

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

FIRST SEMESTER M.TECH DEGREE EXAMINATION, DECEMBER 2017

Mechanical Engineering

Machine Design

01ME6105 CONTINUUM MECHANICS

Answer any two full questions from each part

Limit answers to the required points.

Max. Marks: 60

Duration: 3 hours

PART A

1.
 - a. Write down the equation for Mohr's circle of two-dimensional problems. Write down the equation for the radius of the 2D Mohr's circle? (3 marks)
 - b. What are spherical and deviatoric parts of a tensor? (1 marks)
 - c. $\sigma_{xy}=2$, $\sigma_{xz}=1$, $\sigma_{yy}=0$ and $\sigma_{zz}=0$ be the known components of stress at a point. Find the value σ_{xx} such that at least one plane passing through the point is stress free. Also determine the direction cosines of normal of the stress free plane. (5 marks)
2.
 - a. Derive an equation for octahedral shear stress in terms the stress invariants. (4 marks)
 - b. The principal stresses of stress at a point are σ_1 σ_2 and σ_3 with $\sigma_1 > \sigma_2 > \sigma_3$. Now, derive equations of the direction cosines of a plane passing through this point, which is subjected to normal stress and shear stress σ_n and τ_n respectively. (5 marks)
3.
 - a. With the help of mathematical derivations obtain the relation between circulation of a vector field per unit area around a point in a plane and curl of the vector. (4 marks)
 - b. Differentiate between vector space and space of inner product. (3 marks)
 - c. What is δ_{ij} ? Find the value of δ_{ii} (2 marks)

PART B

- 4 a. Differentiate between Lagrangian and Eulerian descriptions of fluid motion. (4 marks)
- c. The lagrangian coordinates of a material particle is $(x(t), y(t), z(t))$.
Obtain mathematical expression for the component of acceleration along the direction of motion of the material particle. (5 marks)
- 5 a. Explain infinitesimal deformation theory. Obtain an expression for Linearized strain (3 marks)
- b. What is localization theorem. Write down its relevance in the derivation of differential equations (3 marks)
- c. Derive the differential form of conservation of energy. (3 marks)
- 6 a. Write down the six compatibility equations. (3 marks)
- b. Discuss the physical interpretations of components of Linearized strain tensor. (6 marks)

PART C

- 7 a. What is orthotropic material? Write down the number of independent elastic constants for orthotropic material . Write down the structure of the elasticity matrix relating the stress vector and strain vector. (1+1+2=4 marks)
- b. Write down the general stress strain relation through the 4th order elasticity tensor. Discuss the changes in the number of independent constants due to symmetry conditions applicable for all linear elastic materials. (1+4=5 marks)
- c. Write down the stress strain relations of a linear isotropic material.(3 marks)
8. a. Derive the stress compatibility equation for a plain stress problem with body force. State the condition under which it becomes the bi-harmonic equation. (6 marks)
- b. Derive Navier-Stokes equation for incompressible flow. (6 marks)
9. a. Write down the radial and tangential components of stress in terms of Air's stress function. (2 marks)
- b. Derive the governing equation of Prandtl stress function for the torsion of a prismatic bar. (10 marks)