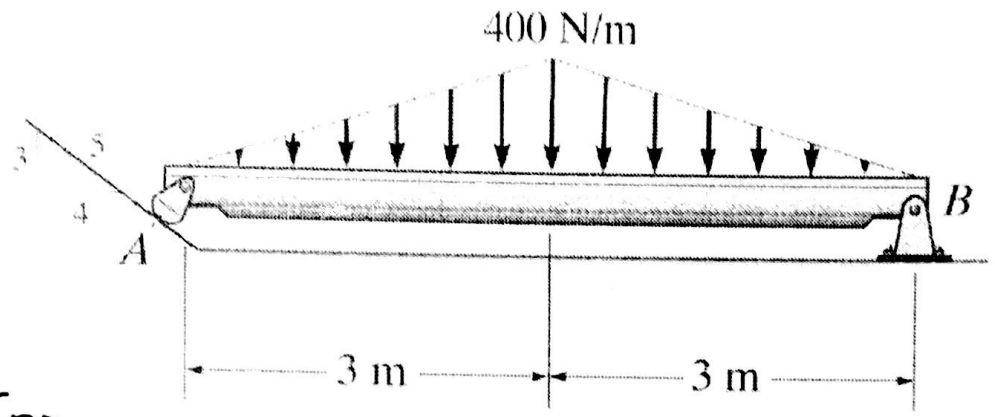
Chinese Name: Key English Name: _____

ID#: _____

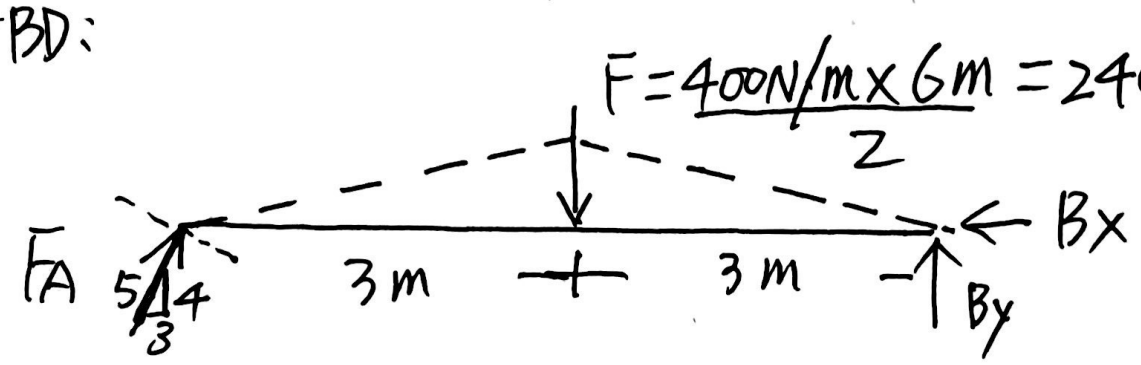
ENSC 2113 – Fall 2023 – Sample EXAM #2

EACH PROBLEM IS WORTH THE POINTS INDICATED. BOX YOUR ANSWERS AND PROVIDE PROPER UNITS, WHERE APPLICABLE. CALCULATIONS AND FREE BODY DIAGRAMS MUST BE SHOWN THAT SUPPORT THE ANSWER TO RECEIVE CREDIT.

1. Determine the external support reactions at the rocker at A and the pin at B. Draw all pertinent free-body diagrams. 20 POINTS



FBD:



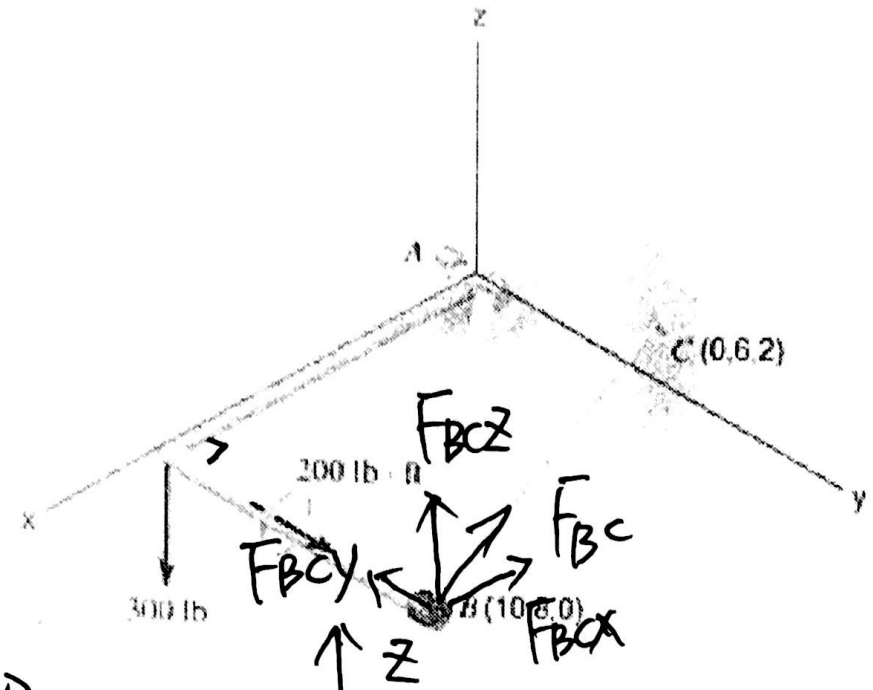
$\circlearrowleft \Sigma M_A(\bar{F}) = 0 = -1200 \times 3 + By \cdot 6 = 0$ $\boxed{By = 600N (\uparrow)}$

$+\uparrow \Sigma F_y = 0 = \frac{4}{5} F_A + By - 1200$ $\boxed{F_A = 750N (\uparrow)}$

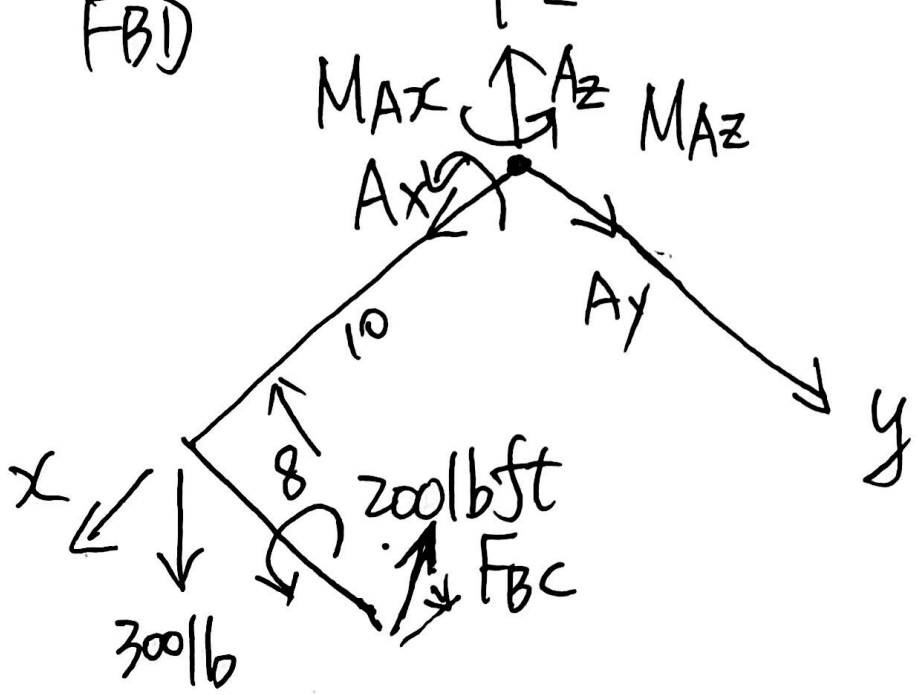
$\pm\rightarrow \Sigma F_x = 0 = \frac{3}{5} F_A - Bx = 0$ $\boxed{Bx = 450N (\leftarrow)}$

2 Rod AB is supported by pin A and cable BC and is subjected to a 300 lb force and an 200 lb-ft applied moment. Draw the free-body diagram (on the axes provided). Assume all support reactions positive in your FBD using right hand rule sign convention. Calculate the support reactions utilizing equilibrium equations. The coordinates for points B and C are given in feet.

