HW 6

Machine Elements

Problem 1 18.6 → $T(r) = \int_{r_i}^{r_0} 2\pi P_{max} r_i f r\, dr\, N = \pi P_{max} r_i f (r_o^2 - r_i^2) N$ method 1.

a. To find inner radius as a function of maximum possible Torque need to find $T'(r) = 0 = \pi P_{max} f N \frac{d}{dr_i} (r_o^2 r_i - r_i^3)$

$$T'(r) = \pi P_{max} f N (r_o^2 - 3 r_i^2) = 0$$

$$r_i = \sqrt{\frac{r_o^2}{3}} = r_o \sqrt{\frac{1}{3}}$$

$$\boxed{r_i = \frac{r_o}{\sqrt{3}}}$$

b. 1. The radius is not of a full circle because of where the majority of the pressure is. since the pressure is not an even distribution, but higher on the inside, a higher Torque can be found inside the circle.

2. As the clutch is used the outside gets worn down faster which cause a pressure distribution change as the clutch is used more and more.

3. A worn clutch does not transmit as much as a new clutch due to ~~[illegible]~~ its increase in friction on the disks, which takes away from the Torque transmission

Problem 2: $I = 0.8\ N.m.s^2$, $\omega_i = 0$ rpm, $\omega_f = 600$ rpm, $T = 7\ N.m$.

a. $600\ \frac{Rev}{min} \cdot \frac{1\ min}{60\ sec} \cdot \frac{\pi\ rad}{180\ rev} = 0.1745\ \frac{rad}{s}$

$\tau = I\alpha$

$$t = \frac{I}{T\alpha} = \frac{I}{T\omega_f} = \frac{0.8}{(7)(0.1745)} = 0.655\ \text{seconds}$$

$\boxed{t = 0.655\ sec.}$

b. $E = \frac{1}{2} I \omega^2 = \frac{1}{2}(0.8\ N.m.s^2)(600)^2$

$\boxed{E = 144\ kJ}$

c. $E_{E.m} = 2\pi T(\#\ of\ revolutions)$ $\quad E_{c.m.} = 2\pi(600\ \frac{rev}{min})(\frac{1\ min}{60\ sec})(0.655 sec)$

$E_{c.m.} = 164.64\ kJ$

$Q = E_{c.m} - E_{d.m} = 164.64 - 144 = \boxed{20.64\ kJ = Q}$

Heat Energy.

Problem 3: $\tau = \frac{P}{2A}$ $\quad F = \frac{T}{r}$

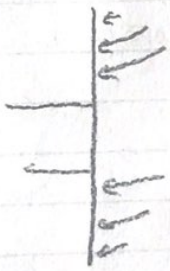
$A = \frac{\pi D^2}{4} \approx .44$

a. 

$$T = \frac{2Ff(r_o^3 - r_i^3)}{3(r_o^2 - r_i^2)}N$$

$$F = \frac{3T(r_o^2 - r_i^2)}{2fN(r_o^3 - r_i^3)} = \frac{3(750)^{\cdot 12}\left(\left(\frac{6.5}{2}\right)^2 - 2^2\right)}{2(0.3)(2)\left(\left(\frac{6.5}{2}\right)^3 - 2^3\right)}$$

$F = 5608.308$ lbs.

b. 

$$T = Ff\left(\frac{r_o + r_i}{2}\right)N \rightarrow F = \frac{T}{fN}\left(\frac{2}{r_o + r_i}\right)$$

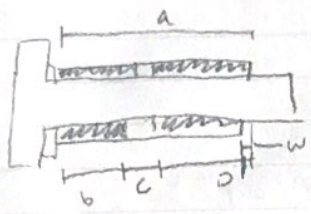
$$F = \frac{750 \cdot 12}{(.3)(2)}\left(\frac{2}{3.25 + 2}\right) = 5714.29 \text{ lbs}$$

c. $\tau = \frac{F}{2A}$ $\quad T = rF \rightarrow F = \frac{T}{r} = \frac{750 \cdot 12}{1.5 \text{ in}} = 6000$ lbs.

$$\frac{\pi D^2}{4} = A = \frac{2\tau}{F}$$

$$D = \sqrt{\frac{8\tau}{\pi F}} = \sqrt{\frac{(8)(50 \text{ ksi})}{\pi(6000 \text{ lbs})}} = 4.61 \text{ in.} = .384 \text{ ft}$$

4.



$a = 1.750 \pm 0.003$ in
$b = 0.750 \pm 0.001$ in
$c = 0.120 \pm 0.005$ in
$d = 0.875 \pm 0.001$ in.

a. $\bar{w} = \bar{a} - \bar{b} - \bar{c} - \bar{d} = 1.750 - 0.750 - 0.120 - 0.875 = 0.005$ in

$t_w = \Sigma t = 0.003 + 0.001 + 0.005 + 0.001 = 0.01$ in

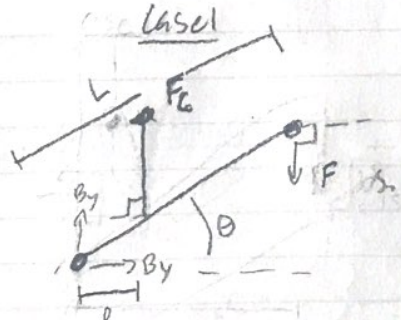
$w = 0.005 \pm 0.01$ in

b. $\bar{w} = w_{in} + t_w = 0.003 + 0.010 = 0.013$

$\bar{d} = \bar{a} - \bar{b} - \bar{c} - \bar{w} = 1.750 - 0.750 - 0.120 - 0.013 = 0.867$ in.

$\bar{d} = 0.867$ in

5.



Assumptions

$\theta = 65°$ $L = 18$ in $\ell = 2$ in $F = 15$ lbs

a. $\Sigma M_B = -F(L\cos\theta) + F_L(\ell) = 0$

$F_L = \dfrac{FL\cos\theta}{\ell}$

$F_L = \dfrac{(15\text{ lbs})(18\text{ in})\cos(65°)}{2\text{ in}}$

$F_L = 57.05$ lbs.

b. $\Sigma M_D = -F(18\text{ in}) + F_L(2\text{ in})$

$F_L = 15(9\text{ in})$

$F_L = 135$ lbs