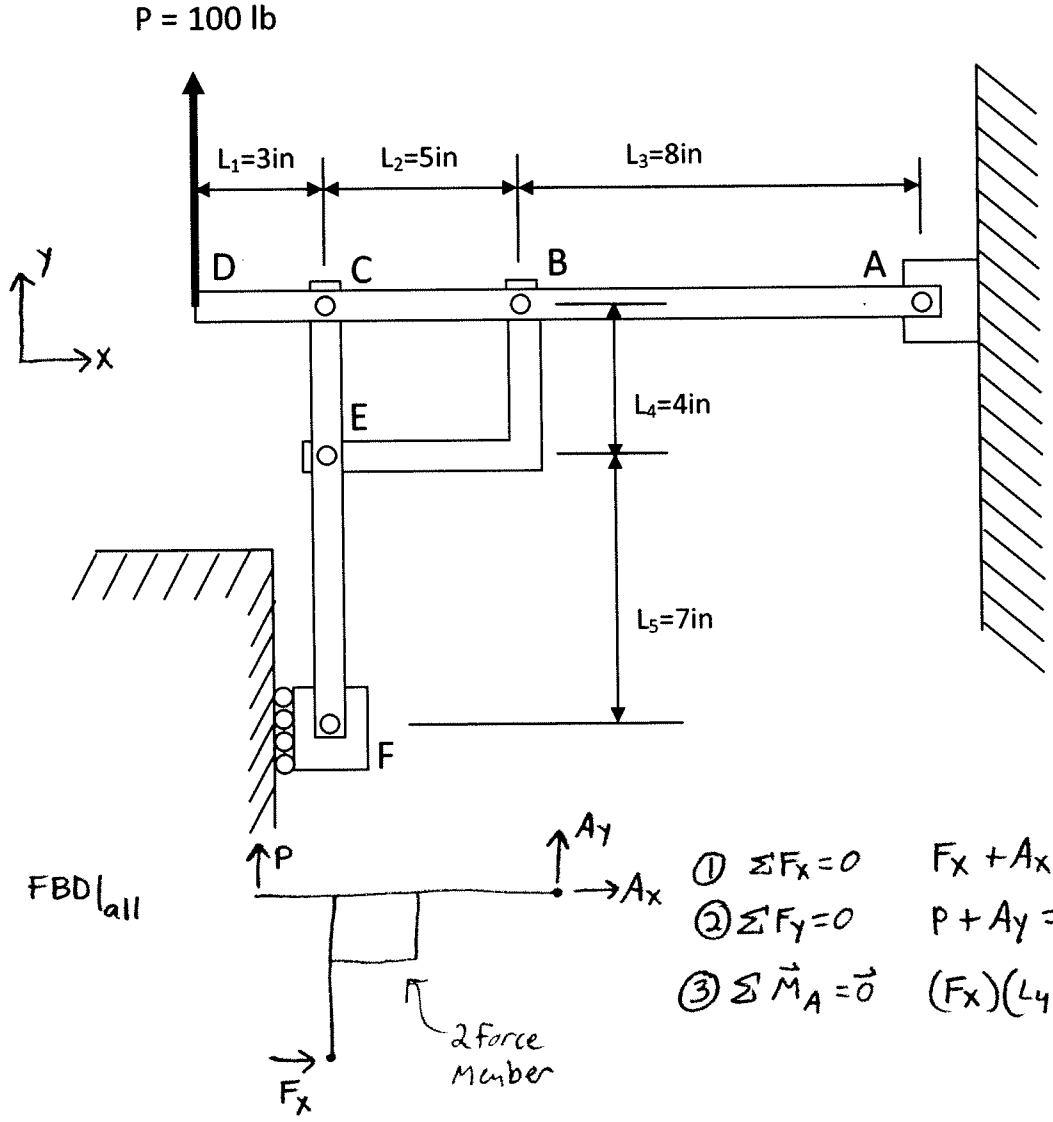
Grading Key

Problem 4 – *30 points*

Set up the following problem completely, but do not solve. Clearly number your equations and list your unknowns. The equations should be sufficient to determine all forces acting on member ABCD of the frame depicted below. The connections at A, B, C, E, and F are frictionless pins. Ignore masses of the members.

