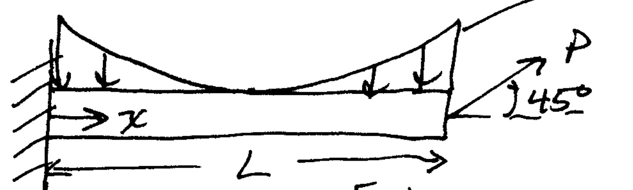
MECH 211

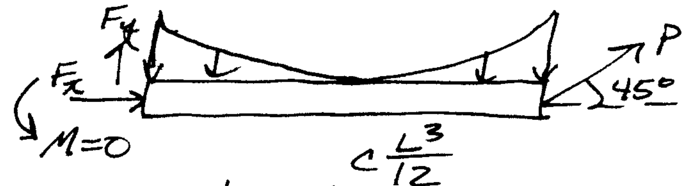
Homework #7 Solutions

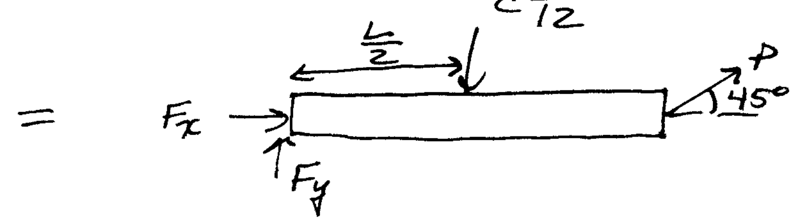
1) Test 1 Problem 2

$q(x) = c\left(x - \frac{L}{2}\right)^2$



a) FBD





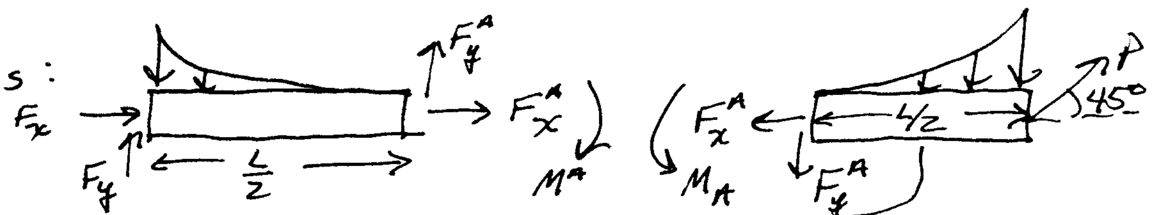
$$\Sigma F_x = 0 = F_x + \frac{\sqrt{2}}{2}P$$

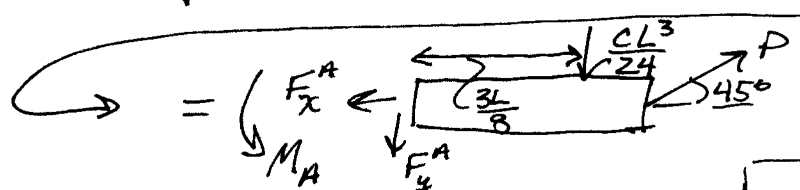
$$\Sigma F_y = 0 = F_y + \frac{\sqrt{2}}{2}P - \frac{cL^3}{12}$$

$$\Sigma M_o = 0 = \frac{\sqrt{2}}{2}PL - \frac{cL^3}{12}\,\frac{L}{2}$$

$$\therefore \boxed{P = \frac{cL^3}{12\sqrt{2}}}$$

b) FBDs:





$$\Sigma F_x = 0 = \frac{\sqrt{2}}{2}\,\frac{cL^3}{12\sqrt{2}} - F_x^A \rightarrow \boxed{F_x^A = \frac{cL^3}{24}}$$

