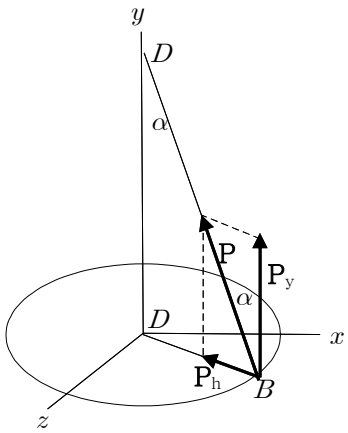
[2.12~14절]

2.75 [공간에서 힘의 직각성분]

$\alpha = 30°, \quad \beta = 35°, \quad P = 220$ N



(a) $P_y = P\cos\alpha = (220\text{ N})\cos30° = 190.53$ N

$P_h = P\sin\alpha$

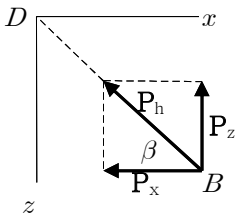
$P_x = -P_h\cos\beta = -(P\sin\alpha)\cos\beta$

$= -(220\text{ N})\sin30°\cos35° = -90.11$ N

$P_z = -P_h\sin\beta = -(P\sin\alpha)\sin\beta$

$= -(220\text{ N})\sin30°\sin35° = -63.09$ N

$\Rightarrow \quad \mathbf{P}_x = -90.1\text{ N}\,\mathbf{i}, \quad \mathbf{P}_y = 190.5\text{ N}\,\mathbf{j}, \quad \mathbf{P}_z = -63.1\text{ N}\,\mathbf{k}$



(b) $P_x = -P\sin\alpha\cos\beta$

$\Rightarrow \quad \cos\theta_x = \dfrac{P_x}{P} = -\sin\alpha\cos\beta = -\sin30°\cos35° = -0.4096$

$\Rightarrow \quad \theta_x = \cos^{-1}(-0.4096) = 114.18° \quad \Rightarrow \quad \theta_x = 114.2°$

$P_y = P\cos\alpha$

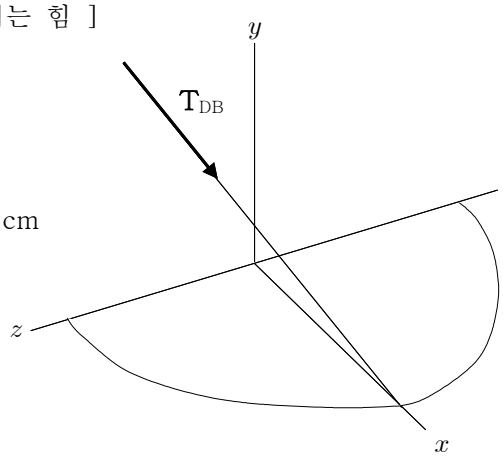
$\Rightarrow \quad \cos\theta_y = \dfrac{P_y}{P} = \cos\alpha \quad \Rightarrow \quad \theta_y = \alpha = 30.0°$

$P_z = -P\sin\alpha\sin\beta$

$\Rightarrow \quad \cos\theta_z = \dfrac{P_z}{P} = -\sin\alpha\sin\beta = -\sin30°\sin35° = -0.2868$

$\Rightarrow \quad \theta_z = \cos^{-1}(-0.2868) = 106.67° \quad \Rightarrow \quad \theta_z = 106.7°$

2.85 [힘의 작용선 상의 두 점과 힘 크기에 의해 정의되는 힘]



$R = 36$ cm, 힘의 크기 $T_{DB} = 55$ N

$d_x = R = 36$ cm, $d_y = -42$ cm, $d_z = -36$ cm

$d = \sqrt{d_x^2 + d_y^2 + d_z^2}$

$= \sqrt{(36\text{ cm})^2 + (-42\text{ cm})^2 + (-36\text{ cm})^2} = 66$ cm

$\boldsymbol{\lambda} = \dfrac{1}{d}(d_x\,\mathbf{i} + d_y\,\mathbf{j} + d_z\,\mathbf{k})$

$= \dfrac{1}{66}[36\,\mathbf{i} + (-42)\,\mathbf{j} + (-36)\,\mathbf{k}]$

$\mathbf{T}_{DB} = T_{DB}\,\boldsymbol{\lambda}$

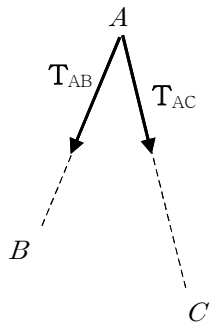
$= (55\text{ N})\dfrac{1}{66}[36\,\mathbf{i} + (-42)\,\mathbf{j} + (-36)\,\mathbf{k}]$

