DESIGN PROCEDURE FOR HELICAL GEAR WITH GEAR LIFE

INDIAN STANDARD

1. **Selection of Material:** Select a suitable pinion and gear materials.
2. **Gear Ratio:**

$$i=\frac{N_1}{N_2}=\frac{Z_2}{Z_1}$$

3. **Gear Life:**

$N_{cycle} = N_{(in\ hrs)} \times 60 \times rpm$

$N_{cycle} = N_{(in\ mins)} \times rpm$

4. **Calculation of Initial design Torque**: $[M_t]$

$[M_t] = M_t \times K \times K_d$….[**PSG data book page no:8.15**]

$K \times K_d = 1.3$

M_t =Transmitted torque $= \frac{60 * p}{2\pi N}$

5. **Calculation of $[E_{eq}]$, $[\sigma_b]$, $[\sigma_c]$:**
   - **d.** $[E_{eq}]$ = Equivalent young's modulus….[**PSG data book page no:8.14**]
   - **e.** **$[\sigma_b] = (\frac{1.4\ K_{bl}}{n K_\sigma})\sigma_{-1}$** …….[**PSG data book page no:8.18**]

     K_{bl}= Life factor for bending…….[**PSG data book page no:8.20**]

     K_σ = Stress concentration factor …….[**PSG data book page no:8.19**]

     n = Factor of safety……..[**PSG data book page no:8.19**]

     σ_{-1} = Endurance limit stress……..[**PSG data book page no: 8.19**]
   - **f.** **$[\sigma_c] = C_B.\ H_B.\ K_{cl}$**……. [**PSG data book page no: 8.16**]

     $C_B = \frac{C_B}{10}$ ……. [**PSG data book page no: 8.16**]

     H_B = Brinell hardness number….. [PSG **data book page no: 8.16**]

     K_{cl}= Life factor for surface strength….[**PSG data book page no: 8.17**]

6. **Calculation of center distance (a):**

$a \geq (i+1)\sqrt[3]{[\frac{0.7}{[\sigma_c]}]^2 \times \frac{E_{eq}[M_t]}{i.\varphi}}$ ….[**PSG data book page no: 8.13**]

Assume $\varphi = \frac{b}{a} = 0.3$

7. **Selection of number of teeth:**

Assume $Z_1 = 17$

$Z_2 = i \times Z_1$

8. **Calculation of module:**

$$m_n = \frac{2a}{(z1+z2)} \times \cos\beta$$ .....[**PSG data book page no: 8.22]**

where β = helix angle.

Standard transverse module in **PSG data book pg no: 8.2**

9. **Calculation of center distance:**

$$a = \frac{m_n(Z1+Z2)}{2*cos\beta}$$ ..... [PSG **data book page no: 8.22]**

10. **Calculation of b,** d, v **and** φ:

Face width, $b = \varphi.a$

pitch circle dia, $d_1 = \frac{m_n}{cos\beta} * Z_1$ .....[PSG **data book page no: 8.21]**

Pitch line velocity, $v = \frac{\pi \times d_1 \times N_1}{60}$

$\varphi_p = \frac{b}{d_1}$

11. **Selectionofqualityofgears:**

Quality of gears can be selected from the **PSG data book page number 8.3**

12. **Revision of design Torque [M_t]:**

$[M_t] = M_t \times K \times K_d$

K= Load concentration factor .....[**PSG data book page no: 8.15]**

K_d= Dynamic Load Factor.....[**PSG data book page no:8.16]**

13. **Check for Bending:**

$$\sigma_b = 0.7 \frac{i \pm 1}{a.m.b.y_v} [M_t]$$ .....**[PSG data book page no:8.13A]**

Y_v from **PSG data book page no: 8.18** for valuc of Z_{v1}

$\sigma_b < [\sigma_b]$ – Design is safe and satisfactory.

