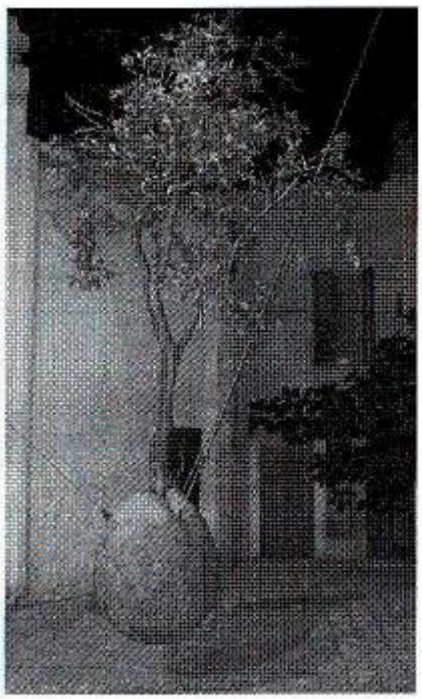
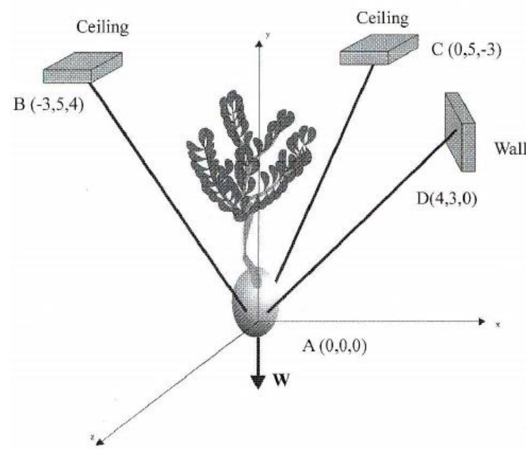
PLEASE INCLUDE THIS PAGE WITH YOUR SUBMISSION

NAME:______________________Student #_____________ GROUP:_____

ENG 1440 Assignment #7 Solution

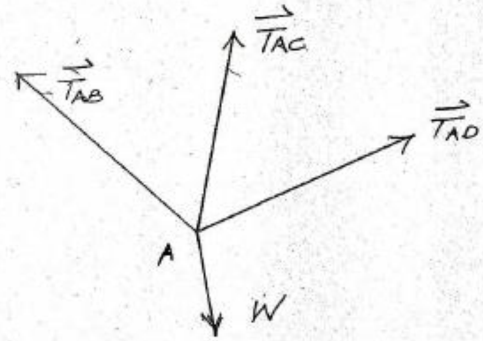
S2-504 A tree is suspended by two cables from the ceiling at *B* and *C* and by a third cable attached to the wall at *D*. If the maximum safe tension force in any one of the three cables is *1.2 kN*, Determine the maximum weight of the tree that can be supported.





PLEASE INCLUDE THIS PAGE WITH YOUR SUBMISSION

$A: (0,0,0)$
$B: (-3,5,4)$
$C: (0,5,-3)$
$D: (4,3,0)$



$-W\hat{j}$

$\vec{T}_{AD} = T_{AD}\vec{\lambda}_{AD}$

$\vec{\lambda}_{AD} = \dfrac{\vec{AD}}{AD}$ $\quad \vec{AD} = 4\hat{i} + 3\hat{j}$

$AD = \sqrt{4^2+3^2} = 5$

$\vec{T}_{AD} = T_{AD}\left(\dfrac{4\hat{i}+3\hat{j}}{5}\right) = 0.8\,T_{AD}\,\hat{i} + 0.6\,T_{AD}\,\hat{j}$

$\vec{\lambda}_{AC} = \dfrac{\vec{AC}}{AC}$ $\quad \vec{AC} = 5\hat{j} - 3\hat{k}$

$\vec{T}_{AC} = T_{AC}\vec{\lambda}_{AC}$ $\quad AC = \sqrt{5^2+(-3)^2}$

$\vec{T}_{AC} = T_{AC}\left(\dfrac{5\hat{j}-3\hat{k}}{\sqrt{34}}\right)$

$\vec{T}_{AC} = 0.857\,T_{AC}\,\hat{j} - 0.514\,T_{AC}\,\hat{k}$

$\vec{\lambda}_{AB} = \dfrac{\vec{AB}}{AB}$ $\quad \vec{AB} = -3\hat{i} + 5\hat{j} + 4\hat{k}$