30 POINTS



FBD



$$\vec{r}_{BC} = -10\vec{i} - 2\vec{j} + 2\vec{k}$$

$$\vec{u}_{BC} = \frac{\vec{r}_{BC}}{|r_{BC}|} = \frac{-10\vec{i} - 2\vec{j} + 2\vec{k}}{\sqrt{(-10)^2 + (-2)^2 + 2^2}}$$

$$= -\frac{10}{\sqrt{108}}\vec{i} - \frac{2}{\sqrt{108}}\vec{j} + \frac{2}{\sqrt{108}}\vec{k}$$

$$\vec{F}_{BC} = F_{BC}\left(-\frac{10}{\sqrt{108}}\vec{i} - \frac{2}{\sqrt{108}}\vec{j} + \frac{2}{\sqrt{108}}\vec{k}\right)$$

$$\vec{F}_{BC} = -F_{BC}\cdot\frac{10}{\sqrt{108}}\vec{i} - \frac{2}{\sqrt{108}}F_{BC}\vec{j} + \frac{2}{\sqrt{108}}F_{BC}\vec{k}$$

$\Sigma M_y(\bar{F}) = 0$

$300 \times 10 + 200 - F_{BCz} \cdot 10 = 0$

$F_{BCz} = 320\,lb = \frac{2}{\sqrt{108}} F_{BC}$

$\boxed{F_{BC} = 1662.8\,lb}$

$F_{BCx} = -1600\,lb \quad F_{BCy} = 320\,lb$

$\Sigma F_x = 0$

$F_{BCx} + A_x = 0 \quad \boxed{A_x = 1600\,lb}$

$\Sigma F_y = 0$

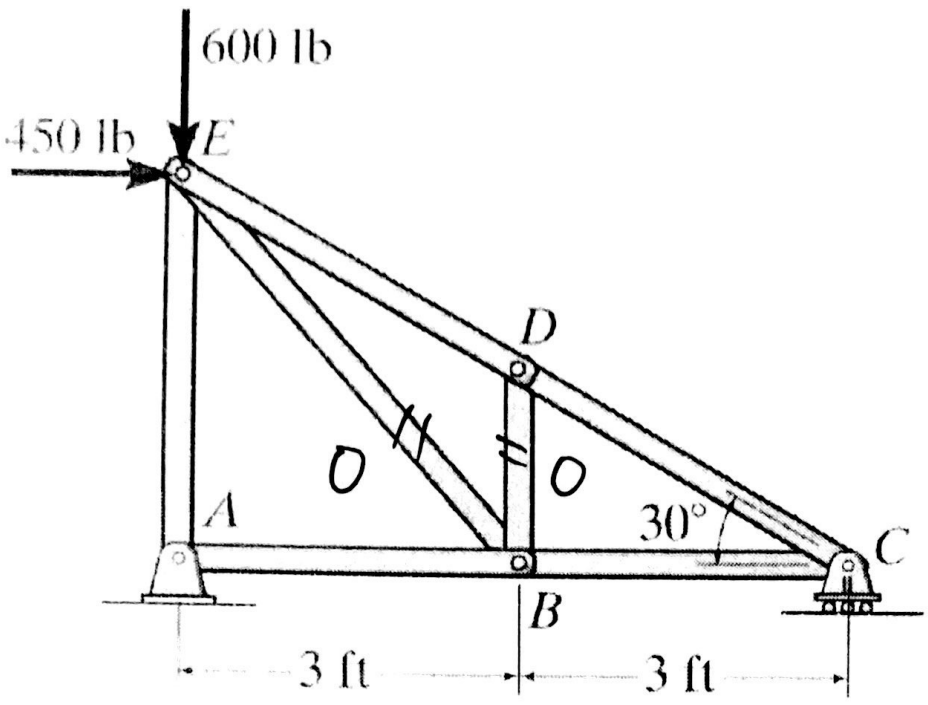
$F_{BCy} + A_y = 0 \quad \boxed{A_y = 320\,lb}$

