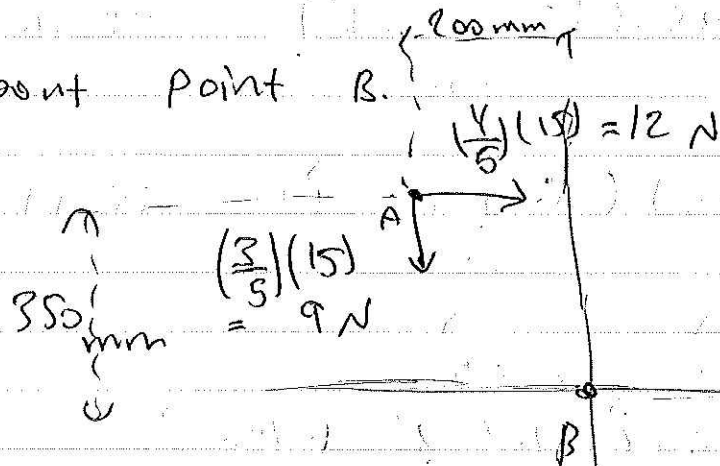


Statics ENCE 232  
 HW #3: Key Solution.

Q.1 moment about point B.



$$M_B = (12)(350) + 9 \times 200$$

$$= -2400 \text{ N}\cdot\text{m}$$

or  $M_B = 2400 \text{ N}\cdot\text{m}$  (clockwise)

Q.2

$$\vec{r}_{BE} = 150\vec{j} - 200\vec{k}$$

$$|\vec{r}_{BE}| = 250 \text{ mm}$$

$$\vec{r}_{BD} = 150\vec{i} - 200\vec{k}$$

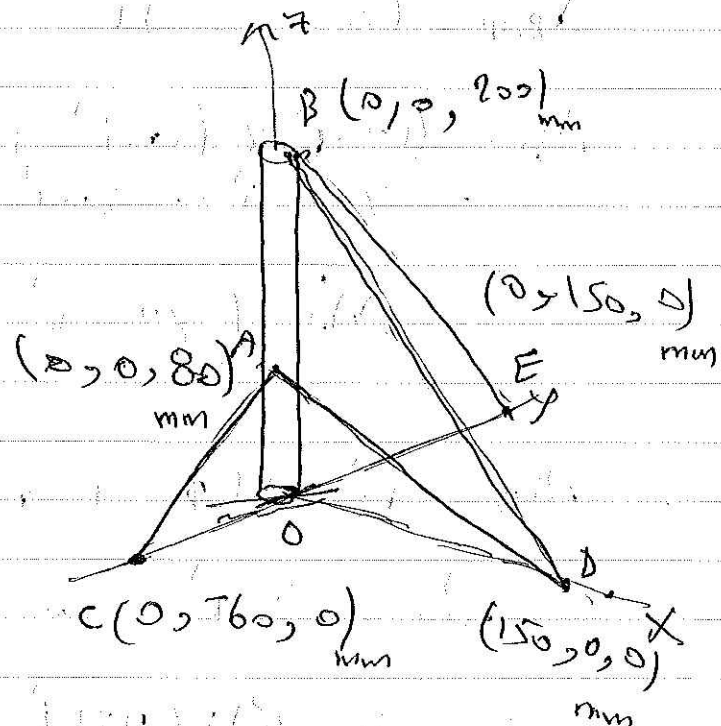
$$|\vec{r}_{BD}| = 250 \text{ mm}$$

$$\vec{r}_{AD} = 150\vec{i} - 80\vec{k}$$

$$|\vec{r}_{AD}| = 170 \text{ mm}$$

$$\vec{r}_{AC} = 60\vec{j} - 80\vec{k}$$

$$|\vec{r}_{AC}| = 100 \text{ mm}$$



$$\vec{F}_{BE} = T_{BE} \frac{\vec{r}_{BE}}{|\vec{r}_{BE}|} = (100) \frac{(150\vec{j} - 200\vec{k})}{250} = 60\vec{j} - 80\vec{k}$$