$\vec{T}_{AB} = T_{AB}\vec{\lambda}_{AB}$

$AB = \sqrt{(-3)^2+5^2+4^2} = \sqrt{50}$

$\vec{T}_{AB} = T_{AB}\left(\dfrac{-3\hat{i}+5\hat{j}+4\hat{k}}{\sqrt{50}}\right)$

$\vec{T}_{AB} = 0.424\,T_{AB}\,\hat{i} + 0.707\,T_{AB}\,\hat{j} + 0.566\,T_{AB}\,\hat{k}$

$\Sigma F_x = 0 \quad 0.8\,T_{AD} + 0.424\,T_{AB} = 0$

$T_{AD} = \dfrac{0.424}{0.8}T_{AB} = 0.53\,T_{AB}$

$0.6\,T_{AD} + 0.857\,T_{AC} + 0.707\,T_{AB} - W = 0$

$\Sigma F_y = 0 \quad 0.6\,T_{AD} + 0.857\,T_{AC} = 0$

$\Sigma F_z = 0 \quad -0.514\,T_{AC} + 0.566\,T_{AB} = 0$

$T_{AC} = \dfrac{0.566}{0.514}T_{AB} = 1.101\,T_{AB}$

Let $T_{AC} = 1.2$ kN   Governs

$\therefore\ T_{AB} = \dfrac{1.2}{1.101} = 1.09 \text{ kN} < 1.2$

$T_{AD} = 0.53\, T_{AB} = 0.53(1.09) = 0.578 \text{ kN}$
< 1.2

From (2)

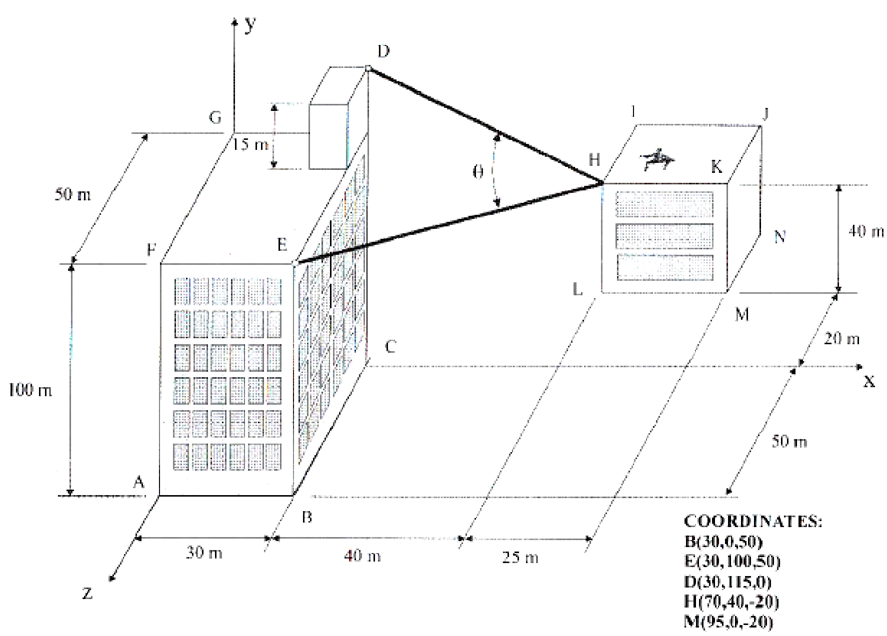
$0.6(0.578) + 0.857(1.2) + 0.707(1.09) = W$

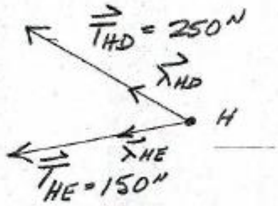
$W = 2.15 \text{ kN}$

S2-602 Spiderman casts two web lines *HE* and *HD* across two buildings as shown in the figure below. In doing so, he applied a force of *150 N* on line *HE* and *250 N* on line *HD* pulling from point *H*.

Determine:

a) The resultant, ***R***, of the two forces acting at the point *H*,
b) The angle, θ, between the two web lines at *H*,
c) The moment of the resultant, ***R***, about the point *B*, and
d) The moment of the resultant, ***R***, about the line *BM*.





