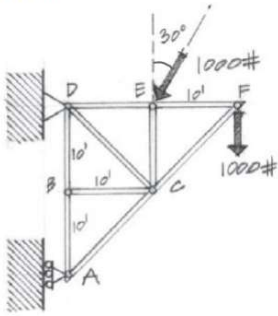
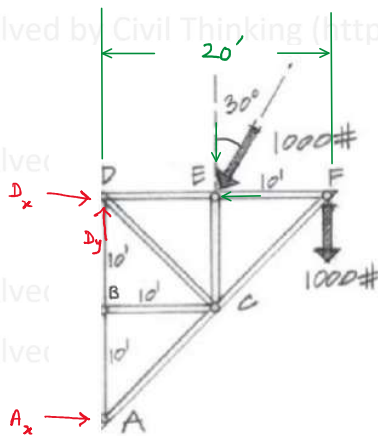


Find Truss Member Forces using Method of Joints

2. Using the method of joints, determine the force in each member of the truss shown in the drawings below. Summarize the results on a force summation diagram, and indicate whether each member is in tension or compression.



Solution:



$$\sum M_D = 0 :$$

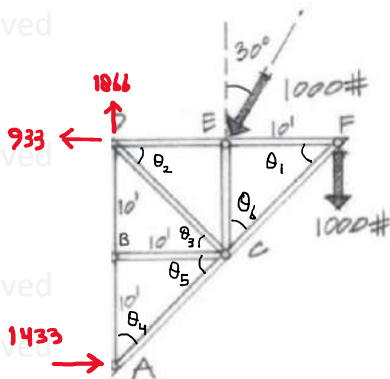
$$(1000 \times 20) + (1000 \cos 30^\circ \times 10) - (A_x \times 20) = 0 \Rightarrow A_x = 1433$$

$$\sum F_x = 0 :$$

$$A_x + D_x - 1000 \sin 30^\circ = 0 \Rightarrow D_x = 1000 \sin 30^\circ - A_x = -933 \Rightarrow D_x = -933$$

$$\sum F_y = 0 :$$

$$D_y - 1000 \cos 30^\circ - 1000 = 0 \Rightarrow D_y = 1866$$



$$\theta_1 = \tan^{-1} \frac{10}{10} = 45^\circ$$

$$\theta_2 = \tan^{-1} \frac{10}{10} = 45^\circ$$

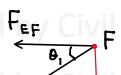
$$\theta_3 = \tan^{-1} \frac{10}{10} = 45^\circ$$

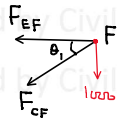
$$\theta_4 = \tan^{-1} \frac{10}{10} = 45^\circ$$

$$\theta_5 = 180^\circ - 90^\circ - \theta_4 = 45^\circ$$

$$\theta_6 = 180^\circ - 90^\circ - \theta_1 = 45^\circ$$

Joint F:





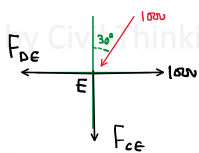
$$+\uparrow \sum F_y = 0 \Rightarrow -F_{CF} \sin \theta_1 - 1000 = 0 \Rightarrow F_{CF} = \frac{1000}{-\sin \theta_1} = \frac{1000}{\sin 45^\circ} = -1000\sqrt{2}$$

$$\Rightarrow F_{CF} = -1000\sqrt{2}$$

$$+\rightarrow \sum F_x = 0 \Rightarrow -F_{EF} - F_{CF} \cos \theta_1 = 0 \Rightarrow F_{EF} = -F_{CF} \cos \theta_1 = -(-1000\sqrt{2} \times \cos 45^\circ) = 1000$$

$$\Rightarrow F_{EF} = 1000$$

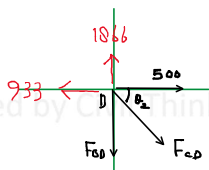
Joint E :



$$+\rightarrow \sum F_x = 0 \Rightarrow -F_{DE} + 1000 - 1000 \sin 30^\circ = 0 \Rightarrow F_{DE} = 500$$

$$+\uparrow \sum F_y = 0 \Rightarrow -F_{CE} - 1000 \cos 30^\circ = 0 \Rightarrow F_{CE} = -500\sqrt{3}$$

Joint D :



$$+\rightarrow \sum F_x = 0 :$$

$$500 + F_{ED} \cos \theta_2 - 933 = 0 \Rightarrow 500 - 933 + F_{ED} \cos 45^\circ = 0$$

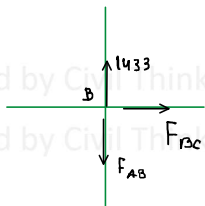
$$\Rightarrow F_{ED} = 433\sqrt{2}$$

$$+\uparrow \sum F_y = 0 :$$

$$-F_{BD} - F_{ED} \sin \theta_2 + 1866 = 0 \Rightarrow F_{BD} = 1866 - F_{ED} \sin \theta_2 = 1866 - 433\sqrt{2} \sin 45^\circ = 1433$$

$$\Rightarrow F_{BD} = 1433$$

Joint B :

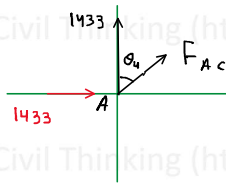


$$+\uparrow \sum F_y = 0 :$$

$$1433 - F_{AB} = 0 \Rightarrow F_{AB} = 1433$$

$$+\rightarrow \sum F_x = 0 : F_{BC} = 0$$

Joint A :



$$+\uparrow \sum F_y = 0:$$

$$1433 + F_{AC} \cos \theta_4 = 0 \Rightarrow F_{AC} = -\frac{1433}{\cos 45^\circ} = -1433\sqrt{2}$$

$$\Rightarrow F_{AC} = -1433\sqrt{2}$$

Cross-check:

$$\sum F_x = 0:$$

$$F_{AC} \sin \theta_4 + 1433 = 0 \Rightarrow F_{AC} = -1433\sqrt{2} \text{ (same as from } \sum F_y = 0)$$

Passed ✓

$$F_{CF} = 1000\sqrt{2} \text{ (C)}$$

$$F_{EF} = 1000 \text{ (T)}$$

$$F_{DE} = 500 \text{ (T)}$$

$$F_{CE} = 500\sqrt{3} \text{ (C)}$$

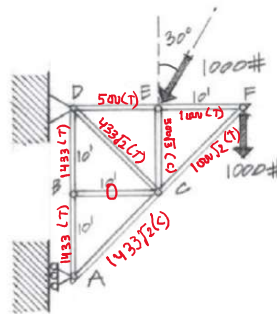
$$F_{ED} = 433\sqrt{2} \text{ (T)}$$

$$F_{BD} = 1433 \text{ (T)}$$

$$F_{AB} = 1433 \text{ (T)}$$

$$F_{BC} = 0 \text{ (Zero force member)}$$

$$F_{AC} = 1433\sqrt{2} \text{ (C)}$$



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