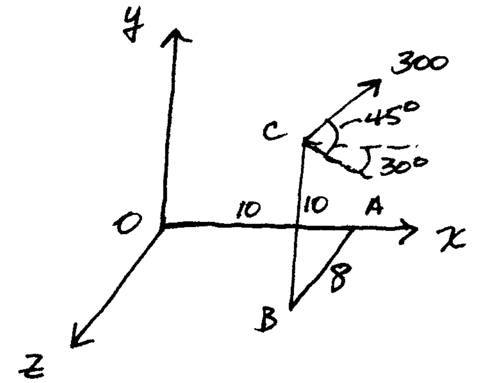
$$\Sigma F_y = 0 = \frac{\sqrt{2}}{2}\,\frac{cL^3}{12\sqrt{2}} - \frac{cL^3}{24} - F_y^A \rightarrow \boxed{F_y^A = 0}$$

$$\Sigma M_A = 0 = M_A - \frac{cL^3}{24}\,\frac{3L}{8} + \frac{\sqrt{2}}{2}\,\frac{cL^3}{12\sqrt{2}}\,\frac{L}{2} \rightarrow \boxed{M_A = \frac{-cL^4}{192}}$$

Forces & moments can be of opposite sign if they are drawn in the opposite direction on the free body diagrams.

(2)

2) Test 1 Problem 3



a) $\vec{F} = 300\left[\cos 45^\circ \cos 30^\circ \vec{i} + \sin 45^\circ \vec{j} + \cos 45^\circ \sin 30^\circ \vec{k}\right]$

$\vec{F} = 300 \frac{\sqrt{6}}{4}\vec{i} + 300 \frac{\sqrt{2}}{2}\vec{j} + 300 \frac{\sqrt{2}}{4}\vec{k}$

$\vec{r}_{oc} = 10\vec{i} + 10\vec{j} + 8\vec{k}$

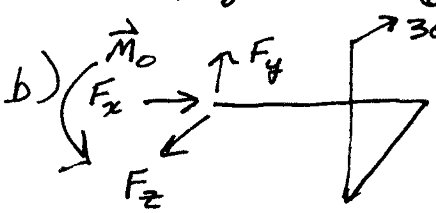
$\vec{M}_o = \vec{r}_{oc} \times \vec{F} = \left[-300 \frac{\sqrt{2}}{2}(8) + (10)300\frac{\sqrt{2}}{4}\right]\vec{i}$

$+\left[(8)300\frac{\sqrt{6}}{4} - (10)300\frac{\sqrt{2}}{4}\right]\vec{j}$

$+\left[(10)300\frac{\sqrt{2}}{2} - (10)300\frac{\sqrt{6}}{4}\right]\vec{k}$

$\vec{M}_o = -636.4\vec{i} + 409.0\vec{j} + 284.2\vec{k}$

b)



$\Sigma F_x = 0 \rightarrow F_x = -300\sqrt{6}/4$

$\Sigma F_y = 0 \rightarrow F_y = -300\sqrt{2}/2$

$\Sigma F_z = 0 \rightarrow F_z = -300\sqrt{2}/4$

$\Sigma \vec{M}_o = 0 \rightarrow \vec{M}_o = 636.4\vec{i} - 409.0\vec{j} + 284.2\vec{k}$

c) $\vec{M}_{oB} = (\vec{M}_o \cdot \vec{e}_{oB})\,\vec{e}_{oB}$, $\vec{e}_{oB} = \dfrac{10\vec{i} + 8\vec{k}}{\sqrt{164}}$

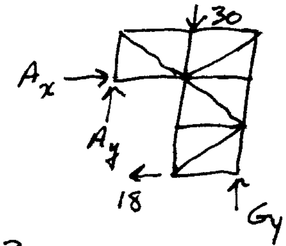
$\vec{M}_{oB} = -249.4\vec{i} - 199.529\vec{k}$

or $\vec{M}_{oB} = 319.4$ in the direction from B to O.

