Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech Degree S4 (S,FE) / S2 (PT) (S,FE) Examination May 2024 (2015 Scheme)

Course Code: ME202

Course Name: ADVANCED MECHANICS OF SOLIDS

Data-books are not permitted to use

Max. Marks: 100 Duration: 3 Hours

PART A

Answer any three questions. Each question carries 10 marks.

1 Derive the differential equations of equilibrium for 3D stress system 10

2 At a point in a given material, the state of the stress is given by 10

$\tau_{ij} = \begin{bmatrix} 10 & 12 & 8 \\ 12 & 15 & -5 \\ 8 & -5 & -7 \end{bmatrix}$ N/m^2. Compute the following: i) Principal stresses ii) Orientation of the maximum plane iii) Maximum shear stresses iv) Octahedral shear stress v) Octahedral normal stress.

3 a Distinguish between plane stress and plane strain conditions citing suitable examples 4

b Show that $\phi = A(xy^3 - \frac{3}{4}xyh^2)$ is an Airy's stress function, where 'A' and 'h' are constants. Also show that it represents the stress distribution in a cantilever beam loaded at the free end with a load. 6

4 Using the stress strain relations, strain compatibility equation and equations of equilibrium, derive the relation for plane strain $\left(\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}\right)(\sigma_x + \sigma_y) = \frac{-1}{1-\nu}\left(\frac{\partial X}{\partial x} + \frac{\partial Y}{\partial y}\right)$ where X and Y are the components of body force per unit volume along the x and y directions and ν is the poisson ratio. 10

PART B

Answer any three questions. Each question carries 10 marks

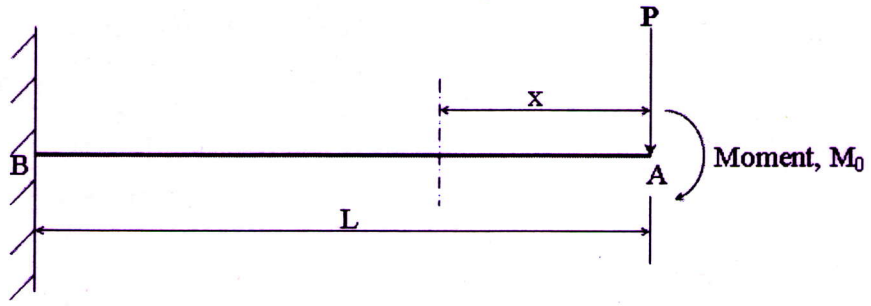
5 Obtain the expressions for the strain components in terms of the displacement components in polar co-ordinates. 10

6		Derive the expressions for maximum stresses in a rotating disc.	10
7	a	Define shear centre. Discuss it's practical applications.	6
	b	Distinguish between symmetric and asymmetric bending	4
8		What is strain energy? Determine the strain energy stored in a bar of uniform cross-section, hangs vertically, subjected only to its own weight.	10

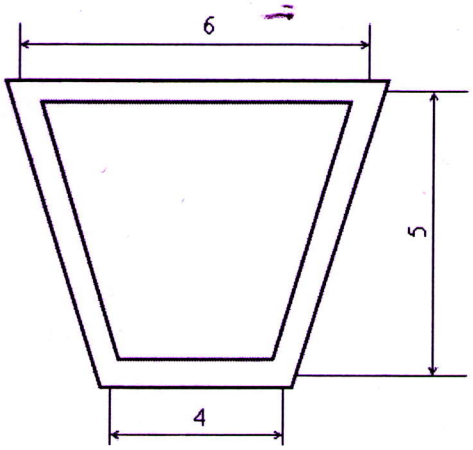
PART C

Answer any four questions. Each question carries 10 marks.

9	a	State and explain Castigliano's theorem. What are their advantages?	4
	b	Find the displacement and slope at the tip of a cantilever beam of length L, loaded by a force P as shown in figure. Assume the flexural rigidity of the beam 'EI' to be a constant for the beam.	6

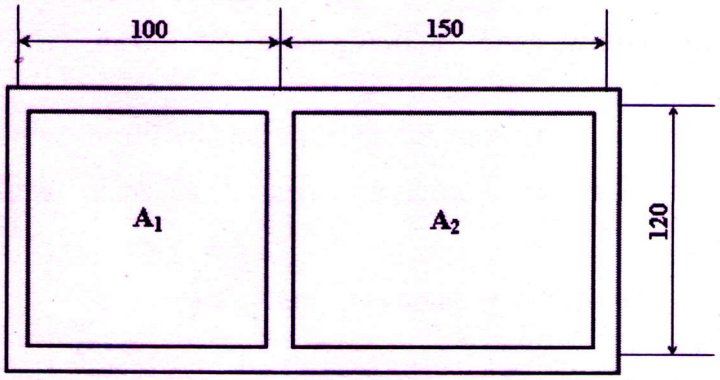


10	a	Explain the principle of virtual work.	4
	b	Explain the principle of minimum potential energy theorem with a suitable application.	6
11		Derive the expression for the angle of twist in the torsion of an elliptical bar.	10
12	a	Explain the general theorem behind Membrane Analogy.	4
	b	A steel tube with the cross section shown carries a torque T. The tube is 6 ft long and has a constant wall thickness of 0.375 in.	6



i) Compute the torsional stiffness of the tube. ii) If the tube is twisted through 0.5°, determine the shear stress in the wall of the tube. Use $G=12x10^6$ psi. And neglect stress concentrations at the corners. All dimensions are in inches.

13 Using the membrane analogy analyze the following section as shown in figure for the torsion shear stresses. The twisting moment applied to each of the cross-sections is 30 kNm. Uniform thickness of the walls of the plates is 3 mm and the heights of the plates are equal. Take the modulus of rigidity G=27 GPa. All dimensions are in mm. 10



14 Derive a governing partial differential equation for the deflection of a membrane subjected to pressure 'p'. 10