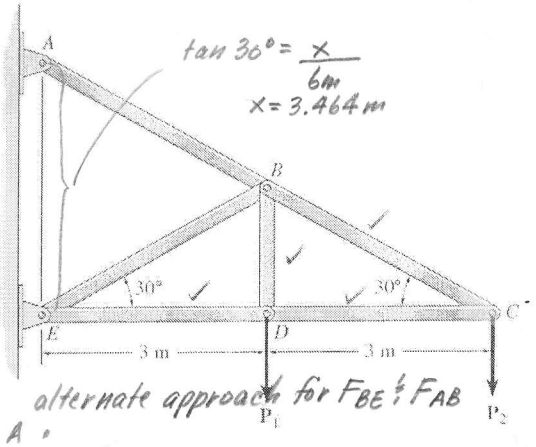
CME 250 – Statics
Exam #6 (11/08/2023)

StarID or TechID (no names) Grading

Show your work (you will not receive any credit if all you have is a final answer, right or wrong).
Do one of the two problems shown below (the second problem is on the back).

1. Determine the force in each member of the truss and state whether the member is in tension or compression.
$P_1 = P_2 = 4$ kN.



$\tan 30° = \frac{x}{6m}$

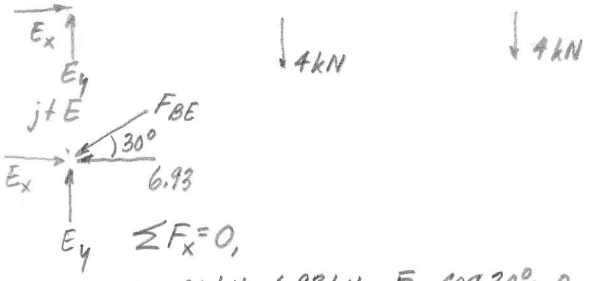
$x = 3.464$ m

alternate approach for F_{BE} & F_{AB}

A:

$\sum M_A = 0,\ E_x(3.464m) - 4kN(3m) - 4kN(6m) = 0$

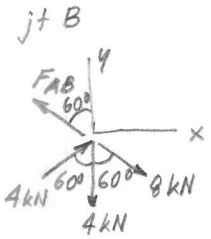
$E_x = 10.393$ kN (↑)



$\sum F_x = 0,$

$10.393\text{kN} - 6.93\text{kN} - F_{BE}\cos 30° = 0$

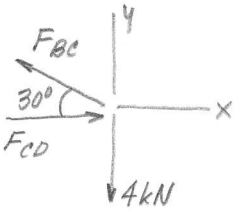
$F_{BE} = 4$ kN (C) (1.5)



$\sum F_x = 0,\ -F_{AB}\sin 60° + 4\text{kN}\sin 60° + 8\text{kN}\sin 60° = 0$

$F_{AB} = 12$ kN (T) (1.5)

jt C:



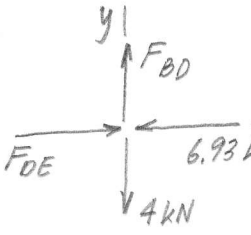
$\sum F_y = 0,\ F_{BC}\sin 30° - 4\text{kN} = 0$

(1.5) $F_{BC} = 8$ kN (T)

$\sum F_x = 0,\ -8\text{kN}\cos 30° + F_{CD} = 0$

(1.5) $F_{CD} = 6.928$ kN or 6.93 kN (C)

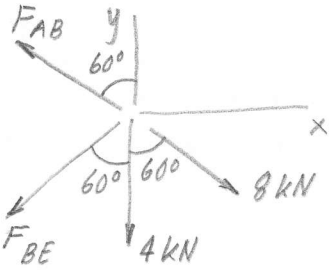
jt D:



(1.5) $\sum F_x = 0,$ $F_{DE} = 6.93$ kN (C)

$\sum F_y = 0,$ $F_{BD} = 4$ kN (T) (1.5)

jt B:



$\sum F_x = 0,\ -F_{AB}\sin 60° - F_{BE}\sin 60° + 8\text{kN}\sin 60° = 0$

$F_{AB} + F_{BE} = 8$ kN ... (a) (1.5)

$\sum F_y = 0,\ F_{AB}\cos 60° - F_{BE}\cos 60° - 4\text{kN} - 8\text{kN}\cos 60° = 0$

$F_{AB} - F_{BE} = \frac{4\text{kN}}{\cos 60°} + 8\text{kN}$

$F_{AB} - F_{BE} = 16$ kN ... (b) (1.5)

adding eqns. (a) & (b):

