

&lt;3.1~3.8 &gt;

$$3.5 \quad [ \mathbf{M} = \mathbf{r} \times \mathbf{F} \quad ( \quad ) \quad M = r F \sin \theta ]$$

$$P = 2.9 \text{ N}, \quad M_A = 17 \text{ N}\cdot\text{m}$$

$$\beta = \tan^{-1} \left( \frac{4.8 \text{ m}}{3.4 \text{ m}} \right) = \tan^{-1} 1.4118 = 54.69^\circ$$

$$r_{AB} = \sqrt{(3.4 \text{ m})^2 + (4.8 \text{ m})^2} = 5.882 \text{ m}$$

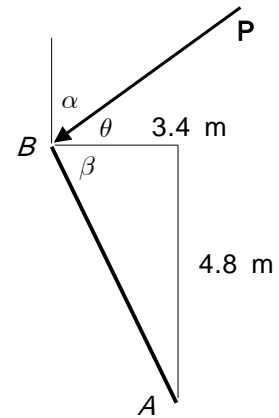
$$\mathbf{M}_A = \mathbf{r}_{B/A} \times \mathbf{P} \quad M_A = r_{AB} P \sin(\beta + \theta)$$

$$\sin(\beta + \theta) = \frac{M_A}{r_{AB} P} = \frac{17 \text{ N}\cdot\text{m}}{(5.882 \text{ m})(2.9 \text{ N})} = 0.9966$$

$$\beta + \theta = \sin^{-1} 0.9966 = 85.26^\circ \quad 94.74^\circ$$

$$\theta = 85.26^\circ - 54.69^\circ = 30.57^\circ$$

$$\theta = 94.74^\circ - 54.69^\circ = 40.05^\circ$$



$$\alpha = 90^\circ - 30.57^\circ = 59.4^\circ$$

$$\alpha = 90^\circ - 40.05^\circ = 49.9^\circ$$

$$3.12 \quad [ \mathbf{M} = \mathbf{r} \times \mathbf{F} \quad (2 \quad ) ]$$

$$\mathbf{r}_{B/C} = -0.042 \mathbf{i} + 0.056 \mathbf{j} \text{ (m)}, \quad F_{AB} = 2.5 \text{ kN}$$

$$d_x = -0.042 \text{ m}, \quad d_y = -0.144 \text{ m}$$

$$d = \sqrt{(-0.042 \text{ m})^2 + (-0.144 \text{ m})^2} = 0.150 \text{ m}$$

$$\lambda = \frac{-0.042 \text{ m} \mathbf{i} - 0.144 \text{ m} \mathbf{j}}{0.150 \text{ m}}$$

$$\mathbf{F}_{AB} = (2.5 \text{ kN}) \frac{-0.042 \mathbf{i} - 0.144 \mathbf{j}}{0.150}$$

$$= -0.700 \mathbf{i} - 2.40 \mathbf{j} \text{ (kN)}$$

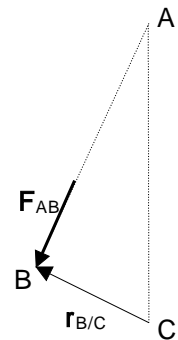
$$\mathbf{M}_C = \mathbf{r}_{B/C} \times \mathbf{F}_{AB}$$

$$= [-0.042 \mathbf{i} + 0.056 \mathbf{j} \text{ (m)}] \times [-0.700 \mathbf{i} - 2.40 \mathbf{j} \text{ (kN)}]$$

$$= [ (-0.042)(-2.40) - (0.056)(-0.700) ] \mathbf{k} \text{ kN}\cdot\text{m}$$

$$= 0.1400 \mathbf{k} \text{ kN}\cdot\text{m} = 140.0 \text{ k N}\cdot\text{m}$$

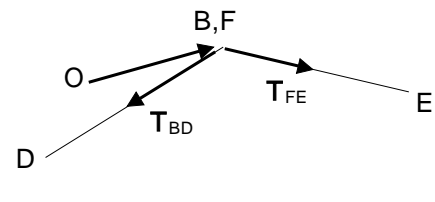
$$\mathbf{M}_C = 140.0 \text{ N}\cdot\text{m} \uparrow$$



3.24 [ (3 ) : ]

$$T_{BD} = 900 \text{ N}, \quad T_{FE} = 675 \text{ N}$$

$$\mathbf{r}_{B/O} = \mathbf{r}_{F/O} = 2.5 \mathbf{i} + 2 \mathbf{j} \text{ (m)}$$



$$(a) \lambda_{BD} = (-1 \mathbf{i} - 2 \mathbf{j} + 2 \mathbf{k}) \frac{1}{\sqrt{(-1)^2 + (-2)^2 + 2^2}}$$

$$= \frac{1}{3}(-1 \mathbf{i} - 2 \mathbf{j} + 2 \mathbf{k})$$

$$\mathbf{T}_{BD} = T_{BD} \lambda_{BD} = (900 \text{ N}) \frac{1}{3}(-1 \mathbf{i} - 2 \mathbf{j} + 2 \mathbf{k}) = -300 \mathbf{i} - 600 \mathbf{j} + 600 \mathbf{k} \text{ (N)}$$

