Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Third Semester B.Tech Degree Examination December 2021 (2019 scheme)

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 What is a stress tensor? Write the stress tensor for plane stress condition. (3)

2 Explain principal stresses and principal strains? (3)

3 Draw the stress-strain curve of a mild steel bar in tension test and show the salient points? (3)

4 Explain Hooke's law for linearly elastic isotropic material? (3)

5 Derive the relation between intensity of loading, shear force and bending moment at a section of a uniformly loaded beam? (3)

6 State the assumptions made in the theory of torsion? (3)

7 Explain elastic strain energy and complementary strain energy? (3)

8 Explain Castigliano's second theorem? (3)

9 What is slenderness ratio? What is the effective length of columns with both ends fixed? (3)

10 State Hencky-von Mises theory for maximum distortion energy? (3)

PART B

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

Module 1

11 a. The state of stress at a point in a body is $\begin{bmatrix} 1 & 3 & 2 \\ 3 & 2 & 1 \\ 2 & 1 & -1 \end{bmatrix}$ Determine the normal and shear stress on a plane that is equally inclined to all the three axes. (9)

b. Write the strain displacement relations in Cartesian coordinates. Write also the strain tensors for plane strain and plane stress condition. (5)

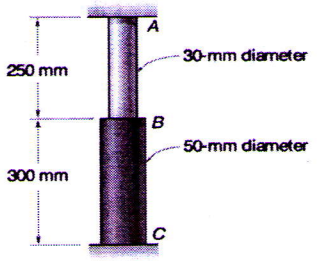
12 At a point in a bracket the stresses on two mutually perpendicular planes are 140 N/mm^2 and 90 N/mm^2 both tensile. The shear stress across these planes is 50 N/mm^2. Find using the Mohr's stress circle the (14)

(i) Principal stresses and

(ii) Maximum shear stress and location of plane of maximum shear

Module 2

13 A rod consisting of two cylindrical portions *AB* and *BC* is restrained at both ends. Portion *AB* is made of steel (E_S = 205 GPa, α_S = 11.7 X 10 $^{-6}$/ °C) and portion *BC* is made of brass (E_b = 100 GPa, α_b = 20.9 X 10 $^{-6}$/ °C). Knowing that the rod is initially unstressed, determine the compressive force induced in *ABC* when there is a temperature rise of 60 °C. (14)



14 a) A rod of length 1 m and diameter 20 mm is subjected to a tensile load of 20 kN. The increase in length of the rod be 0.30 mm and decrease in diameter is 0.0018 mm. Calculate the poison's ratio, Young's modulus, Bulk modulus and Modulus of rigidity? (8)

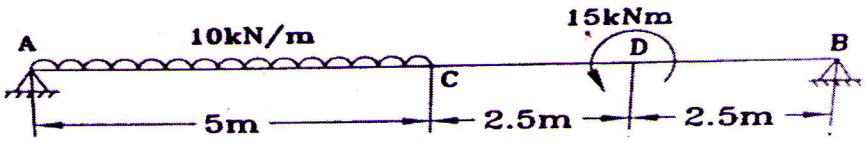
b) Explain Generalized Hooke's law for linear elastic isotropic solids. Write the stress and strain tensor for plain strain condition. (6)

Module 3

15 a) Determine the diameter of a solid shaft which will transmit 90 kW at 160 rpm if the shear stress in the shaft is limited to 60 N/mm^2. Find also the length of the shaft, if the twist must not exceed 1 degree over the entire length. Take modulus of rigidity = 8 X 10^4 N/mm^2. (8)

b) Compare the weights of equal length of solid and hollow shaft to transmit a given torque for the same maximum stress, if inside diameter of the shaft is ¾ of the outside. (6)

16 Draw the shear force and bending moment diagram for the simply supported beam shown in the figure. (14)



Module 4

17 A beam section is 10 m long and is simply supported at the ends. It carries concentrated loads of 100 kN and 60 kN at distances of 2 m and 5 m (14)

respectively from the left end. Calculate the deflection under each load using Macaulay's method. Find also the maximum deflection. Take moment of inertia as 18 X 10^8 mm^4 and E = 200 kN /mm^2

18 A simply supported beam of 6 m span carries a uniformly distributed load of 2 kN/m from the left end up to the mid span and a concentrated load of 10 kN at a distance of 2 m from the right end. Determine the deflection at the point of application of point load using Castigliano's theorem? (14)

Module 5

19 Find Euler's critical load for a hollow cylindrical cast iron column 200 mm external diameter and 25 mm thick. The column is 6 m long and hinged at both ends. Take E= 8 X 10^4 N/mm^2. Find Euler's critical load and Rankine's critical load taking σ_c= 550 N/mm^2, $\alpha=\frac{1}{1600}$. For what length of the column would the critical loads by Euler's and Rankine's formula be equal? (14)

20 A mild steel shaft of 100 mm diameter is to sustain a maximum torque of 20 kNm and maximum bending moment of 10 kNm at a point in the material. Determine the factor of safety based on any three theories of failure. Assume Poisson's ratio as 0.3 and elastic limit in tension as 220MPa. (14)