Lebanese American University
Department of Civil Engineering
STATICS – CIE 200 - Beirut
TEST 2 – Fall 2011

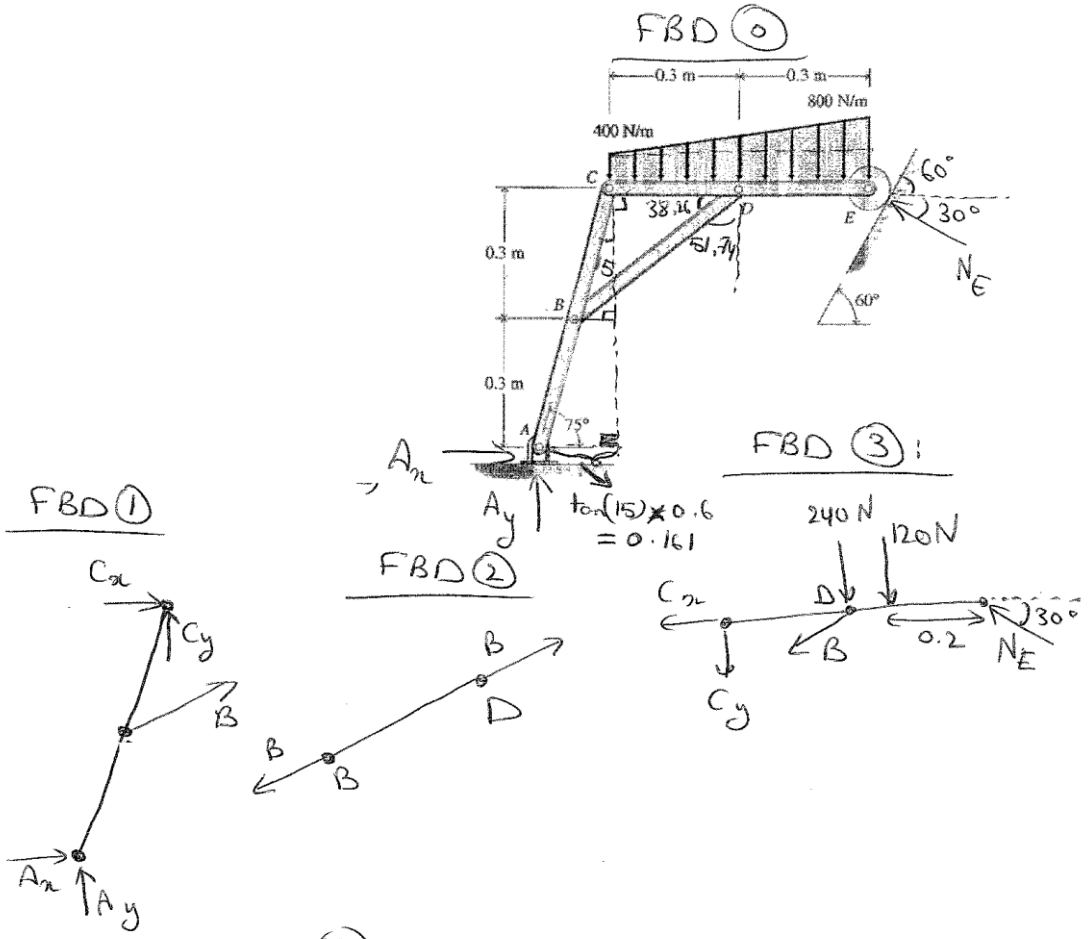
Date: December 9, 2011, 06:30 p.m.
Duration: 80 minutes

Name	***SOLUTION***
ID #	

NOTES	***Show all calculations, and indicate the proper units***
	All problem solutions must include an FBD
	Closed book and notes
	Assume any missing information that is necessary
	Questions have weights as indicated
	Do not unstaple the exam booklet
	Exam booklet consists of 11 pages

Problem I (30%)

Draw the free-body diagram (FBD) of the frame member CDE showing all forces acting on it (magnitude and direction).



From FBD ②: $\circlearrowleft^{+} \Sigma M_A = N_E \cos(30) \times 0.6 + N_E \sin(30) \times (0.6 + 0.6 \tan(15)) - 240 \times (0.3 + 0.6 \tan(15)) - 120 \times (0.4 + 0.6 \tan(15)) = 0$

$\Rightarrow N_E = 197.73\,N$.

$\Sigma f_x = A_x - E \sin(60) = 0 \Rightarrow \boxed{A_x = 171.24\,N}$.

