ME 323: Mechanics of Materials — **Homework Set H02**

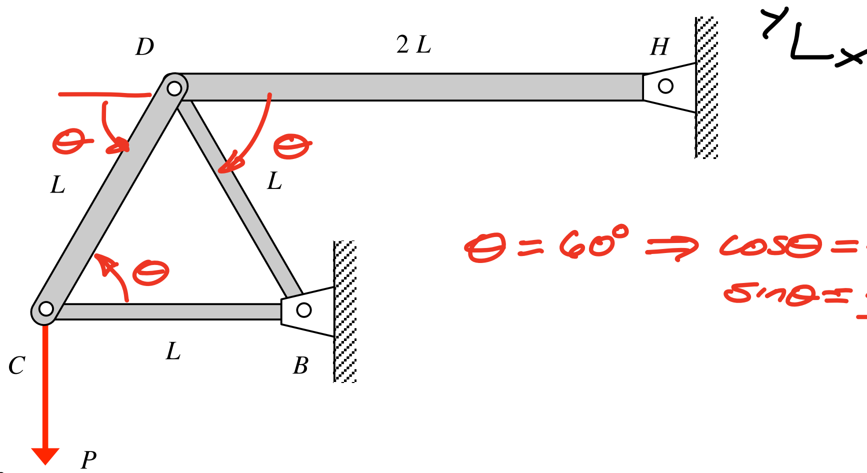
Summer 2024 — **Assigned/Due: June 11/June12**

In the truss shown below, all members have square cross sections, with BC and BD having cross-sectional dimensions of $b \times b$, and CD and DH having cross-sectional dimensions of $2b \times 2b$. All members are made up of a material having a Young's modulus of E and a Poisson's ratio of ν. A vertical force P is applied to joint C of the truss. As a result of this applied load:

a) Determine the stress in each of the four members. State whether each member is in tension or compression.

b) Determine the elongation of member DH.

c) Evaluate your answer in b) using the following: $E = 30 \times 10^6$ psi, $\nu = 0.3$, $b = 1$ in, $L = 12$ in and $P = 20$ kips.



$\theta = 60° \Rightarrow \cos\theta = \frac{1}{2}$

$\sin\theta = \frac{\sqrt{3}}{2}$

(a)

<u>Method of joints</u>

<u>C</u>: $\Sigma F_y = F_{CD}\sin\theta - P = 0$

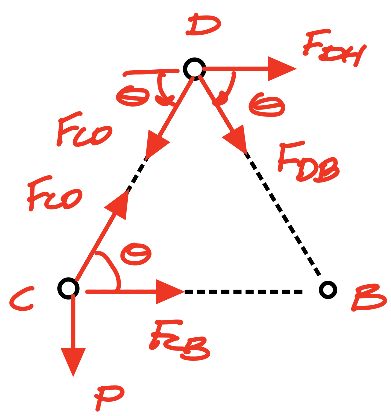
$\hookrightarrow F_{CD} = \frac{P}{\sin\theta} = \frac{2}{\sqrt{3}}P \ (T)$

$\Sigma F_x = F_{CB} + F_{CD}\cos\theta = 0$

$\hookrightarrow F_{CB} = -\left(\frac{P}{\sin\theta}\right)\cos\theta$

$= -\left(\frac{1/2}{\sqrt{3}/2}\right)P$

$= -\frac{1}{\sqrt{3}}P \ (C)$



<u>D</u>: $\Sigma F_y = -F_{CD}\sin\theta - F_{DB}\sin\theta = 0$

$\hookrightarrow F_{DB} = -F_{CD} = -\frac{2}{\sqrt{3}}P \ (C)$

$\Sigma F_x = -F_{CD}\cos\theta + F_{DB}\cos\theta + F_{DH} = 0$

$\hookrightarrow F_{DH} = (F_{CD} - F_{DB})\cos\theta = 2\left(\frac{2}{\sqrt{3}}P\right)\frac{1}{2} = \frac{2}{\sqrt{3}}P \ (T)$

$$\therefore \quad \sigma_{CD} = \frac{F_{CD}}{(2b)^2} = \frac{1}{2\sqrt{3}} \frac{P}{b^2} \ (T)$$

$$\sigma_{CB} = \frac{F_{CB}}{b^2} = -\frac{1}{\sqrt{3}} \frac{P}{b^2} (C)$$

$$\sigma_{DB} = \frac{F_{DB}}{b^2} = -\frac{2}{\sqrt{3}} \frac{P}{b^2} (C)$$

$$\sigma_{DH} = \frac{F_{DH}}{(2b)^2} = \frac{1}{2\sqrt{3}} \frac{P}{b^2} (T)$$

b) $$e_{DH} = \varepsilon_{DH} L_{DH} = \frac{\sigma_{DH}}{E} L_{DH} = \frac{1}{2\sqrt{3}} \frac{PL}{Eb^2}$$

c) $$e_{DH} = \frac{1}{2\sqrt{3}} \frac{(20\times10^3\,lb)(12\,in)}{\left(30\times10^6 \frac{lb}{in^2}\right)(1)^2} = \frac{4}{\sqrt{3}} \times 10^{-3}\,in$$