

Important Design of Helical Gears Formulas PDF



Formulas
Examples
with Units

List of 55 Important Design of Helical Gears Formulas

1) Core Design Parameters Formulas ↗

1.1) Actual Number of Teeth on Gear given Virtual Number of Teeth Formula ↗

Formula

$$z = (\cos(\psi))^3 \cdot z'$$

Example with Units

$$40.1995 = (\cos(25^\circ))^3 \cdot 54$$

Evaluate Formula ↗

1.2) Addendum Circle Diameter of Gear Formula ↗

Formula

$$d_a = m_n \cdot \left(\left(\frac{z}{\cos(\psi)} \right) + 2 \right)$$

Example with Units

$$128.4749 \text{ mm} = 3 \text{ mm} \cdot \left(\left(\frac{37}{\cos(25^\circ)} \right) + 2 \right)$$

Evaluate Formula ↗

1.3) Addendum Circle Diameter of Gear given Pitch Circle Diameter Formula ↗

Formula

$$d_a = 2 \cdot h_a + d$$

Example with Units

$$126 \text{ mm} = 2 \cdot 4 \text{ mm} + 118 \text{ mm}$$

Evaluate Formula ↗

1.4) Addendum of Gear given Addendum Circle Diameter Formula ↗

Formula

$$h_a = \frac{d_a - d}{2}$$

Example with Units

$$10 \text{ mm} = \frac{138 \text{ mm} - 118 \text{ mm}}{2}$$

Evaluate Formula ↗

1.5) Angular Velocity of Gear given Speed Ratio Formula ↗

Formula

$$n_g = \frac{n_p}{i}$$

Example with Units

$$8.2727 \text{ rad/s} = \frac{18.2 \text{ rad/s}}{2.2}$$

Evaluate Formula ↗

1.6) Angular Velocity of Pinion given Speed Ratio Formula ↗

Formula

$$n_p = i \cdot n_g$$

Example with Units

$$18.04 \text{ rad/s} = 2.2 \cdot 8.2 \text{ rad/s}$$

Evaluate Formula ↗



1.7) Center to Center distance between Two Gears Formula

Formula

$$a_c = m_n \cdot \frac{z_1 + z_2}{2 \cdot \cos(\psi)}$$

Example with Units

$$99.304_{\text{mm}} = 3_{\text{mm}} \cdot \frac{18 + 42}{2 \cdot \cos(25^\circ)}$$

Evaluate Formula 

1.8) Dedendum Circle Diameter of Gear given Pitch Circle Diameter Formula

Formula

$$d_f = d - 2 \cdot d_h$$

Example with Units

$$108_{\text{mm}} = 118_{\text{mm}} - 2 \cdot 5_{\text{mm}}$$

Evaluate Formula 

1.9) Normal Module of Helical Gear Formula

Formula

$$m_n = m \cdot \cos(\psi)$$

Example with Units

$$3.0814_{\text{mm}} = 3.4_{\text{mm}} \cdot \cos(25^\circ)$$

Evaluate Formula 

1.10) Normal Module of Helical Gear given Addendum Circle Diameter Formula

Formula

$$m_n = \frac{d_a}{\frac{z}{\cos(\psi)} + 2}$$

Example with Units

$$3.2224_{\text{mm}} = \frac{138_{\text{mm}}}{\frac{37}{\cos(25^\circ)} + 2}$$

Evaluate Formula 

1.11) Normal Module of Helical Gear given Center to Center Distance between Two Gears Formula

Formula

$$m_n = a_c \cdot \frac{2 \cdot \cos(\psi)}{z_1 + z_2}$$

Example with Units

$$2.9999_{\text{mm}} = 99.3_{\text{mm}} \cdot \frac{2 \cdot \cos(25^\circ)}{18 + 42}$$

Evaluate Formula 

1.12) Normal Module of Helical Gear given Pitch Circle Diameter Formula

Formula

$$m_n = d \cdot \frac{\cos(\psi)}{z}$$

Example with Units

$$2.8904_{\text{mm}} = 118_{\text{mm}} \cdot \frac{\cos(25^\circ)}{37}$$

Evaluate Formula 

1.13) Normal Module of Helical Gear given Virtual Number of Teeth Formula

Formula

$$m_n = \frac{d}{z'} \cdot (\cos(\psi))^2$$

Example with Units

$$1.7949_{\text{mm}} = \frac{118_{\text{mm}}}{54} \cdot (\cos(25^\circ))^2$$

Evaluate Formula 



1.14) Number of Teeth on First Gear given Center to Center Distance between Two Gears