$2F_{AB} = 24$ kN

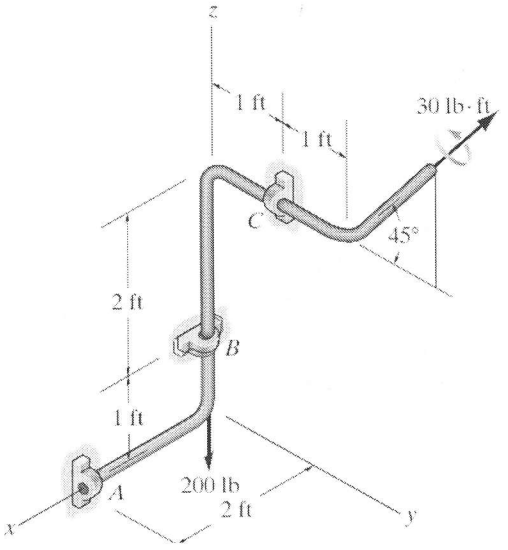
$F_{AB} = 12$ kN (T) (0.5)

subst. F_{AB} back into eqn (a):

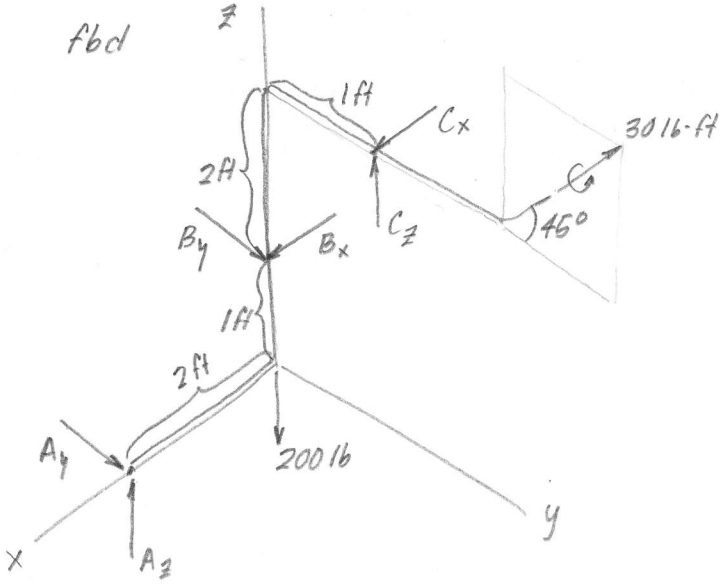
$12\text{kN} + F_{BE} = 8\text{kN}$

$F_{BE} = -4$ kN or 4 kN (C) (0.5)

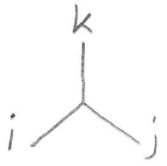
2. The rod is supported by journal bearings at A, B, and C. The bearings are in proper alignment and exert only force reactions on the rod. Determine the reactions at the bearings when the rod is subjected to the 200 lb vertical force and the 30 lb-ft couple moment (which lies in the y-z plane) as shown.



fbd



$\sum \vec{M}_A = 0,\quad -2i\,(ft) \times -200k\,(lb)$
$+ (-2i+1k)(ft) \times (B_x i + B_y j)$
$+ (-2i+1j+3k)(ft) \times (C_x i + C_z k)$
$+ 30\cos 45°\, j\,(lb\text{-}ft) + 30\sin 45°\, k\,(lb\text{-}ft) = 0$



$-400j$
$-2B_y k + B_x j - B_y i$
$+ 2C_z j - C_x k + C_z i + 3C_x j$
$+ 21.21 j + 21.21 k = 0$

(1.5) i: $-B_y + C_z = 0$ → $B_y = C_z \ldots (a)$

(1.5) j: $B_x + 3C_x + 2C_z - 400 + 21.21 = 0$ → $B_x + 3C_x + 2C_z = 378.79 \ldots (b)$

(1.5) k: $-2B_y - C_x + 21.21 = 0$ → $2B_y + C_x = 21.21 \ldots (c)$

$\sum \vec{F} = 0$

(1.5) i: $B_x + C_x = 0$ → $B_x = -C_x \ldots (d)$

(1.5) j: $A_y + B_y = 0$ → $A_y = -B_y \ldots (e)$

(1.5) k: $A_z + C_z - 200 = 0$ → $A_z + C_z = 200 \ldots (f)$

6 eqns & 6 unknowns could use capable calculator or

subst eqn (d) into (b): $2C_x + 2C_z = 378.79 \ldots (g)$

subst eqn (a) into (c): $C_x + 2C_z = 21.21 \ldots (h)$

multiply eqn (h) by -1 & add to eqn (g): $C_x = 358$ lb

from eqn (d) $B_x = -358$ lb

from eqns (c) & (a) $B_y = C_z = -168$ lb

from eqn (e) $A_y = 168$ lb

from eqn (f) $A_z = 368$ lb

(1)