Reg No.:_______________ Name:_______________

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (S,FE) Examinations June 2026 (2019 Scheme)

Course Code: RAT303

Course Name: SOLID MECHANICS

Max. Marks: 100 Duration: 3 Hours

PART A

(Answer all questions; each question carries 3 marks)

		Marks
1	Define plane stress and plane strain? Give an example for both the conditions.	3
2	What do you mean by direction cosines of a plane? Write down the Cauchy's stress equations in terms of direction cosines.	3
3	Define the following terms (a) Longitudinal Strain, (b) Lateral Strain and (c) Poisson's Ratio	3
4	Draw the stress-strain curve of a mild steel bar (ductile) in tension test and show the salient points.	3
5	Define the following terms: (a) Polar Moment of Inertia, (b) Torsional Rigidity and (c) Torsional Stiffness	3
6	What are the different types of beams & loading?	3
7	Define the following terms :- (a) Elastic strain energy b) Complementary strain energy c) Strain Energy density	3
8	State and explain Castigliano's Second theorem.	3
9	State three core assumptions made in Euler's buckling theory for long columns.	3
10	Why is Euler's formula invalid for short columns? Explain.	3

PART B

(Answer one full question from each module, each question carries 14 marks)

Module -1

11 a) Derive the differential equations of equilibrium in Cartesian coordinates with the help of a neat figure. If the displacement field is $(3x^2+y)$ i+ $(2y^2+z)$ j+ $(4z^2+x)$ k, obtain the strain tensor at (2, 1, 1). 14

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

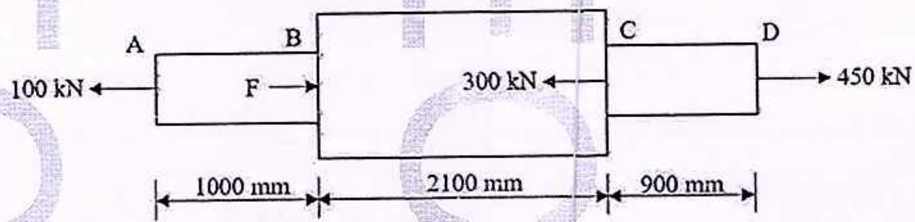
(i) Principal stresses and

(ii) Maximum shear stress

Location of plane of maximum principal stress and maximum shear.

Module -2

13 a) A steel bar ABCD of varying section is subjected to axial force as shown in figure. Find the value of the load, F necessary for the bar to be in equilibrium.Determine the total elongation of the bar. Given: Area of section AB = 500 mm2, Area of section BC = 1000 mm2, and Area of section CD = 750 mm2. Take E = 210 GPa. 7

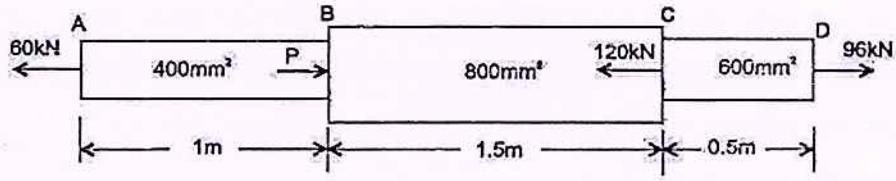


Also determine the total strain in the bar.

b) Calculate the Modulus of rigidity and Young's modulus of a cylindrical bar of 7 diameter 50 mm and of 1 m length, if the longitudinal strain in a bar during a tensile stress is 3.5 times the lateral strain. Find the change in volume when the bar is subjected to a hydrostatic pressure of $100 N/mm^2$. Take $E = 210 \times 10^3$ MPa. 7

14 a) The rigid beam shown in figure is fixed to the top of three posts made of steel and Aluminium. The posts each have a length of 250 mm when no load is applied to the beam, and the temperature is $T_1 = 20^0C$. Determine the force supported by each post, if the bar is subjected to a point load of 100 kN at the middle and the temperature is raised to $T_2 = 70^0C$. Take: diameter of steel, (d_s) = 40 mm, diameter of aluminium (d_a) = 50 mm, thermal expansion coefficient of steel $(\alpha_s) = 12 \times 10^{-6}\ /^0C$, thermal expansion coefficient of aluminium $(\alpha_a) = 23 \times 10^{-6}\ /^0C$, Modulus of elasticity (E_s = 200 GPa, E_a = 70 GPa 7

b) A steel bar ABCD of varying cross section is subjected to axial force as shown in the figure. Find the value of P necessary for equilibrium. Determine the total deformation of the bar. What will be the axial load which will produce the same strain, if the steel bar is replaced by a bar of uniform cross section with the same length and 20 mm diameter? Take E = 200 GPa. 7

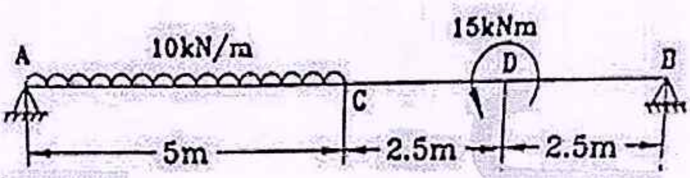


Module -3

15 a) Derive the differential equations connecting the Load, Shear Force and Bending Moment. 7

b) A solid shaft is proposed to be replaced by a hollow shaft (of the same length and the same material) for transmitting a torque of 30 kNm. If the allowable shear stress of the material used is $100 N/mm^2$, find the ratio of the weight of hollow shaft to the solid one, if the inner diameter for hollow one is to be 0.5 times its outer diameter. 7

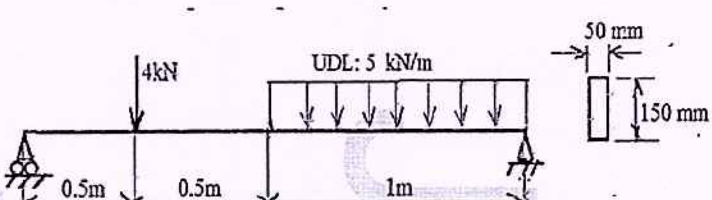
16 a) Draw the shear force and bending moment diagram for the simply supported beam shown in the figure . 14



Module -4

17 a) 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 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 18×10^8 mm^4 and $E = 200 kN/m^2$. 14

18 a) Find deflection at the mid-span using Macaulay's method, if E=12GPa and cross section as shown. 14



Module -5

19 a) Explain the five theories of failure used in structural mechanics. Also define factor of safety. 14

20 a) If the principal stresses at a point are: $\{\sigma 1, \sigma 2, \sigma 3\}=\{10,0,-4\}$MPa and if the yield strength of the material under consideration is 40MPa, find the factor of safety in design as per (a) Max. Normal Stress Theory (b) Max. Shear Stress Theory and (c) Max. Distortion Energy Theory. 14

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