14-25 $Y_P = 0.331$, $Y_G = 0.422$, $J_P = 0.345$, $J_G = 0.410$, $K_o = 1.25$. The service conditions are adequately described by K_o. Set $S_F = S_H = 1$.

$$d_P = 22 / 4 = 5.500 \text{ in}$$
$$d_G = 60 / 4 = 15.000 \text{ in}$$
$$V = \frac{\pi(5.5)(1145)}{12} = 1649 \text{ ft/min}$$

Pinion bending

$$_{0.99}(S_t)_{10^7} = 77.3H_B + 12\,800 = 77.3(250) + 12\,800 = 32\,125 \text{ psi}$$
$$Y_N = 1.6831[3(10^9)]^{-0.0323} = 0.832$$

Eq. (14-17): $$\left(\sigma_{\text{all}}\right)_P = \frac{32\,125(0.832)}{1(1)(1)} = 26\,728 \text{ psi}$$

$$B = 0.25(12 - 6)^{2/3} = 0.8255$$
$$A = 50 + 56(1 - 0.8255) = 59.77$$
$$K_v = \left(\frac{59.77 + \sqrt{1649}}{59.77}\right)^{0.8255} = 1.534$$
$$K_s = 1, \quad C_m = 1$$
$$C_{mc} = \frac{F}{10d} - 0.0375 + 0.0125F$$
$$= \frac{3.25}{10(5.5)} - 0.0375 + 0.0125(3.25) = 0.0622$$
$$C_{ma} = 0.127 + 0.0158(3.25) - 0.093(10^{-4})(3.25^2) = 0.178$$
$$C_e = 1$$
$$K_m = C_{mf} = 1 + (1)[0.0622(1) + 0.178(1)] = 1.240$$
$$K_B = 1, \quad K_T = 1$$

Eq. (14-15): $$W_1^t = \frac{26\,728(3.25)(0.345)}{1.25(1.534)(1)(4)(1.240)} = 3151 \text{ lbf}$$
$$H_1 = \frac{3151(1649)}{33\,000} = 157.5 \text{ hp}$$

Gear bending By similar reasoning, $W_2^t = 3861$ lbf and $H_2 = 192.9$ hp

Pinion wear

$$m_G = 60 / 22 = 2.727$$
$$I = \frac{\cos 20^\circ \sin 20^\circ}{2}\left(\frac{2.727}{1 + 2.727}\right) = 0.1176$$
$$_{0.99}(S_c)_{10^7} = 322(250) + 29\,100 = 109\,600 \text{ psi}$$

$$(Z_N)_P = 2.466[3(10^9)]^{-0.056} = 0.727$$

$$(Z_N)_G = 2.466[3(10^9) / 2.727]^{-0.056} = 0.769$$

$$(\sigma_{c,\text{all}})_P = \frac{109\ 600(0.727)}{1(1)(1)} = 79\ 679 \text{ psi}$$

$$W_3^t = \left(\frac{\sigma_{c,\text{all}}}{C_p}\right)^2 \frac{Fd_P I}{K_o K_v K_s K_m C_f}$$

$$= \left(\frac{79\ 679}{2300}\right)^2 \left[\frac{3.25(5.5)(0.1176)}{1.25(1.534)(1)(1.24)(1)}\right] = 1061 \text{ lbf}$$

$$H_3 = \frac{1061(1649)}{33\ 000} = 53.0 \text{ hp}$$

Gear wear

Similarly, $W_4^t = 1182$ lbf, $H_4 = 59.0$ hp

Rating

$$H_{\text{rated}} = \min(H_1, H_2, H_3, H_4)$$

$$= \min(157.5, 192.9, 53, 59) = 53 \text{ hp} \quad \textit{Ans.}$$

Note differing capacities. Can these be equalized?