Overall FBDs = 12 pts (min. +5)
Eqns = 18 pts (min. +1 ea)



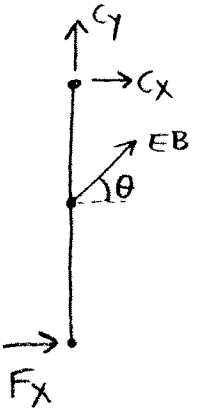
Set #1) FBD|all

① $\Sigma F_x = 0$ $\quad F_x + A_x = 0$

② $\Sigma F_y = 0$ $\quad P + A_y = 0$

③ $\Sigma \vec{M}_A = \vec{0}$ $\quad (F_x)(L_4+L_5) - (P)(L_1+L_2+L_3) = 0$

FBD|CEF



④ $\Sigma F_x = 0$ $\quad F_x + C_x + EB\cos\theta = 0$

⑤ $\Sigma F_y = 0$ $\quad C_y + EB\sin\theta = 0$

⑥ $\Sigma \vec{M}_C = \vec{0}$ $\quad (F_x)(L_4+L_5) + (EB\cos\theta)(L_4) = 0$

7 eqns
7 unk: $F_x, A_x, A_y, C_x, C_y, EB, \theta$

⑦ geometry $\tan\theta = \frac{L_4}{L_2}$

Grading: FBDs (12 total) — -1 each missing/inconsistent force
- -2 if system not clearly identified
- -1 if no coord sys given

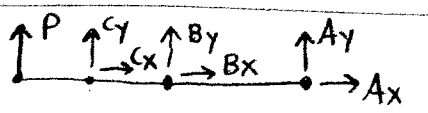
(if they exist, minimum is +5)

Eqns (18 total) — -2 each non-moment eqn
- -1 sign error
- -1 missing term

-4 each moment eqn

(if eqn is listed, minimum +1 each)

Set#2) FBD|$_{DCBA}$

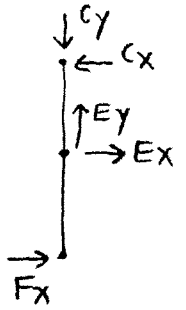


① $\Sigma F_x = 0$ $\quad C_x + B_x + A_x = 0$

② $\Sigma F_y = 0$ $\quad P + C_y + B_y + A_y = 0$

③ $\Sigma \vec{M}_A = \vec{0}$ $\quad -(P)(L_1+L_2+L_3) - (C_y)(L_2+L_3) - (B_y)(L_3) = 0$

FBD|$_{CEF}$

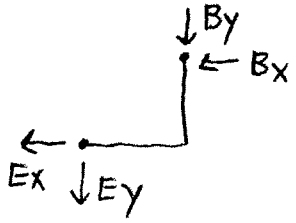


④ $\Sigma F_x = 0$ $\quad F_x + E_x - C_x = 0$

⑤ $\Sigma F_y = 0$ $\quad E_y - C_y = 0$

⑥ $\Sigma \vec{M}_C = 0$ $\quad (F_x)(L_4+L_5) + (E_x)(L_4) = 0$

FBD|$_{EB}$



⑦ $\Sigma F_x = 0$ $\quad -E_x - B_x = 0$

⑧ $\Sigma F_y = 0$ $\quad -E_y - B_y = 0$

⑨ $\Sigma \vec{M}_E = 0$ $\quad (B_x)(L_4) - B_y(L_2) = 0$

9 eqns, 9 unks: $C_x, C_y, B_x, B_y, E_x, E_y, A_x, A_y, F_x$

Grading: FBDs (12 total) — -1 each missing/inconsistent force
- -2 if system not clearly defined
- -1 if coord sys not given

(if they exist, minimum is +5)

Eqns (18 total) — 2 pts each eqn
- -1 sign error
- -1 missing term

(if eqn is listed, minimum is +1 each)