Reg No.:_______________ Name:___________________________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S,FE)/S1 (PT)(S) June 2024 (2019 Scheme)/S3 (WP)(R) December 2023 Examination

Course Code: MET201

Course Name: MECHANICS OF SOLIDS

Max. Marks: 100 Duration: 3 Hours

PART A

Answer all questions. Each question carries 3 marks Marks

1	Define state of stress at a point.? Represent the 3D stress tensor in Matrix form	(3)
2	Draw the Mohr's circle for a body subjected to a state of pure shear	(3)
3	Draw the Engineering stress strain curve for a ductile material. Distinguish it with true stress strain curve for the same materials. Mark the salient features	(3)
4	Provide the relationship between elastic constants E, G, v and K	(3)
5	State the assumptions made in pure bending	(3)
6	Define torsional rigidity?	(3)
7	Explain strain energy and complementary strain energy with figures	(3)
8	Define Maxwell's Reciprocal theorem	(3)
9	State the Assumptions Made in the Euler's Column Theory	(3)
10	State any failure theory applicable for ductile materials	(3)

PART B

Answer any one full question from each module. Each question carries 14 marks

Module 1

11.a A body is subjected to three-dimensional forces and the state of stress at a point in it is represented as (8)

$$\begin{bmatrix} 200 & 200 & 200 \\ 200 & -100 & 200 \\ 200 & 200 & -100 \end{bmatrix} MPa$$

Determine the normal stress, shearing stress and resultant stress on the octahedral plane.

11.b What are stress invariants. Provide the expression for stress invariants in matrix form. Also express the equation for principal stress in terms of stress invariants (6)

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12 At a certain point in a strained material, the stresses on the two planes at right angles to each other are 40 N/mm^2 and 20 N/mm^2 both tensile. They are accompanied by a shear stress of magnitude 20 N/mm^2. Using method of Mohr's circle, Determine the Principal stresses, the Maximum shear stress and the Plane of maximum shear stress. (14)

Module 2

13.a Distinguish between ductile and brittle materials using stress strain curve. Give example for each. Draw the true stress true strain for a ductile material (8)

13.b Formulate the generalised Hook's law for a 3-D isotropic material. Write the stress and strain tensor for a state of plane stress (6)

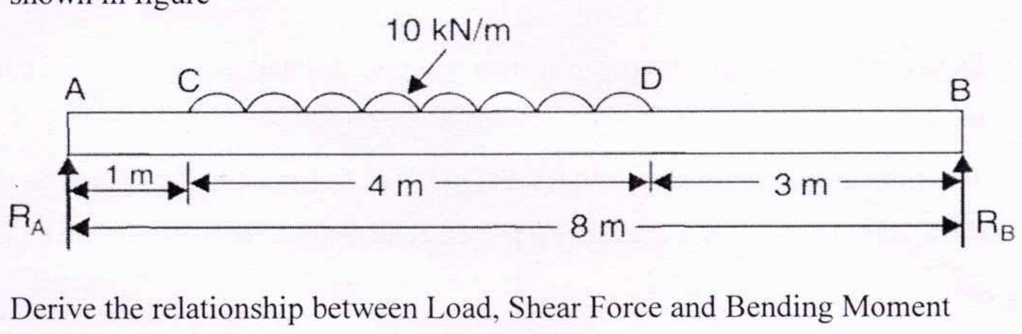
14 A steel rod of 20 mm diameter passes centrally through a copper tube of 50 mm external diameter and 40 mm internal diameter. The tube is closed at each end by rigid plates of negligible thickness. The nuts are tightened lightly home on the projecting parts of the rod Calculate the stresses induced in the copper and steel if the temperature of the combination is raised by 50°C. Take, Es = 200 GN/m^2; Ec = 100 GN/m^2; αs = 12 × 10⁻6 per °C; αc = 18 × 10⁻6 per °C. (14)

Module 3

15.a Determine the diameter of a solid shaft which will transmit 300 kW at 250 r.p.m. The maximum shear stress should not exceed 30 N/mm^2 and twist should not be more than 1° in a shaft length of 2 m. Take modulus of rigidity = 1 × 10^5 N/mm^2. (9)

15.b What are the assumptions made in the derivation of shear stress produced in a circular shaft subjected to torsion (5)

16.a Draw the shear force and B.M. diagrams for a simply supported beam of length 8 m and carrying a uniformly distributed load of 10 kN/m for a distance of 4 m as shown in figure (8)



16.b Derive the relationship between Load, Shear Force and Bending Moment (6)

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Module 4

17 A beam of length 6 m is simply supported at its ends and carries two-point loads of 48 kN and 40 kN at a distance of 1 m and 3 m respectively from the left support. Calculate the deflection under each load using. Macaulay's method. Find also the maximum deflection. Given $E = 2 \times 10^5$ N/mm^2 and $I = 85 \times 10^6$ mm^4. (14)

18 Using Castigliano's theorem, prove that the vertical deflection at the centre of a simply supported beam carrying a uniformly distributed load of intensity w over the full span is equal to $\delta = \frac{5wl^4}{384EI}$ The flexural rigidity EI of the beam is constant and only strain energy of bending is to be considered. Assume the length of the beam as l. (14)

Module 5

19 A hollow C.I. column whose outside diameter is 200 mm has a thickness of 20 mm. It is 4.5 m long and is fixed at both ends. Calculate the safe load by Rankine's formula using a factor of safety of 4. Calculate the slenderness ratio and the ratio of Euler's and Rankine's critical loads. Take $\sigma_c = 550$ N/mm^2, α =(1/1600) in Rankine's formula and $E = 9.4 \times 10^4$ N/mm^2. (14)

20.a A mild steel shaft 120 mm diameter is subjected to a maximum torque of 20 kNm and a 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 220 MN/m^2. (8)

20.b Represent graphically the following failure theories (6)

1. Maximum Principal stress theory
2. Maximum Shear stress theory
3. Maximum strain energy theory