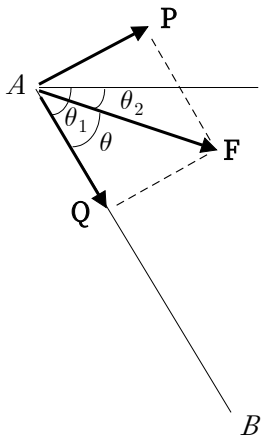
정 역 학　　연습문제 풀이　　제3장　　(2009년)

<3.1~3.8절>

3.1　[Varignon의 정리]



F = 90 N,　$r_{A/B}$ = 0.225 m,　θ_1 = 65°,　θ_2 = 25°,

$\theta = \theta_1 - \theta_2$ = 65° - 25° = 40°

$\mathbf{M}_B = \mathbf{r}_{A/B} \times (\mathbf{P} + \mathbf{Q}) = (\mathbf{r}_{A/B} \times \mathbf{P}) + (\mathbf{r}_{A/B} \times \mathbf{Q})$

$\mathbf{r}_{A/B} \times \mathbf{Q} = 0$

$P = F \sin\theta$ = (90 N) sin40° = 57.85 N

$M_B = -\, r_{A/B}\, P$ = - (0.225 m)(57.85 N) = - 13.016 N·m

⇒　$\mathbf{M}_B$ = 13.02 N·m ↺

3.6　[$\mathbf{M} = \mathbf{r} \times \mathbf{F}$　모멘트의 직각성분 (2차원)]

T_{BF} = 200 N,　θ = 60°

(a) $\mathbf{r}_{B/A}$ = (2 m) **i** -(1.35 m - 0.95 m) **j** = (2 m) **i** -(0.40 m) **j**

$\mathbf{T}_{BF} = T_{BF} \cos\theta\ \mathbf{i} + T_{BF} \sin\theta\ \mathbf{j}$

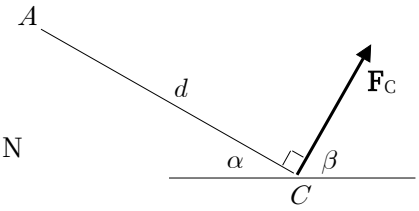
= (200 N) cos60° **i** + (200 N) sin60° **j** = (100 N) **i** + (173.2 N) **j**

$\mathbf{M}_A = \mathbf{r}_{B/A} \times \mathbf{T}_{BF}$ = [(2 m) **i** - (0.40 m) **j**] × [(100 N) **i** + (173.2 N) **j**]

= [(2 m)(173.2 N) + (0.40 m)(100 N)] **k** = (386.4 N·m) **k**

⇒　$\mathbf{M}_A$ = 386 N·m ↻

(b) $\tan\alpha = \dfrac{1.35\text{ m}}{2\text{ m}}$ = 0.675,　$\alpha = \tan^{-1}(0.675)$ = 34.0°



β = 90° - α = 90° - 34.0° = 56.0°

$d = \sqrt{(2\text{ m})^2 + (1.35\text{ m})^2}$ = 2.413 m

$M_A = d\ F_C$　⇒　$F_C = \dfrac{M_A}{d} = \dfrac{386\text{ N}\cdot\text{m}}{2.413\text{ m}}$ = 159.97 N

⇒　$\mathbf{F}_C$ = 160.0 N ∠56.0°

3.14　[$\mathbf{M} = \mathbf{r} \times \mathbf{F}$　모멘트의 직각성분 (2차원)]

F_{CB} = 80 N,　d_x = 176 mm,　d_y = 300 mm - 90 mm = 210 mm

$d_{BC} = \sqrt{d_x^2 + d_y^2} = \sqrt{(176\text{ mm})^2 + (210\text{ mm})^2}$ = 274 mm

$F_x = \dfrac{d_x}{d_{BC}} F_{CB} = \dfrac{176\text{ mm}}{274\text{ mm}}$ (80 N) = 51.39 N,

$F_y = \dfrac{d_y}{d_{BC}} F_{CB} = \dfrac{210\text{ mm}}{274\text{ mm}}$ (80 N) = 61.31 N

$\mathbf{r}_{B/D}$ = (-0.280 m) **i** +(-0.090 m) **j**

$\mathbf{M}_D = \mathbf{r}_{B/D} \times \mathbf{F}_{CB}$ = [(-0.280 m) **i** +(-0.090 m) **j**] × [(51.39 N) **i** + (61.31 N) **j**]

= [(-0.280 m)(61.31 N) - (-0.090 m)(51.39 N)] **k** = (-12.542 N·m) **k**

⇒　$\mathbf{M}_D$ = 12.54 N·m ↺

3.31 [모멘트의 직각성분 (3차원) : 각도로부터 벡터 방향 결정]

<3.25 해답>

P = 150 N, AB = 0.152 m, BC = 0.16 m

$\boldsymbol{\lambda}$ = sin5° **j** + cos5° (cos70° **i** - sin70° **k**) = 0.3407 **i** + 0.0872 **j** - 0.9361 **k**

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

= 51.105 **i** + 13.08 **j** - 140.42 **k** (N)

$\mathbf{r}_{BA}$ = (0.152 m) [cos20° **j** + sin20°(-cos15° **i** - sin15° **k**)]

= -0.05022 **i** + 0.14283 **j** - 0.013455 **k** (m)

$\mathbf{r}_{CB}$ = (0.160 m) [-sin80° **j** + cos80°(-cos15° **i** - sin15° **k**)]

= -0.02684 **i** - 0.15757 **j** - 0.000719 **k** (m)

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

= (-0.02684 **i** - 0.15757 **j** - 0.000719 **k**)

+ (-0.05022 **i** + 0.14283 **j** - 0.013455 **k**) (m)

= -0.07706 **i** - 0.01474 **j** - 0.02064 **k** (m)

$\mathbf{M}_C = \mathbf{r}_{CA} \times \mathbf{P}$ = [-0.20779 **i** - 0.02490 **j** - 0.058395 **k** (m)]

× [51.105 **i** + 13.08 **j** - 140.42 **k** (N)]

= [(-0.01474)(-140.42) - (-0.02064)(13.08)] **i**

+ [(-0.02064)(51.105) - (-0.07706)(-140.42)] **j**

+ [(-0.07706)(13.08) - (-0.01474)(51.105)] **k** (N·m)

= 2.34 **i** - 11.88 **j** - 0.255 **k** (N·m)

<3.31 해답>

$M_C = \sqrt{(2.34\ \mathrm{N\cdot m})^2 + (-11.88\ \mathrm{N\cdot m})^2 + (-0.255\ \mathrm{N\cdot m})^2}$ = 12.11 N·m

$M_C = d\,P$

$\Rightarrow \quad d = \dfrac{M_C}{P} = \dfrac{12.11\ \mathrm{N\cdot m}}{150\ \mathrm{N}}$ = 0.0807 m = 8.07 cm