{3.1~3.8절}

3.4 [한 점에 관한 모멘트 (2차원, 직각성분)]

m = 80 kg

$W = mg$ = (80 kg)(9.81 m/s^2) = 784.8 N

$d_{AC} = d_{BD}$ = 0.5 m, d_{ED} = 0.85 m,

$d_{AF} = d_{FB}$ = 0.6 m
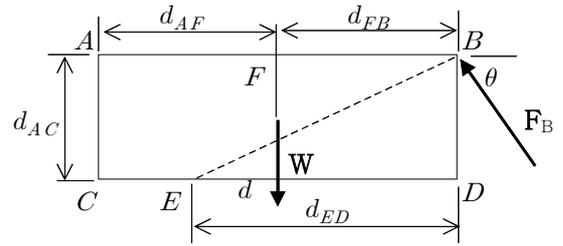
(a) $d = d_{ED} - d_{FB}$ = (0.85 m) – (0.6 m) = 0.25 m

$M_E = d\ W$ = (0.25 m) (784.8 N) = 196.2 N·m

⇒ $\mathbf{M}_E$ = 196.2 N·m ↺

(b) $d_{EB} = \sqrt{d_{ED}^2 + d_{BD}^2} = \sqrt{(0.85\,\text{m})^2 + (0.05\,\text{m})^2}$ = 0.9861 m

$M_E = d_{EB}\ F_B$

⇒ $F_B = \dfrac{M_E}{d_{EB}} = \dfrac{196.2\ \text{N} \cdot \text{m}}{0.9861\ \text{m}}$ = 198.96 N

$\tan\theta = \dfrac{d_{ED}}{d_{BD}} = \dfrac{0.85\ \text{m}}{0.5\ \text{m}}$ = 1.7

⇒ $\theta = \tan^{-1}(1.7)$ = 59.5°   ⇒ $\mathbf{F}_B$ = 199.0 N ↖59.5°

3.7 [한 점에 관한 모멘트 (2차원, 직각성분)]

P = 400 N, d_{OA} = 200 mm = 0.2 m

α = 40°, β = 30°

(a) $\theta = 90° - (\alpha + \beta)$ = 90° – (40°+ 30°) = 20°

$P_n = P\ \sin\theta$ = (400 N) sin20° = 136.31 N

$M_O = d_{OA}\ P$ = (0.2 m) (136.31 N)

= 27.36 N·m

⇒ $\mathbf{M}_O$ = 27.4 N·m ↻
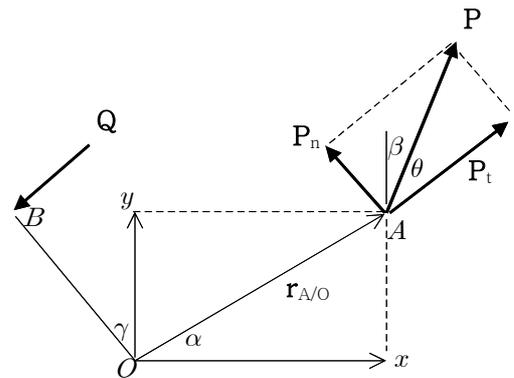
(b) d_{OB} = 120 mm = 0.12 m, γ = 48°

$M_O = d_{OB}\ Q$

⇒ $Q = \dfrac{M_O}{d_{OB}} = \dfrac{27.36\ \text{N} \cdot \text{m}}{0.12\ \text{m}}$ = 228.0 N

$\phi = 90° - \gamma$ = 90° – 48° = 42°   ⇒ $\mathbf{Q}$ = 228 N ↙42.0°

3.8 F_C = 200 N, d_{BC} = 0.100 m, d_{AB} = 0.450 m, β = 70°

(a) $M_B = d_{BC}\,F_C = (0.100 \text{ m})(200 \text{ N}) = 20.0 \text{ N·m}$

$\Rightarrow$ $\mathbf{M}_B$ = 20.0 N·m ↰

(b) α = 10°

$\gamma = 90° - \beta + \alpha = 90° - 70° + 10° = 30°$

$M_B = d_{AB}\,(P\,\cos\gamma)$

$\Rightarrow$ $P = \dfrac{M_B}{d_{AB}\,\cos\gamma} = \dfrac{20.0 \text{ N·m}}{(0.450 \text{ m})\cos 30°} = 51.32 \text{ N}$