$H(70, 40, -20)$
$D(30, 115, 0)$
$E(30, 100, 50)$
$B(30, 0, 50)$
$M(95, 0, -20)$

a) $\vec{T}_{HD} = T_{HD}\vec{\lambda}_{HD} = 250\,\vec{\lambda}_{HD}$

$\vec{\lambda}_{HD} = \dfrac{\vec{HD}}{HD}$ $\quad HD = -40\hat{i} + 75\hat{j} + 20\hat{k}$

$HD = \sqrt{(-40)^2 + (75)^2 + (20)^2} = 87.32$

$\vec{\lambda}_{HD} = \dfrac{-40\hat{i} + 75\hat{j} + 20\hat{k}}{87.32}$

$\vec{T}_{HD} = 250\left(\dfrac{-40\hat{i} + 75\hat{j} + 20\hat{k}}{87.32}\right) = \left(-114.52\hat{i} + 214.73\hat{j} + 57.26\hat{k}\right)N$

$\vec{T}_{HE} = T_{HE}\vec{\lambda}_{HE} = 150\,\vec{\lambda}_{HE}$ $\quad \vec{\lambda}_{HE} = \dfrac{\vec{HE}}{HE}$

$\vec{HE} = -40\hat{i} + 60\hat{j} + 70\hat{k}$

$HE = \sqrt{(-40)^2 + (60)^2 + (70)^2} = 100.5$

$\vec{\lambda}_{HE} = \dfrac{-40\hat{i} + 60\hat{j} + 70\hat{k}}{100.5}$

$\vec{T}_{HE} = 150\left(\dfrac{-40\hat{i} + 60\hat{j} + 70\hat{k}}{100.5}\right) = \left(-59.7\hat{i} + 89.55\hat{j} + 104.48\hat{k}\right)$

$\vec{R} = \vec{T}_{HD} + \vec{T}_{HE}$

$\vec{R} = (-174.22\hat{i} + 304.28\hat{j} + 161.74\hat{k})$

b) $\cos\theta = \vec{\lambda}_{HD} \cdot \vec{\lambda}_{HE}$

$\cos\theta = \dfrac{1}{(87.32)(100.5)}\left[(-40)(-40) + (75)(60) + (20)(70)\right]$

$\cos\theta = 0.85464 \Rightarrow \theta = 31.28^\circ$

c) $\vec{M}_B = \vec{r}_{BH} \times \vec{R}$ $\quad \vec{r}_{BH} = 40\hat{i} + 40\hat{j} - 70\hat{k}$

$$\vec{M}_B = \left|\begin{array}{ccc|cc} i & j & k & i & j \\ 40 & 40 & -70 & 40 & 40 \\ -174.22 & 304.28 & 161.74 & -174.22 & 304.28 \end{array}\right| = \begin{array}{l} [6469.6\hat{i} + 12195.4\hat{j} + 12171.2\hat{k}] \\ - \\ [-6968.8\hat{k} - 21299.6\hat{i} + 6469.6\hat{j}] \end{array}$$

$\vec{M}_B = (27769.2\hat{i} + 5701.6\hat{j} + 19140\hat{k})\ N.m$

PLEASE INCLUDE THIS PAGE WITH YOUR SUBMISSION

d) $M_{BM} = \vec{\lambda}_{BM} \cdot \vec{M}_B$

$$\vec{\lambda}_{BM} = \frac{\vec{BM}}{BM} \qquad BM = 65\hat{i} + 0\hat{j} - 70\hat{k}$$

$$BM = \sqrt{(65)^2 + (-70)^2} = \sqrt{9125}$$

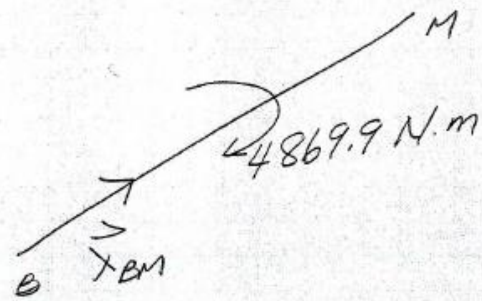
$$= 95.52$$

$$\vec{\lambda}_{BM} = \frac{65\hat{i} + 0\hat{j} - 70\hat{k}}{\sqrt{9125}}$$

$$\vec{\lambda}_{BM} \cdot \vec{M}_B = \left(\frac{65\hat{i} + 0\hat{j} - 70\hat{k}}{\sqrt{9125}}\right) \cdot \left(27769.2\hat{i} + 5701.8\hat{j} + 19140\hat{k}\right)$$