$$\vec{F}_{BD} = T_{BD} \frac{\vec{r}_{BD}}{|\vec{r}_{BD}|} = (100) \frac{(150\vec{i} - 200\vec{k})}{250} = 60\vec{i} - 80\vec{k}$$

$$\vec{F}_{AD} = (250) \frac{(150\vec{i} - 80\vec{k})}{170} = 220.6\vec{i} - 117.6\vec{k}$$

$$\vec{F}_{AC} = (150) \frac{(-60\vec{j} + 80\vec{k})}{100} = -150\vec{j} + 200\vec{k}$$

$$\begin{aligned}\vec{F}_1 &= \vec{F}_{BE} + \vec{F}_{BD} \\ &= 60\vec{i} + 60\vec{j} - 120\vec{k}\end{aligned}$$

$$\vec{F}_R = 221\vec{i} - 150\vec{j} - 82\vec{k}$$

$$M_A = \vec{r}_{AB} \times \vec{F}_1$$

$$\vec{r}_{AB} = (200 - 80)\vec{k} = 120\vec{k}$$



$$\begin{aligned}\vec{M}_A &= (120\vec{k}) \times (60\vec{i} + 60\vec{j} - 120\vec{k}) \\ &= 7200\vec{j} - 7200\vec{i}\end{aligned}$$

$$\boxed{\vec{M}_A = (-7200\vec{i} + 7200\vec{j})}$$

$$M_O = \vec{r}_{OA} \times \vec{F}_R + \vec{r}_{OB} \times \vec{F}_1$$

$$\vec{r}_{OA} = 80\vec{k} \quad , \quad \vec{r}_{OB} = 200\vec{k}$$

$$\begin{aligned}\vec{M}_O &= (80\vec{k}) \times (221\vec{i} - 150\vec{j} - 82\vec{k}) \\ &\quad + (200\vec{k}) \times (60\vec{i} + 60\vec{j} - 120\vec{k})\end{aligned}$$

