PROB. 17-4

$m_A = 15^{kg}$, $r_A = 0.125^{m}$, $t_A = b$, $t_B = 3b$, $M = 20^{N\cdot m}$

$\omega_0 = 0$, $\theta = (4\ REV)\left(\frac{2\pi}{REV}\right) = 8\pi\ RAD$

$\omega_F = \left(600\ \frac{REV}{MIN}\right)\left(\frac{MIN}{60\ s}\right)\left(\frac{2\pi}{REV}\right) = 20\pi\ \frac{RAD}{s}$, FIND r_B

WORK AND ENERGY: $T_1 + U_{1-2} = T_2$

KINETIC ENERGY: $T = \frac{1}{2} m \bar{v}^2 + \frac{1}{2} I \omega^2$

$T_1 = 0$, $T_2 = \frac{1}{2} I \omega_F^2$

$U_{1-2} = \int_{\theta_1}^{\theta_2} M\, d\theta = M(\theta_2 - \theta_1)$

$M(\theta_2 - \theta_1) = \frac{1}{2} I \omega_F^2$

$I = \frac{1}{2} m_A r_A^2 + \frac{1}{2} m_B r_B^2$

$m_B = \rho V_B = \rho(\pi r_B^2 \cdot 3b) = 3\pi \rho b r_B^2$

$m_A = \rho V_A = \rho(\pi r_A^2 \cdot b) = \pi \rho b r_A^2$

$\rho b = \frac{m_A}{\pi r_A^2}$

$m_B = 3\pi\left(\frac{m_A}{\pi r_A^2}\right) r_B^2 = 3 m_A \left(\frac{r_B^2}{r_A^2}\right)$

$I = \frac{1}{2} m_A r_A^2 + \frac{1}{2}\left[3 m_A \left(\frac{r_B^2}{r_A^2}\right)\right] r_B^2$

$I = \frac{1}{2} m_A r_A^2 \left[1 + 3\left(\frac{r_B}{r_A}\right)^4\right]$

$M(\theta_2 - \theta_1) = \frac{1}{2}\left\{\frac{1}{2} m_A r_A^2 \left[1 + 3\left(\frac{r_B}{r_A}\right)^4\right]\right\} \omega_F^2$

$$M(\theta_2-\theta_1) = \frac{1}{4} m_A r_A^2 \omega_F^2 \left[1 + 3\left(\frac{r_B}{r_A}\right)^4\right]$$

$$1 + 3\left(\frac{r_B}{r_A}\right)^4 = \frac{4M(\theta_2-\theta_1)}{m_A r_A^2 \omega_F^2}$$

$$\left(\frac{r_B}{r_A}\right)^4 = \frac{1}{3}\left[\frac{4M(\theta_2-\theta_1)}{m_A r_A^2 \omega_F^2} - 1\right]$$

$$r_B = r_A\left\{\frac{1}{3}\left[\frac{4M(\theta_2-\theta_1)}{m_A r_A^2 \omega_F^2} - 1\right]\right\}^{1/4}$$

$$r_B = (0.125^{m})\left\{\frac{1}{3}\left[\frac{4(20^{N\cdot m})(8\pi\ RAD)}{(15^{kg})(0.125^{m})^2\left(20\pi\ \frac{RAD}{s}\right)^2} - 1\right]\right\}^{1/4}$$

$$\boxed{r_B = 0.09884^{m}}$$