MECH 211

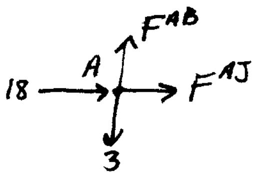
Homework #8 Solutions

1) Test 1 Problem 4 FBD:

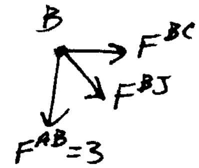


$$\Sigma F_x = 0 = A_x - 18 \rightarrow A_x = 18$$
$$\Sigma F_y = 0 = A_y + G_y - 30$$
$$\Sigma M_A = 0 = 2a\,G_y - 2a(18) - a30$$
$$\therefore G_y = 33$$
$$A_y = -3$$

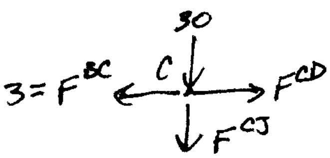
FBDs of joints



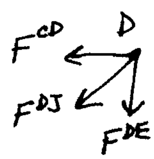
$$\Sigma F_x = 0 = F^{AJ} + 18$$
$$\Sigma F_y = 0 = F^{AB} - 3$$
$$\therefore \boxed{\begin{array}{l} F^{AJ} = -18 \ (c) \\ F^{AB} = 3 \ (t) \end{array}}$$



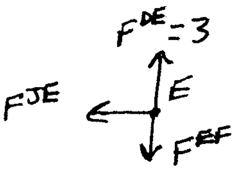
$$\Sigma F_x = 0 = F^{BC} + \tfrac{\sqrt{2}}{2} F^{BJ}$$
$$\Sigma F_y = 0 = -3 - \tfrac{\sqrt{2}}{2} F^{BJ}$$
$$\therefore \boxed{\begin{array}{l} F^{BJ} = -3\sqrt{2} \ (c) \\ F^{BC} = 3 \ (t) \end{array}}$$



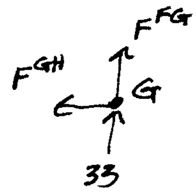
$$\Sigma F_x = 0 = F^{CD} - F^{BC}$$
$$\Sigma F_y = 0 = -30 - F^{CJ}$$
$$\therefore \boxed{\begin{array}{l} F^{CD} = 3 \ (t) \\ F^{CJ} = -30 \ (c) \end{array}}$$



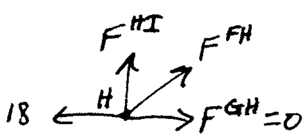
$$\Sigma F_x = 0 = -F^{CD} - \tfrac{\sqrt{2}}{2} F^{DJ}$$
$$\Sigma F_y = 0 = -F^{DE} - \tfrac{\sqrt{2}}{2} F^{DJ}$$
$$\therefore \boxed{\begin{array}{l} F^{DJ} = -3\sqrt{2} \ (c) \\ F^{DE} = 3 \ (t) \end{array}}$$



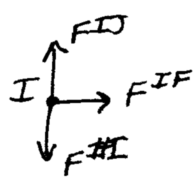
$$\Sigma F_x = 0 = F^{JE}$$
$$\Sigma F_y = 0 = 3 - F^{EF}$$
$$\therefore \boxed{\begin{array}{l} F^{JE} = 0 \\ F^{EF} = 3 \ (t) \end{array}}$$



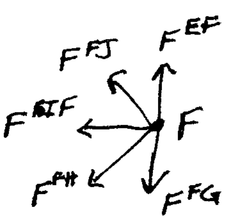
$$\Sigma F_x = 0 = F^{GH}$$
$$\Sigma F_y = 0 = F^{FG} + 33$$
$$\therefore \boxed{\begin{array}{l} F^{GH} = 0 \\ F^{FG} = -33 \ (c) \end{array}}$$



$$\Sigma F_x = 0 = 0 + \tfrac{\sqrt{2}}{2} F^{FH} - 18$$
$$\Sigma F_y = 0 = F^{HI} + \tfrac{\sqrt{2}}{2} F^{FH}$$
$$\therefore \boxed{\begin{array}{l} F^{FH} = 18\sqrt{2} \ (t) \\ F^{HI} = -18 \ (c) \end{array}}$$



$$\Sigma F_x = 0 = F^{IF}$$
$$\Sigma F_y = 0 = F^{IJ} - F^{HI}$$
$$\therefore \boxed{\begin{array}{l} F^{IF} = 0 \\ F^{IJ} = -18 \ (c) \end{array}}$$

