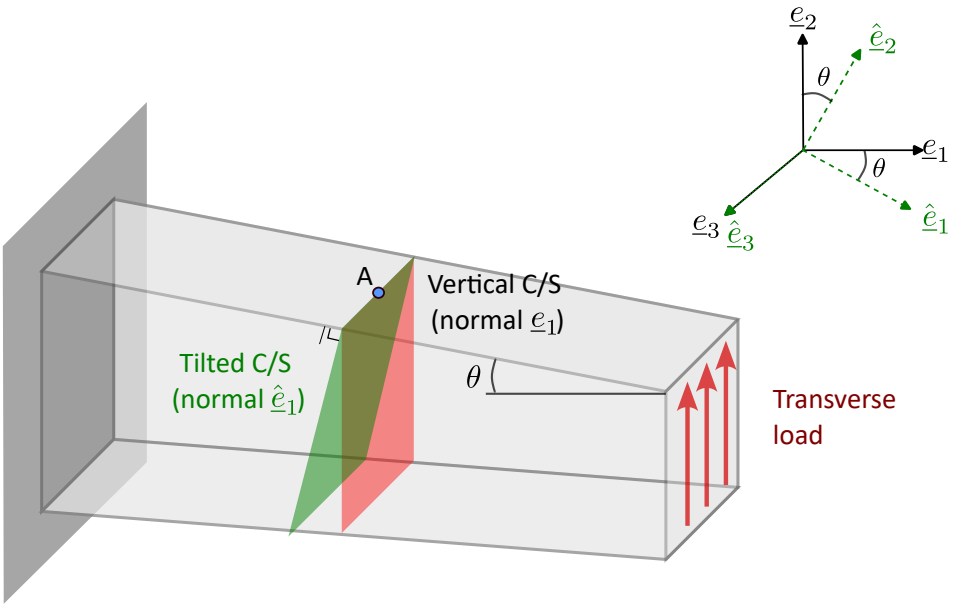
Tutorial 3: Stress tensor and its transformation

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 slanted surface of the beam. What can you say about the state of stress at point A?
Suppose we know $\hat{\sigma}_{11}$ at point A, then can we find the components $\tau_{21}, \sigma_{11}, \hat{\tau}_{21}$ at point A? (Assume that traction has no component along $\underline{e}_3$ at any pt in the body)



Q2. The state of stress at a point is given by $\left[\underline{\underline{\sigma}}\right] = \begin{bmatrix} \tau_{11} & 2 & 1 \\ 2 & 0 & 2 \\ 1 & 2 & 0 \end{bmatrix}$.
What should be τ_{11} such that there is at least one plane at that point on which the traction vanishes? Also, find the normal to the surface.

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 normal to a plane perpendicular to z-axis such that traction on that the plane is tangential to the plane.

Q4. Consider a sphere of radius R subjected to diametral compression. Let σ_r, σ_θ, and σ_ϕ be the normal stresses and $\tau_{r\theta}$, $\tau_{\theta\phi}$ and $\tau_{\phi r}$ the shear streses at a point. At point $P(x, y, z)$ on the surface and lying in the yz plane, determine the rectangular normal stress components σ_x, σ_y and σ_z in terms of the spherical stress components.