

13-43 $H = 35$ hp, $n_i = 1200$ rev/min, $\phi = 20^\circ$

$N_2 = N_4 = 16$ teeth, $N_3 = N_5 = 48$ teeth, $P = 10$ teeth/in

$$(a) \quad n_{\text{intermediate}} = n_3 = n_4 = \frac{N_2}{N_3} n_i = \frac{16}{48} (1200) = 400 \text{ rev/min} \quad \text{Ans.}$$

$$n_o = \frac{N_2}{N_3} \frac{N_4}{N_5} n_i = \frac{16}{48} \left(\frac{16}{48} \right) (1200) = 133.3 \text{ rev/min} \quad \text{Ans.}$$

$$(b) \quad P = \frac{N}{d} \Rightarrow d = \frac{N}{P}$$

$$d_2 = d_4 = \frac{16}{10} = 1.6 \text{ in} \quad \text{Ans.}$$

$$d_3 = d_5 = \frac{48}{10} = 4.8 \text{ in} \quad \text{Ans.}$$

$$V_i = V_2 = V_3 = \frac{\pi d_2 n_2}{12} = \frac{\pi (1.6) (1200)}{12} = 502.7 \text{ ft/min} \quad \text{Ans.}$$

$$V_o = V_4 = V_5 = \frac{\pi d_4 n_4}{12} = \frac{\pi (1.6) (400)}{12} = 167.6 \text{ ft/min} \quad \text{Ans.}$$

$$(c) \quad W_{ti} = 33000 \frac{H}{V_i} = \frac{33000(35)}{502.7} = 2298 \text{ lbf} \cdot \text{lbf} \quad \text{Ans.}$$

$$W_{ri} = W_{ti} \tan \phi = 2298 \tan 20^\circ = 836.4 \text{ lbf} \quad \text{Ans.}$$

$$W_i = \frac{W_{ti}}{\cos \phi} = \frac{2298}{\cos 20^\circ} = 2445 \text{ lbf} \quad \text{Ans.}$$

$$W_{to} = 33000 \frac{H}{V_o} = \frac{33000(35)}{167.6} = 6891 \text{ lbf} \quad \text{Ans.}$$

$$W_{ro} = W_{to} \tan \phi = 6891 \tan 20^\circ = 2508 \text{ lbf} \quad \text{Ans.}$$

$$W_o = \frac{W_{to}}{\cos 20^\circ} = \frac{6891}{\cos 20^\circ} = 7333 \text{ lbf} \quad \text{Ans.}$$

$$(d) \quad T_i = W_{ti} \left(\frac{d_2}{2} \right) = 2298 \left(\frac{1.6}{2} \right) = 1838 \text{ lbf} \cdot \text{in} \quad \text{Ans.}$$

$$(e) \quad T_o = T_i \left(\frac{48}{16} \right)^2 = 1838 \left(\frac{48}{16} \right)^2 = 16\,540 \text{ lbf} \cdot \text{in} \quad \text{Ans.}$$