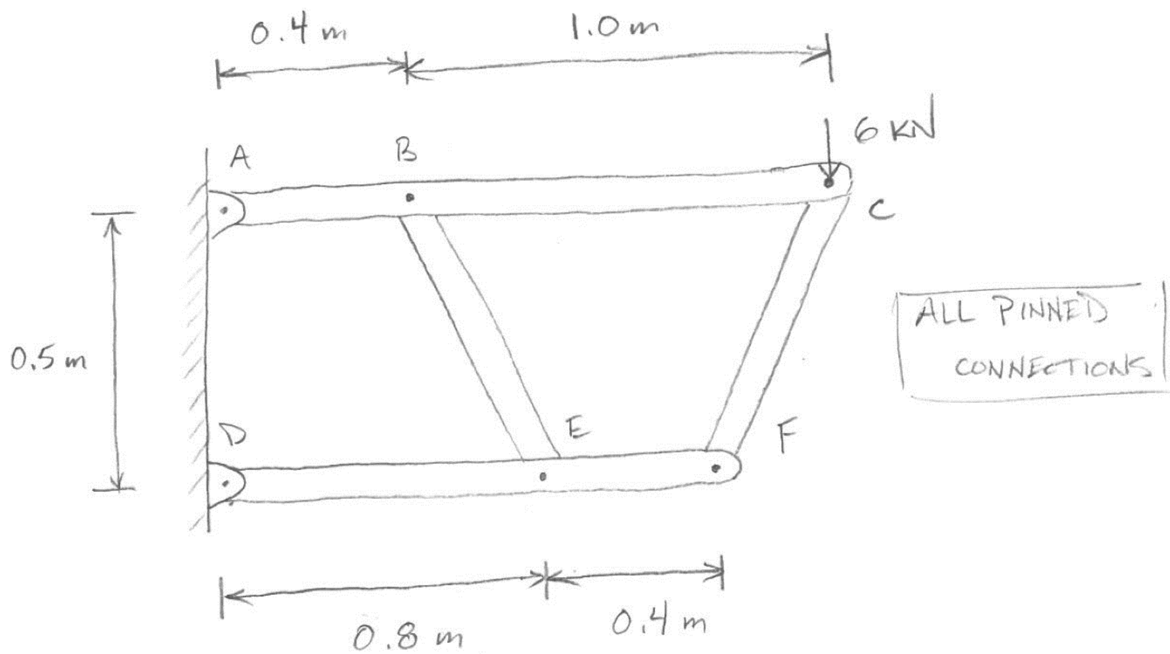
**Lecture 20 (Supplement)**
GEN_ENG 205-2: Engineering Analysis 2
Winter Quarter 2018
Prof. James P. Hambleton
§6.5 Frames and Machines