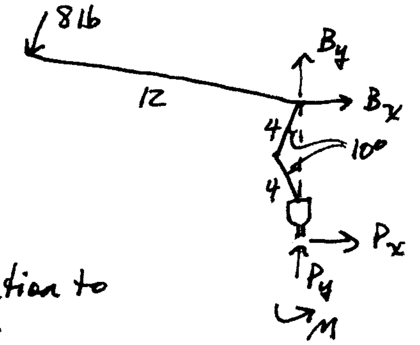


$$\Sigma F_x = 0 = -F^{IF} + -\tfrac{\sqrt{2}}{2} F^{FJ} - \tfrac{\sqrt{2}}{2} F^{FH}$$
$$\Sigma F_y = 0 = F^{EF} + \tfrac{\sqrt{2}}{2} F^{FJ} - \tfrac{\sqrt{2}}{2} F^{FH} - F^{FG}$$
$$0 = 3 + \tfrac{\sqrt{2}}{2} F^{FJ} - 18 + 33 \quad \therefore \boxed{F^{FJ} = -18\sqrt{2} \ (c)}$$

$$0 = 0 + 18 - \tfrac{\sqrt{2}}{2} F^{FH} \quad \therefore \boxed{F^{FH} = 18\sqrt{2} \ (t)}$$

(2)

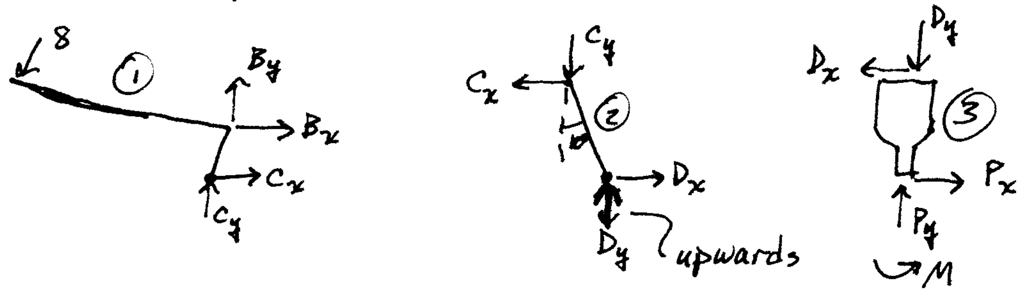
2) Test 1 Problem 5 FBD.



$$\Sigma F_x = 0 = -8 \sin 10° + P_x + B_x$$
$$\Sigma F_y = 0 = -8 \cos 10° + P_y + B_y$$

not enough information to do moments.

FBDs of components



From (2) $\Sigma F_x = 0 = D_x - C_x$

$\Sigma F_y = 0 = D_y - C_y$

$\Sigma M_c = D_x \cos 10° + D_y \sin 10° = 0$

$\therefore \dfrac{D_y}{D_x} = \dfrac{C_y}{C_x} = -\tan 10° \rightarrow D = C$

$C_x = -C \sin 10°$
$C_y = C \cos 10°$
$D_x = -C \sin 10°$
$D_y = C \cos 10°$

from (1): $\Sigma F_x = 0 = -8 \sin 10° + B_x - C \sin 10°$

$\Sigma F_y = 0 = -8 \cos 10° + B_y + C \cos 10°$

$\Sigma M_B = 0 = 12(8) - C \cos 10° (4 \sin 10°) + (-C \sin 10°)(4 \cos 10°)$

$$\therefore C = \frac{96}{8 \cos 10° \sin 10°} = 70.17 \text{ lb.}$$

$$\therefore D = 70.17 \text{ lb}$$

From (3): $\Sigma F_x = -70.17 \sin 10° + P_x = 0 \quad \therefore P_x = 12.185$

$\Sigma F_y = -70.17 \cos 10° + P_y = 0 \quad \therefore P_y = 69.1$

$P = 70.17$

2 Interpretations

a) Mechanical Advantage $= \dfrac{P}{F} = \dfrac{70.17}{8} = 8.77$

b) Mechanical Advantage $= \dfrac{P_y}{F} = \dfrac{69.1}{8} = 8.64$