Engineering Design II

Spring 2014

Tutorial # 4- Solution

1- A 20° spur pinion with 20 teeth and a module of 2.5 mm transmits 120 W to a 36 tooth gear. The pinion speed is 100 rev/min, and the gears are grade 1, 18 mm face width, through-hardened steel at 200 Brinell, uncrowned, manufactured to a No.6 quality standard, and considered to be of open gearing quality installation.

Determine the maximum power that could be transmitted through this gear set for a pinion life of 10^8 cycles, a reliability of 0.95 and a safety factor of 2.5

Note: This is the same gear set of problem 2 in Tutorial 3 so you can use all its results to solve this problem except the safety factor.

Solution:

Using same factors obtained in Tutorial 3

Pinion	Gear
1- Bending:	
$n_p = \frac{272}{\sigma_p} = 2.5$	$n_G = \frac{281}{\sigma_G} = 2.5$
$\sigma_p = 108.8$ MPa	$\sigma_G = 112.4$ MPa
$W^t_p = 641.6$ N	$W^t_G = 764.8$ N

∴ The max tangential force that can be applied to both gears according to bending is $W^t_{max} = 641.6$ N

$H_{max})_{bend} = W^t_{max} \times r_p \times \omega_p = \underline{167.9\ W}$

2- Contact:	
$n_{c_p} = \frac{(690)^2}{\sigma_p^2} = 2.5$	$n_{c_G} = \frac{(698.5)^2}{\sigma_G^2} = 2.5$
$\sigma_p = 436.39$ MPa	$\sigma_G = 441.77$ MPa
$W^t_p = 195.12$ N	$W^t_G = 199.95$ N

∴ Max. tang. applied to both $W^t_{max} = 195.12$ N

∴ $H_{max})_{cont.} = W^t_{max} \times r_p \times \omega_p = 51$ W

∴ Max power applied to the gears to have an overall factor of safety 2.5

$H_{max} = 51$ W

2- A parallel shaft gearset consists of an 18-tooth helical pinion driving 32-tooth helical gear (figure 4-1). The pinion has a left-hand helix angle of 25°, a normal pressure angle of 20°, and 3mm normal module.

a) Find the normal, transverse and axial circular pitches.
b) Find the transverse module and the transverse pressure angle
c) Find the pitch diameters of the two gears.

Solution:

(a) $p_n = \pi m_n = 3\pi \text{ mm} \quad Ans.$

$p_t = 3\pi/\cos 25^\circ = 10.4 \text{ mm} \quad Ans.$

$p_x = 10.4/\tan 25^\circ = 22.3 \text{ mm} \quad Ans.$

(b) $m_t = 10.4/\pi = 3.310 \text{ mm} \quad Ans.$

$$\phi_t = \tan^{-1}\frac{\tan 20^\circ}{\cos 25^\circ} = 21.88^\circ \quad Ans.$$

(c) $d_P = 3.310(18) = 59.58 \text{ mm} \quad Ans.$

$d_G = 3.310(32) = 105.92 \text{ mm} \quad Ans.$