BIRLA INSTITUTE OF TECHNOLOGY AND SCIENCE, PILANI
FIRST SEMESTER 2022– 2023
Advance Structural Mechanics and Stability – Mid-Semester Examination

Course No: CE G552 **Date: 01-11-2022**
Duration: 90 Mins. (Open book) **Max. Marks: 30**

---

1. The state of stress at a point in a body is given as, $a_{ij} = \begin{bmatrix} 1 & 1 & 0 \\ 1 & 1 & 1 \\ 0 & 1 & 1 \end{bmatrix}$ **[9]**

Find, (a) The principal stresses and corresponding principal directions.
(b) The maximum shear stresses and the direction of maximum shear stress.

2. The displacement field of a body is given by, **[6]**

$$u = \left[\left(3 + xy\right) e_x + \left(5y + 3yz\right) e_y + \left(x^2 + 2z^2\right) e_z \right].$$

Find the displacement gradient, small strain tensor and rotation tensor at a point (3, 4, 2)

3. The state of strain at a point with reference to $\boldsymbol{X} = (x,\ y,\ z)$ are, $\varepsilon_{ij} = p \begin{bmatrix} 3 & 1 & 0 \\ 1 & 2 & 0 \\ 0 & 0 & 1 \end{bmatrix}$. **[7]**

Where, $p = 10^{-2}$.

(i) Find the strain tensor at the same point with respect to new set of co-ordinate axes $\boldsymbol{X}' = (x',\ y',\ z')$, which is obtained after 60^0 rotations of co-ordinate axes $\boldsymbol{X} = (x,\ y,\ z)$ about the *z*-axis in counterclockwise direction.

(ii) Find the stain invariants in new set of co-ordinate axes $\boldsymbol{X}' = (x',\ y',\ z')$.

(iii) Resolve the strain tensor in new set of co-ordinate axes $\boldsymbol{X}' = (x',\ y',\ z')$ into spherical (i.e., isotropic) state of strain and deviatoric state of strain.

(iv) Determine the volumetric strain in new set of co-ordinate axes $\boldsymbol{X}' = (x',\ y',\ z')$.

4. The cantilever beam with rectangular cross-section having unit width subjected to moment (M_o), shear force (F_s) and axial force (F_a) at the free end shown in figure 1. Find the stress distributions ($\sigma_{xx},\ \sigma_{yy},\ \tau_{xy}$) within cantilever beam using Airy stress approach. **[8]**

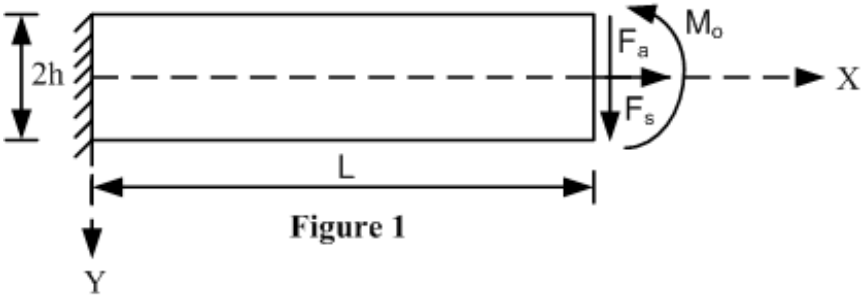

Figure 1