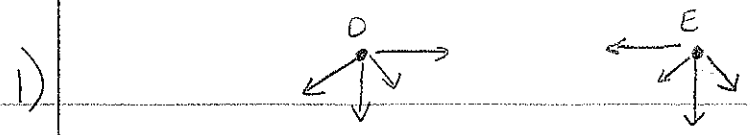
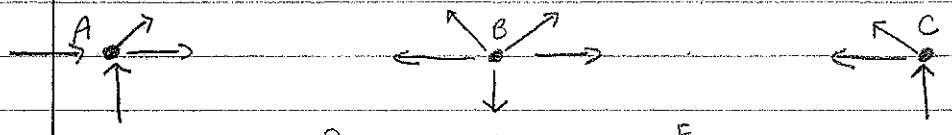
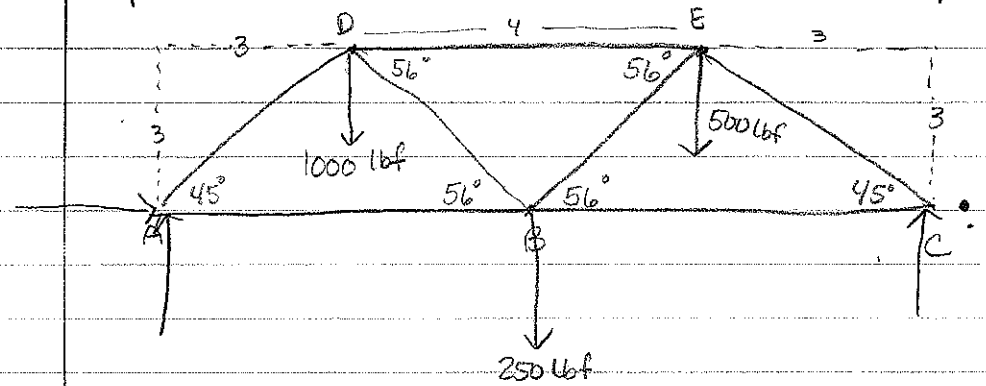
Activity 2.1.6 Step-By-Step Truss System

1)



FBD of joints





FBD of entire truss

2. a) $\sum F_x = 0$ $\sum F_y = 0$ $\sum M = 0$

b) • forces in x direction: $R_{Ax} = \rightarrow$

forces in y direction:

$R_{Ay} = \uparrow$ $R_{Cy} = \uparrow$ $F_D = 1000$ lbf $\downarrow$ $F_B = 250$ lbf $\downarrow$ $F_E = 500$ lbf $\downarrow$

Choosing A as pivot:

(from A)
moment forces:

$M_D = (1000 \text{ lbf})(3) = 3000$ lbft ↻

$M_B = (250 \text{ lbf})(5) = 1250$ lbft ↻

$M_E = (500 \text{ lbf})(7) = 3500$ lbft ↻

$M_{RC} = (R_{Cy})(10) = 10(R_{Cy})$ ↺

c) $\sum M = 0$ so $-3000 \text{ lbf} - 1250 \text{ lbf} - 3500 \text{ lbf} + 10R_{Cy} = 0$

$10R_{Cy} = 7750$ lbf

$R_{Cy} = 775$ lbf

d) $\sum F_x = 0$ so $\boxed{R_{Ax} = 0}$

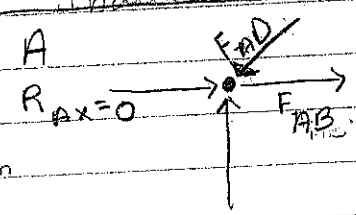
e) $\sum F_y = 0$ $R_{Ay} + 775 \text{ lbf} - 1000 \text{ lbf} - 250 \text{ lbf} - 500 \text{ lbf} = 0$

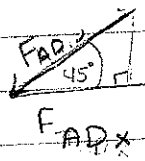
$\boxed{R_{Ay} = 975 \text{ lbf}}$

f) drawing remains the same so I didn't redraw

3. Calculating Individual Truss Member Forces:

FBD at A





assuming AD is in Compression
AB is in tension

$\sin 45 = \frac{F_{ADY}}{F_{AD}}$

$\cos 45 = \frac{F_{ADx}}{F_{AD}}$

forces in x direction:

$R_{AX}=0$ $\quad F_{AB} = \rightarrow \quad F_{ADx} = \rightarrow \quad (F_{AD} \cdot \cos 45)$

forces in y direction:

$R_{AY} = 975$ lbf ↑ $\quad F_{ADY}$ ↓ which is $(F_{AD} \cdot \sin 45)$ ↓

$\sum F_y = 0$ so $975 \text{ lbf} + -F_{AD} \cdot \sin 45 = 0$

$F_{AD} = 1378.86$ lbf

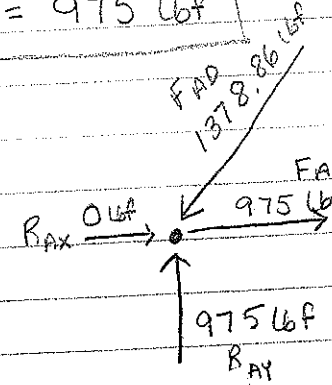
assuming compression was correct

forces in x direction:

$\sum F_x = 0$ so $F_{AB} + (-1378.86 \text{ lbf}) \cdot \cos 45 = 0$

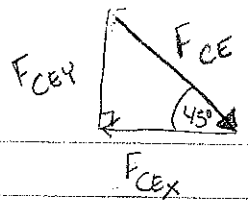
$F_{AB} = 975$ lbf so assuming tension was correct

