2.1) $N_1 = 30$, $m = 6\ mm$, $\phi = 20°$, $r_v = 0.3$

a) $r_v = \frac{N_1}{N_2}$

$0.3 = \frac{30}{N_2}$

$N_2 = 100$

$c = \frac{m(N_1 + N_2)}{2}$

$= \frac{6(30+100)}{2}$

$= 390\ mm$

b) $r_{b_1} = r_1 \cos\phi$

$= \frac{m N_1}{2} \cos(20°)$

$= \frac{6(30)}{2} \cos(20°)$

$= 84.57\ mm$

$r_{b_2} = r_2 \cos\phi$

$= \frac{m N_2}{2} \cos(20°)$

$= \frac{6(100)}{2} \cos(20°)$

$= 281.91\ mm$

2.1 c) $t = \frac{\pi}{2} m$

$= \frac{\pi}{2}(6)$

$= 9.42\,mm$

2.2) $P_d = \frac{N}{d_p}$

$P_d = \frac{N}{2r}$

$r = \frac{N}{2P_d}$

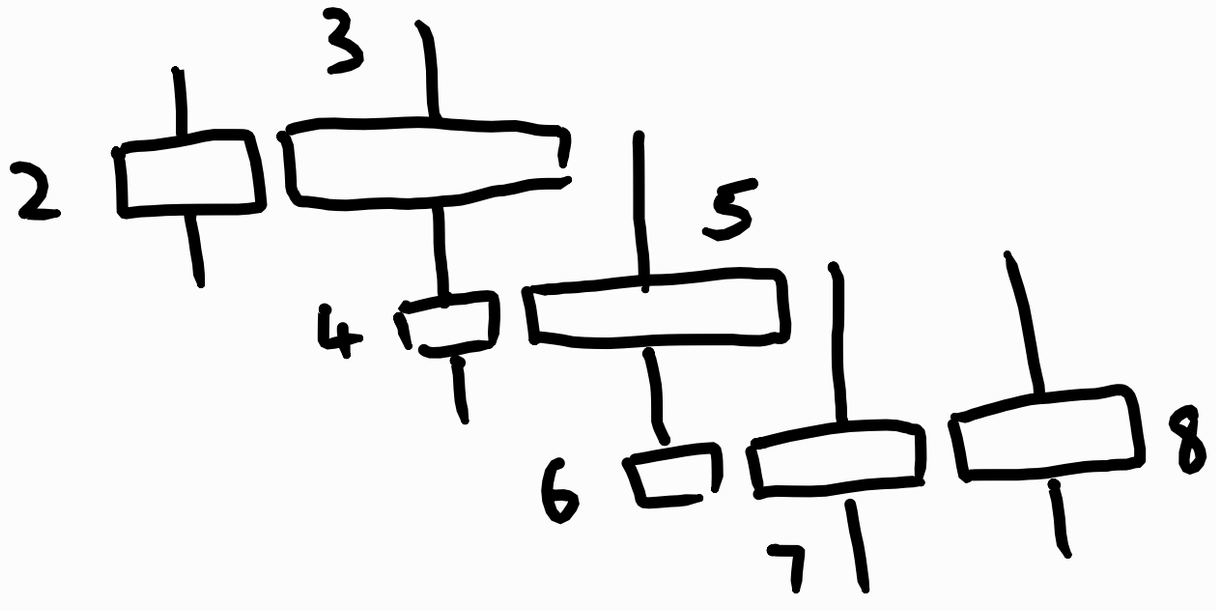
$\therefore r_2 = \frac{24}{2(6)}$ $\quad r_3 = \frac{48}{2(6)}$

$= 2$ inches $\quad = 4$ inches

$$C.R. = \frac{\sqrt{(r_2 + a_2)^2 - r_2^2\cos^2\phi} - r_2\sin\phi}{P_D} + \frac{\sqrt{(r_1 + a_1)^2 - r_1^2\cos^2\phi} - r_1\sin\phi}{P_D}$$

$$= \frac{\sqrt{(2 + \frac{1}{6})^2 - 2^2\cos^2 20^\circ} - 2\sin 20^\circ}{\frac{1}{6}\pi\cos 20^\circ} + \frac{\sqrt{(4 + \frac{1}{6})^2 - 4^2\cos^2 20^\circ} - 4\sin 20^\circ}{\frac{1}{6}\pi\cos 20^\circ} = 1.67$$

