Question Paper

Exam Date & Time: 02-Jan-2020 (08:30 AM - 11:30 AM)

MANIPAL INSTITUTE OF TECHNOLOGY
MANIPAL
(A constituent unit of MAHE, Manipal)

THIRD SEMESTER B.TECH END SEMESTER MAKEUP EXAMINATIONS, DEC-2019
STRENGTH OF MATERIALS [MME 2154]

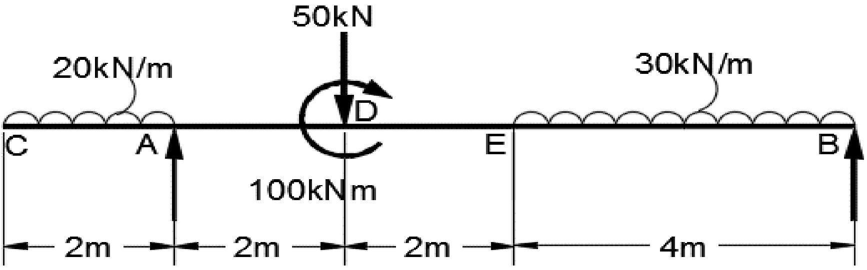
Marks: 50 **Duration: 180 mins.**

Instructions to Candidates: Answer ALL questions
Missing data may be suitably assumed

Q1A). With the help of engineering stress-strain diagram, explain ductile and brittle failure in engineering materials subjected to tension. (3M)

Q1B). An aluminum frame of 6061 alloy for a window is 4.350 m long and holds a piece of plate glass 4.347 m long when the temperature is 35°C. At what temperature would the aluminium and glass be the same length? Take $\alpha_{Aluminum} = 23.4 \times 10^{-6}$ /°C and for glass as $\alpha_{Glass} = 9 \times 10^{-6}$ /°C. (2M)

Q1C). For the beam configuration shown in figure, plot the shear force and bending moment distribution diagram. Also determine the location of point of contra flexure if any. (5M)



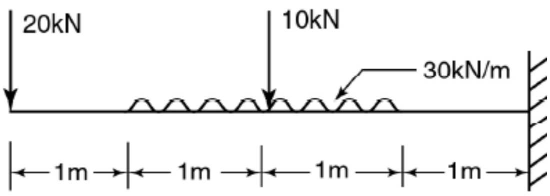
Q2A). A cylindrical compression member with both ends pinned and made of SAE 1020 cold-drawn steel (Yield strength = 441 MPa; Ultimate tensile strength = 628 MPa; Ultimate crushing strength = 359 MPa, E = 207 GPa, a = 1/7500) is to be used in a machine as column. Its diameter is 25 mm, and its length is 950 mm.

i) Predict whether the member has to be treated as long or short column with suitable justification.

ii) Depending on the prediction in (i), use appropriate theory of column failure and determine the maximum load the member can take before buckling. (3M)

Q2B). With an example discuss the limitations of Euler's theory of buckling in columns. (2M)

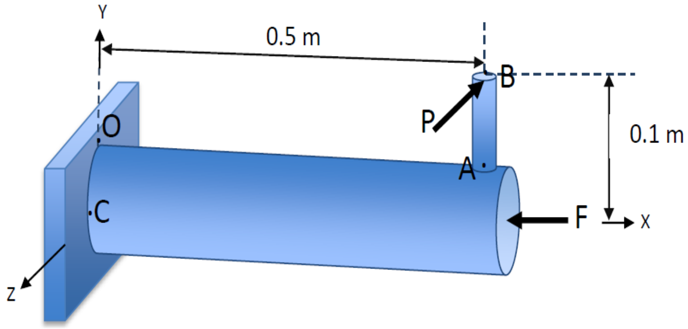
Q2C). For the beam configuration shown in figure, determine the maximum deflection and maximum slope through Macaulay's method. Take E = 200 GPa, $I = 300 \times 10^6$ mm^4. Also find the deflections at an interval of 1 m throughout the length of the beam and plot the deflected shape.
(5M)



Q3A). A cylindrical shell 5 m long has 800 mm internal diameter and 50 mm thickness. The cylinder carries a fluid pressure of 2.5 MPa. Find percentage error in maximum circumferential stress if it is taken as thin shell, instead of thick shell. (3M)