$$\mathbf{M}_O = \mathbf{r}_{B/O} \times \mathbf{T}_{BD} = [2.5 \mathbf{i} + 2 \mathbf{j} \text{ (m)}] \times [-300 \mathbf{i} - 600 \mathbf{j} + 600 \mathbf{k} \text{ (N)}]$$

$$= (2)(600) \mathbf{i} + [-(2.5)(600)] \mathbf{j} + [(2.5)(-600) - (2)(-300)] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= 1200 \mathbf{i} - 1500 \mathbf{j} - 900 \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$(b) \lambda_{FE} = (-0.5 \mathbf{i} - 2 \mathbf{j} - 4 \mathbf{k}) \frac{1}{\sqrt{(-0.5)^2 + (-2)^2 + (-4)^2}} = \frac{1}{4.5}(-0.5 \mathbf{i} - 2 \mathbf{j} - 4 \mathbf{k})$$

$$\mathbf{T}_{FE} = T_{FE} \lambda_{FE} = (675 \text{ N}) \frac{1}{4.5}(-0.5 \mathbf{i} - 2 \mathbf{j} - 4 \mathbf{k}) = -75 \mathbf{i} - 300 \mathbf{j} - 600 \mathbf{k} \text{ (N)}$$

$$\mathbf{M}_O = \mathbf{r}_{F/O} \times \mathbf{T}_{FE} = [2.5 \mathbf{i} + 2 \mathbf{j} \text{ (m)}] \times [-75 \mathbf{i} - 300 \mathbf{j} - 600 \mathbf{k} \text{ (N)}]$$

$$= (2)(-600) \mathbf{i} + [-(2.5)(-600)] \mathbf{j} + [(2.5)(-300) - (2)(-75)] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= -1200 \mathbf{i} + 1500 \mathbf{j} - 600 \mathbf{k} \text{ (N}\cdot\text{m)}$$

3.25 [ (3 ) : ]

$$P = 150 \text{ N}, \quad AB = 0.152 \text{ m}, \quad BC = 0.16 \text{ m}$$

$$\lambda = \sin 5^\circ \mathbf{j} + \cos 5^\circ (\cos 70^\circ \mathbf{i} - \sin 70^\circ \mathbf{k}) = 0.3407 \mathbf{i} + 0.0872 \mathbf{j} - 0.9361 \mathbf{k}$$

$$\mathbf{P} = P \lambda = (150 \text{ N}) (0.3407 \mathbf{i} + 0.0872 \mathbf{j} - 0.9361 \mathbf{k})$$

$$= 51.105 \mathbf{i} + 13.08 \mathbf{j} - 140.42 \mathbf{k} \text{ (N)}$$

$$\mathbf{r}_{BA} = (0.152 \text{ m}) [\cos 20^\circ \mathbf{j} + \sin 20^\circ (-\cos 15^\circ \mathbf{i} - \sin 15^\circ \mathbf{k})]$$

$$= -0.05022 \mathbf{i} + 0.14283 \mathbf{j} - 0.013455 \mathbf{k} \text{ (m)}$$

$$\mathbf{r}_{CB} = (0.160 \text{ m}) [-\sin 80^\circ \mathbf{j} + \cos 80^\circ (-\cos 15^\circ \mathbf{i} - \sin 15^\circ \mathbf{k})]$$

$$= -0.02684 \mathbf{i} - 0.15757 \mathbf{j} - 0.000719 \mathbf{k} \text{ (m)}$$

$$\mathbf{r}_{CA} = \mathbf{r}_{CB} + \mathbf{r}_{BA}$$

$$= (-0.02684 \mathbf{i} - 0.15757 \mathbf{j} - 0.000719 \mathbf{k})$$

$$+ (-0.05022 \mathbf{i} + 0.14283 \mathbf{j} - 0.013455 \mathbf{k}) \text{ (m)}$$

$$= -0.07706 \mathbf{i} - 0.01474 \mathbf{j} - 0.02064 \mathbf{k} \text{ (m)}$$

$$\mathbf{M}_C = \mathbf{r}_{CA} \times \mathbf{P} = [-0.07706 \mathbf{i} - 0.01474 \mathbf{j} - 0.02064 \mathbf{k} \text{ (m)}]$$

$$\times [51.105 \mathbf{i} + 13.08 \mathbf{j} - 140.42 \mathbf{k} \text{ (N)}]$$

$$= [(-0.01474)(-140.42) - (-0.02064)(13.08)] \mathbf{i}$$

$$+ [(-0.02064)(51.105) - (-0.07706)(-140.42)] \mathbf{j}$$

$$+ [(-0.07706)(13.08) - (-0.01474)(51.105)] \mathbf{k} \text{ (N}\cdot\text{m)}$$

$$= 2.34 \mathbf{i} - 11.88 \mathbf{j} - 0.255 \mathbf{k} \text{ (N}\cdot\text{m)}$$