Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S,FE) (FT/WP) (S1 PT) Examination May 2025 (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 Explain the use of Mohr's circle for stress analysis. (3)

2 Define plane stress problem. Give an example with neat figure. (3)

3 Write the generalised Hooke's law in matrix form for linear elastic isotropic solids. (3)

4 A steel rod of 3cm diameter and 5 m long is connected to two grips and the rod is maintained at a temperature of 95°C. Determine the stress, when the temperature falls to 30°C, where the ends yield by 0.12cm. Take E = 2×10^5 MN/m^2 and $\alpha = 12\times10^{-6}$/°C. (3)

5 Define torsional rigidity. Write its equation. (3)

6 Differentiate between point of inflexion and point of contraflexure. (3)

7 Define complimentary strain energy. Show it on a neat stress strain graph. (3)

8 Explain reciprocal relation. (3)

9 List any three assumptions of Euler buckling theory. (3)

10 Explain the effects of end conditions in the buckling of columns. (3)

PART B

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

Module 1

11 Determine the principal stresses and their axes for the states of stress characterised by the following stress matrices (units are 1000 kPa). (14)

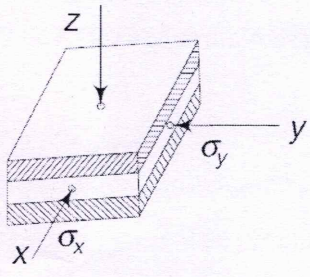
$$\begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix} \times 10^3\ kPa$$

12 a Write the strain-displacement relations. The displacement field is given by U=(-yz) **i** + (xz) **j** + (xy) **k**. Obtain the strain matrix. What is the strain along the direction $n_x=n_y=n_z=1/\sqrt{3}$ (8)

b Prove the equality of cross shear. (6)

Module 2

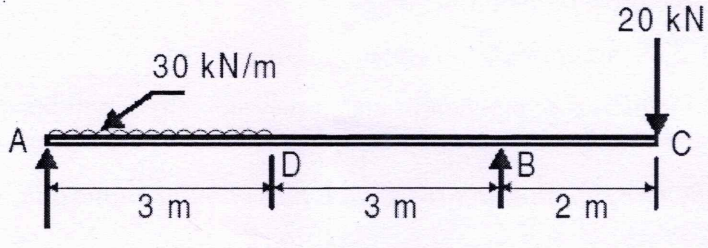
13 A thin rubber sheet is enclosed between two fixed hard steel plates. Friction between the rubber and steel faces is negligible. If the rubber plate is subjected to stresses σ_x and σ_y as shown, determine the strains ϵ_{xx} and ϵ_{yy} and the stress σ_z. (14)



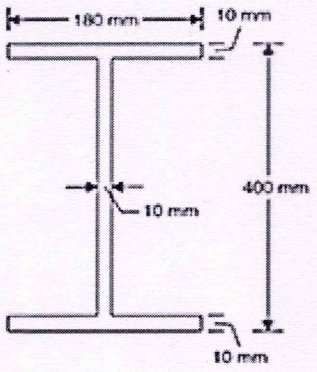
14 A compound bar of length 600 mm consists of a strip of aluminium 40 mm wide and 20 mm thick and a strip of steel 60 mm wide x 15 mm thick rigidly joined at the ends. If elastic modulus of aluminium and steel are 1 x 10^5 N/mm^2 and 2 x 10^5 N/mm^2, determine the stresses developed in each material and the extension of the compound bar when an axial tensile force of 60 kN acts. (14)

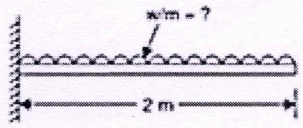
Module 3

15 The overhanging beam ABC is supported at A and B, the span AB being 6 m. The overhang BC is 2 m (see figure). It carries a uniformly distributed load of 30 kN/m over a length of 3 m from A and concentrated load of 20 kN at free end. Draw SF and BM diagrams. (14)



16 Figure shows the cross-section of a cantilever beam of 2.5 m span. Material used is steel for which maximum permissible stress is 150 N/mm^2. What is the maximum uniformly distributed load this beam can carry? (14)



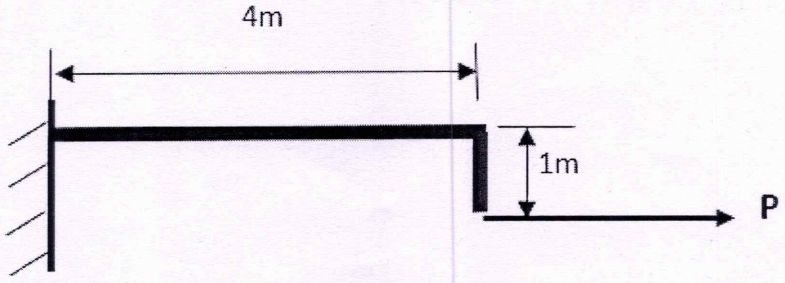


Module 4

17 A simply supported beam has its supports 8m apart at A and B. It carries a uniformly distributed load of 4 kN/m between A and B starting from 2 m and ending at 5 m from A. The end B of the beam has an overhang of 3 m and at the free end a concentrated load of 6 kN is applied. Determine deflection of the free end and the maximum deflection between A and B. Take E = 200 GPa and I = $15\times10^6 mm^4$ (14)

18 a Explain Castigliano's second theorem. (4)

b Find the deflection in the direction of load for the bar of 2 cm diameter with load P as 25 kN. Assume Young's modulus as 205 GPa. (10)



Module 5

19 A hollow alloy tube having internal and external diameters as 36 mm and 52 mm respectively is 6 m long. It extends by 3 mm under a tensile load of 50 kN. Determine the crippling load for the tube when used as a strut with both ends pinned. (14)

20 A cylindrical shaft made of steel is subjected to a static load consisting of bending moment of 15 kNm and a torsional moment of 25 kNm. Determine the diameter of the shaft according to: (a) Maximum shear stress theory (b) Strain (14)

energy theory (c) Maximum principal strain theory. Yield stress – 700 MPa, Young's modulus – 200 GPa, Poisson's ratio – 0.3 and Factor of safety – 2.
