Given:

Pinion	Gear
$N = 22$ teeth	$N = 60$ teeth
$h_p = 15$ hp @ 1200 rev/min	Mat'l = Cast Fe
$P_d = 6$	$P_d = 6$
$F = 2$ $\quad \phi = 20°$	
mat'l = Cast Fe	

Find: Contact stress.

Solution: The AGMA contact stress equation is

$$\sigma_c = C_p \left(\frac{W_t C_a}{C_v} \frac{C_s}{F d} \frac{C_m C_f}{I} \right)^{1/2}$$

$$C_p = \left[\frac{1}{\pi \left(\frac{1-\nu_p^2}{E_p} + \frac{1-\nu_g^2}{E_g} \right)} \right]^{1/2}$$

From Table A-5, $E_p = E_G = 14.5 \times 10^6$ psi

$\nu_p = \nu_g = 0.211$

$\Rightarrow C_p = 1,554$ psi

$$I = \frac{\cos\phi \sin\phi}{2} \frac{m_g + 1}{m_g} \qquad m_g = \frac{d_g}{d_p}$$

$$P_d = \frac{N}{d} \Rightarrow \quad d_p = \frac{N_p}{P_d} = \frac{22}{6} = 3.67 \text{ in}$$

$$d_g = \frac{N_G}{P_d} = \frac{60}{6} = 10 \text{ in}$$

$\Rightarrow I = 0.220$

Load Distribution Factor, C_m

From TABLE 14-6, use value of 1.6 for 2in face

Size Factor, C_s

According to section 14-10, $C_s = 1.0$

Dynamic Factor, C_v

Pitch Line Velocity of Pinion

$$V = r\omega = \left(\frac{3.67\,in}{2}\right)\left(\frac{ft}{12\,in}\right)\left(1200\,\frac{rev}{min}\right)\left(\frac{2\pi\,rad}{rev}\right)$$

$$= 1,153\ ft/min$$

From Figure 14-7, choosing $C_v = 0.78$

Application Factor, C_a

No information is given about the application that the speed reducer is used in. Choose $C_a = 1.0$

Surface-Condition Factor, C_f

According to section 14-9 no values are available, choose $C_f = 1.0$

$$T = 63,000\,\frac{P}{n} = 63,000\left(\frac{15\,hp}{1200\,rev/min}\right) = 787.5\ in\text{-}lb$$

$$W_t = \frac{T}{d_p/2} = \frac{787.5\,in\text{-}lb}{(3.67\,in/2)} = 429.2\ lb$$

$$\sigma_c = 1{,}554 \left[\frac{(429.2)(1.0)}{0.78} \frac{1.0}{(8.0)(3.67)} \frac{(1.6)(1.0)}{0.220} \right]^{1/2}$$

$$= 36{,}286 \simeq 36.3 \text{ ksi}$$

$$\boxed{\sigma_c = 36.3 \text{ ksi}}$$

Given:

pinion	gear
$P_d = 5$	$P_d = 5$
$\phi = 20$	$\phi = 20$
$N = 24$	$N = 48$
mat'l = cast iron	mat'l = cast iron
$n = 50$ rev/min	$\sigma_{c\,max} = 100{,}000$ psi.
$F = 2.5$ in	

Find: Maximum transmission horsepower

Solution:

$$\sigma_c = C_p \left(\frac{W_t C_a}{C_v} \frac{C_s}{F d_p} \frac{C_m C_f}{I} \right)^{1/2}$$

$$W_t = \frac{T}{d_p/2} = \frac{63{,}000\, hP}{(d_p/2)\, n} = \frac{126{,}000\, hP}{d_p\, n}$$

$$\Rightarrow \left(\frac{\sigma_c}{C_p} \right)^2 = \frac{126{,}000\, hP\, C_a}{d_p\, C_v\, n} \frac{C_s}{F d_p} \frac{C_m C_f}{I}$$

$$\Rightarrow hP = \frac{d_p^2\, C_v\, F\, I\, n}{126{,}000\, C_a C_s C_m C_f} \left(\frac{\sigma_c}{C_p} \right)^2$$

$C_p = 1{,}554$ (See Lecture 22, Problem #1)

$$P_d = \frac{N}{d} \Rightarrow d_p = \frac{N_p}{P_d} = \frac{24}{5} = 4.8$$

$$d_g = \frac{N_g}{P_d} = \frac{48}{5} = 9.6$$

$$I = \frac{\cos\phi \sin\phi}{2} \frac{m_g + 1}{m_g} \qquad m_g = \frac{d_g}{d_p} = \frac{9.6}{4.8} = 2.0$$

$$\Rightarrow I = 0.241$$

Choose $C_s = 1.0$, $C_a = 1.0$, $C_f = 1.0$

From table 14-6, $C_m = 1.7$ for face = 2.5 in

The pitch line velocity is

$$V = r\omega = \left(\frac{4.8\,in}{2}\right)\left(\frac{ft}{12\,in}\right)\left(50\,\frac{rev}{min}\right)\left(\frac{2\pi\,rad}{rev}\right)$$

$$= 62.8\ ft/min$$

$$\Rightarrow C_v \simeq 1.0$$

$$\Rightarrow h_p = \left(\frac{(4.8)^2(1.0)(2.5)(0.241)(50)}{(126{,}000)(1.0)(1.0)(1.7)(1.0)}\right)\left(\frac{100{,}000}{1{,}554}\right)^2$$

$$h_p = 13.4$$

Power = 13.4 hp