$\Sigma F_z = 0 \quad F_{BCz} + A_z - 300 = 0 \quad \boxed{A_z = -20\,lb}$

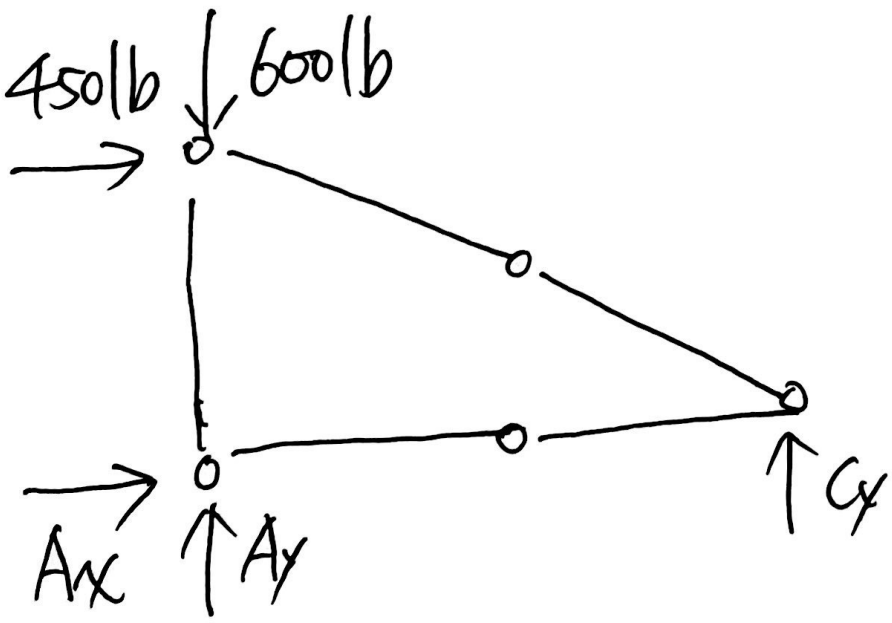
$\Sigma M_x = 0 \quad M_{Ax} + F_{BCz} \cdot 8 = 0 \quad \boxed{M_{Ax} = -2560\,lb \cdot ft}$

$\Sigma M_z = 0 \quad M_{Az} + |F_{BCx}|8 - |F_{BCy}|\cdot 10 = 0 \quad \boxed{M_{Az} = -9600\,lb\,ft}$

3. Determine the force in each of the truss members using method of joints. Draw all pertinent free-body diagrams and indicate tension or compression for the internal forces. 20 POINTS

