DEPARTMENT OF MECHANICAL ENGINEERING
College of Engineering Thalassery

ME202 Advanced Mechanics of Solids

Tutorial-1: Analysis of Stress

1. A rectangular beam is subjected to a pure bending moment M. The cross section of the beam is shown in Fig. 1. Using the elementary flexure formula, determine the normal and shearing stresses at a point (x, y) on the plane AB shown.

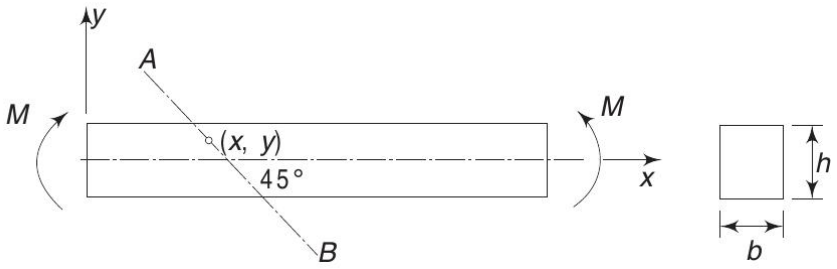

Figure 1: Problem 1

2. The state of stress at a point is characterised by the matrix shown. Determine T_{11} such that there is at least one plane passing through the point in such a way that the resultant stress on that plane is zero. Determine the direction cosines of the normal to that plane.

$$\tau_{ij} = \begin{bmatrix} T_{11} & 2 & 1 \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$$

3. If the rectangular components of stress at a point are as in the matrix below, determine the unit normal of a plane parallel to the z axis,i.e. $n_z = 0$, on which the resultant stress vector is tangential to the plane

$$\tau_{ij} = \begin{bmatrix} a & 0 & d \\ 0 & b & e \\ d & e & c \end{bmatrix}$$

4. Determine the principal stresses, their axes, principal shears and the associated normal stresses for the states of stress characterised by the following stress matrices (units are 1000 kPa).

   (a)
   $$\tau_{ij} = \begin{bmatrix} 18 & 0 & 24 \\ 0 & -50 & 0 \\ 24 & 0 & 32 \end{bmatrix}$$

   (b)
   $$\tau_{ij} = \begin{bmatrix} 3 & -10 & 0 \\ -10 & 0 & 30 \\ 0 & 30 & -27 \end{bmatrix}$$

   (c)
   $$\tau_{ij} = \begin{bmatrix} 12.31 & 4.20 & 0 \\ 4.20 & 8.96 & 5.27 \\ 0 & 5.27 & 4.34 \end{bmatrix}$$

5. A solid shaft of diameter $d = \sqrt{10}cm$ is subjected to a tensile force $P = 10,000N$ and a torque$T = 5000Ncm$. At a point on the surface, determine the principal stresses, the octahedral shearing stress and the maximum shearing stress.

6. The state of stress at a point for a given reference is given below. If a new set of axes $x'y'z'$ is formed by rotating xyz through 60^Oabout z axis,find the new stress tensor

$$\tau_{ij} = \begin{bmatrix} 200 & 100 & 0 \\ 100 & 0 & 0 \\ 0 & 0 & 500 \end{bmatrix}$$

7. At a point P, the rectangular stress components are, $\sigma_x = 1, \sigma_y = -2, \sigma_z = 4, \tau_{xy} = 2, \tau_{yz} = -3$ and $\tau_{zx} = 1$ all in units of KPa. Find the principal stresses and directions.

8. Find the principal stresses and check for invariance in the following case.

$$\tau_{ij} = \begin{bmatrix} 1 & 2 & 1 \\ 2 & -2 & -3 \\ 1 & -3 & 4 \end{bmatrix}$$

9. The stress at a point is given by the three principal stresses $100, 120$ and $200N/mm^2$. Determine the shear and normal stresses on a plane which has normal with direction cosines as $\frac{1}{\sqrt{2}}, \frac{1}{\sqrt{2}}$ and 0.