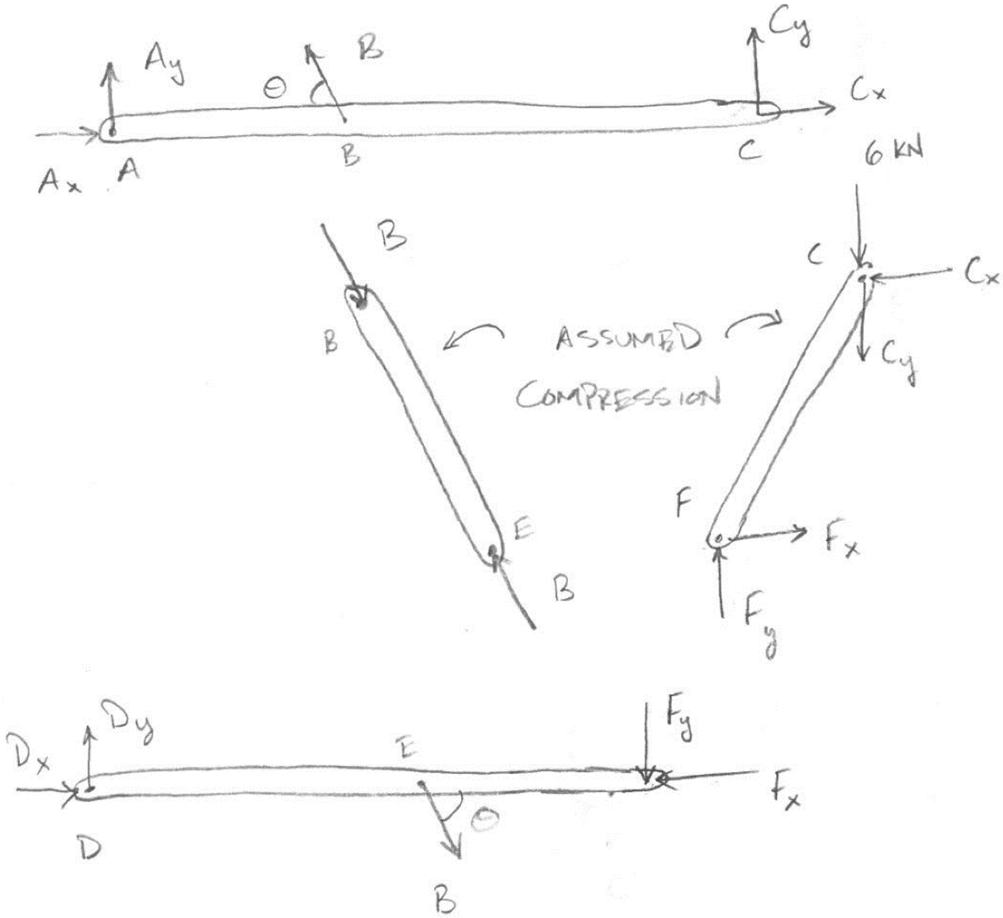
Acknowledgements

Portions of these lecture notes are taken from those of Prof. Jeff Thomas.

Example: Problem 6.79 (alternative solution)




Determine the reactions at the supports and joints.




$$\tan\theta = \frac{0.5\text{ m}}{0.4\text{ m}} \;\;\Rightarrow\;\; \theta = 50.34^\circ$$

Member *ABC*:

$$\sum F_x = 0:\; A_x - B\cos\theta + C_x = 0$$

$$\sum F_y = 0:\; A_y + B\sin\theta + C_y = 0$$

$$\sum M_A = 0:\; B\sin\theta(0.4) + C_y(1.4) = 0 \;\; (\text{kN}\cdot\text{m})$$

Member *DEF*:

$$\sum F_x = 0:\ D_x + B\cos\theta - F_x = 0$$

$$\sum F_y = 0: D_y - B\sin\theta - F_y = 0$$

$$\sum M_D = 0: -B\sin\theta(0.8) - F_y(1.2) = 0\ \ (\mathrm{kN\cdot m})$$

Member *CF*:

$$\sum F_x = 0:\ F_x - C_x = 0$$

$$\sum F_y = 0: F_y - C_y - 6 = 0\ \ (\mathrm{kN})$$

$$\sum M_C = 0: F_x(0.5) - F_y(0.2) = 0\ \ (\mathrm{kN\cdot m})$$

Global equilibrium:

