APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY
FIRST SEMESTER M.TECH DEGREE EXAMINATION
MECHANICAL ENGINEERING
(Machine Design)
04 ME 6505 - ADVANCED MECHANICS OF SOLIDS

Time: 3 hrs Max. Marks: 60

Use of data sheets may be permitted

PART A
(Answer all questions. Each question carry 3 marks).

1. Differentiate between hydrostatic and deviatoric state of stress
2. Explain the construction of 3-D Mohrs circle:
3. Starting from the stress compatibility equation for plane stress cases, derive the biharmonic equation:
4. Discuss the assumptions involved in contact stress problems:
5. Derive expressions for stresses in a thin rectangular plate subjected to torsion:
6. Explain warping in prismatic bars with neat sketch.
7. Differentiate between Elastic behavior and Visco-elastic behavior:
8. Explain Kelvin-Voigt Model with neat labelled diagram.

PART B
(Each full question carries 6 marks).

9. Derive the governing equations of equilibrium in Polar coordinate system for a 3D stress analysis problem:

OR

10. The state of stress at a point wrt x, y and z axis are given as σx = 4 MPa, σy = 6 MPa; σz = 8 MPa; τxy = 1 MPa; τyz = 2 MPa; τzx = 0 MPa. Show that the transformation of the axes by 450 about the z axis the stress invariants remain unchanged:
11. At a point P, the rectangular stress components are σx = 1, σy = 2, σz = 4, τxy = 2, τyz = -3, and τzx = 1 all in units of kPa. Find the principal stresses and check for invariance.

OR

12. The principal stresses on a plane are: $\sigma 1 = 9$, $\sigma 2 = 6$, $\sigma 3 = 3$ kPa. Determine the normal and shearing stresses on a plane whose direction cosines are 0.5, 0.5, $\sqrt{}2$; by using 3-D Mohrs circle.
13. A beam of span 3m is simply supported at the ends. It has a rectangular cross-section 60 mm x 80 mm and is subjected to a uniformly distributed load of intensity 2 kN/m. Determine the distribution of maximum stresses in the beam.

OR

14. Derive the stress compatibility equation in case of plane strain case:

15. A steel railway car wheel may be considered a cylinder with a radius of 440 mm. The wheel rolls on a steel rail whose top surface may be considered another cylinder with a radius of 330 mm. For the steel wheel and steel rail, E = 200 GPa, $\nu = 0.29$, and σyt = 880 MPa. If the wheel load is 110 kN, determine max, max, oct max, 2τo and the factor of safety against initiation of yielding based on the maximum shear-stress criterion.

OR

16. A feed roll consists of two circular cylindrical steel rollers, each 200 mm in diameter and arranged so that their longitudinal axes are parallel. A cylindrical steel shaft (60 mm in diameter) is fed between the rollers in such a manner that its longitudinal axis is perpendicular to that of the rollers. The total load P between the shaf and rollers is 4.5 kN. Determine the values of the maximum principal stress and maximum shear stress in the shaft. Determine the distance from the plane of contact to the point of maximum shear stress. Use E = 200 GPa and $\nu = 0.29$ for the shaft.

17. Derive the expression for angle of twist in a thin walled tube subjected to torsion.

OR

18. (i) A 30 cm I beam, with flanges and with a web 1.25 cm thick, is subjected to a torque T = 4900 Nm. Find the maximum shear stress and the angle of twist per unit length.
(ii) In order to reduce the stress and the angle of twist, 1.25 cm thick flat plates are welded onto the sides of the section, as shown by dotted lines. Find the maximum shear stress and the angle of twist.

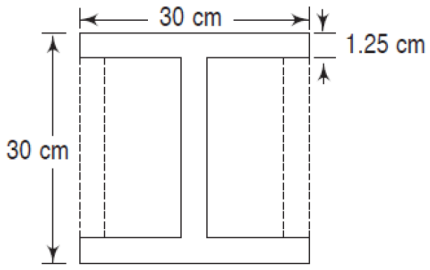

Figure 1: Cross-section of the beam

19. Explain any two constitutive models of linear viscoelasticity

OR

20. Explain:
a. Maximum Shear stress theory
b. Distortion Energy Theory