Given Formulae:
Normal stress $\sigma = \frac{F}{A}$, where $F$ is the force that is normal to the cut and $A$ is the area of the cut.
Shear stress $\tau = \frac{V}{A}$, where $V$ is the force that is parallel to the cut and $A$ is the area of the cut.

BONUS QUESTIONS (0.1 POINTS EACH):
Provide the date for the following world events to the tolerances specified
1. (+/- 20 years). Martin Luther puts his Ninety-Five Theses on the church door at Wittenberg, starting the Protestant Reformation.
   OCTOBER 31, 1517
2. (+/- 0 days). The Allied Forces invade Normandy: D-Day.
   JUNE 6, 1944
3. (+/- 0 years). The Austrian Archduke Franz Ferdinand is assassinated, initiating World War I.
   JUNE 28, 1914
4. (+/- 50 years). Michelangelo completes the painting of the Sistine Chapel’s ceiling.
   1512
5. (+/- 1 year). The USSR announces that it has successfully launched the world’s first manmade satellite: Sputnik I.
   OCTOBER 5, 1957
6. (+/- 0 months). Lee Harvey Oswald assassinates President Kennedy in Dallas, TX.
   NOVEMBER 22, 1963 12:30PM CST
7. (+/- 20 years). Gutenberg develops the first movable-type printing press.
   1439
8. (+/- 0 months). The Berlin Wall comes down.
   NOVEMBER 9, 1989
9. (+/- 4 years). Mao Tse Tung announces the formation of the People’s Republic of China.
   OCTOBER 1, 1949
10. (+/- 1 year). The Korean Armistice is signed, ending the active conflict of the Korean War.
    JUNE 27, 1953
1. (45 points). Given: allowable normal stress $\sigma_{allow} = 3\text{ ksi}$, allowable shear stress $\tau_{allow} = 4\text{ ksi}$
   1. Determine the minimum required pin diameter at pin C.
   2. Determine the minimum required cross-section area for bar BC.
   3. Determine the internal N, V, M acting on the cross-section at D and indicate signs

   ![Diagram of the structure with forces and moments applied](image)

   $A_x = \frac{\sum M_A}{x} = \frac{4F_c(3') - 300(5') - 150(10\cos(30))}{3} = \frac{240q(5q)}{3} = F_c = 1004\text{ lb}$

   $o = \sum F_x = A_x - \frac{3}{8}(1004) - 150\sin(30)\Rightarrow A_x = 527.3\text{ lb}$

   $o = \sum F_y = A_y + \frac{3}{8}(1004) - 300 - 150\cos(30)\Rightarrow A_y = -373.3\text{ lb}$ or $373.3\text{ lb}$

   $A_x = 527.3\text{ lb} \Rightarrow \text{ Cut at D:} \Rightarrow C = 527.3\text{ lb}$

   $A_y = 373.3\text{ lb}$

   2. $1004\text{ lb} \text{ in Double Shear}$

   $\tau = \frac{V}{A} \Rightarrow A = \frac{V}{\tau} = \frac{502\text{ lb}}{2000\text{ psi}} = 0.25\text{ in}^2 \Rightarrow r = 0.200" \Rightarrow D = 0.400"$

   3. $1004\text{ lb on Cross Section}$

   $\sigma = \frac{F}{A} \Rightarrow A = \frac{F}{\sigma} = \frac{1004\text{ lb}}{3000\text{ psi}} = 0.3347\text{ in}^2$

   **Answers:**
   
   a. Minimum pin diameter: $0.400$ inches
   b. Minimum cross-section area: $0.335$ in$^2$
   c. $N = 527\text{ lb}$
   $V = 373\text{ lb}$
   $M = 373\text{ ft-lb}$

   **Signs**
1. (20 points). A steel nail with a diameter of 0.15" was driven 1" into wood. Determine the force \( P \) that is needed to pull the nail out of the wood, then determine the normal stress that is in the nail when this force is applied.

Given:
- the maximum shear stress that the interface between wood and steel can resist is 60 psi.
- the maximum normal stress that the interface between wood and steel can resist in tension is 0 psi (this interface resists no tensile normal stress).

\[
A_n = \pi D L = 0.15 \pi \text{ in}^2
\]
\[
P = \tau A_n = (60 \text{ psi})(0.15 \pi)
= 28.27 \text{ lbs}
\]
\[
\sigma_{\text{nail}} = \frac{P}{\pi r^2} = \frac{28.27 \text{ lbs}}{\pi (0.15 \text{ in})^2} = 1600 \text{ psi}
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**Answer**

\[
P = 28.3 \text{ lbs}
\]
\[
\sigma \text{ in the nail} = 1600 \text{ psi}
\]
2. (35 points) Two pieces of wood with a cross-section of 2” x 2” are glued together at the 30° angle shown and subjected to the force P. The glue fails if the normal stress in the glue exceeds 1 ksi.

Determine the maximum force P that can be applied without glue-failure occurring.

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A = \frac{4''}{2\sqrt{3}} = \frac{4}{2\sqrt{3}} = \frac{2}{\sqrt{3}} \quad \text{in}^2
\]

\[
N = (1 \text{ ksi})(8 \text{ in}^2) = 8 \text{ kips}
\]

\[
\sigma = \frac{N}{A} = \frac{8}{\frac{2}{\sqrt{3}}} = \frac{8\sqrt{3}}{2} = 4\sqrt{3} \text{ ksi}
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\[
0 = \sum F_N = N - P \cos 60°
\]

\[
\Rightarrow 8 = P \cdot \frac{1}{2} \Rightarrow P = 16 \text{ kips}
\]

Answer:

\[
P = 16000 \text{ lbs}
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