Q3B). State the assumptions made in theory of beam deflection and derive the equation for beam deflection. (3M)

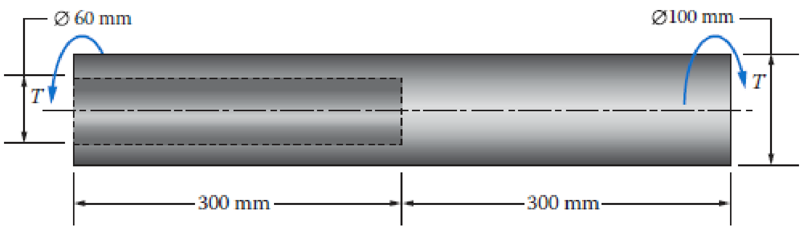
Q3C). A horizontal rod OA is subjected to load F of 50 kN, applied in the negative x-direction and a load P of 20 kN, applied in the negative z-direction at point B as shown in figure. Assume rod AB is rigid and not deforming under applied load P. The rod OA is of diameter 50 mm and is fixed at left end. Point C is along the front-most edge on the circumference of rod OA, in the XZ plane. Predict the nature and magnitude of the stresses developed at point 'C'. Also compute the principal and maximum shear stresses using analytical method. (4M)



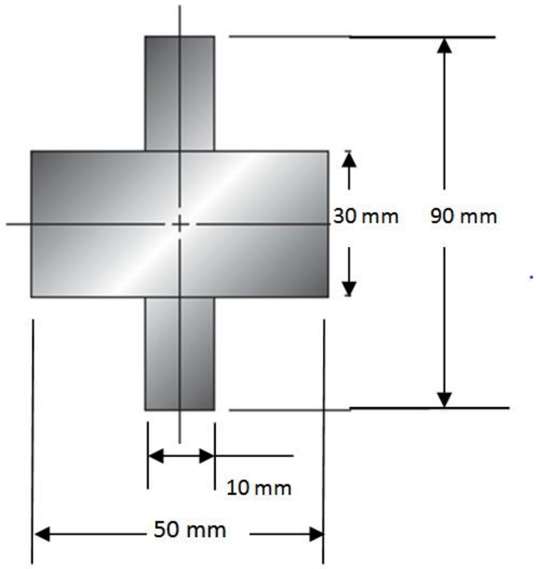
Q4A). Differentiate between: (3M)

i) Beams and Columns
ii) Thin and Thick cylinders
iii) Stress and Strength

Q4B). An alloy steel (E = 210 GPa, μ = 0.3, σ_Y = 650 MPa, τ_y = 335 MPa) shaft has an outside diameter of 100 mm. A central hole of 60 mm diameter is bored in part of its length as shown in Figure. Compute the shearing stress and angle of twist in the hollow section if the stress in the solid section is 200 MPa. (3M)



Q4C). A square cross section beam is oriented as shown in figure and it experiences a shearing force of 50 kN. Compute the maximum shearing stress and its location. Plot the variation of stress in the section. (4M)



Q5A). Stating the assumptions made in theory of pure bending, derive the bending equation. (3M)

Q5B). A plane element is subjected to 120 N/mm^2 compressive stresses along horizontal X-direction, 80 N/mm^2 compressive stresses along vertical Y-direction and negative shear stresses of 60 N/mm^2 on each side of the plane. Determine the principal stresses, maximum shear stress and corresponding inclinations of the planes. Use graphical method. (3M)

Q5C). A person is trying to twist a solid bar of diameter 25 mm and length 1 m, with a torque of 15 N-m as shown in figure. The bar is made of nylon material (Elastic Modulus = 3.4 GPa, Poison's ratio = 0.4, Tensile strength = 92 MPa, Compressive strength = 95 MPa, Shear strength = 45 MPa). Determine the total twist and the stress developed in the solid bar.

If the same person has to twist a hollow bar of outer diameter 25 mm and inner diameter 0.5 times the outer diameter, what would be the torque he needs to apply to keep same angle of twist and stress as that in solid bar? Assume same material and length for both bars. (4M)