$$\sum F_x = 0:\ A_x + D_x = 0$$

$$\sum F_y = 0: A_y + D_y - 6 = 0\ \ (\mathrm{kN})$$

$$\sum M_A = 0: -(6)(1.4) + D_x(0.5) = 0\ \ (\mathrm{kN\cdot m})$$

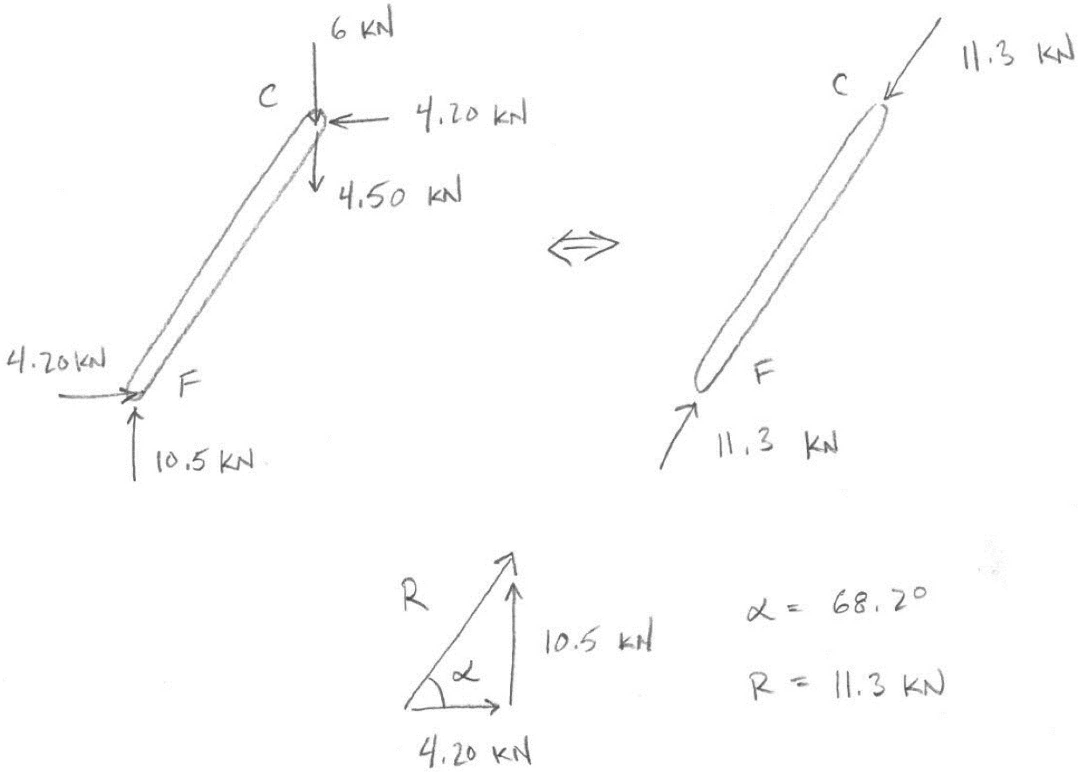
Solve the system using MATLAB:

$$\begin{bmatrix} 1 & 0 & -\cos\theta & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 1 & \sin\theta & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & (0.4)\sin\theta & 0 & 1.4 & 0 & 0 & 0 & 0 \\ 0 & 0 & \cos\theta & 0 & 0 & 1 & 0 & -1 & 0 \\ 0 & 0 & -\sin\theta & 0 & 0 & 0 & 1 & 0 & -1 \\ 0 & 0 & -(0.8)\sin\theta & 0 & 0 & 0 & 0 & 0 & -1.2 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.5 & -0.2 \end{bmatrix} \begin{Bmatrix} A_x \\ A_y \\ B \\ C_x \\ C_y \\ D_x \\ D_y \\ F_x \\ F_y \end{Bmatrix} = \begin{Bmatrix} 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \\ 6 \\ 0 \end{Bmatrix}$$

$$\begin{Bmatrix} A_x \\ A_y \\ B \\ C_x \\ C_y \\ D_x \\ D_y \\ F_x \\ F_y \end{Bmatrix} = \begin{Bmatrix} -16.8 \\ 11.3 \\ -20.2 \\ 4.20 \\ 4.50 \\ 16.8 \\ -5.25 \\ 4.20 \\ 10.5 \end{Bmatrix} \text{ (kN)}$$

Solution Summary:

We have the same solution as before, except that the internal forces at joint *C* differ and the forces on member *CF* are as follows:




$$\tan\alpha = \frac{0.5\text{ m}}{0.2\text{ m}} \;\Rightarrow\; \alpha = 68.20^\circ$$

We have effectively demonstrated that member *CF* is a two-force member!

And there are still other ways to solve this problem…

Previous Solution:

Here was the previous solution we developed (in lecture) considering that the external load was applied to member *ABC*: