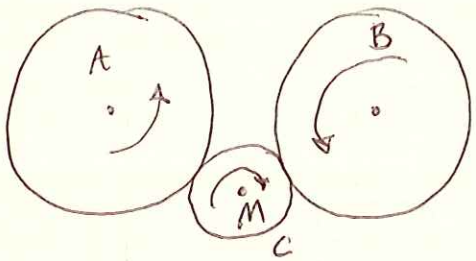
PROB. 16-35

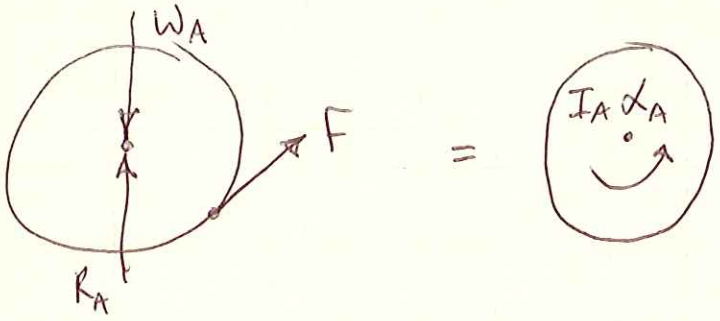
$W_A = W_B = 20^{LB}$, $K_A = K_B = 7.5^{IN}$, $W_C = 5^{LB}$, $K_C = 3^{IN}$,
$M_C = 50^{IN-LB}$, FIND α_A, F_t ON GEAR A.
$r_A = r_B = 10^{IN}$, $r_C = 4^{IN}$.



TANGENTIAL ACCELERATION AT POINT OF CONTACT BETWEEN GEAR A AND GEAR C:

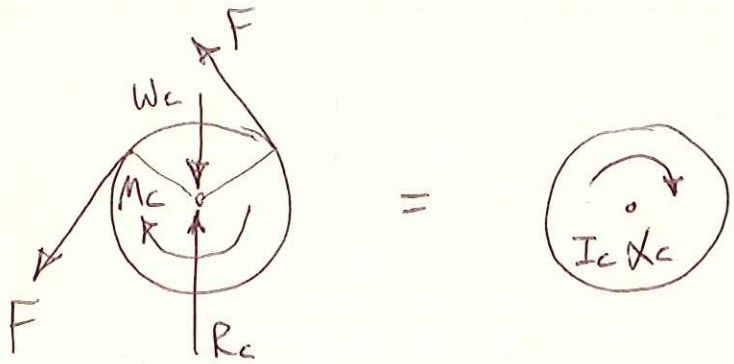
$$a_t = r_C \alpha_C = r_A \alpha_A \Rightarrow \alpha_C = \left(\frac{r_A}{r_C}\right)\alpha_A$$

FBD OF GEAR A:



$$\Sigma \vec{M}_G = \Sigma (\vec{M}_G)_{EFF} \quad +\circlearrowleft: \quad r_A F = I_A \alpha_A \Rightarrow F = \frac{I_A \alpha_A}{r_A}$$

FBD OF GEAR C:



SINCE A AND B ARE THE SAME, THEY IMPART THE SAME TANGENTIAL FORCE TO GEAR C

PROB. 16-35 CONT.

$$\Sigma \vec{M}_G = \Sigma (\vec{M}_G)_{EFF} \quad +\circlearrowleft: \quad -M_C + 2 r_C F = -I_C \alpha_C$$

$$-M_C + 2 r_C \left(\frac{I_A \alpha_A}{r_A} \right) = -I_C \cdot \left(\frac{r_A}{r_C} \right) \alpha_A$$

$$\alpha_A \left[2 \left(\frac{r_C}{r_A} \right) I_A + \left(\frac{r_A}{r_C} \right) I_C \right] = M_C$$

$$\alpha_A = \frac{M_C}{\left[2 \left(\frac{r_C}{r_A} \right) I_A + \left(\frac{r_A}{r_C} \right) I_C \right]}$$

$$I_A = m_A k_A^2 = \left(\frac{W_A}{g} \right) k_A^2, \quad I_C = m_C k_C^2 = \left(\frac{W_C}{g} \right) k_C^2$$

$$\alpha_A = \frac{M_C}{\left[2 \left(\frac{r_C}{r_A} \right) \left(\frac{W_A}{g} \right) k_A^2 + \left(\frac{r_A}{r_C} \right) \left(\frac{W_C}{g} \right) k_C^2 \right]}$$

$$\alpha_A = \frac{M_C \, g}{\left[2 \left(\frac{r_C}{r_A} \right) W_A k_A^2 + \left(\frac{r_A}{r_C} \right) W_C k_C^2 \right]}$$

$$\alpha_A = \frac{(50^{IN \cdot LB})\left(32.2 \frac{ft}{s^2}\right)}{\left[2 \left(\frac{4}{10} \right) (20^{LB}) (7.5^{IN})^2 + \left(\frac{10}{4} \right) (5^{LB}) (3^{IN})^2 \right]} \cdot \left(\frac{12^{IN}}{ft} \right)$$

$$\boxed{\alpha_A = 19.08 \frac{RAD}{s^2} \circlearrowright}$$

$$F = \frac{I_A \alpha_A}{r_A} = \frac{\left(\frac{W_A}{g} \right) k_A^2 \alpha_A}{r_A} = \frac{W_A k_A^2 \alpha_A}{r_A \cdot g}$$

$$F = \frac{(20^{LB})(7.5^{IN})^2 \left(19.08 \frac{RAD}{s^2}\right)}{(10^{IN})\left(32.2 \frac{ft}{s^2}\right)} \cdot \left(\frac{ft}{12^{IN}} \right) \boxed{= 5.555^{LB}}$$