$\Sigma f_y = A_y - 240 - 120 + E \cos(60) = 0 \Rightarrow \boxed{A_y = 261.14\,N}$

From FBD ③ :

$$\circlearrowleft^{+} \quad \Sigma M_B = -120 \times 0.1 + C_y \times 0.3 + N_E \sin(30) \times 0.3 = 0$$

$$C_y = -58.86\ N.$$

$$\boxed{C_y = 58.86\ N \uparrow}$$

From FBD ①:

$$\circlearrowleft^{+} \quad \Sigma M_B = C_y \times 0.08 + A_x \times 0.3 - C_x \times 0.3 - A_y \times 0.08 = 0$$

$$-58.86 \times 0.08 + 171.24 \times 0.3 - 0.3 C_x - 261.14 \times 0.08 = 0$$

$$\Rightarrow \boxed{C_x = \frac{-4.71 + 51.37 - 20.89}{0.3} = 85.91\ N. \rightarrow}$$

From FBD ③:

$$\Sigma F_x = -C_x - B_x - N_E \cos(30) = 0 \Rightarrow B_x = -85.91 - 197.73 \cos(30)$$

$$= -257.15\ N$$

$$\boxed{B_x = 257.15\ N \rightarrow}$$

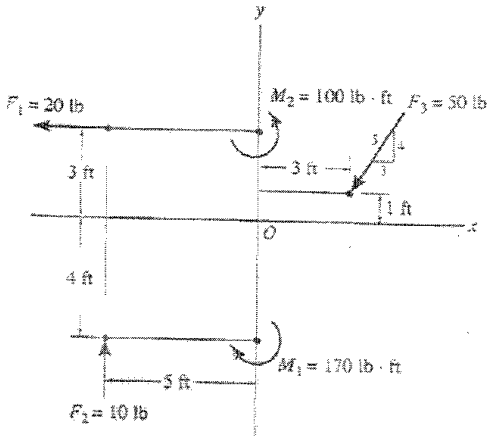
$$\Sigma F_y = -C_y - 360 - B_y + N_E \sin(30) = 0 \Rightarrow B_y = 58.86 - 360 + 197.73 \sin(30)$$

$$\boxed{B_y = -202.27\ N \uparrow}$$

$$\Rightarrow \boxed{B = 327.16\ N}$$

Problem II (20%)

Replace the force and couple-moment system by an equivalent resultant force and specify its coordinate point of application (0, y) on the y-axis.



$\oplus \rightarrow F_{R_x} = \Sigma F_x = -20 - 50 \times \frac{3}{5}$

$= -50$ lb

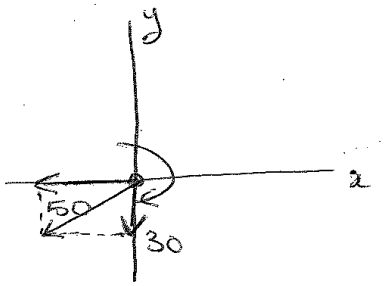
$\boxed{F_{R_x} = 50 \text{ lb} \leftarrow}$

$\oplus \uparrow F_{R_y} = \Sigma f_y = 10 - 50 \times \frac{4}{5} = -30 \text{ lb} \Rightarrow \boxed{F_{R_y} = 30 \text{ lb} \downarrow}$

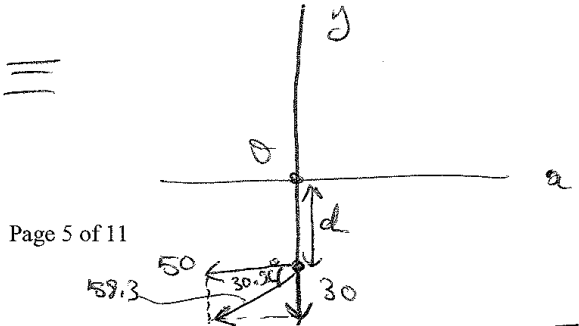
$\circlearrowleft \oplus \Sigma M_O = 20 \times 3 - 10 \times 5 + 50 \times \frac{3}{5} \times 1 - 50 \times \frac{4}{5} \times 3 + 100 - 170$