$= (30\text{ N})\,\mathbf{i} - (35\text{ N})\,\mathbf{j} - (30\text{ N})\,\mathbf{k}$

$(\mathbf{T}_{DB})_x = (30.0\text{ N})\,\mathbf{i}, \quad (\mathbf{T}_{DB})_y = (-35.0\text{ N})\,\mathbf{j}, \quad (\mathbf{T}_{DB})_z = (-30.0\text{ N})\,\mathbf{k}$

2.94 [공간에서 힘의 직각성분 합성]

T_{AB} = 510 N, T_{AC} = 425 N



$(d_{AB})_x$ = 40 cm, $(d_{AB})_y$ = −45 cm, $(d_{AB})_z$ = 60 cm

$$d_{AB} = \sqrt{(d_{AB})_x^2 + (d_{AB})_y^2 + (d_{AB})_z^2}$$

$$= \sqrt{(40\text{ cm})^2 + (-45\text{ cm})^2 + (60\text{ cm})^2} = 85.0\text{ cm}$$

$$\boldsymbol{\lambda}_{AB} = \frac{1}{d_{AB}}\left[(d_{AB})_x\,\mathbf{i} + (d_{AB})_y\,\mathbf{j} + (d_{AB})_z\,\mathbf{k}\right]$$

$$= \frac{1}{85.0}\left[(40)\,\mathbf{i} + (-45)\,\mathbf{j} + (60)\,\mathbf{k}\right]$$

$$\mathbf{T}_{AB} = T_{AB}\,\boldsymbol{\lambda}_{AB} = (510\text{ N})\,\frac{1}{85.0}\left[(40)\,\mathbf{i} + (-45)\,\mathbf{j} + (60)\,\mathbf{k}\right]$$

$$= 240\,\mathbf{i} - 270\,\mathbf{j} + 360\,\mathbf{k}\ \text{(N)}$$

$(d_{AC})_x$ = 100 cm, $(d_{AC})_y$ = −45 cm, $(d_{AC})_z$ = 60 cm

$$d_{AC} = \sqrt{(d_{AC})_x^2 + (d_{AC})_y^2 + (d_{AC})_z^2}$$

$$= \sqrt{(100\text{ cm})^2 + (-45\text{ cm})^2 + (60\text{ cm})^2} = 125\text{ cm}$$

$$\boldsymbol{\lambda}_{AC} = \frac{1}{d_{AC}}\left[(d_{AC})_x\,\mathbf{i} + (d_{AC})_y\,\mathbf{j} + (d_{AC})_z\,\mathbf{k}\right]$$

$$= \frac{1}{125}\left[(100)\,\mathbf{i} + (-45)\,\mathbf{j} + (60)\,\mathbf{k}\right]$$

$$\mathbf{T}_{AC} = T_{AC}\,\boldsymbol{\lambda}_{AC} = (425\text{ N})\,\frac{1}{125}\left[(100)\,\mathbf{i} + (-45)\,\mathbf{j} + (60)\,\mathbf{k}\right]$$

$$= 340\,\mathbf{i} - 153\,\mathbf{j} + 204\,\mathbf{k}\ \text{(N)}$$

$$\mathbf{R} = \mathbf{T}_{AB} + \mathbf{T}_{AC}$$

$$= [240\,\mathbf{i} - 270\,\mathbf{j} + 360\,\mathbf{k}\ \text{(N)}] + [340\,\mathbf{i} - 153\,\mathbf{j} + 204\,\mathbf{k}\ \text{(N)}]$$

$$= 580\,\mathbf{i} - 423\,\mathbf{j} + 564\,\mathbf{k}\ \text{(N)}$$

합력의 크기

$$R = \sqrt{R_x^2 + R_y^2 + R_z^2} = \sqrt{(580\text{ N})^2 + (-423\text{ N})^2 + (564\text{ N})^2} = 912.9\text{ N}$$

$$\Rightarrow \quad R = 913\text{ N}$$

합력의 방향

$$\cos\theta_x = \frac{R_x}{R} = \frac{580}{912.9} = 0.6353 \quad \Rightarrow \quad \theta_x = \cos^{-1}(0.6353) = 50.6°$$

$$\cos\theta_y = \frac{R_y}{R} = \frac{-423}{912.9} = -0.4634 \quad \Rightarrow \quad \theta_x = \cos^{-1}(-0.4634) = 117.6°$$

$$\cos\theta_z = \frac{R_z}{R} = \frac{564}{912.9} = 0.6178 \quad \Rightarrow \quad \theta_x = \cos^{-1}(0.6178) = 51.8°$$