$$= 17680\vec{j} - 12000\vec{i} + 12000\vec{j} - 12000\vec{i}$$

$$\boxed{\vec{M}_O = -24000\vec{i} + 29680\vec{j}}$$

Q.3

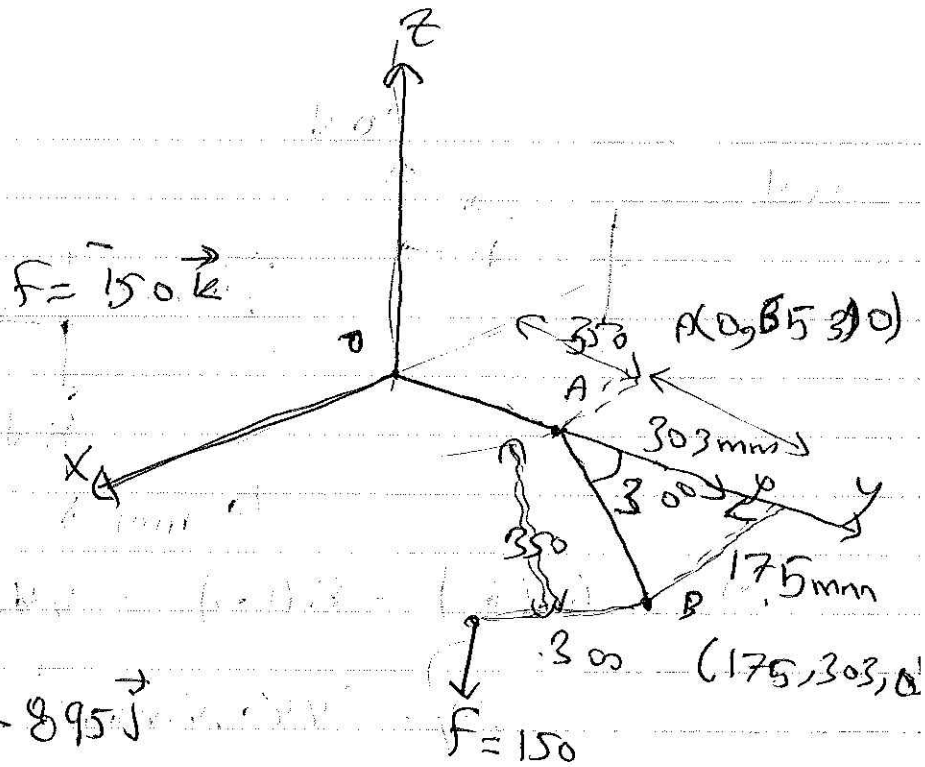
$$r_{OA} = 350 \vec{j}$$

$$F = 150 \vec{k}$$

$$\vec{r}_{AB} = \frac{\vec{r}_{AB}}{|\vec{r}_{AB}|}$$

$$= \frac{175 \vec{i} - 350 \vec{j}}{391}$$

$$= 0.447 \vec{i} - 0.895 \vec{j}$$



$$M_{OA} = (\vec{j}) \cdot (\vec{r}_{OA} \times \vec{F})$$

$$= (\vec{j}) \cdot (350 \vec{j} \times 150 \vec{k})$$

$$= \vec{j} \cdot 52500 \vec{i}$$

$$= +52500 \text{ N}\cdot\text{mm}$$



$$M_{AB} = \vec{r}_{AB} \cdot (\vec{r}_{AB} \times \vec{F})$$

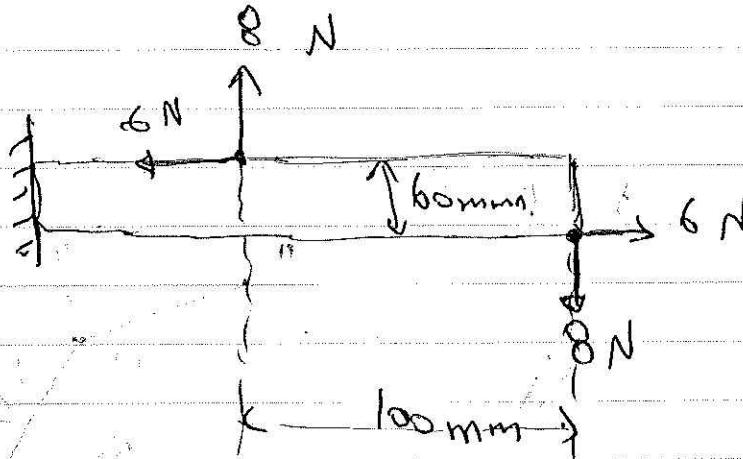
$$= (0.447 \vec{i} - 0.895 \vec{j}) \cdot [(175 \vec{i} - 350 \vec{j}) \times 150 \vec{k}]$$

$$= \begin{vmatrix} 0.447 & -0.895 & 0 \\ 175 & -350 & 0 \\ 0 & 0 & 150 \end{vmatrix}$$

