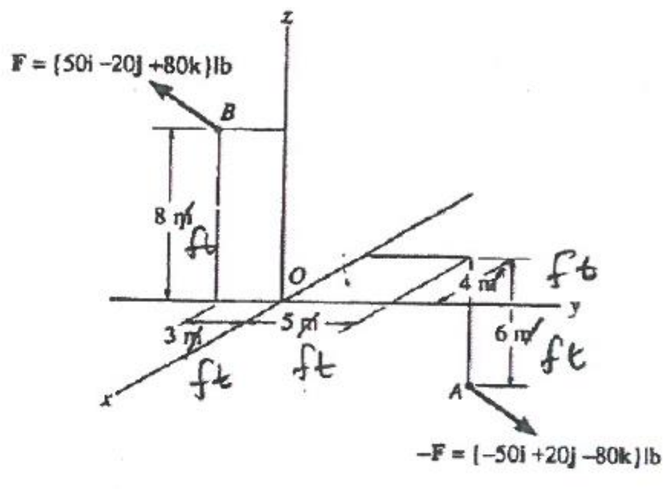
19/11/2020

ES 221 MECHANICS I (STATICS) RECITATION V

Q1)

Determine the couple moment. Express the result as a Cartesian vector.



Solution to Q1

Coordinates of the Points:

$A(-4,5,-6)$

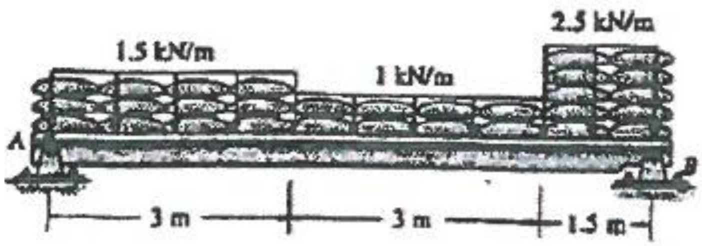
$B(0,-3,8)$

$\vec{r}_{AB} = \{4\vec{i} - 8\vec{j} + 14\vec{k}\}\,ft$

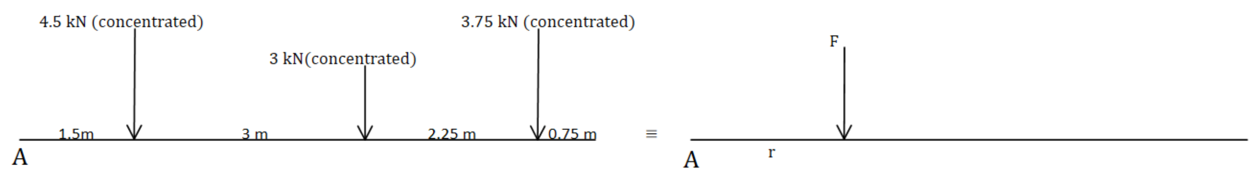
$$M = \begin{vmatrix} i & j & k \\ 4 & -8 & 14 \\ 50 & -20 & 80 \end{vmatrix} = \{-360\vec{i} + 380\vec{j} + 320\vec{k}\}\,lb.ft$$

Q2)

The beam supports the distributed load caused by the sandbags. Determine the resultant force on the beam and specify its location measured from point A.



Solution to Q2



$$\sum F = 4.5\ kN + 3\ kN + 3.75\ kN = 11.25\ kN \downarrow$$

$$\circlearrowright \sum M_A = 0$$

$$4.5\ kN \times 1.5m + 3\ kN \times 4.5\ m + 3.75\ kN \times 6.75\ m = 45.56\ kNm$$

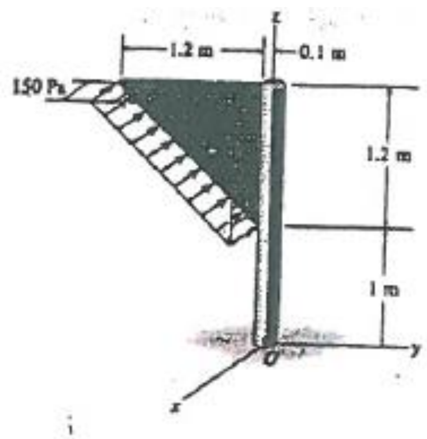
$$M = r \times F$$

$$45.56\ kNm = r \times 11.25\ kN$$

$$r = 4.05\ m$$

Q3)

The wind pressure acting on a triangular sign is uniform. Replace this loading by an equivalent resultant force and couple moment at point O.



Solution to Q3

$$P = \frac{F}{A}$$

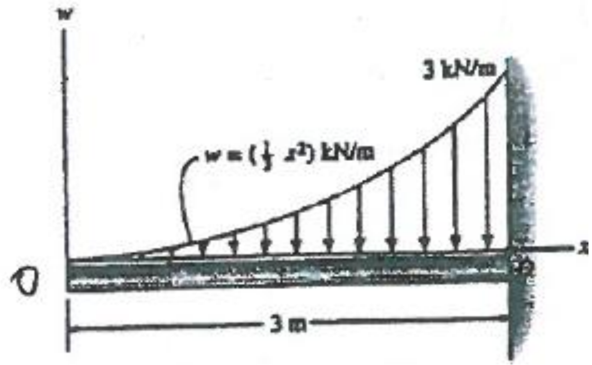
$$F = PA = 150\frac{N}{m^2} \times \frac{1.2^2}{2} = 108\ N$$

$$\vec{F} = \{-108\ \vec{\imath}\}N$$

$$\sum M_O = \{1.8\vec{k}\}\ m \times \{-108\vec{\imath}\}\ N + \{-0.5\vec{\jmath}\}\ m \times \{-108\vec{\imath}\}\ N = \{-194.4\vec{\jmath} - 54\vec{k}\}\ Nm$$

Q4)

Determine the equivalent resultant force and couple moment at point O.



Solution to Q4

$$F = \int \omega(x)dx = \int_0^3 \frac{x^2}{3} dx = \frac{1}{3} \times \frac{3^3}{3} = 3\ kN \downarrow$$

$$\bar{x} = \frac{\int \tilde{x}\omega(x)dx}{\int \omega(x)dx} = \frac{\int_0^3 \frac{x^3}{3}}{3} = 2.25\ m$$

$$\sum F = 3\ kN \downarrow$$

$$\sum M_O = 3\ kN \times 2.25\ m = 6.75\ kNm \circlearrowright$$

Equivalent Resultant Force and Couple Moment: