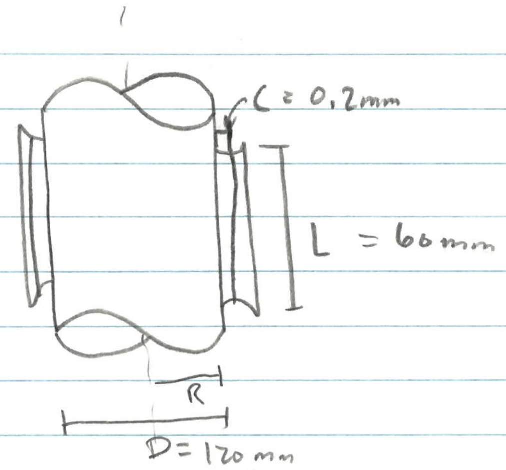
5.



$\omega = 3000 \text{ rpm} \cdot \frac{1}{60} \frac{s}{min}$

Lubricant: SAE 20 oil $\quad T_{avg} = 70°C \downarrow 158°F$

$$T_f = \frac{4\pi^2 \mu n L R^3}{c}$$

$$P_f = 2\pi n T_f$$

$$\cancel{T_f = \frac{4\pi^2 (1.8 \cdot 10^{-6})(3000)\left(\frac{1}{60}\right)(60\text{ mm})(60)^3}{(0.2\text{ mm})}}$$

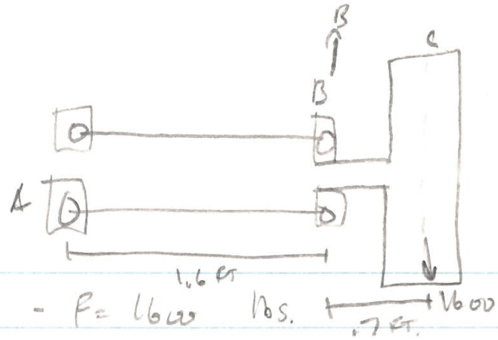
$\mu \approx 1.8$ (μreyn.)

$$T_f = \frac{4\pi^2 (1.8 \cdot 10^{-6} \text{ reyn})\left(3000 \frac{rev}{min}\right)\left(\frac{1 \text{ min}}{60 \text{ sec}}\right)(0.06 \text{ m})^4}{(0.0002 \text{ m})}$$

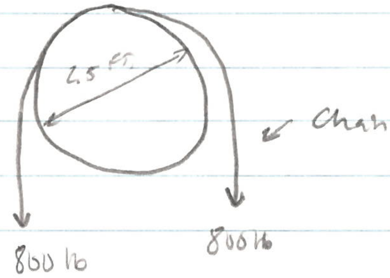
$T_f = 2.3 \cdot 10^{-4}$

$P_f = 2\pi(3000)(2.3 \cdot 10^{-4})$ -

$\boxed{P_f = 4.34}$



4. - $\omega = 280$ rpm - $F = 1600$ lbs.



Assumptions: - design Life = 30,000 hrs. Table 14.4
- Reliability 90%
- $K_a = 1.1$

$$\Sigma M_A = (1600)(2.3\ ft) - B(1.6\ ft) = 0 \qquad \Sigma F_y = -1600 + 2300\ lbs + A_y = 0$$

$$B = 2300\ lbs \qquad A_y = -700\ lbs.$$

The bearing Selection is based on B since it is higher.

$$C_{req} = F_e K_a (L/K_r L_r)^{0.3} \qquad F_e = B \quad K_a = 1.1 \quad K_r = 1 \text{ for } 90\%$$

$$L_r = 90 \cdot 10^6 \qquad L = \frac{280\ rev}{min} \cdot \frac{60\ min}{1\ hr} \cdot \frac{30{,}000\ hrs}{1} = 504 \cdot 10^6$$

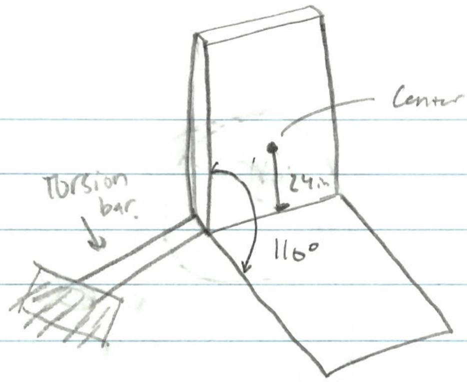
$$C_{req} = (2300\ lbs)(1.1)\left[\frac{504 \cdot 10^6\ rev}{(1)(90 \cdot 10^6)}\right]^{0.3}$$

$$C_{req} = 4242.06\ lbs.$$

$\hookrightarrow$ 18,868 kN.

From Table 14.2 Select 85 mm bore bearing 213.

3.



