Q 4 A pair of straight teeth spur gears is to transmit 25 kW when the pinion rotates at 500 r.p.m. The velocity ratio is 1: 4. The allowable static stresses for the pinion and gear materials are 130 MPa and 110 MPa respectively. The pinion has 20 teeth and its face width is 12 times the module. Determine: 1. module; 2. face width; and 3. pitch circle diameters of both the pinion and the gear from the standpoint of strength only, taking into consideration the effect of the dynamic loading. The tooth form factor y can be taken as:

$$y = 0.154 - \frac{0.912}{T}$$

Q Given $P = 25\ kW = 25 \times 10^3\ W$

$N_p = 500\ rpm$

$\frac{N_G}{N_p} = 1:4$

$N_p = 500$

$N_G = \frac{500}{4} \Rightarrow 125\ rpm$

$\sigma_{op} = 130\ mpa = 130\ N/mm^2$

$\sigma_{oG} = 110\ mpa = 110\ N/mm^2$

$T_p = 20$ teeth

$T_G = 20 \times 4 = 80$ teeth

$b = 12m$

$P = P_t \times V$

$P_t = \frac{P}{V}$

$\equiv$

$P_t = (\sigma_0 \times C_V) \times b \times \pi \times m \times y$

$D_p = mT_p$

$D_G = mT_G$

$C_V = \frac{3}{3+V}$

$V = \frac{\pi D_p N_p}{60} = \frac{\pi D_G N_G}{60}$

$V_p = \frac{\pi D_p N_p}{60} \Rightarrow \frac{\pi \times (m \times T_p) \times 500}{60}$

$$V_p = \frac{\pi m \times 20 \times 500}{60} \Rightarrow 5$$

$$V_p = 523\,m\ mm/s \Rightarrow V_p = \frac{523}{1000}\,m\ m/s \Rightarrow V_p = 0.523\,m\ m/s$$

$$C_V = \frac{3}{3+V} \Rightarrow \left(\frac{3}{3+0.523m}\right)$$

$$P_t = \frac{P}{V} \Rightarrow \frac{25\times10^3}{0.523\,m} \Rightarrow \frac{25000}{0.523\,m} \Rightarrow \frac{47801}{m}$$

y_p

$= 0.154 - \frac{0.912}{T_p}$

$\Rightarrow 0.154 - \frac{0912}{20}$

$\Rightarrow 0.154 - 0.0456$

$y_p \Rightarrow 0.1084$

y_p = Lewis form factor for pinion

y_p = " " " " Gear

T_p = Teeth on Pinion

T_g = Teeth on Gear

$y_g = 0.154 - \frac{0.912}{80}$

$y_g = 0.1426$

$\bar{\sigma}_{op} \times y_p = 130 \times 0.1084 \Rightarrow 14.092$ Value ↓

$\bar{\sigma}_{oh} \times y_g = 110 \times 0.1426 \Rightarrow 15.68$ Value ↑

weak = Pinion

$$P_t = (\bar{\sigma}_{op} \times C_v) \times b \times \bar{\pi} \times m \times y_p$$

$$\frac{47801}{m} = \left(130 \left(\frac{3}{3+0.523m}\right) \times 12m \times \bar{\pi} \times m \times 0.1084\right.$$

$$\frac{47801}{m} = \frac{130 \times 3 \times 12 \times \pi \times 0.1084 \times m^2}{3+0.523m}$$

