(d) \( \sigma_A, \sigma_B = 15, -25 \text{ ksi} \)

Eq. (6-33b):

\[
\frac{n(15)}{30} + \left( \frac{-25n + 30}{30 - 109} \right)^2 = 1
\]

\( n = 1.90 \quad \text{Ans.} \)

(a) \( n = \frac{OB}{OA} = \frac{4.25}{2.83} = 1.50 \)

(b) \( n = \frac{OD}{OC} = \frac{4.24}{2.12} = 2.00 \)

(c) \( n = \frac{OF}{OE} = \frac{15.5}{11.3} = 1.37 \quad (3\text{rd quadrant}) \)

(d) \( n = \frac{OH}{OG} = \frac{5.3}{2.9} = 1.83 \)

6-14 Given: AISI 1006 CD steel, \( F = 0.55 \text{ N}, \ P = 8.0 \text{ kN}, \) and \( T = 30 \text{ N} \cdot \text{m}, \) applying the DE theory to stress elements A and B with \( S_y = 280 \text{ MPa} \)

A:

\[
\sigma_x = \frac{32Fl}{\pi d^3} + \frac{4P}{\pi d^2} = \frac{32(0.55)(10^3)(0.1)}{\pi(0.020^3)} + \frac{4(8)(10^3)}{\pi(0.020^2)}
\]

\[= 95.49(10^6) \text{ Pa} = 95.49 \text{ MPa} \]
\[
\tau_{xy} = \frac{16T}{\pi d^3} = \frac{16(30)}{\pi(0.020^3)} = 19.10(10^6) \text{ Pa} = 19.10 \text{ MPa}
\]

\[
\sigma' = (\sigma_x^2 + 3 \tau_{xy}^2)^{1/2} = [95.49^2 + 3(19.1)^2]^{1/2} = 101.1 \text{ MPa}
\]

\[
n = \frac{S_y}{\sigma'} = \frac{280}{101.1} = 2.77 \quad \text{Ans.}
\]

B:

\[
\sigma_x = \frac{4P}{\pi d^3} = \frac{4(8)(10^3)}{\pi(0.020^2)} = 25.47(10^6) \text{ Pa} = 25.47 \text{ MPa}
\]

\[
\tau_{xy} = \frac{16T}{\pi d^3} + \frac{4V}{3A} = \frac{16(30)}{\pi(0.020^3)} + \frac{4}{3} \left[ \frac{0.55(10^3)}{(\pi/4)(0.020^2)} \right] = 21.43(10^6) \text{ Pa} = 21.43 \text{ MPa}
\]

\[
\sigma' = [25.47^2 + 3(21.43^2)]^{1/2} = 45.02 \text{ MPa}
\]

\[
n = \frac{280}{45.02} = 6.22 \quad \text{Ans.}
\]

### 6-15 Design decisions required:

- Material and condition
- Design factor
- Failure model
- Diameter of pin

Using \( F = 416 \text{ lbf} \) from Ex. 6-3

\[
\sigma_{\text{max}} = \frac{32M}{\pi d^3}
\]

\[
d = \left( \frac{32M}{\pi \sigma_{\text{max}}} \right)^{1/3}
\]

**Decision 1:** Select the same material and condition of Ex. 6-3 (AISI 1035 steel, \( S_y = 81000 \)).

**Decision 2:** Since we prefer the pin to yield, set \( n_d \) a little larger than 1. Further explanation will follow.

**Decision 3:** Use the Distortion Energy static failure theory.

**Decision 4:** Initially set \( n_d = 1 \)

\[
\sigma_{\text{max}} = \frac{S_y}{n_d} = \frac{S_y}{1} = 81000 \text{ psi}
\]

\[
d = \left[ \frac{32(416)(15)}{\pi(81000)} \right]^{1/3} = 0.922 \text{ in}
\]