14. **Check for wear strength:**

$$\sigma_c = 0.7 \left(\frac{i \pm 1}{a}\right) \sqrt{\frac{i \pm 1}{ib} E_{eq} [M_t]}$$ .....**[PSG data book page no:8.13]**

$\sigma_c < [\sigma_c]$ - Dcsign is safc and satisfactory.

15. **Basic Dimensions:**

For Basic Dimcnsions of Hclical gear ..**[PSG data book page no:8.22]**

UNIT– II: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS (PART - A)

1. What is pressure angle? What is the effect of increase in pressure angle? (May/june 2014)

Soln.

It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. The standard pressure angle is $14\frac{1^{0}}{2}$ and 20^{0}

2. What condition must be satisfied in order that a pair of spur gears may have a constant velocity ratio? (May/june 2014)

Soln.

Normally spur gear are the replaced by other gears like helical, double helical gears, bevel gears etc. Spur gear is normally used in lower speed due its ability of generating zero axial thrust. Now in order to maintain constant gear ratio or speed ratio, their centre of pitch circle must be from fixed and the pitch circle of two mating gears should meet at a point and the line of action should meet at pitch point in order to satisfy the law of gearing.

3. What are the profiles of spur gear (May/june 2016)

Soln.

1. *Involute tooth profile*
2. *Cycloidal tooth profile*

4. What are the main types of gear tooth failure? (May/june2013) (May/june2012)

Soln. *The two modes of gear tooth failures are:*

1. *Tooth breakage (due to static and dynamic loads),and*
2. *Tooth wear (or) surface deterioration)*
   - *(a). abrasion,*
   - *(b). pitting, and*
   - *(c). scoring or seizure*

5. Define the various pitch in a helical gear. (May/June 2012)

Soln.

1. *Transverse circular pitch (p_t):the distance between corresponding points on adjacent teeth measured in a plane perpendicular to the shaft axis is known as Transverse circular pitch*
2. *normal circular pitch (p_n): the distance between corresponding points on adjacent teeth measured in a plane perpendicular to helix is known as normal circular pitch*
3. *Axial pitch (p_a): the distance between corresponding points on adjacent teeth measured in a plane parallel to the shaft axis is known as axial pitch.*

UNIT– II: SPUR GEARS AND PARALLEL AXIS HELICAL GEARS (PART - A)
6 .What is herringbone gear (April/May 2016)
Soln. Herringbone gears, also called double helical gears, are gear sets designed to transmit power through parallel or, less commonly, perpendicular axes. It do not have any grooves in between the gears
7. State the law of gearing or conditions of correct gearing (Nov/Dec 2010)
Soln. It states that for obtaining a constant velocity ratio, at any instant of teeth the common normal at each of contact should always pass through a pitch point, situated on the line joining the centre of rotation of the pair of mating parts.
8. What is tangential component of gear tooth force called useful component? (April/May 2010)
Soln. *Tangential component (F_t) : the tangential F_t is a useful component. Because it transmits power. Using the value of F_t the magnitudes of torque transmitted power can be determined.* *Transmitted load, = $W_t = F_t$* *Radial component (F_r): the radial component F_r is a separating force which is always directed towards the centre of the gear. F_r does no work. So it is not really a useful component. This force F_r causes bending of the shaft. The force $F_r$is also called as transverse force or bending force*
9. Compare the contact between mating teeth of spur and helical gears. (April/May 2010)
Soln. i) In spur gears the line of contact is parallel to the axis of rotation. The total length of contact line is equal to the face width. ii) In helical gears the line of contact is diagonal across the face of the tooth. The total length of contact line is greater than the face width. This lowers the unit loading & increases load carrying capacity.
10. why is a gear tooth subjected to dynamic loading (April/May 2015)
Soln. In addition to the static load due to power transmission, there are dynamic loads between the meshing teeth. The dynamic loads are due to the following reasons: (a). Inaccuracies of tooth spacing, b). Irregularities in tooth profiles, (c). Elasticity of parts, (d). Misalignment between bearings, (e). Deflection of teeth under load, and (f). Dynamic unbalance of rotating masses.