ME 363 Homework #4 (2024)

1. (a).

$$r_t = \frac{t}{t_c} = \frac{0.015}{0.3} = 0.5$$

$$\tan\phi = \frac{r_t \cos\alpha}{1 - r_t \sin\alpha}$$

$$= \frac{0.5\cos 12^o}{1 - 0.5 \times \sin 12^o} = 0.546$$

$$\therefore \phi = 28.6^o$$

(b).

$$F_s = F_c \cos\phi - F_t \sin\phi$$

$$= 300 \times \cos 28.6° - 125 \sin 28.6°$$

$$= 203.6 \ lbs$$

(c).

$$\tau_s = \frac{F_s}{wt / \sin\phi}$$

$$= \frac{203.6}{0.015 \times 0.1 / \sin 28.6}$$

$$= \frac{203.6}{0.00313}$$

$$= 65,047 \ psi$$

(d)

$$\mu = \frac{F_t + F_c \tan\alpha}{F_c - F_t \tan\alpha}$$

$$= \frac{125 + 300\tan 12^o}{300 - 125\tan 12^o}$$

$$= 0.69$$

2. (a).

$$HP_s = \frac{HP}{MRR} = \frac{F_c \times V_c}{12V_c f \times t}$$

(a)

$$HP = \frac{F_c \times V_c}{33,000} = \frac{F_c\left(\pi D\mathrm{N}\right)}{33,000} \qquad (V_c = \pi DN = \pi \times {}^{6}\!/_{12} \times 500 = 785.4\ fpm) -$$

$$= \frac{500(\pi \times {}^{6}\!/_{12} \times 500)}{33,000}$$

$$= 11.9\ HP$$

(b)

$$MRR = 12 \times V_C \times f \times t$$

$$= 12 \times 785.4 \times 0.0075 \times 0.0075$$

$$= 0.53\ {}^{in^3}\!/_{\min}$$

$$HP_s = \frac{11.9}{0.53} = 22.45\ {}^{HP}\!/\,{}^{in^3}\!/_{\min}$$

(c)

$$HP_m = \frac{HP}{E} = \frac{11.9}{0.8} = 14.875\ HP$$

(d)

$$\phi = \tan^{-1}\frac{r_t \cos\alpha}{1 - r_t \sin\alpha} = \tan^{-1}\frac{0.5\cos 10°}{1 - 0.5\sin 10°} = 28.3°$$

$$\frac{F_s V_s}{F_c V_c} = \frac{(F_c \cos\phi - F_t \sin\phi)\cos\alpha}{F_c \cos(\phi - \alpha)}$$

$$= \frac{(500\cos\phi - 250\sin\phi)\cos\alpha}{500\cos(\phi - \alpha)}$$

$$= \frac{(500\cos 28.3° - 250\sin 28.3°)\cos 10°}{500\cos(18.3°)} = 0.667$$

3. (a).

$$w > \frac{D}{2} \Rightarrow l_c = D/2 = \frac{3}{2} = 1.5''$$
$$V = \pi DN$$
$$\text{N}=\frac{500\times 12}{\pi\times 3} = 637\ rpm$$
$$f_m = f_t \cdot n_t \cdot N = 0.01\times 4\times 637 = 25.46\, in/\text{min}$$

$$CT = \frac{2l_c + l}{f_m} = \frac{2\times 1.5 + 12}{25.46} = 0.59\,\text{min}$$

(b).

$$\begin{aligned}\text{MRR} &= w \cdot t \cdot f_m \\ &= 2\times 0.15\times 25.46 = 7.6\ in^3/\text{min}\end{aligned}$$

(c).

$$\begin{aligned}HP &= HP_s \cdot MRR \\ &= 1.1\times 7.6 = 8.4\, HP\end{aligned}$$

$$\text{HP} = T\cdot\omega \qquad 1HP = 396{,}000\, {}^{in-lb}\!/_{\text{min}}$$

$$8.4\times 396{,}000 = T(2\pi\times 637)$$

$$\therefore T = 831\ in-lb = 69.2\ ft-lb$$

4.

(a)

$$VT^{n} = C$$

$$100 \times 10^{n} = 75 \times 30^{n}$$

$$\left(\frac{30}{10}\right)^{n} = \frac{100}{75} \qquad 3^{n} = 1.333$$

$$n = \frac{\log 1.333}{\log 3} = 0.262$$

$$\therefore C = 100 \times (10)^{0.262} = 182.8$$

(b)

$$90 \bullet T^{0.262} = 182.8$$

$$0.262 \ln T = \ln \frac{182.8}{90}$$

$$\ln T = \ln \frac{182.8}{90} = 2.7$$

$$\therefore T = 15 \text{ min}$$

(c)

$$V \bullet 20^{0.262} = 182.8$$

$$\therefore V = 83.4 \text{ m/ min}$$