DEPARTMENT OF MECHANICAL ENGINEERING

UNIVERSITY INSTITUTE OF ENGINEERINGAND TECHNOLOGY, CSJM UNIVERSITY, KANPUR

Advanced strength of materials (MEE –S206)

Semester: 2021-22 (Odd Semester) **Year: 2nd Year (2K21)**

Mid Semester Examination

Time: 1.5 h **Maximum marks: 30**

All questions are compulsory

Section A

1. Given the stress tensor (in MPa)

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Calculate the traction vector on a surface with unit normal n = (0.400, 0.600 , 0.693).

2. Given the stress tensor (in MPa)

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Calculate normal and shear stresses with unit normal n = (0.400, 0.600 , 0.693).

3. The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Determine the principal stresses.

4. The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Determine the principal direction.

5. The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Find the maximum Shear stress

6. The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Draw 3D- Mohr circle

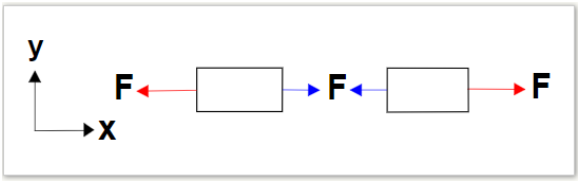
7. The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 1 & 1 & -1 \\ 1 & 2 & -1 \\ -1 & -1 & 3 \end{bmatrix}$$

Find the normal stress on the plane of maximum shear stress acts by using 3D-Mohr circle.

8. The object below has a 400 mm2 cross sectional area and is being pulled in tension by a 4,000 N force (red) in the x-direction. So the (arbitrarily chosen) rightward pointing internal force vector (blue) is

F = 4000 N i



9. Suppose the state of stress at a point in a x, y, z coordinate system is given by

$$\begin{bmatrix} 100 & 0 & 180 \\ 0 & 20 & 0 \\ 180 & 0 & 20 \end{bmatrix}$$

Calculate the three invariants of this stress tensor. [1 x 9]

Section B

1. What do understand by stress invariants?

2 . Find the expression of normal stress and shear stress on an arbitrary plane.

3. Explain the procedure to calculate Eigen vector and Eigen value of stress matrix. Also proof principal directions are perpendicar to each other with suitable example.

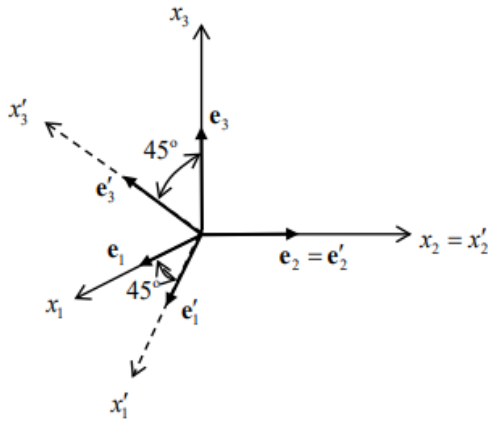
[3 x 3]

Section C

1 The state of stress at a point with respect to an $Ox_1x_2x_3$ coordinate system is given by

$$\sigma = \begin{bmatrix} 2 & 1 & 0 \\ 1 & 3 & -2 \\ 0 & -2 & 1 \end{bmatrix}$$

What are the stress components with respect to axes $0x_1'$ x_2' x_3' which are obtained from the first by a 45^0 rotation (positive counter clockwise) about the x_2 axis.



2. Derive the expression for 3D-stress equilibrium equation.

[2 x 6]