ME 323: Mechanics of Materials **_Homework Set H01_ – SOLUTION**

Summer 2025 **_Assigned/Due: June 16/June 19_**

A frame is made up of two L-shaped members BCD and DHK, as shown, with the straight sections of these members being aligned with the x- and y-axes. A constant line load p_0 acts in the positive x-direction on section HK. The weights of the two members can be considered to be negligible compared to the applied load on the frame.

a) Draw individual free body diagrams of the two members. Take note that one of these two members is a two-force member.

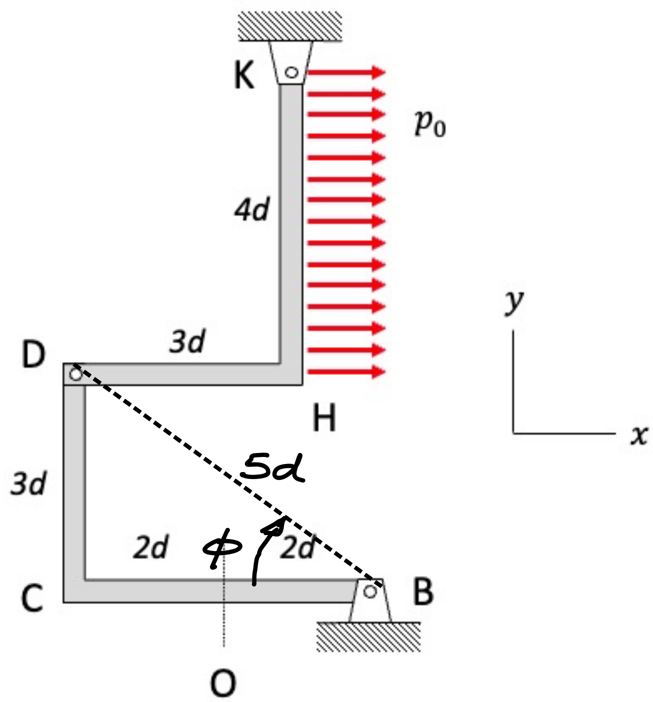
b) Determine the external reactions acting on the two members at B and K. Write your answers as vectors.

c) Determine the internal resultants (shear force, axial force and bending moment) at point O on section BC of member BCD. Write your answers as vectors.

Express all answers in terms of the given parameters of d and p_0. If these parameters are given in terms of SI units, verify that all your answers have the correct units.

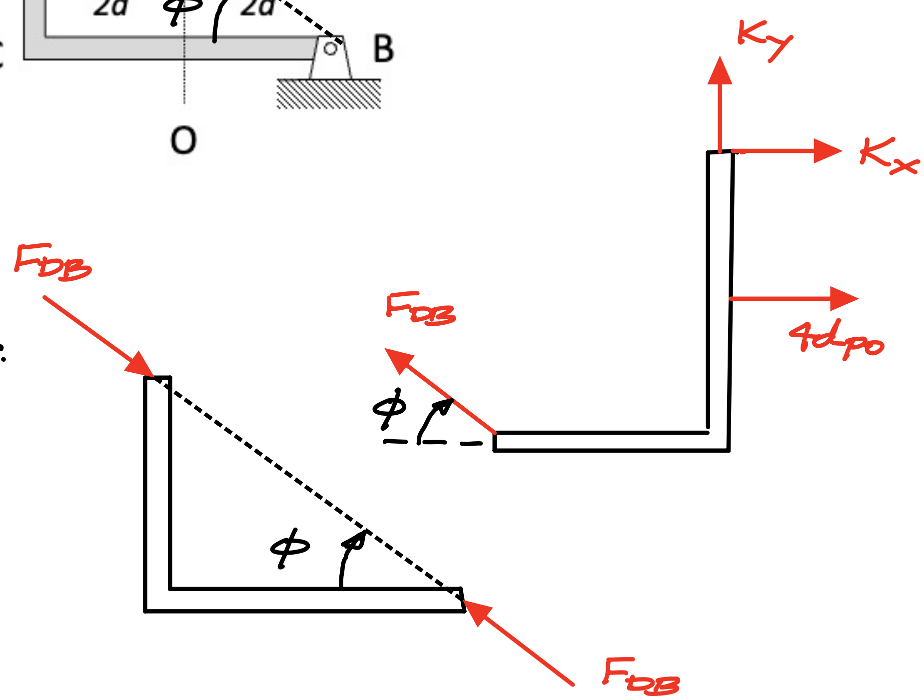
$\cos\phi = \frac{4d}{5d} = \frac{4}{5}$