$$\frac{47801}{m} = \frac{1593.72\,m^2}{3+0.523m}$$

$$47801\,(3+0.523m) = 1593.72\,m^2 \times m$$

$$143403 + 25000\,m \Rightarrow 1593.72\,m^3$$

$$1593.72\,m^3 - 25000m - 143403 = 0$$

$$\pm Ax^3 \pm Bx^2 \pm Cx \pm D = 0 \quad (Bx^2 \Rightarrow =0)$$

$A = 1593.72$

$B = 0$

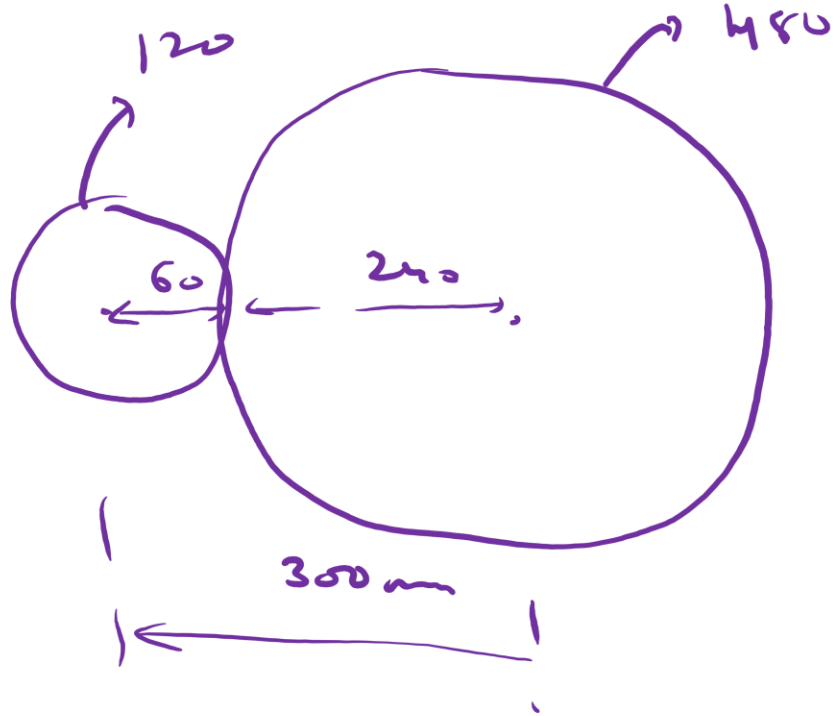
$C = -25000$

$D = -143403$

$m = 5.62 \approx 6\,mm$ or ~~8 mm~~

→ $D_p = m \times T_p \Rightarrow 6 \times 20 \Rightarrow 120\,mm$

$D_G = m \times T_G \Rightarrow 6 \times 80 \Rightarrow 480\,mm$



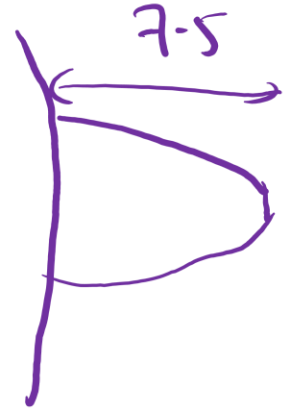
$R_A = 1.048\,m$

$\Rightarrow 1.048 \times 6$

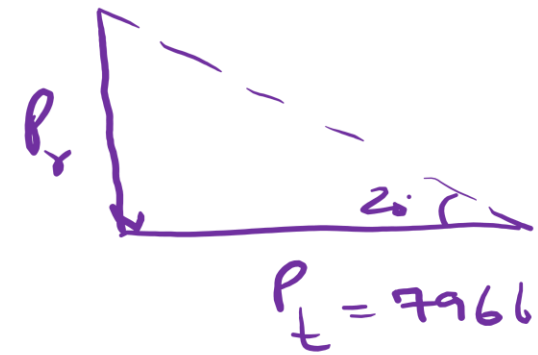
$\Rightarrow 7.5$

120 + 7.5

127.5



$$P_t = \frac{47801}{m} = \frac{47801}{6} \Rightarrow 7966\,N$$

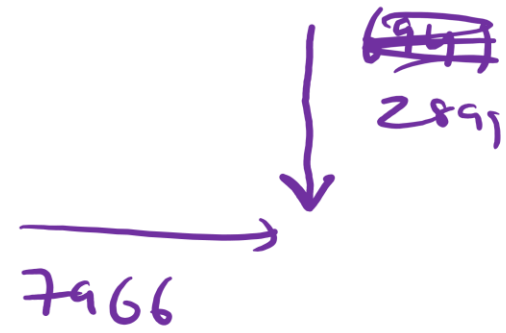


$$\frac{P}{B} = \tan\phi$$

$$P_r = P_t \times \tan 20^\circ$$

$$P_r = 7966 \times \tan(20^\circ)$$

$$P_r = 2899\,N$$



$b = 12\,m$

$\Rightarrow 12 \times 6 = 72\,mm$