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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M. TECH DEGREE EXAMINATION

Mechanical Engineering

Machine Design

04ME 6505—Advanced Mechanics of Solids

Max. Marks : 60 Duration: 3 Hours

PART A

Answer All Questions

Each question carries 3 marks

1. What are octahedral stresses ? State the hydrostatic and deviatoric stress components in a stress tensor ?
2. What is shear flow. Explain with a neat diagram
3. Define Airy's Stress Function approach. State the condition check required for a stress function.
4. Briefly explain the method of polynomials for solving a 2-D elastic problem
5. What are stress invariants ? What is its significance in stress or strain tensor problems ?
6. With the help of a neat figure, explain Maxwell model.
7. What are compatibility equations ? Mention its significance
8. Mention any three assumption from a general Torsional Problem

PART B

Each question carries 6 marks

9. Determine the principal stresses and their axes for the following state of stress.

$\sigma_{ij}=$

3	-1	1
-1	5	-1
1	-1	3

kPa

OR

10. With the help of a neat figure, derive the differential equation of equilibrium for a cubical element.

11. The components of strain tensor at a point in a solid are given by

$\varepsilon_x=a_1(x^2+y^2)$, $\varepsilon_y=a_2(y^2+z^2)$, $\varepsilon_z=a_3(z^2+x^2)$, $\gamma_{xy}=a_4xy$, $\gamma_{yz}=a_5yz$ and $\gamma_{zx}=a_6zx$

What possible conditions should hold between constants a_1 to a_6 so that all the above is a possible strain field.

OR

12. The displacement field in a solid body is given by

$$u=\{3x^2z+60x)i+(5z^2+20xy)j+(6z^2+2xyz)k) \times 10^{-3} \text{ mm}$$

Evaluate the strain at the point (3,4,0.5)mm. Also, Determine the principal strains and principal axes.

13. Derive the stress compatibility condition. Further, formulate the biharmonic equation.

OR

14. Show that $\phi=\{a_1e^{bx}+a_2e^{-bx}+a_3xe^{bx}+a_4xe^{-bx})$ cos by is a possible stress function for the constant a_1 to a_4 and b.
15. A Steel railway car wheel may be considered a cylinder with a radius of 440mm. The wheel rolls on a steel rail whose tops surface may be considered another cylinder of radius of 330 mm. For the steel wheel and steel rail, E=200GPa, ν=0.29, and Y= 880MPa. If the wheel load is 110 kN, Determine σ_{max}, τ_{max}, $\tau_{oct(max)}$, $2\tau_0$ and the factor of safety against initiation of yielding based on the maximum shear stress criterion.

OR

16. A hard steel ball(E=200GPa and ν=0.29) of diameter 50mm is pressed against a thick aluminum plate (E=72GPa,ν=0.33 and Y= 450MPa). Determine the magnitude of load P_y required to initiate yield in the aluminum plate according to octahedral shear-stress criterion of failure.
17. Investigate if ψ=Axy is a possible warping function, where A is a constant. If yes, formulate the J integral , torque and the resultant shear stresses.

OR

18. Derive the equation for the deflection of thin walled tubes subjected to torsion.
19. A 30 cm I beam with flanges and web thickness of 1.25 cm thick is subjected to a torque of 4900 Nm. Find the maximum shear stress and the angle of twist per unit length. In order to reduce the stress and the angle of twist, 1.25 cm thick plates are welded onto the sides of the section. Find the modified shear stress and twist per unit length.

OR

20. Explain viscoelasticity. Explain any two visco elastic models briefly.