$\sin\phi = \frac{3d}{5d} = \frac{3}{5}$



FBDs

Note that DB is a two-force member.



Equilibrium – external reactions

DHK:

$$\Sigma M_K = -(F_{DB}\sin\phi)(3\not{d}) - (F_{DB}\cos\phi)(4\not{d}) + (4dp_o)(2\not{d}) = 0$$

$$\hookrightarrow\ F_{DB} = \frac{8dp_o}{3\sin\phi + 4\cos\phi} = \frac{8dp_o}{(3)(\frac{3}{5}) + (4)(\frac{4}{5})} = \frac{8}{5}dp_o$$

$$\Sigma F_x = K_x + 4dp_o - F_{DB}\cos\phi = 0$$

$$\hookrightarrow\ K_x = -4dp_o + (\tfrac{8}{5}dp_o)(\tfrac{4}{5}) = -\frac{68}{25}dp_o$$

$$\Sigma F_y = K_y + F_{DB}\sin\phi = 0$$

$$\hookrightarrow\ K_y = -(\tfrac{8}{5}dp_o)(\tfrac{3}{5}) = -\frac{24}{25}dp_o$$

∴ on member DHK:

$$\vec{K} = K_x\hat{\imath} + K_y\hat{\jmath} = -\left(\frac{68}{25}\hat{\imath} + \frac{24}{25}\hat{\jmath}\right)dp_o$$

and, on member DB:

$$\vec{F}_{DB} = F_{DB}(-\cos\phi\,\hat{\imath} + \sin\phi\,\hat{\jmath})$$

$$= \frac{8}{5}dp_o\left(-\frac{4}{5}\hat{\imath} + \frac{3}{5}\hat{\jmath}\right)$$

$$= \frac{8}{25}dp_o(-4\hat{\imath} + 3\hat{\jmath})$$

Equilibrium – internal resultants

$$\Sigma F_x = F_N - F_{DB}\cos\phi = 0$$

$$\hookrightarrow\ \vec{F}_N = (F_{DB}\cos\phi)\hat{\imath} = \frac{32}{25}dp_o\hat{\imath}$$

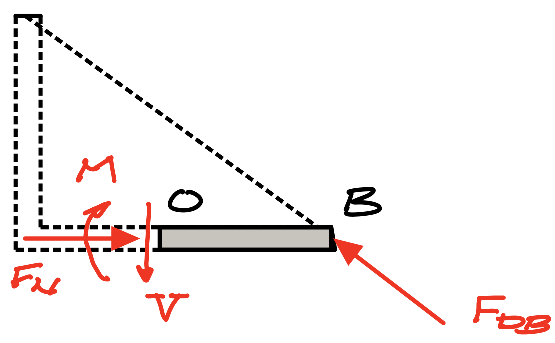
$$\Sigma F_y = -V + F_{DB}\sin\phi = 0$$

$$\hookrightarrow\ \vec{V} = -(F_{DB}\sin\phi)\hat{\jmath} = -\frac{24}{35}dp_o\hat{\jmath}$$

$$\Sigma M_O = -M + (F_{DB}\sin\phi)(2d) = 0$$

$$\hookrightarrow\ \vec{M} = 2dF_{DB}\sin\phi(-\hat{k})$$

$$= -\frac{48}{25}d^2p_o\hat{k}$$



Units check

- All forces have the same units as:

$$dp_o = (m)\left(\frac{N}{m}\right) = N \checkmark$$

- The couple at O has the same units as:

$$d^2p_o = (m^2)\left(\frac{N}{m}\right) = N\cdot m \checkmark$$