$$= \frac{1}{\sqrt{9125}}\left[(65)(27769.2) + (-70)(19140)\right]$$

$$= +4869.9 \text{ N.m}$$



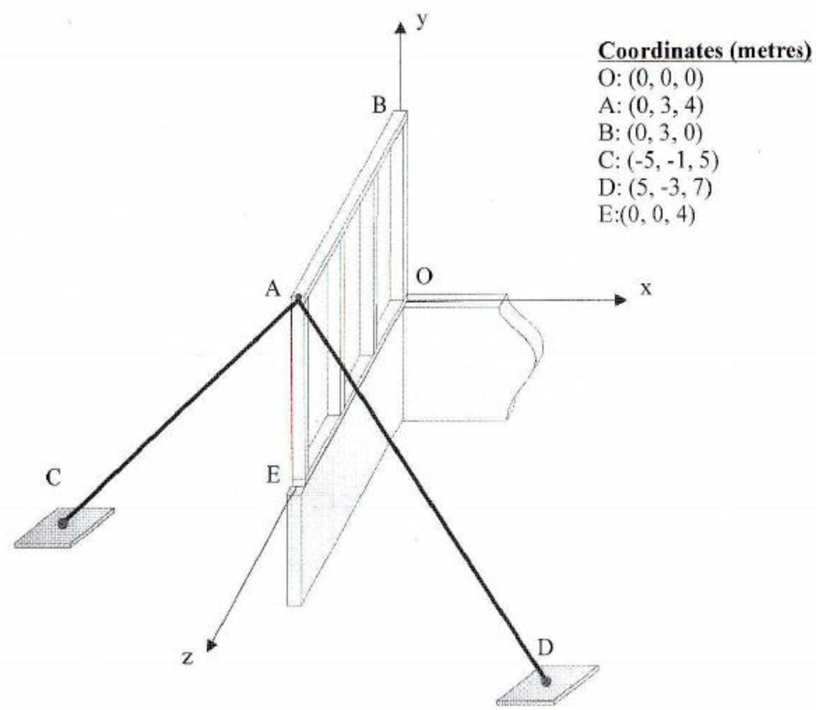
PLEASE INCLUDE THIS PAGE WITH YOUR SUBMISSION

S2-605 A *3 m x 4 m* wood stud wall sits on top of a concrete foundation wall as shown in the figure. The stud wall is bolted to the foundation wall and is supported by two cables *AC* and *AD* attached to the wall at point *A*. The tension in cable *AC* is *1.2 kN*. Determine:

(a) The angle between cable *AC* and cable *AD*,

(b) The moment of the *1.2 kN* force applied at *A* by cable *AC* about the line *EO*,

(c) The moment of the *1.2 kN* force applied at *A* about the line *CD* and



a)

$\overline{AC} = -5\bar{i} - 4\bar{j} + \bar{k}$ $\quad AC = 6.48$ m

$\overline{AD} = 5\bar{i} - 6\bar{j} + 3\bar{k}$ $\quad AD = 8.37$ m

$\overline{AC} \cdot \overline{AD} = (AC)(AD)\cos\theta$

$= (6.48)(8.37)\cos\theta$

$= 54.24 \cos\theta$

Also $\overline{AC} \cdot \overline{AD} = -25 + 24 + 3 = 2$

$\therefore 2 = 54.24 \cos\theta$

$\theta = 87.89^\circ$

b) Find M_{EO}

$M_{EO} = \overline{M}_E \cdot \bar{\lambda}_{EO}$

$\overline{M}_E = \bar{r}_{EA} \times \overline{F}_{AC}$

$\overline{F}_{AC} = F_{AC}\bar{\lambda}_{AC}$ $\quad \bar{\lambda}_{AC} = \dfrac{-5\bar{i} - 4\bar{j} + \bar{k}}{6.48}$

$= 1.2\,\bar{\lambda}_{AC}$ $\quad = -0.7716\,\bar{i} - 0.6173\,\bar{j} + 0.1543\,\bar{k}$

$= (-0.9260\bar{i} - 0.7408\bar{j} + 0.1852\bar{k})$ kN

$\bar{r}_{EA} = -3\bar{j}$

PLEASE INCLUDE THIS PAGE WITH YOUR SUBMISSION

$$\bar{M}_E = \begin{vmatrix} \bar{i} & \bar{j} & \bar{k} \\ 0 & -3 & 0 \\ -0.9260 & -0.7408 & 0.1852 \end{vmatrix} \begin{matrix} i & j \\ 0 & -3 \\ -0.926 & -0.7408 \end{matrix}$$

$$= (-0.556\,\bar{i}) - (2.778\,\bar{k})$$

$$\bar{\lambda}_{EO} = -\bar{k}$$

$$M_{EO} = (+0.556\,\bar{i} + 2.778\,\bar{k}) \cdot (-\bar{k})$$

$$= -2.778 \quad kN\text{-}m$$

(c) $M_{CD} = 0$ since line CD intersects the line of action of the force F_{AC}