$\Rightarrow$ P = 51.3 N
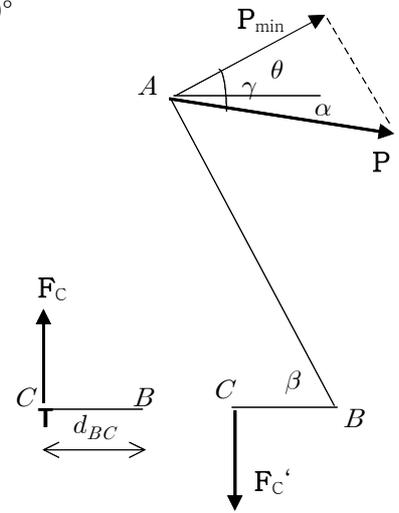
(c) $M_B = d_{AB}\,P_{\min}$

$\Rightarrow$ $P_{\min} = \dfrac{M_B}{d_{AB}} = \dfrac{20.0 \text{ N·m}}{0.450 \text{ m}} = 44.44 \text{ N}$

$\theta = \gamma - \alpha = 30° - 10° = 20°$ $\Rightarrow$ $\mathbf{P}_{\min}$ = 44.4 N ⟋20.0°

3.28   [합력의 모멘트의 직각성분 (3차원, 직각성분)]
3.21 F_{AE} = 435 N

$\mathbf{r}_{BA}$ = −(0.09 + 0.12) $\mathbf{i}$ (m) = −0.21 $\mathbf{i}$ (m)

$(d_{AE})x$ = 0.21 m, $(d_{AE})y$ = −0.16 m, $(d_{AE})z$ = 0.12 m

$d_{AE} = \sqrt{(0.21 \text{ m})^2 + (-0.16 \text{ m})^2 + (0.12 \text{ m})^2} = 0.29 \text{ m}$

$\boldsymbol{\lambda}_{AE} = \dfrac{1}{0.29}\,(0.21\,\mathbf{i} - 0.16\,\mathbf{j} + 0.12\,\mathbf{k})$

$\mathbf{F}_{AE} = F_{AE}\,\boldsymbol{\lambda}_{AE}$

   $= (435 \text{ N})\,\dfrac{1}{0.29}\,(0.21\,\mathbf{i} - 0.16\,\mathbf{j} + 0.12\,\mathbf{k})$

   $= 315\,\mathbf{i} - 240\,\mathbf{j} + 180\,\mathbf{k}$ (N)
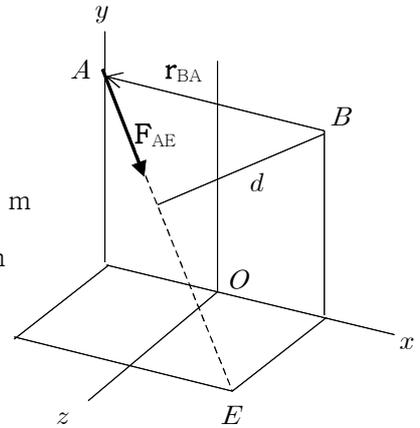
$\mathbf{M}_B = \mathbf{r}_{BA} \times \mathbf{F}_{AE}$

   $= [-0.21\,\mathbf{i}\ (\text{m})] \times [315\,\mathbf{i} - 240\,\mathbf{j} + 180\,\mathbf{k}\ (\text{N})]$

   $= -(0.21)(180)]\,\mathbf{j} + [(-0.21)(-240)]\,\mathbf{k}$ (N·m)

   $= 37.8\,\mathbf{j} + 50.4\,\mathbf{k}$ (N·m)

$\Rightarrow$ $M_B = \sqrt{37.8^2 + 50.4^2}$ N·m = 63.0 N·m

$M_B = d\,F_{AE}$ $\Rightarrow$ $d = \dfrac{M_B}{F_{AE}} = \dfrac{63.0 \text{ N·m}}{435 \text{ N}} = 0.1448 \text{ m} = 144.8 \text{ mm}$