$$= 350 \times 150 + 175 \times 150$$

$$= 26250 \text{ N}\cdot\text{mm}$$

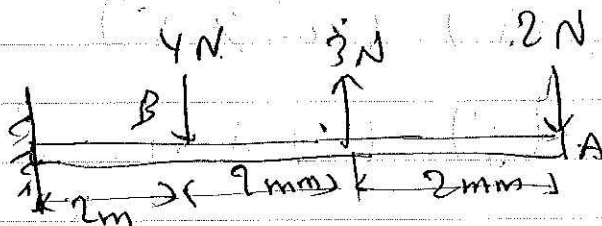
Q.4



$$M = 6(60) - 8(100) = -440 \text{ N}\cdot\text{mm}$$

$$M = -440 \text{ N}\cdot\text{mm} \vec{k}$$

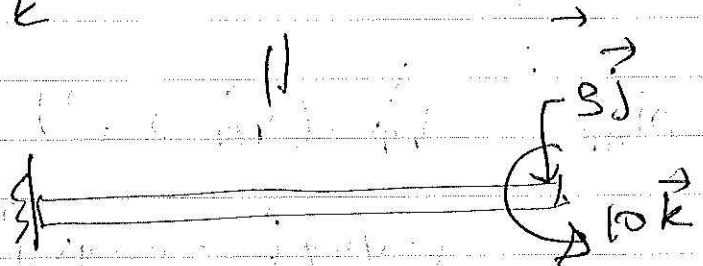
Q.5



$$R = -2 + 3 = 1$$

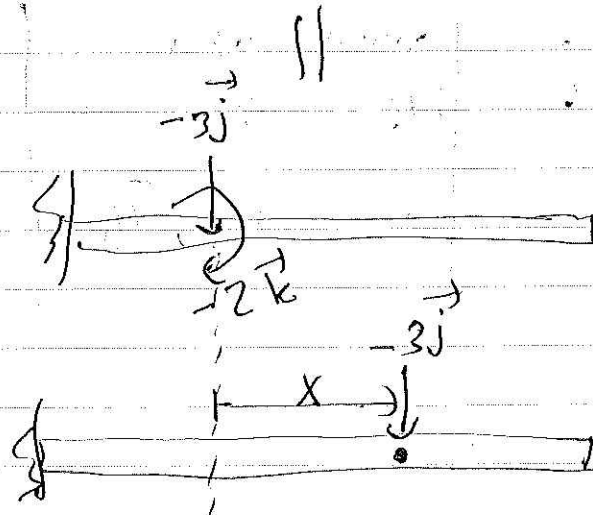
$$R = -3 \text{ N} \vec{j}$$

$$M_A = -3(2) + 4(4) = 10 \vec{k}$$



$$R = -3 \text{ N} \vec{j}$$

$$M_B = -2(4) + 3(2) = -2 \vec{k} \text{ N}\cdot\text{m}$$



$$M = x(2) = 2$$

$$x = \frac{2}{2} \text{ mm}$$

P.7

$$R_x = 40 + 80 \cos 30 - 60 \cos 45 = 66.9 \text{ N}$$

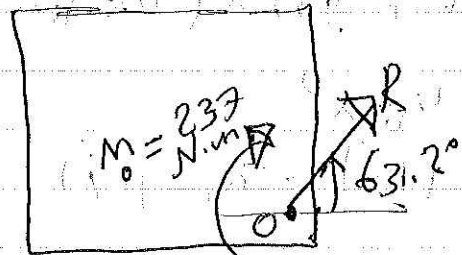
$$R_y = 50 + 80 \sin 30 + 60 \sin 45 = 132.4 \text{ N}$$

$$R = \sqrt{R_x^2 + R_y^2} = 148.3 \text{ N}$$

$$\theta = \tan^{-1} \left( \frac{132.4}{66.9} \right) = 63.2^\circ$$

$$M_o = 140 - 50(5) + 60 \cos 45 (4) - 60 \sin 45 (7) \\ = -237 \text{ N}\cdot\text{m}$$

$$d = \frac{M}{R} = \frac{237}{148.3} = 1.60 \text{ m}$$



$$(x\mathbf{i} + y\mathbf{j}) \times (66.9\mathbf{i} + 132.4\mathbf{j}) = -237\mathbf{k}$$

$$(132.4x - 66.9y)\mathbf{k} = 237\mathbf{k}$$

$$\text{Setting } y=0 \rightarrow x = -1.792 \text{ m}$$

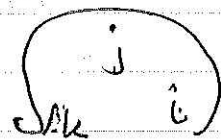
Q.6

$$\vec{R} = 120\vec{j} + 260\vec{j} - 100\vec{j}$$
$$= -480\vec{k} \text{ N}$$

$$\vec{M}_0 = -120(0.4)\vec{i} + (260 \times 0.2)\vec{i} + (100 \times 0.3)\vec{i}$$
$$+ 260 \times 0.5\vec{j} - (100 \times 0.4)\vec{j}$$

$$\vec{M}_0 = -70\vec{i} + 90\vec{j}$$

$$r \times F = M$$
$$(x\vec{i} + y\vec{j}) \times (-480\vec{k}) = -70\vec{i} + 90\vec{j}$$



$$x(480)(+\vec{j}) - y(480\vec{j})(\vec{i}) = -70\vec{i} + 90\vec{j}$$

$$480x = 90 \rightarrow x = 0.1875 \text{ m.}$$
$$480y = 70 \rightarrow y = 0.1458 \text{ m.}$$