Updated FBD at A



4. FBD at C

assuming CE compression
CB tension



rt +x
down -y

$$\cos 45 = \frac{F_{CEx}}{F_{CE}}$$

$$\sin 45 = \frac{F_{CEy}}{F_{CE}}$$

forces in x direction

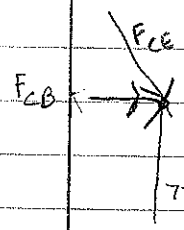
$F_{CB} \leftarrow \quad F_{CE_x} \rightarrow$

forces in y direction

$R_C \uparrow$ 775 lbf $\quad F_{CE_y} \downarrow$

$\Sigma F_y = 0$ so $775\text{ lbf} + -F_{CE_y} = 0$

$F_{CE_y} = -775\text{ lbf}$



$$\sin 45 = \frac{-775\text{ lbf}}{F_{CE}}$$

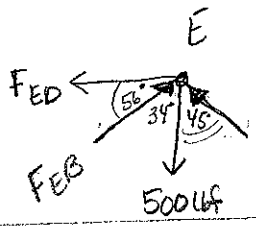
$$\boxed{F_{CE} = -1096.02\text{ lbf}}$$ assuming CE compression was correct

$\Sigma F_x = 0$ so $-F_{CB} + F_{CE}(\cos 45^\circ) = 0$

$-F_{CB} + (1096.02\text{ lbf})(\cos 45^\circ) = 0$

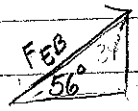
$\boxed{F_{CB} = 775\text{ lbf}}$ so tension assumption was correct

Assuming EB and EC in compression
ED in tension



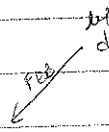
5. FBD for joint E

rt +
up +



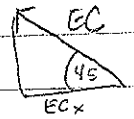
$\sin 56° = \frac{F_{EB_y}}{F_{EB}}$ $\cos 56° = \frac{F_{EB_x}}{F_{EB}}$

$F_{EB_y} = F_{EB} \cdot \sin 56$ $F_{EB_x} = F_{EB} \cdot \cos 56$



forces in x direction:

$F_{ED} \leftarrow$ $F_{EB_x} \rightarrow$ $(F_{EB} \cdot \cos 56)$ $F_{EC_x} \leftarrow$ $(EC \cdot \cos 45)$



$\cos 45 = \frac{EC_x}{EC}$

forces in y direction:

$F_{EB_y} \uparrow$ $(F_{EB} \cdot \sin 56)$ 500 lbf $\downarrow$ $F_{EC_y} \uparrow$ $(EC \cdot \sin 45)$

$\sin 45 = \frac{EC_y}{EC}$

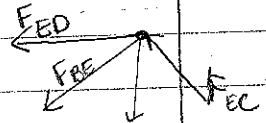
$EC = 1096.02$

$\sum F_y = 0$ so $F_{EB} \cdot \sin 56 + -500 \text{ lbf} + EC \cdot \sin 45 = 0$

$F_{EB} \cdot \sin 56 - 500 + 1096.02 (\sin 45) = 0$

$F_{EB} = \frac{-275}{\sin 56} = -331.714$ lb so my assumption that EB was in compression was wrong - change arrow

update FBD



going back to x direction equilibrium:

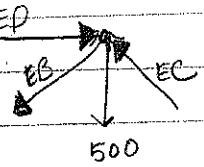
$\sum F_x = 0$ so $-F_{ED} + -F_{EB} \cdot \cos 56 - F_{EC} \cdot \cos 45 = 0$

$-F_{ED} + -(331.714)(\cos 56) - (1096.02)(\cos 45) = 0$

$-185.492 \quad -775.003 \quad = F_{ED}$

$-960.5 \quad = F_{ED}$

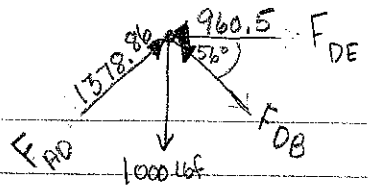
again, my assumption of tension was wrong so final updated FBD is:



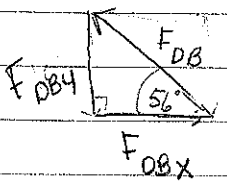
I know AD and DE are in compression from previous calculations.

I am assuming DB is also in compression

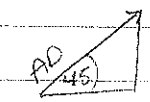
6. FBD for D



-x left
+y up



$\cos 56 = \frac{F_{DBx}}{F_{DB}}$ $\sin 56 = \frac{F_{DBy}}{F_{DB}}$



$\cos 45 = \frac{AD_x}{AD}$

Sum of forces in x:

$F_{DE}^{\leftarrow} = 960.5$ lbf $F_{AD_x}^{\rightarrow} = F_{AD} \cdot \cos 45°$ $F_{DBx}^{\leftarrow} = F_{DB} \cdot \cos 56°$

$\Sigma F_x = 0$ so $-960.5 \text{ lb} + F_{AD} \cdot \cos 45° - F_{DB} \cdot \cos 56 = 0$

$$\frac{-960.5 + 1378.86(\cos 45)}{\cos 56°} = F_{DB}$$

$$\boxed{25.93 \text{ lb} = F_{DB}}$$ assuming compression was correct