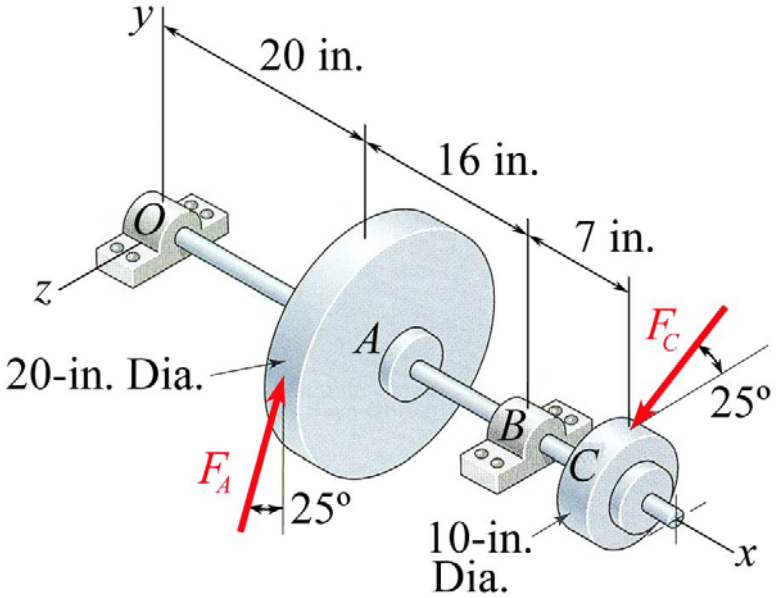
MEEG 4103 Quiz 5.3.081 (Open book, closed notes)

1. ④ Derive the octahedral normal stress σ_{oct}.

2. ⑥ The gear forces shown are parallel to the *yz* plane, where F_A = 400 lb, the bearings at *O* and *B* may be taken as simple supports, and the shaft has $S_y = 60$ kpsi. For static analysis and a factor of safety of 3.5, use *distortion-energy theory* to find the minimum safe diameter *d* of the shaft.



1.

$$[\sigma_{ij}] = \begin{bmatrix} \sigma_1 & 0 & 0 \\ 0 & \sigma_2 & 0 \\ 0 & 0 & \sigma_3 \end{bmatrix} \text{ (½)} \qquad n_i \Rightarrow \frac{1}{\sqrt{3}}\langle 1,\ 1,\ 1\rangle \text{ ①}$$

$$t_i = \sigma_{ji} n_j \Rightarrow \frac{1}{\sqrt{3}}\langle \sigma_1,\ \sigma_1,\ \sigma_1\rangle \text{ ①} \qquad \sigma_{oct} = t_i n_i \text{ ①} \qquad \sigma_{oct} = \frac{1}{3}(\sigma_1 + \sigma_2 + \sigma_3) \text{ (½)}$$

2. $F_A = 400$ lb Draw FBD ① $F_C = 800$ lb (½) $\mathbf{O} = -226.8620\mathbf{j} + 216.1133\mathbf{k}$ lb ①
(or $\mathbf{B} = 202.4335\mathbf{j} - 772.1122\mathbf{k}$ lb) $M_A = 6266.46$ lb·in. (½) $M_B = 5600$ lb·in. (½)

At *A*: $\sigma_x = 7978.705\, r^{-3}$ (½) $\tau_{xy} = -2307.894\, r^{-3}$ (½) $\sigma' = 8924.06\, r^{-3}$ (½) $n = 3.5$
$S_y = 60\times10^3$ psi $n = S_y/\sigma'$ $r = 0.8044$ in. $d = 1.609$ in. (½) Use $d = 1.75$ in. (½)