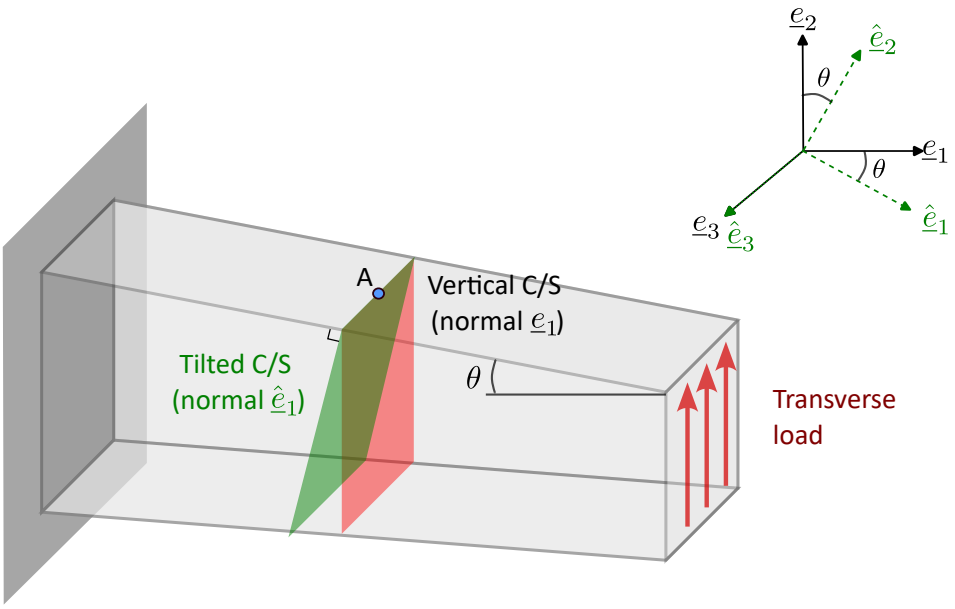
Tutorial 3: Stress tensor and its transformation

APL 104 - 2022 (Solid Mechanics)

Q1. A tapered beam is clamped at one end and subjected to transverse load (along $\underline{e}_2$) at the other end. Think of a point A on the top slanted surface of the beam. What can you say about the state of stress at point A? What can you say about the state of stress at point A?

Suppose we know $\hat{\sigma}_{11}$ at point A. Can we find the components $\tau_{21}, \sigma_{11}, \hat{\tau}_{21}$ at point A?

Assume that traction has no components along $\underline{e}_3$ at any point in the body.



Q2. The state of stress at a point is given by $\left[\underline{\underline{\sigma}}\right] = \begin{bmatrix} \sigma_{11} & 2 & 1 \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$.

What should be σ_{11} such that there is at least one plane at that point on which the traction vanishes? Also, find the corresponding plane normal.

Q3. Suppose the stress matrix at a point equals $\left[\underline{\underline{\sigma}}\right] = \begin{bmatrix} a & 0 & d \\ 0 & b & e \\ d & e & c \end{bmatrix}$.

Determine the plane having its normal perpendicular to z-axis such that the traction on that plane is tangential to the plane.

Q4. Consider a sphere of radius R subjected to diametrical compression as shown in the figure. Let σ_{rr}, $\sigma_{\theta\theta}$, and $\sigma_{\phi\phi}$ be the normal stresses and $\tau_{r\theta}$, $\tau_{\theta\phi}$ and $\tau_{\phi r}$ the shear stresses at any point in the sphere. At point $P(x, y, z)$ on the sphere's surface and lying in the $y - z$ plane, determine the rectangular normal stress components σ_{xx}, σ_{yy} and σ_{zz} in terms of the spherical stress components.