Formula 

Evaluate Formula 

Formula

$$z_1 = a_c \cdot \frac{2 \cdot \cos(\psi)}{m_n} - z_2$$

Example with Units

$$17.9976 = 99.3\text{mm} \cdot \frac{2 \cdot \cos(25^\circ)}{3\text{mm}} - 42$$

1.15) Number of Teeth on Gear given Addendum Circle Diameter Formula

Formula

$$z = \left(\frac{d_a}{m_n} - 2 \right) \cdot \cos(\psi)$$

Example with Units

$$39.8775 = \left(\frac{138\text{mm}}{3\text{mm}} - 2 \right) \cdot \cos(25^\circ)$$

Evaluate Formula 

1.16) Number of Teeth on Gear given Pitch Circle Diameter Formula

Formula

$$z = d \cdot \frac{\cos(\psi)}{m_n}$$

Example with Units

$$35.6481 = 118\text{mm} \cdot \frac{\cos(25^\circ)}{3\text{mm}}$$

Evaluate Formula 

1.17) Number of Teeth on Helical Gear given Speed Ratio for Helical Gears Formula

Formula

$$z = Z_p \cdot i$$

Example

$$44 = 20 \cdot 2.2$$

Evaluate Formula 

1.18) Number of Teeth on Pinion given Speed Ratio Formula

Formula

$$Z_p = \frac{z}{i}$$

Example

$$16.8182 = \frac{37}{2.2}$$

Evaluate Formula 

1.19) Number of Teeth on Second Helical Gear given Center to Center Distance between Two Gears Formula

Formula

$$z_2 = a_c \cdot \frac{2 \cdot \cos(\psi)}{m_n} - z_1$$

Example with Units

$$41.9976 = 99.3\text{mm} \cdot \frac{2 \cdot \cos(25^\circ)}{3\text{mm}} - 18$$

Evaluate Formula 

1.20) Pitch Circle Diameter of Gear given Addendum Circle Diameter Formula

Formula

$$d = d_a - 2 \cdot h_a$$

Example with Units

$$130\text{mm} = 138\text{mm} - 2 \cdot 4\text{mm}$$

Evaluate Formula 

1.21) Pitch Circle Diameter of Gear given Dedendum Circle Diameter Formula

Formula

$$d = d_f + 2 \cdot d_h$$

Example with Units

$$136\text{mm} = 126\text{mm} + 2 \cdot 5\text{mm}$$

Evaluate Formula 



1.22) Pitch Circle Diameter of Gear given Radius of Curvature at Point Formula

Formula

$$d = 2 \cdot r' \cdot (\cos(\psi))^2$$

Example with Units

$$118.2807 \text{ mm} = 2 \cdot 72 \text{ mm} \cdot (\cos(25^\circ))^2$$

Evaluate Formula 

1.23) Pitch Circle Diameter of Helical Gear Formula

Formula

$$d = z \cdot \frac{m_n}{\cos(\psi)}$$

Example with Units

$$122.4749 \text{ mm} = 37 \cdot \frac{3 \text{ mm}}{\cos(25^\circ)}$$

Evaluate Formula 

1.24) Speed Ratio for Helical Gears Formula

Formula

$$i = \frac{n_p}{n_g}$$

Example with Units

$$2.2195 = \frac{18.2 \text{ rad/s}}{8.2 \text{ rad/s}}$$

Evaluate Formula 

1.25) Transverse Module of Helical Gear given Normal Module Formula

Formula

$$m = \frac{m_n}{\cos(\psi)}$$

Example with Units

$$3.3101 \text{ mm} = \frac{3 \text{ mm}}{\cos(25^\circ)}$$

Evaluate Formula 

1.26) Transverse Module of Helical Gear given Transverse Diametrical Pitch Formula

Formula

$$m = \frac{1}{p}$$

Example with Units

$$3.4483 \text{ mm} = \frac{1}{0.29 \text{ mm}^{-1}}$$

Evaluate Formula 

1.27) Virtual Number of Teeth on Helical Gear Formula

Formula

$$z' = 2 \cdot \pi \cdot \frac{r_{vh}}{P_N}$$

Example with Units

$$20.944 = 2 \cdot 3.1416 \cdot \frac{32 \text{ mm}}{9.6 \text{ mm}}$$

Evaluate Formula 

1.28) Virtual Number of Teeth on Helical Gear given Actual Number of Teeth Formula

