JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT

TEST -3 EXAMINATIONS-2022

M. Tech.-II Semester (Civil)

COURSE CODE (CREDITS): 12M1WCE211 (3) MAX. MARKS: 35

COURSE NAME: Solid Mechanics in Structural Engineering

COURSE INSTRUCTOR: Arnav Anuj Kasar MAX. TIME: 2 Hours

Note: *All questions are compulsory. Marks are indicated against each question in square brackets.*

Q1. The following displacement field is imposed on a body

$$\boldsymbol{u} = (xy\boldsymbol{i} + 3x2z\boldsymbol{j} + 4\boldsymbol{k})10^{-2}$$

Consider a point P and a neighbouring point Q where PQ has the following direction cosines

$$n_x = 0.200,\ n_y = 0.800,\ n_z = 0.555$$

Point P has coordinates (2, 1, 3). If PQ = Δs, find the components of $\boldsymbol{P'Q'}$ after deformation. **[5 Marks]**

Q2. The following state of strain exists at a point P:

$$[\varepsilon_{ij}] = \begin{matrix} 0.02 & -0.04 & 0 \\ -0.04 & 0.06 & 0.02 \\ 0 & -0.02 & 0 \end{matrix}$$

In the direction PQ having direction cosines $n_x = 0.6$, $n_y = 0$ *and* $n_z = 0.8$, determine ε_{PQ} . **[8 Marks]**

Q3. What is Displacement Gradient Matrix? Derive its general form from the state of strain on a general body. **[5 Marks]**

Q4. Write the generalized Hooke's law for an isotropic material explaining its derivation. **[5 Marks]**

Q5. A cubical element is subjected to the following state of stress.

$$\sigma_x = 100\ MPa,\ \sigma_y = -20\ MPa,\ \sigma_z = -40\ MPa,\ \tau_{xy} = \tau_{yz} = \tau_{zx} = 0$$

Assuming the material to be homogeneous and isotropic, determine the principal shear strains and the octahedral shear strain, if E = 2×10^5 MPa and ν = 0.25. **[7 Marks]**

Q6. At a point P in a body, $\sigma_x = 10{,}000\ N/cm^2$, $\sigma_y = -5{,}000\ N/cm^2$, $\sigma_z = -5{,}000\ N/cm^2$, $\tau_{xy} = \tau_{yz} = \tau_{zx} = 10{,}000\ N/cm^2$. Determine the normal and shearing stresses on a plane that is equally inclined to all the three axes. **[5 Marks]**