$\Rightarrow M_{R_O} = 60 - 50 + 30 - 120 + 100 - 170 = -150$ lb.ft

$\Rightarrow \boxed{M_{R_O} = 150 \text{ lb.ft} \circlearrowright}$



$\equiv$

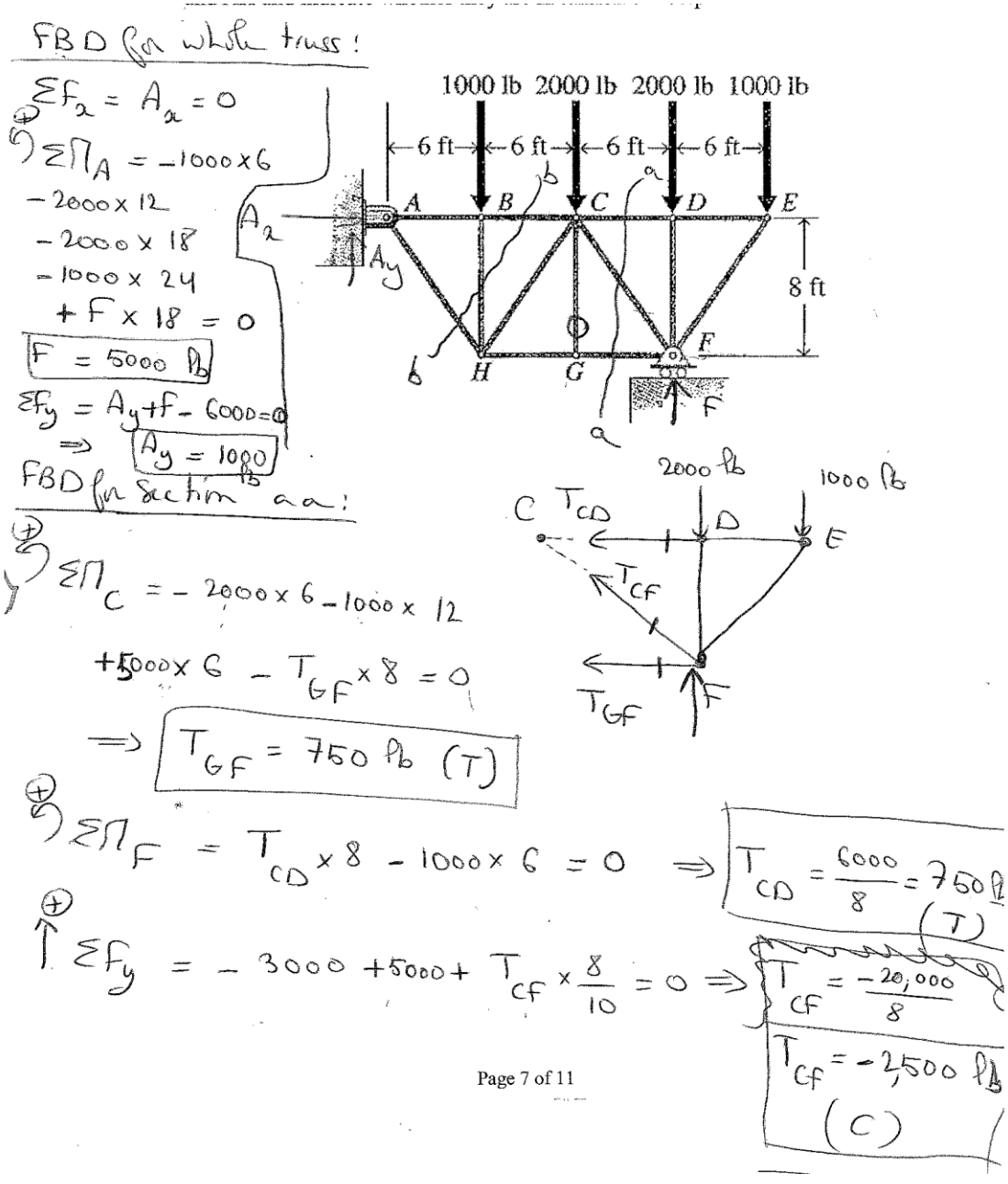


$\Sigma M_O = M_{R_O} = 150 \circlearrowright$

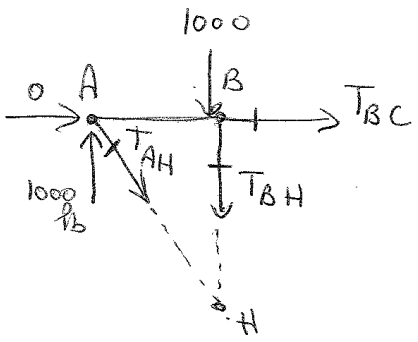
$\circlearrowright \Sigma M_O = 50\,d = 150 \Rightarrow \boxed{d = 3 \text{ ft}}$

Problem III (30%)

Determine the forces inside the truss members CD, CF, GF, CG, BC, BH and AH and indicate whether they are in tension or compression.