- Counter balance @ 80% of bars weight.
- $T = (40)(24)$ in
- $\theta = 110°$
- $\tau \leq 30$ ksi
- $G = 11.5 \times 10^6$ psi

$$\tau = \frac{Tr}{J} = \frac{16T}{\pi d^3} \qquad \theta = \frac{TL}{GJ} = \frac{32TL}{G\pi d^4} \qquad K = \frac{T}{\theta} = \frac{G\pi d^4}{32L}$$

$$30\text{ksi} = \frac{T\, d/2}{\left(\frac{\pi}{32} d^4\right)} = \frac{T}{\frac{\pi d^3}{16}} \rightarrow (30\text{ksi})\left(\frac{\pi d^3}{16}\right) = T$$

$$d^3 \geq \frac{16}{3\pi} T$$

$$d \geq \sqrt[3]{\frac{16\ T}{(30{,}000)\pi}}$$

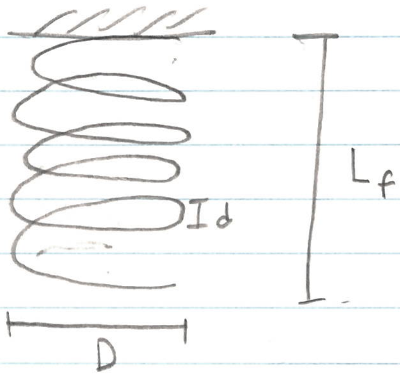
$$d \geq \sqrt[3]{\frac{16(40)(24)}{(30{,}000)\pi}}$$

$$\boxed{d = .55 \text{ in}}$$

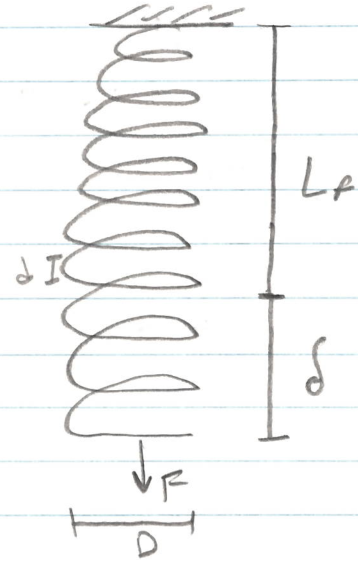
$$K = \frac{T}{\theta} = \frac{G\pi d^4}{32L} \Rightarrow \quad L = \frac{G\pi d^4 \theta}{32T} = \frac{(11.5 \times 10^6 \text{ psi})(\pi)(.55 \text{ in})^4 \left(110 \cdot \frac{\pi}{180}\right)}{(32)(40)(24) \text{ lb in}}$$

$$\boxed{L = 206 \text{ in}}$$

2a.

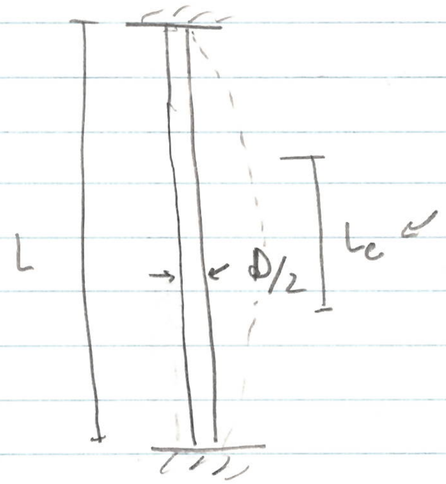


b.



c. Curve A represents buckling when both ends are fixed
Curve B represents buckling when one end is fixed and the other is a pin. Curve B is to the Lower-Left of Curve A because it has a Longer effective Length which means that its critical Load would be smaller causing it to become more unstable faster than Curve A.

d.

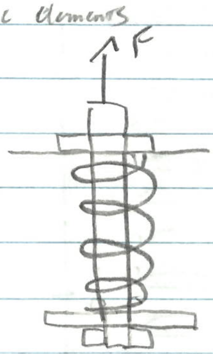


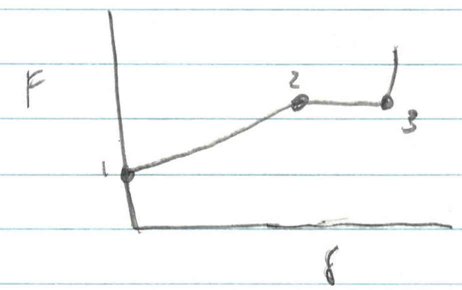
Same as in Curve A, by making the Diameter smaller than Curve A. The ratio would be higher than Curve A so it would go up and to the right.

Matthew Donaldson

Machine elements　　HW 6 Springs / Bearings　　March 3, 2020.

1. a.





- At Point 1, There is enough Force To cause The Spring To Start compressing.
- At Point 2, The Spring has now Deformed enough That it will Start To plastically Deform Due To enough Stress on it.
- At Point 3, There is a Sharp Spike because There is enough Force To where The Spring breaks.

b. Spring surge → it is when a spring oscillates Due To a Force with a frequency at The natural Frequency of The spring.

C. Misumi Technical Tutorial, #279 Spring Design - 7: Surging Phenomenon of Spring, MISUMI Corporation, Mar. 10, 2017. Accessed on: Mar. 1, 2020 [website]. Available: www.misumi-techcentral.com/tt/en/Ica/2017/03/279-Spring-design--7-Surging-Phenomenon-of-Spring.html

D.