

[9.5절]

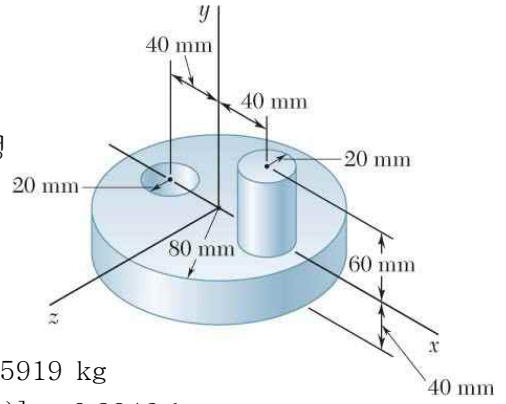
9.141  $\rho = 7,850 \text{ kg/m}^3$

$m = \rho V$       ① 원판, ② 원기둥, ③ 원판 구멍

$$\begin{aligned} m_1 &= \rho V_1 \\ &= (7,850 \text{ kg/m}^3) [\pi (0.08 \text{ m})^2 (0.04 \text{ m})] \\ &= 6.313 \text{ kg} \end{aligned}$$

$$\begin{aligned} m_2 &= \rho V_2 \\ &= (7,850 \text{ kg/m}^3) [\pi (0.02 \text{ m})^2 (0.06 \text{ m})] = 0.5919 \text{ kg} \end{aligned}$$

$$m_3 = \rho V_3 = (7,850 \text{ kg/m}^3) [\pi (0.02 \text{ m})^2 (0.04 \text{ m})] = 0.3946 \text{ kg}$$



$$\begin{aligned} \text{(a)} \quad I_{x_1} &= \frac{1}{12} m_1 (3r_1^2 + 4L_1^2) \\ &= \frac{1}{12} (6.313 \text{ kg}) [3 (0.08 \text{ m})^2 + 4 (0.04 \text{ m})^2] = 13.467 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_{x_2} &= \frac{1}{12} m_2 (3r_2^2 + 4L_2^2) \\ &= \frac{1}{12} (0.5919 \text{ kg}) [3 (0.02 \text{ m})^2 + 4 (0.06 \text{ m})^2] = 0.7695 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_{x_3} &= \frac{1}{12} m_3 (3r_3^2 + 4L_3^2) \\ &= \frac{1}{12} (0.3946 \text{ kg}) [3 (0.02 \text{ m})^2 + 4 (0.04 \text{ m})^2] = 0.2499 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_x &= I_{x_1} + I_{x_2} - I_{x_3} = [(13.467) + (0.7695) - (0.2499)] \times 10^{-3} \text{ kg}\cdot\text{m}^2 \\ &= 13.9886 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \quad \Rightarrow \quad I_x = 13.99 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} \text{(b)} \quad I_{y_1} &= \frac{1}{2} m_1 r_1^2 \\ &= \frac{1}{2} (6.313 \text{ kg}) (0.08 \text{ m})^2 = 20.20 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_{y_2} &= \frac{1}{2} m_2 r_2^2 + m_2 d_2^2 \\ &= \frac{1}{2} (0.5919 \text{ kg}) (0.02 \text{ m})^2 + (0.5919 \text{ kg}) (0.04 \text{ m})^2 = 1.0654 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_{y_3} &= \frac{1}{2} m_3 r_3^2 + m_3 d_3^2 \\ &= \frac{1}{2} (0.3946 \text{ kg}) (0.02 \text{ m})^2 + (0.3946 \text{ kg}) (0.04 \text{ m})^2 = 0.7103 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_y &= I_{y_1} + I_{y_2} - I_{y_3} = [(20.20) + (1.0654) - (0.7103)] \times 10^{-3} \text{ kg}\cdot\text{m}^2 \\ &= 20.5551 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \quad \Rightarrow \quad I_y = 20.6 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\text{(c)} \quad I_{z_1} = I_{x_1} = 13.467 \times 10^{-3} \text{ kg}\cdot\text{m}^2$$

$$\begin{aligned} I_{z_2} &= \frac{1}{12} m_2 (3r_2^2 + 4L_2^2) + m_2 d_2^2 \\ &= (0.7695 \times 10^{-3} \text{ kg}\cdot\text{m}^2) + (0.5919 \text{ kg}) (0.04 \text{ m})^2 = 1.7165 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_{z_3} &= \frac{1}{12} m_3 (3r_3^2 + 4L_3^2) + m_3 d_3^2 \\ &= (0.2499 \times 10^{-3} \text{ kg}\cdot\text{m}^2) + (0.3946 \text{ kg}) (0.04 \text{ m})^2 = 0.88126 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$

$$\begin{aligned} I_z &= I_{z_1} + I_{z_2} - I_{z_3} = [(13.467) + (1.7165) - (0.88126)] \times 10^{-3} \text{ kg}\cdot\text{m}^2 \\ &= 14.3022 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \quad \Rightarrow \quad I_z = 14.30 \times 10^{-3} \text{ kg}\cdot\text{m}^2 \end{aligned}$$