Tutorial 2: Traction vector

APL 104 - 2022 (Solid Mechanics)

Q1. Show that if $\underline{t}^n = \sum_i \underline{t}^i\,(\underline{n}\cdot\underline{e}_i) = \sum_i \hat{\underline{t}}^i\,(\underline{n}\cdot\hat{\underline{e}}_i)$, i.e, the formula is independent of what three planes are chosen to determine $\underline{t}^n$!

Q2. Suppose, $[\underline{t}^1] = \begin{bmatrix}0\\1\\0\end{bmatrix}$, $[\underline{t}^2] = \begin{bmatrix}1\\5\\7\end{bmatrix}$, $[\underline{t}^3] = \begin{bmatrix}0\\7\\9\end{bmatrix}$ in $(\underline{e}_1, \underline{e}_2, \underline{e}_3)$ coordinate system.
What will be the traction on a plane with normal $\underline{n} = \hat{\underline{e}}_1$ where $(\hat{\underline{e}}_1, \hat{\underline{e}}_2, \hat{\underline{e}}_3)$ is the rotation of $(\underline{e}_1, \underline{e}_2, \underline{e}_3)$ about $\underline{e}_3$ by 45°?

Q3. Show that component of traction on $\underline{n}$ plane in the direction $\underline{m}$ equals components of traction on $\underline{m}$ plane in the direction $\underline{n}$!

Q4. Consider a vertical bar having a mass density ρ. Assuming that the bar of length H is subjected to a uniform body force due to gravity, find the traction vector acting on plane with unit outward normal

$$\underline{n} = -\sin\theta\ \underline{e}_1 + \cos\theta\ \underline{e}_2$$

at a height y from the base. Also find the normal and tangential components of the traction vector along the plane.