Formula

$$z' = \frac{z}{(\cos(\psi))^3}$$

Example with Units

$$49.7021 = \frac{37}{(\cos(25^\circ))^3}$$

Evaluate Formula 



2) Helix Geometry Formulas

2.1) Axial Pitch of Helical Gear given Helix Angle Formula

Formula

$$p_a = \frac{p}{\tan(\psi)}$$

Example with Units

$$22.9033 \text{ mm} = \frac{10.68 \text{ mm}}{\tan(25^\circ)}$$

Evaluate Formula 

2.2) Helix Angle of Helical Gear given Actual and Virtual Number of Teeth Formula

Formula

$$\psi = \arccos\left(\left(\frac{z}{z'}\right)^{\frac{1}{3}}\right)$$

Example with Units

$$28.1646^\circ = \arccos\left(\left(\frac{37}{54}\right)^{\frac{1}{3}}\right)$$

Evaluate Formula 

2.3) Helix Angle of Helical Gear given Addendum Circle Diameter Formula

Formula

$$\psi = \arccos\left(\frac{z}{\frac{d_a}{m_n} - 2}\right)$$

Example with Units

$$32.7638^\circ = \arccos\left(\frac{37}{\frac{138 \text{ mm}}{3 \text{ mm}} - 2}\right)$$

Evaluate Formula 

2.4) Helix Angle of Helical Gear given Axial Pitch Formula

Formula

$$\psi = \arctan\left(\frac{p}{p_a}\right)$$

Example with Units

$$25.5909^\circ = \arctan\left(\frac{10.68 \text{ mm}}{22.3 \text{ mm}}\right)$$

Evaluate Formula 

2.5) Helix Angle of Helical Gear given Center to Center Distance between Two Gears Formula

Formula

$$\psi = \arccos\left(m_n \cdot \frac{z_1 + z_2}{2 \cdot a_c}\right)$$

Example with Units

$$24.995^\circ = \arccos\left(3 \text{ mm} \cdot \frac{18 + 42}{2 \cdot 99.3 \text{ mm}}\right)$$

Evaluate Formula 

2.6) Helix Angle of Helical Gear given Normal Circular Pitch Formula

Formula

$$\psi = \arccos\left(\frac{p_N}{p}\right)$$

Example with Units

$$25.9892^\circ = \arccos\left(\frac{9.6 \text{ mm}}{10.68 \text{ mm}}\right)$$

Evaluate Formula 



2.7) Helix Angle of Helical Gear given Normal Module Formula

Formula

$$\psi = \arccos\left(\frac{m_n}{m}\right)$$

Example with Units

$$28.0725^\circ = \arccos\left(\frac{3\text{ mm}}{3.4\text{ mm}}\right)$$

Evaluate Formula 

2.8) Helix Angle of Helical Gear given Pitch Circle Diameter Formula

Formula

$$\psi = \arccos\left(z \cdot \frac{m_n}{d}\right)$$

Example with Units

$$19.8343^\circ = \arccos\left(37 \cdot \frac{3\text{ mm}}{118\text{ mm}}\right)$$

Evaluate Formula 

2.9) Helix Angle of Helical Gear given Pressure Angle Formula

Formula

$$\psi = \arccos\left(\frac{\tan(\alpha_n)}{\tan(\alpha)}\right)$$

Example with Units

$$25.0751^\circ = \arccos\left(\frac{\tan(20.1^\circ)}{\tan(22^\circ)}\right)$$

Evaluate Formula 

2.10) Helix Angle of Helical Gear given Radius of Curvature at Point Formula

Formula

$$\psi = \sqrt{\arccos\left(\frac{d}{2 \cdot r'}\right)}$$

Example with Units

$$44.7625^\circ = \sqrt{\arccos\left(\frac{118\text{ mm}}{2 \cdot 72\text{ mm}}\right)}$$

Evaluate Formula 

2.11) Helix Angle of Helical Gear given Virtual Number of Teeth Formula

Formula

$$\psi = \arccos\left(\left(\frac{d}{m_n \cdot z'}\right)^{\frac{1}{2}}\right)$$

Example with Units

$$31.4099^\circ = \arccos\left(\left(\frac{118\text{ mm}}{3\text{ mm} \cdot 54}\right)^{\frac{1}{2}}\right)$$

