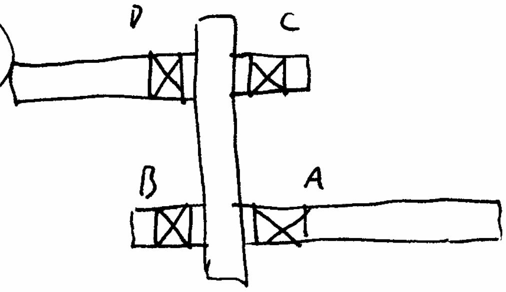
13.30



diametrical pitch of 5 teeth/in

18-tooth 20° pinion driving a 45 tooth gear

horsepower = 32 1800 rpm

$$V = \frac{\pi d n}{12} = \frac{\pi \cancel{d}(9)(1800)}{12} = 4241.15$$

$$d = \frac{45}{5} = 9$$

$$W_t = \frac{33{,}000\ H}{V} = \frac{(33{,}000)(32)(\cancel{4241.15})}{(4241.15)} = 248.99$$

$$F = \frac{W_t}{\cos(20)} = 264.97$$

$$F_A = F_B = F_C = F_D = \frac{F}{2} = \underline{132.485}$$

(14.2) A steel Spur Pinion has a pitch of 6 teeth/in, 22 full-depth teeth, and 20° pressure angle. ~~This pinion runs at~~ ~~1200 rpm~~.
~~hp = 15hp to~~ face width of $\frac{3}{4}$"
1.5 hp @ 700 rpm

$N = 16$

$\phi = 20°$

$F = 0.75$

$H = 1.5$

$n = 700$

$$d = \frac{N}{P} = \frac{16 \text{ teeth}}{12 \text{ teeth/in}} = 1.33''$$

$$V = \frac{\pi d n}{12} = \frac{\pi (1.33)(700)}{12} = 243.7 \frac{\text{ft}}{\text{min}}$$

$$K_v = \frac{1200}{1200+V} = 0.831$$

$$W_t = \frac{H(33{,}000)}{V} = \frac{(1.5)(33{,}000)}{243.7} = 203.12 \text{ lbs.}$$

table 14-2 $Y = 0.296$

$$\sigma = \frac{W_t P}{K_v F Y} = \frac{(203.126)(12)}{(0.831)(0.750)(0.296)} = \boxed{13.212 \text{ kpsi}}$$

14.4 $m = 5\ mm$

$N = 15$ teeth

$\phi = 20°$

$F = 60\ mm$

$n = 200$ rpm

$H = 5\ kW$

$$d = mN = (5)(15) = 75\ mm$$

$$V = \frac{\pi d N}{60} = \frac{\pi(.075)(200)}{60} = 0.785\ \frac{m}{s}$$

$$K_v = \frac{6.1}{6.1 + 0.785} = 0.886$$

$$W_t = \frac{60(10^3)H}{\pi d N} = 6.37\ kN$$

14-2 – $Y = 0.290$

$$\sigma = \frac{W_t}{K_v F m Y} = \frac{6.37}{(.886)(60)(5)(.290)} = \boxed{82.6\ MPa}$$

14-15 Use $W_t = \frac{K_v F Y \sigma}{P}$ $\underline{F = 0.75 \text{ in}}$

(This is The allowable stress for This problem!) $\Rightarrow \sigma = \frac{S_e}{n_{safety}}$ $K_v = \frac{1200}{1200+V}$

and $S_e = k_a k_b k_c k_d k_e S_e'$

$N = 18$ $P = 16 \text{ in}^{-1}$ $n = 1000 \text{ rpm}$

from Table 14-2 $Y = 0.309$

also $d = N/P = 18/16 = \underline{1.125 \text{ in}}$

$V = \frac{\pi d n}{12} = \frac{\pi(1.125)(1000)}{12} = \underline{294.5 \text{ ft/min}}$

