10^6 mm^4. (3)

3) A simply supported beam of uniform cross section and having 5 m long. Two vertical concentrated loads of 50 kN and 60 kN act at 1 m and 3 m respectively from the right-hand support. Determine deflection at loading points using Macaulay's method. Assume

A) elastic modulus of beam material as 200 GPa and moment of inertia as 100 x 10^{-6} m^4. (4)

B) Find the Euler's crippling load for a hollow cylindrical cast iron column of 4.2 m long, 120 mm external diameter, 20 mm thick and it is hinged at both ends. Compare this load with the load obtained by Rankine's equation. Assume material constants as E = 80 GPa, σ_C = 550 N/mm^2 and a = 1/1600. (3)

C) A solid shaft 500 mm length and 40 mm diameter is bored with a diameter 20 mm up till the midpoint. If the shearing stress is not to exceed 80 MPa, find the maximum power transmitted by the shaft at a speed of 200 rpm. (3)

4) A hollow shaft of diameter ratio 3/8 is required to transmit 600 kW at 110 rpm, the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and the twist in a length of 3 m not to exceed 1.4°. Calculate the diameter of the

A) shaft satisfying these conditions. The modulus of rigidity of the shaft material is 84 GPa. (4)

B) A cylindrical shell 3 m long which is closed at the ends has an internal diameter of 1 m and a wall thickness of 15 mm. Calculate the circumferential and longitudinal stresses induced and change in the dimensions of the shell if it is subjected to an internal pressure of 1.5 MPa. Take E = 200 GPa and Poisson's ratio as 0.3. (3)

C) Sketch and explain the Mohr's circle for a material subjected to only normal stresses that are unequal in magnitude but same in nature (tensile or compressive). (3)

5) Explain the concept of principal stresses, principal planes and their orientation, and maximum shear stress for a body subjected to complex stresses. (4)

A)

B) a. Define hardness and factor of safety.

b. Briefly explain Hertzian contact stress. (3)

C) Explain the following theories of failure:

a. Maximum principal stress theory.

b. Maximum shear stress theory. (3)

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