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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S5 (R,S) Examination November 2025 (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 principal stresses and principal planes.	3
2	Explain stress tensor with its components	3
3	A bar of circular cross-section consisting of three sections are having different lengths and different diameters. The bar is subjected to an axial load 'P'. Determine the total change in length of the bar if the Young's Modulus of different sections are same?	3
4	Explain longitudinal & lateral strain.	3
5	Differentiate between a point load and a uniformly distributed load.	3
6	Write down Torsional Formula? What are the assumptions made in the theory of torsion?	3
7	Define the term elastic strain energy and complimentary strain energy?	3
8	State and explain Castigliano's Second Theorem.	3
9	Write down any three assumptions in Euler's column theory?	3
10	Define the terms: (i) Critical load (ii) Slenderness Ratio	3

PART B

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

Module -1

11	a)	At a point P in a body σ_x = 10000 N/cm^2, σ_y= -5000 N/cm^2, σ_z= -5000 N/cm^2, τ_{xy} =τ_{yz}=τ_{zx} =10000 N/cm^2. Determine the normal and shearing stresses on a plane that is equally inclined to all the three axes.	7

b) The state of stress at a point is given by the components σ_x = 12.31 MPa, σ_y = 8.96 MPa, σ_z = 4.34 MPa, τ_{xy} = 4.20 MPa, τ_{yz} = 5.27 MPa, τ_{zx} =0.84 MPa. Obtain the values of principal stresses? 7

OR

12 a) The state of plane stress at a point is given by σ_x = 50 MPa, σ_y = -35 MPa, τ_{xy} = 40 MPa. Using Mohr's circle determine 14

(i) Principle stresses

(ii) Principle planes

(iii) Maximum shear stress and

(iv) Maximum shear planes

Module -2

13 a) Explain and mark the salient points given below with the help of a stress-strain curve for brittle material: (i) Proportionality limit (ii) Elastic limit (iii) Ultimate stress (iv) Breaking point 4

b) A steel rod of 20mm diameter passes centrally through a copper tube of 50mm 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 on the projecting parts of the rod. If the temperature of the assembly is raised by 50^0C, Calculate the stresses developed in copper and steel. Take E for steel and copper as 200 GN/m^2 and 100 GN/m^2 and α for steel and copper as 12 x 10^{-6} per ^{0}C and 18 x 10^{-6} per ^{0}C 10

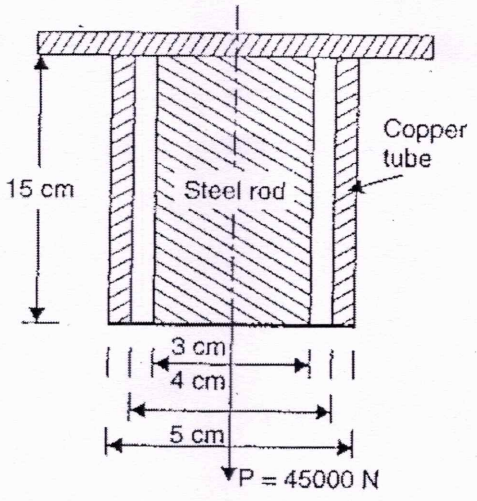
OR

14 a) A metallic bar 300 mm x 100 mm x 40 mm is subjected to a force of 5 KN (Tensile), 6KN (Tensile) and 4 KN (Tensile) along x, y and z directions respectively. Determine the change in the volume of the block. Take E = 2 x10^5 N/mm^2, Poisson's ratio = 0.25 5

b) A composite bar consists of steel rod enclosed in a hollow copper tube of length 15 cm is subjected to an axial pull of 45000 N as shown in figure. Calculate 9

(i) The stresses in the rod and tube

(ii) Load carried by each bar



Module -3

15 a) A simply supported beam of length 8 m carries point loads of 4 KN and 6 KN at a distance of 2m and 4m from the left end. Draw the SF and BM diagrams for the beam. 9

b) A hollow shaft of external diameter 120mm transmits 300 KW power at 200 rpm. Determine the maximum internal diameter if the maximum stress in the shaft is not to exceed 60 N/mm^2. 5

OR

16 a) A rectangular beam 200mm deep and 300mm wide is simply supported over a span of 8m. What uniformly distributed load per metre the beam may carry, if the bending stress is not to exceed 120 N/mm^2 5

b) A rectangular beam 100mm wide and 250mm deep is subjected to a maximum shear force of 50KN. Determine 9

(i) Average shear stress

(ii) Maximum Shear stress and

(iii) Shear stress at a distance of 25 mm above the neutral axis.

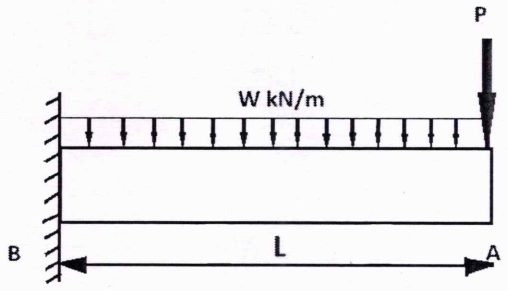
Module -4

17 a) A simply supported beam of 6 m span carries two-point loads of 48 KN and 40 KN at a distance of 1 m and 3 m from left end. Determine the deflection under each load and maximum deflection using Macauley's method. Take $E = 2 \times 10^5$ N/mm^2, $I = 85 \times 10^6$ mm^4. 14

OR

18 a) Obtain an expression for strain energy in terms of load, geometry and material properties for the case of bending moment? 5

b) A cantilever beam AB supports a uniformly distributed load 'w' and a concentrated load 'P' as shown in figure. Apply Castigliano's second theorem to determine the deflection at point A, when L = 2m, w = 4kN/m, P= 6kN and EI= 5 x 10^3 kN/m^2 9



Module -5

19 a) Derive the Rankine's formula for columns. 5

b) A 1.5 m long column has a circular cross-section of 5 cm diameter. One of the ends of the column is fixed in direction and other end is free. Take factor of safety as 3, Calculate the safe load using Rankine's and Euler's formula. Take E = 1.2 x 10^5 N/mm^2, yield stress σ_c = 560 N/mm^2 and Rankine's constant α = 1/1600. 9

OR

20 a) The principal stresses at a point in an elastic material are 100 N/mm^2 (tensile), 80N/mm^2 (tensile) and 50 N/mm^2 (compressive). If the stress at the elastic limit in simple tension is 200 N/mm^2. Determine whether the failure of material will occur according to maximum principal stress theory. If not, then determine the factor of safety 5

b) Determine the diameter of a bolt which is subjected to an axial pull of 9 kN together with a transverse shear force of 4.5 kN using Maximum principal strain theory. Take elastic limit in tension as 225 N/mm^2, Factor of safety =3 and poisons ratio as 0.3 9

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