

ME5339

HOMEWORK SET NO.1

Due January 29, 2007

(34 points)

Homework grading policy:

Problems in each set of the homework assignments will be selected for grading. Each of the problems graded will be assigned for 10 points. The problem not selected will be given for 2 point as long as a reasonable effort is shown. Just copying the problem will not give any point at all. The solution will be posted in the website after completion of grading. Normally, the homework will be returned within a week after the due date.

Late homework will be accepted. A 20% penalty will be enforced per lecture day. The late homework will not be accepted when the solution is posted.

(Three problems will be graded.)

Problem 1

A stress state at a point **P** is given as below.

$$[\sigma] = \begin{bmatrix} -60 & 10 & 10 \\ 10 & -60 & 20 \\ 10 & 20 & 100 \end{bmatrix} \cdot MPa$$

Consider a plane through the point M, which unit vector is :

$$\vec{n} = \frac{1}{\sqrt{3}}(i - j + k)$$

1. Find the normal component of the traction σ_n and its tangential component τ_s acting at that point P on this plane.
2. Find the direction cosines of σ_n and τ_s .

Problem 2 (Problem 1.25, P 42, 1st text)

A steel shaft of radius $r=75\text{mm}$ is subjected to an axial compression $p=81\text{ kN}$, a twisting moment, $T=15.6\text{ kN-m}$, and a bending moment, $M=13\text{ kN-m}$ at both ends, Calculate the magnitude of the principal stresses, maximum shear stress and the planes on which they act in the shaft.

Problem 3 (use computer any available tools to solve this problem)

A state of stress at a point in a structural part is given as

$$[\sigma] = \begin{bmatrix} -8 & 6 & -2 \\ 6 & 4 & 2 \\ -2 & 2 & -5 \end{bmatrix} \cdot MPa$$

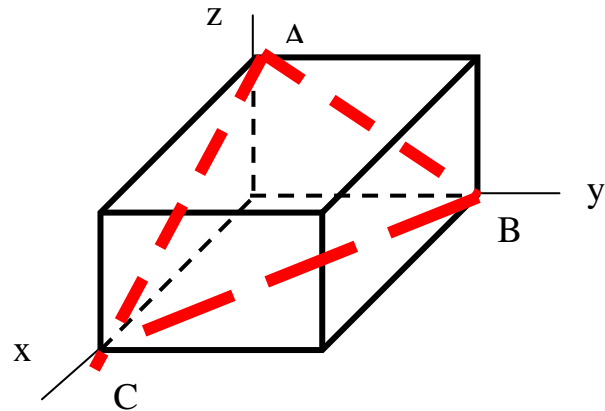
Determine

- Stresses on an element that is oriented by first rotating the xyz axes 45° about z-axis and then rotating the resulting axes about 30° about the new x-axis.
- Stresses on an element that is oriented by first rotating the xyz axes 30° about x-axis and then rotating the resulting axes about 45° about the new z-axis.
- Are the result obtained from a) and b) the same?
- Does the three stress invariants hold true? Show the work of your justification.

Problem 4

An octahedral element is shown below. Find the normal and shear stresses on plane ABC for the state of stress given as below:

$$[\sigma] = \begin{bmatrix} -8 & 6 & -2 \\ 6 & 4 & 2 \\ -2 & 2 & -5 \end{bmatrix} \cdot MPa$$



Determine:

- The directional cosines of plane ABC.
- The octahedral normal and shear stress components

Problem 5 (Problem 1.53 on page 48 in the 1st text)

The state of stress at a point in a member relative to an x, y, and z coordinate system is

$$[\sigma] = \begin{bmatrix} 20 & 10 & -10 \\ 10 & 30 & 0 \\ -10 & 0 & 50 \end{bmatrix} \cdot MPa$$

Determine the normal stress, σ , and shearing stress, τ on the surface intersecting the point and parallel to the plane: $2x+y-3z=9$.