and $K_v = \frac{1200}{1200+V} = \frac{1200}{1200+294.5} = \underline{0.80}$

Next need to find σ i.e. obtain S_e

$S_e' = 0.504 S_{ut} = 0.504(135) = \underline{68.04 \text{ kpsi}}$

$k_a, k_c, k_d = 1$ need k_b & k_e

As in example in Notes & Text

$$k_b = \left(\frac{d_e}{0.3}\right)^{-.1133} \qquad d_e = 0.808(Ft)^{1/2}$$

$$t = (4\,\ell x)^{1/2} \qquad \ell = \frac{1}{P} + \frac{1.25}{P} = 0.141$$

$$t = ((4)(.141)(.058))^{1/2} \qquad x = \frac{3Y}{P} = \frac{3(.309)}{16} = 0.058$$

$$t = 0.18$$

$$\therefore \quad d_e = 0.808((0.75)(0.18))^{1/2} = 0.297 \simeq 0.30$$

and $k_b = \left(\frac{0.30}{0.30}\right)^{-0.1133} = \underline{\underline{1.0}}$ just a fluke!

$$k_e = \frac{1.33}{K_f} \qquad K_f = 1 + q(K_t - 1)$$

$q = 0.75$ from Fig 5-16

find K_t from Fig A-15-6

$$r_f = \frac{0.3}{P} = \frac{0.3}{16} = 0.019 \qquad \text{"} r/d \text{"} = \frac{0.019}{t} = \underline{\underline{0.106}}$$

from A-15-6 $K_t \simeq 1.95$

$$\therefore \quad K_f = 1 + (0.75)(1.95 - 1) = 1.71$$

$$k_e = \frac{1.33}{1.71} = 0.78$$

and

$$S_e = (0.78)(68.04) = \underline{53.1\ kpsi}$$

and $$\sigma = \frac{S_e}{n_{safety}} = \frac{53.1}{2} = \underline{26.5\ kpsi}$$

Allowable stress is 26.5 kpsi!

find $$W_t = \frac{K_v F Y \sigma}{P}$$

$$= \frac{(0.80)(0.75)(0.309)(26{,}500)}{16}$$

$$W_t = \underline{307\ lbs}$$

and $$H = \frac{W_t V}{33{,}000} = \frac{(307)(294.5)}{33{,}000}$$

$$\boxed{H = 2.74\ hp.}$$

14-17/

$N_p = 22$ $\quad$ $P = 6$ teeth/in

$N_G = 60$ $\quad$ $F = 2$ inches

$H = 15\,Hp$ $\quad$ $\phi = 20°$

$n_p = 1200$ rev/min $\quad$ $H_B = 300$

$S_{ut} = 135$ Kpsi

$$d_1 = 22/6 = 3.667\,in$$

$$d_2 = 60/6 = 10\,in$$

$$V = \frac{\pi d n}{12} = \frac{\pi(3.667)(1200\,rev/min)}{12}$$

$$= 1151.9\ ft/min$$

$$C_v = \frac{1200}{1200+V} = 0.51.$$

$$W_t = \frac{H}{V} = \frac{H \times 33{,}000}{V} = 430\ lb.$$

Eq 14-13,

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

From table A-5,

$$E_G = E_p = 30\ Mpsi$$

$$\nu_p = 0.292$$

$$\Rightarrow C_p = 2085 \quad (\text{See notes})$$

$$r_1 = \frac{6 \sin 20}{2} = 1.03 \text{ in} \qquad r_2 = \frac{(22/6) \sin 20}{2} = 1.26 \text{ in}$$

$$\sigma_c = -C_p \left[\frac{W_t}{C_v F \cos\phi} \left(\frac{1}{r_1} + \frac{1}{r_2} \right) \right]^{1/2}$$

$$= -2085 \left[\frac{430}{(0.51)(2)(\cos 20)} \left(\frac{1}{1.03} + \frac{1}{1.26} \right) \right]^{1/2}$$

$$= 75.3 \text{ kpsi}$$

For the pinion

$$n = \frac{S_c}{|\sigma_c|}$$

$$S_c = 0.4\,HB - 10\text{ kpsi} \quad \left(\text{from notes and eq. 7-60}\right)$$

$$= 0.4(300) - 10$$

$$\boxed{S_c = 110\text{ kpsi}}$$

$$n = \frac{110}{75.3} = \underline{\underline{1.46}}$$

The gear will have a higher factor of safety since, for every engagement of a pinion tooth ~~the~~ a gear tooth only sees $\frac{N_P}{N_G} = \frac{22}{60} = 0.37$ engagements (or cycles of loading).