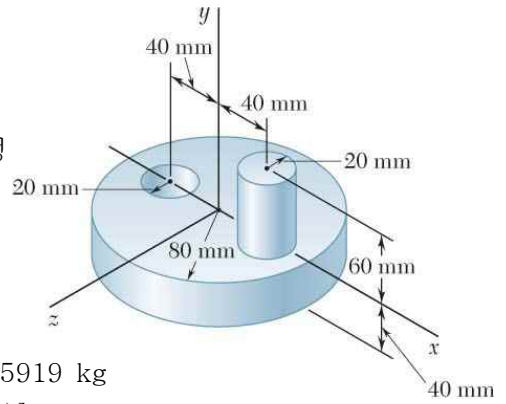{9.5절}

9.141 ρ = 7,850 kg/m³

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

   $m_1 = \rho V_1$

      $= (7{,}850 \text{ kg/m}^3) \, [\pi \, (0.08 \text{ m})^2 \, (0.04 \text{ m})]$

      $= 6.313 \text{ kg}$

   $m_2 = \rho V_2$

      $= (7{,}850 \text{ kg/m}^3) \, [\pi \, (0.02 \text{ m})^2 \, (0.06 \text{ m})] = 0.5919 \text{ kg}$

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

(a) $I_{x1} = \dfrac{1}{12} \, m_1 \, (3r_1^2 + 4L_1^2)$

   $= \dfrac{1}{12}(6.313 \text{ kg})[3 \, (0.08 \text{ m})^2 + 4 \, (0.04 \text{ m})^2] = 13.467 \times 10^{-3} \text{ kg·m}^2$

   $I_{x2} = \dfrac{1}{12} \, m_2 \, (3r_2^2 + 4L_2^2)$

   $= \dfrac{1}{12}(0.5919 \text{ kg})[3 \, (0.02 \text{ m})^2 + 4 \, (0.06 \text{ m})^2] = 0.7695 \times 10^{-3} \text{ kg·m}^2$

   $I_{x3} = \dfrac{1}{12} \, m_3 \, (3r_3^2 + 4L_3^2)$

   $= \dfrac{1}{12}(0.3946 \text{ kg})[3 \, (0.02 \text{ m})^2 + 4 \, (0.04 \text{ m})^2] = 0.2499 \times 10^{-3} \text{ kg·m}^2$

   $I_x = I_{x1} + I_{x2} - I_{x3} = [(13.467) + (0.7695) - (0.2499)] \times 10^{-3} \text{ kg·m}^2$

       $= 13.9886 \times 10^{-3} \text{ kg·m}^2$ $\Rightarrow$ $I_x = 13.99 \times 10^{-3} \text{ kg·m}^2$

(b) $I_{y1} = \dfrac{1}{2} \, m_1 \, r_1^2$

   $= \dfrac{1}{2}(6.313 \text{ kg}) \, (0.08 \text{ m})^2 = 20.20 \times 10^{-3} \text{ kg·m}^2$

   $I_{y2} = \dfrac{1}{2} \, m_2 \, r_2^2 + m_2 \, d_2^2$

   $= \dfrac{1}{2}(0.5919 \text{ kg}) \, (0.02 \text{ m})^2 + (0.5919 \text{ kg}) \, (0.04 \text{ m})^2 = 1.0654 \times 10^{-3} \text{ kg·m}^2$

   $I_{y3} = \dfrac{1}{2} \, m_3 \, r_3^2 + m_3 \, d_3^2$

   $= \dfrac{1}{2}(0.3946 \text{ kg}) \, (0.02 \text{ m})^2 + (0.3946 \text{ kg}) \, (0.04 \text{ m})^2 = 0.7103 \times 10^{-3} \text{ kg·m}^2$

   $I_y = I_{y1} + I_{y2} - I_{y3} = [(20.20) + (1.0654) - (0.7103)] \times 10^{-3} \text{ kg·m}^2$

       $= 20.5551 \times 10^{-3} \text{ kg·m}^2$ $\Rightarrow$ $I_y = 20.6 \times 10^{-3} \text{ kg·m}^2$

(c) $I_{z1} = I_{x1} = 13.467 \times 10^{-3} \text{ kg·m}^2$

   $I_{z2} = \dfrac{1}{12} \, m_2 \, (3r_2^2 + 4L_2^2) + m_2 \, d_2^2$

   $= (0.7695 \times 10^{-3} \text{ kg·m}^2) + (0.5919 \text{ kg}) \, (0.04 \text{ m})^2 = 1.7165 \times 10^{-3} \text{ kg·m}^2$

   $I_{z3} = \dfrac{1}{12} \, m_3 \, (3r_3^2 + 4L_3^2) + m_3 \, d_3^2$

   $= (0.2499 \times 10^{-3} \text{ kg·m}^2) + (0.3946 \text{ kg}) \, (0.04 \text{ m})^2 = 0.88126 \times 10^{-3} \text{ kg·m}^2$

   $I_z = I_{z1} + I_{z2} - I_{z3} = [(13.467) + (1.7165) - (0.88126)] \times 10^{-3} \text{ kg·m}^2$

       $= 14.3022 \times 10^{-3} \text{ kg·m}^2$ $\Rightarrow$ $I_z = 14.30 \times 10^{-3} \text{ kg·m}^2$