Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S3 (S,FE) (FT/WP) / S1 (PT) Examination November/December 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 Consider the displacement field $U=[y^2\mathbf{i}+3yz\mathbf{j}+(4+6x^2)\mathbf{k}]10^{-2}$. Find the rectangular strain components at the point P (1, 0, 2). (3)

2 Define stress at a point. What do you mean by stress tensor? (3)

3 Draw and explain the stress-strain diagram of steel. (3)

4 If the diameter of a circular rod is doubled keeping the axial load P unchanged, what will be the change in the deflection of the rod? (3)

5 The shearing stress of a solid shaft is not to exceed 40 N/mm^2 when the torque transmitted is 20000Nm. Determine the maximum diameter of the shaft. (3)

6 Define Section modulus and Flexural rigidity. Write their equations. (3)

7 State Castigliano's second theorem. Give its mathematical expression. (3)

8 A tensile load of 60kN is gradually applied to a circular bar of 4cm diameter and 5m long. If the value of E is 2×10^5 N/mm^2, determine the strain energy absorbed by the rod. (3)

9 Define slenderness ratio. Explain the concept of equivalent length. (3)

10 Explain with equation, the Guest's theory of failure. (3)

PART B

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

Module 1

11 a At a point P in a body, $\sigma_x = 10{,}000$N/cm^2, $\sigma_y = -5{,}000$N/cm^2, $\sigma_z = -5{,}000$N/cm^2, $\tau_{xy} = \tau_{yz} = \tau_{zx} = 10{,}000$ N/cm^2. Determine the normal and shearing stresses on a plane that is equally inclined to all the three axes. (10)

b If the displacement field is (kxy) **i**+ (kxy) **j**+ 2k(x+y)z **k**, obtain the Strain tensor. (4)

12 At a certain point in a strained material, the intensities of stresses on two planes at right angles to each other are 20N/mm^2 and 10 N/mm^2 both tensile. They are accompanied by a shear stress of magnitude 10N/mm^2. Find graphically the location of principal planes and evaluate the principal stresses. (14)

Module 2

13 For the given strain matrix at a point, determine the stress matrix. (14)

$$\begin{pmatrix} 0.001 & 0 & -0.002 \\ 0 & -0.003 & 0.0003 \\ -0.002 & 0.0003 & 0 \end{pmatrix}$$

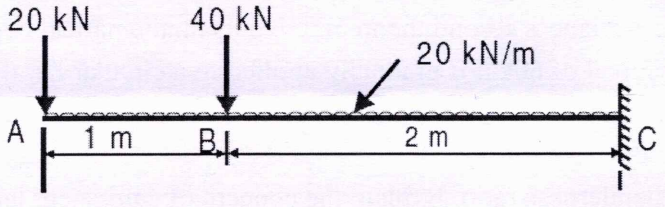
Given: E = 207×10^6 kPa and G = 80×10^6 kPa.

14 A steel tube of 30mm external diameter and 20mm internal diameter encloses a copper rod of 15mm diameter to which it is rigidly joined at each end. If, at a temperature of 10°C there is no longitudinal stress, calculate the stresses in the rod and the tube when the temperature is raised to 200°C. Take E for steel and copper as 2.1×10^5 N/mm^2 and 1×10^5 N/mm^2 respectively. The value of coefficient of linear expansion for steel and copper is given as 11×10^{-6}/°C and 18×10^{-6}/°C respectively. (14)

Module 3

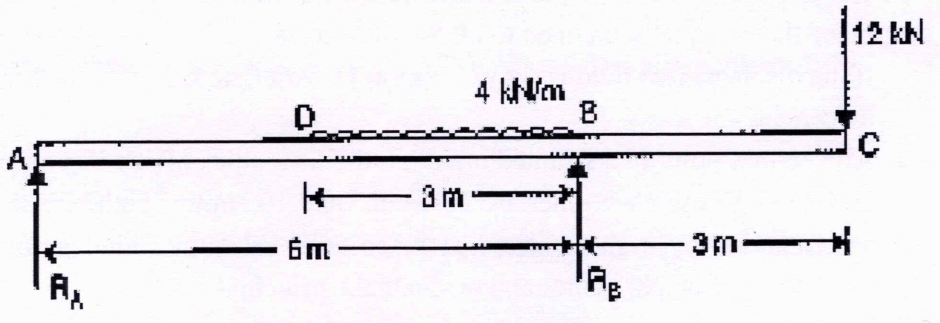
15 Determine the diameter of a solid shaft which will transmit 300kW at 250rpm. The maximum shear stress should not exceed 30N/mm^2 and the twist should not be more than 1° in a shaft length of 2m. Take modulus of rigidity = 1×10^5 N/mm^2. (14)

16 Draw the shear force and bending moment diagram for the cantilever beam shown in figure. The inclined load (60 degrees with horizontal) is acting at a distance of 1.2 m from the fixed end. (14)



Module 4

17 A beam ADBC of length 9 m has one support of the left end and the other support at a distance of 6 m from the left end. The beam carries a point load of 12 kN at right end and also carries a uniformly distributed load of 4 kN/m over a length of 3 m as shown in figure. Determine the slope and deflection at point C using Macaulay's method. Take E = 2×10^5 N/mm^2 and I = 5×10^8 mm^4 (14)



18 Derive the expressions for strain energy for a body subjected to axial, shearing, bending and torsional loads in terms of load, geometry and material property. (14)

Module 5

19	a	Derive the equation for Euler's buckling load of a column with both ends hinged.	(8)
19	b	A hollow cylindrical cast iron column is 4m long with both ends fixed. Determine the maximum diameter of the column if it must carry a safe load of 250 kN with a factor of safety of 5. Take the internal diameter as 0.8 times the external diameter. Take $\sigma_c = 550$ N/mm^2 and $\alpha = 1/1600$ in Rankine's formula.	(6)
20		A bolt is designed to take up direct tensile load of 25 kN and a shear load of 18 kN with a factor of safety of 3. The yield stress is 300 MPa. Calculate the size of the bolt using any three theories of failure. Assume Poisson' ratio as 0.3	

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