Section bb :



$\oplus$ $\circlearrowleft \Sigma M_H = -1000 \times 6 - T_{BC} \times 8 = 0 \Rightarrow$ $T_{BC} = \frac{-6000}{8} = -750$ (C)

$\oplus$ $\rightarrow \Sigma f_x = T_{AH} \times \frac{6}{10} + (-750) = 0$

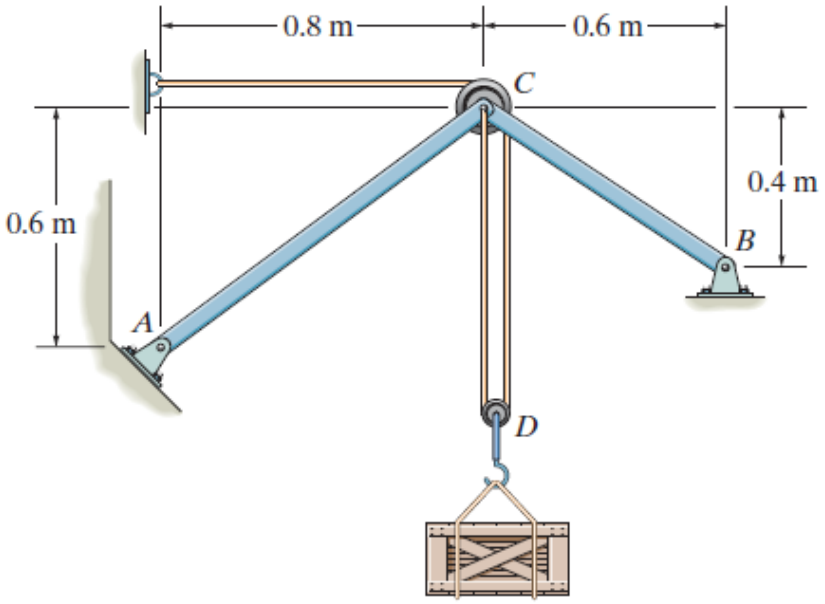
$T_{AH} = \frac{750 \times 10}{6} = 1250$ lb (T)

$\oplus$ $\uparrow \Sigma f_y = -1000 + 1000 - T_{BH} - 1250 \times \frac{8}{10} = 0$

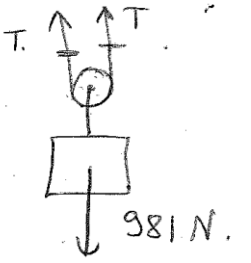
$T_{BH} = -1000$ lb (C)

Problem IV (20%)

Determine the forces which the pins at A and B exert on the two-member frame which supports the 100-kg crate.

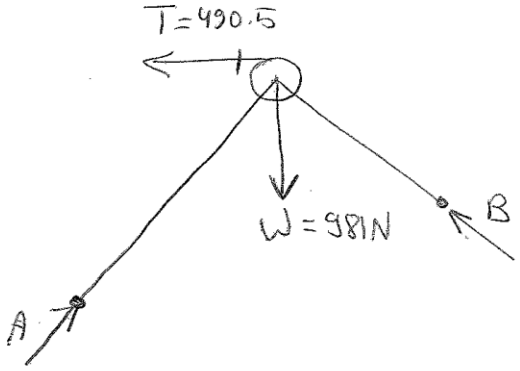


FBD @ D:



$2T - 981 = 0$

$T = \frac{981}{2} = 490.5\ N$



① $\Sigma F_x = A \times \frac{0.8}{1} - B \times \frac{0.6}{\sqrt{0.52}} - 490.5 = 0$.

② $\Sigma F_y = A \times \frac{0.6}{1} + B \times \frac{0.4}{\sqrt{0.52}} - 981 = 0$

$$+ \begin{cases} ① \times 0.4 \Rightarrow 0.32A - B \times \frac{0.4 \times 0.6}{\sqrt{0.52}} - 490.5 \times 0.4 = 0 \\ ② \times 0.6 \Rightarrow 0.36A + B \times \frac{0.4 \times 0.6}{\sqrt{0.52}} - 981 \times 0.6 = 0 \end{cases}$$

$$0.68A = 0.4 \times 490.5 + 0.6 \times 981$$

$$\Rightarrow \boxed{A = 1154.12\ N}$$

$$\Rightarrow \boxed{B = 520\ N}$$