2.3)



$$\frac{n_8}{n_2} = \left(-\frac{N_2}{N_3}\right)\left(-\frac{N_4}{N_5}\right)\left(-\frac{N_6}{\cancel{N_7}}\right)\left(-\frac{\cancel{N_7}}{N_8}\right)$$

$$= \frac{N_2 N_4 N_6}{N_3 N_5 N_8}$$

$$= \frac{18 \times 15 \times 18}{44 \times 33 \times 48}$$

$$= \frac{135}{1936}$$

$$\frac{n_8}{860} = \frac{135}{1936}$$

$$n_8 = 55.785123967$$

$$\approx 55.79 \text{ rpm}$$

2.4) $\phi = 20°$ $m = 3\ mm$

a) $c = \dfrac{m(N_1 + N_2)}{2}$

$= \dfrac{3(24+60)}{2}$

$= 126\ mm$

b) $a_1 = a_2 = 3\ mm$ $\quad r = \dfrac{mN}{2}$

$r_1 = \dfrac{3(24)}{2} \quad r_2 = \dfrac{3(60)}{2}$

$= 36 \quad = 90$

$P_b = m\pi\cos\phi$

$= 3\pi\cos 20°$

$= 8.856$

$$C.R. = \frac{\sqrt{(r_2+a_2)^2 - r_2^2\cos^2\phi} - r_2\sin\phi}{\dfrac{P_b}{\sqrt{(r_1+a_1)^2 - r_1^2\cos^2\phi} - r_1\sin\phi}} +$$

$$= \frac{\sqrt{(90+3)^2 - 90^2\cos^2 20°} - 90\sin 20°}{\dfrac{8.856}{\sqrt{(36+3)^2 - 36^2\cos^2 20°} - 36\sin 20°}} +$$

$$\frac{}{8.856}$$

$= 1.69$

2.4) When C increases by 0.5mm,

$$r_1' + r_2' = C + 0.5\ mm$$

$$r_1' + r_2' = 126 + 0.5\ mm$$

$$r_1' + r_2' = 126.5\ mm - (1)$$

$$r_v = \frac{r_2'}{r_1'}$$

$$\frac{90}{36} = \frac{r_2'}{r_1'}$$

$$r_2' = \frac{90}{36} r_1' - (2)$$

Sub (2) into (1)

$$r_1' + \frac{90}{36} r_1' = 126.5$$

$$r_1' = \frac{253}{7}$$

$$r_{b1} = r_1 \cos\phi$$

$$r_{b1} = 36 \cos 20^\circ$$

$$= 33.83$$

$$r_{b1} = \frac{253}{7} \cos 20^\circ$$

$$33.83 = \frac{253}{7} \cos\phi$$

$$\phi = 20.6^\circ$$

2.5) $\phi = 20°$, $m = 2\,mm$, $N_1 = 15$

$$r_2 + a_2 \leq \sqrt{r_2^2 \cos^2\phi + c^2 \sin^2\phi}$$

$$\frac{mN_2}{2} + m \leq \sqrt{\left(\frac{mN_2}{2}\right)^2 \cos^2\phi + \left(\frac{m(N_1+N_2)}{2}\right)^2 \sin^2\phi}$$

$$\left(\frac{mN_2}{2} + m\right)^2 \leq \left(\frac{mN_2}{2}\right)^2 \cos^2\phi + \left(\frac{m(N_1+N_2)}{2}\right)^2 \sin^2\phi$$

$$\left(\frac{mN_2}{2}\right)^2 + 2m\left(\frac{mN_2}{2}\right) + m^2 \leq \left(\frac{mN_2}{2}\right)^2 \cos^2\phi + \left(\frac{m(N_1+N_2)}{2}\right)^2 \sin^2\phi$$

$$(1-\cos^2\phi)\left(\frac{N_2}{2}\right)^2 + N_2 + 1 \leq \left(\frac{N_1+N_2}{2}\right)^2 \sin^2\phi$$

when $N_1 = 15$, $\phi = 20°$

$$0.0585 N_2^2 + N_2 + 1 \leq \frac{15^2 + 30N_2 + N_2^2}{4} (\sin^2 20)$$

$$N_2^2 + 34.19 N_2 + 34.19 \leq 15^2 + 30N_2 + N_2^2$$

$$4.19 N_2 \leq 190.805$$

$$N_2 \leq 45.489$$

$$\therefore N_{2\,max} = 45$$