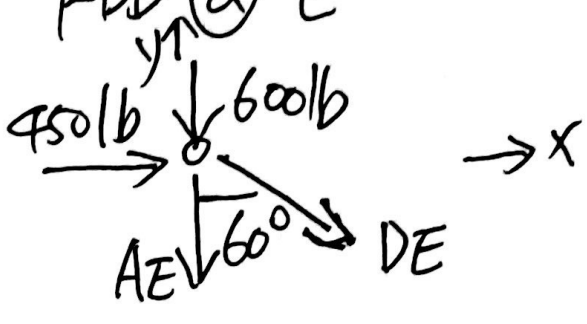


Overall FBD



$\Sigma FM : BD.\ BE$

FBD @ E



$\Sigma F_x = 0$

$DE\sin 60° + 450 = 0$

$\boxed{DE = -519.6\,lb\ (C)}$

$\Sigma F_y = 0$

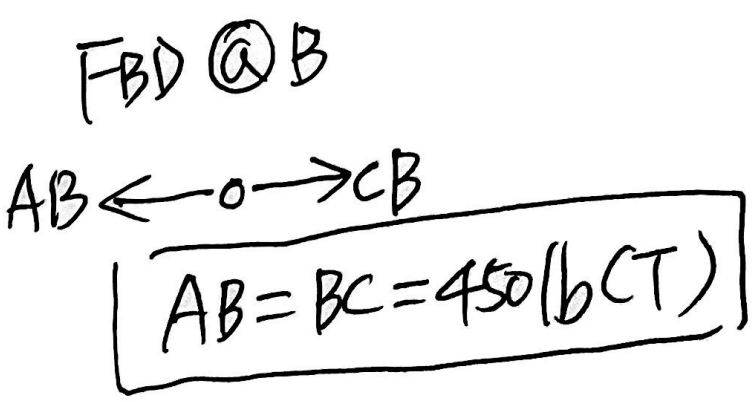
$-600 - AE - DE\cos 60° = 0$

$\boxed{AE = -600 - (-519.6)\cos 60° \\ = -340.2\,lb (C)}$

FBD @ D

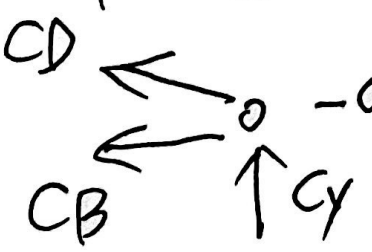
$\boxed{CD = DE = -519.8\,lb \\ (C)}$

FBD @ B



$\boxed{AB = BC = 450\,lb\,(T)}$

FBD @ C

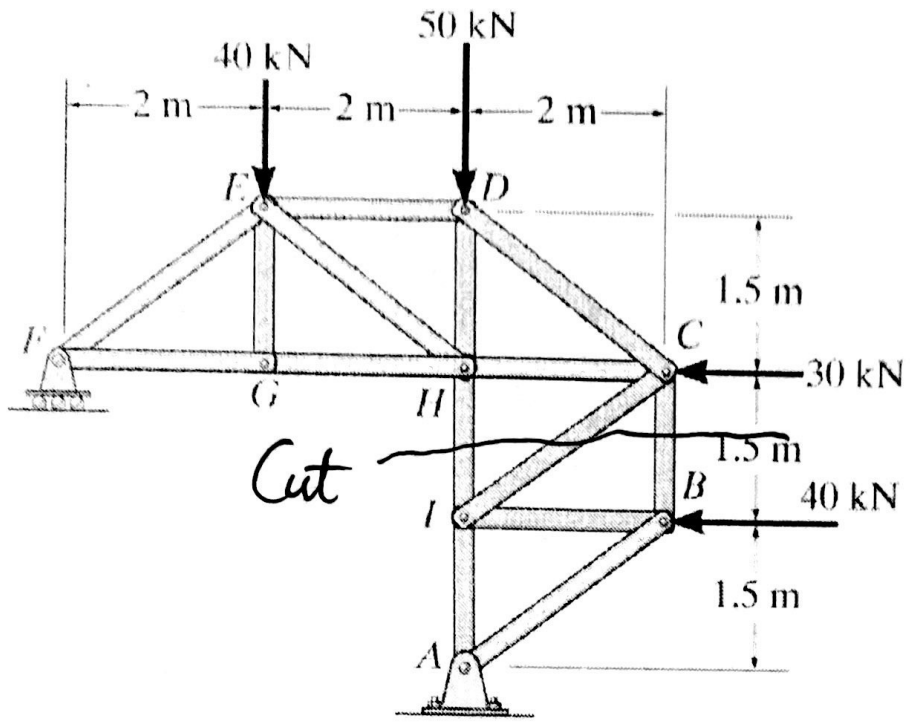


$\Sigma F_x = 0$

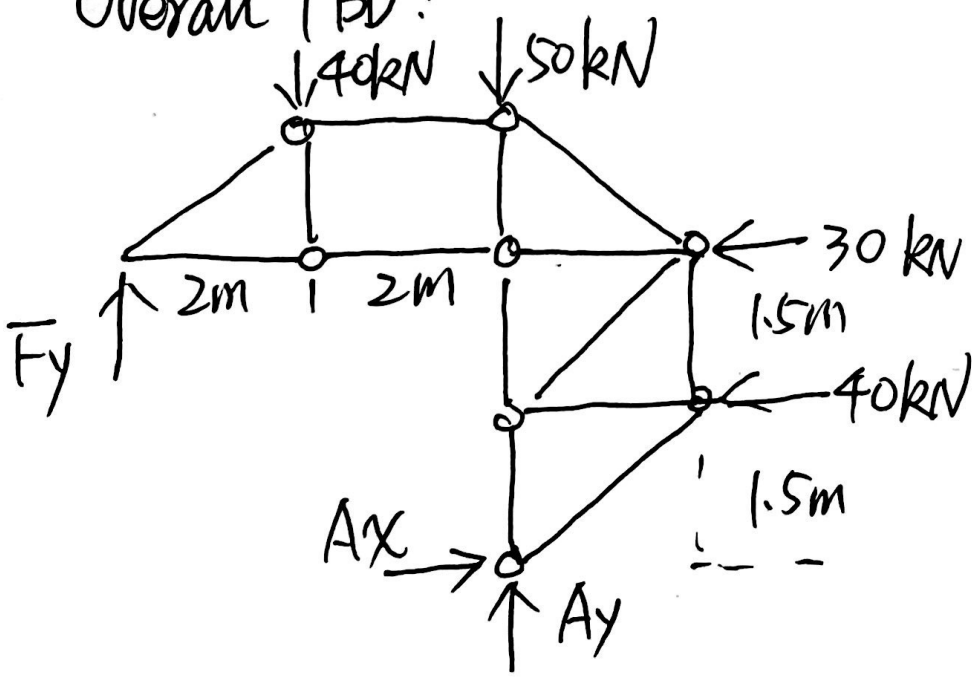
$-\cos 30° CD - CB = 0$

$\boxed{CB = (-519.8)\cdot\frac{\sqrt{3}}{2} \\ = 450\,lb\,(T)}$

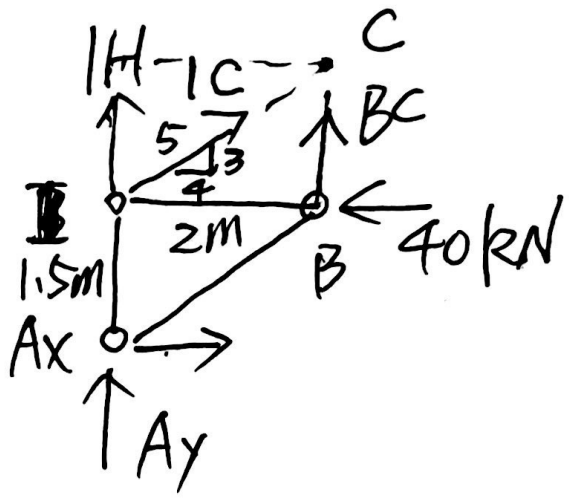
4. Determine internal force in members BC, IC, and IH using method of sections. Draw all pertinent free-body diagrams and indicate tension or compression for the internal forces. 30 POINTS



Overall FBD:



Cut FBD



Equilibrium:

$\xrightarrow{+} \Sigma F_x = 0 \quad A_x - 30 - 40 = 0$

$A_x = 70\,kN$

$\circlearrowleft \Sigma M_F(\vec{F}) = 0$

$-40\times2 - 50\times4 - 40\times1.5 + A_x\cdot3 + A_y\cdot4 = 0$

$A_y = 32.5\,kN$

$+\uparrow \Sigma F_y = 0 \quad A_y + F_y - 40 - 50 = 0$

$F_y = 57.5\,kN$

(This is not necessary)

$\xrightarrow{+} \Sigma F_x = 0$

$-40 + IC\cdot\frac{4}{5} + A_x = 0$

$\boxed{IC = -\frac{30}{4}\cdot5 = -37.5\,kN\,(C)}$

$\circlearrowleft \Sigma M_C(\vec{F}) = 0$

$-IH\cdot2 - A_y\cdot2 + A_x\cdot3 - 40\times1.5 = 0$

$\boxed{IH = 42.5\,kN\,(T)}$

$\circlearrowleft \Sigma M_I(\vec{F}) = 0$

$A_x\cdot1.5 + BC\cdot2 = 0$

$\boxed{BC = -52.5\,kN\,(C)}$