Evaluate Formula 

2.12) Normal Circular Pitch of Helical Gear Formula

Formula

$$P_N = p \cdot \cos(\psi)$$

Example with Units

$$9.6794\text{ mm} = 10.68\text{ mm} \cdot \cos(25^\circ)$$

Evaluate Formula 

2.13) Normal Circular Pitch of Helical Gear given Virtual Number of Teeth Formula

Formula

$$P_N = 2 \cdot \pi \cdot \frac{r_{vh}}{z'}$$

Example with Units

$$3.7234\text{ mm} = 2 \cdot 3.1416 \cdot \frac{32\text{ mm}}{54}$$

Evaluate Formula 



2.14) Normal Pressure Angle of Helical Gear given Helix Angle Formula

Formula

$$\alpha_n = \text{atan}(\tan(\alpha) \cdot \cos(\psi))$$

Example with Units

$$20.1113^\circ = \text{atan}(\tan(22^\circ) \cdot \cos(25^\circ))$$

Evaluate Formula 

2.15) Pitch Circular Diameter of Gear given Radius of Curvature Formula

Formula

$$d' = 2 \cdot r'$$

Example with Units

$$144\text{ mm} = 2 \cdot 72\text{ mm}$$

Evaluate Formula 

2.16) Pitch Circular Diameter of Gear given Virtual Gear Formula

Formula

$$d = 2 \cdot r' \cdot (\cos(\psi))^2$$

Example with Units

$$118.2807\text{ mm} = 2 \cdot 72\text{ mm} \cdot (\cos(25^\circ))^2$$

Evaluate Formula 

2.17) Pitch Circular Diameter of Gear given Virtual Number of Teeth Formula

Formula

$$d = m_n \cdot z' \cdot (\cos(\psi))^2$$

Example with Units

$$133.0658\text{ mm} = 3\text{ mm} \cdot 54 \cdot (\cos(25^\circ))^2$$

Evaluate Formula 

2.18) Pitch of Helical Gear given Axial Pitch Formula

Formula

$$p = p_a \cdot \tan(\psi)$$

Example with Units

$$10.3987\text{ mm} = 22.3\text{ mm} \cdot \tan(25^\circ)$$

Evaluate Formula 

2.19) Pitch of Helical Gear given Normal Circular Pitch Formula

Formula

$$p = \frac{P_N}{\cos(\psi)}$$

Example with Units

$$10.5924\text{ mm} = \frac{9.6\text{ mm}}{\cos(25^\circ)}$$

Evaluate Formula 

2.20) Radius of Curvature at Point on Helical Gear Formula

Formula

$$r' = \frac{a^2}{b}$$

Example with Units

$$69.1364\text{ mm} = \frac{19.5\text{ mm}^2}{5.5\text{ mm}}$$

Evaluate Formula 

2.21) Radius of Curvature at Point on Virtual Gear Formula

Formula

$$r' = \frac{d}{2 \cdot (\cos(\psi))^2}$$

Example with Units

$$71.8291\text{ mm} = \frac{118\text{ mm}}{2 \cdot (\cos(25^\circ))^2}$$

Evaluate Formula 



2.22) Radius of Curvature of Virtual Gear given Pitch Circular Diameter Formula

Formula

$$r' = \frac{d'}{2}$$

Example with Units

$$71.5 \text{ mm} = \frac{143 \text{ mm}}{2}$$

Evaluate Formula 

2.23) Radius of Curvature of Virtual Gear given Virtual Number of Teeth Formula

Formula

$$r_{vh} = z' \cdot \frac{P_N}{2 \cdot \pi}$$

Example with Units

$$82.5059 \text{ mm} = 54 \cdot \frac{9.6 \text{ mm}}{2 \cdot 3.1416}$$

Evaluate Formula 

2.24) Semi Major Axis of Elliptical Profile given Radius of Curvature at Point Formula

Formula

$$a = \sqrt{r' \cdot b}$$

Example with Units

$$19.8997 \text{ mm} = \sqrt{72 \text{ mm} \cdot 5.5 \text{ mm}}$$

Evaluate Formula 

2.25) Semi Minor Axis of Elliptical Profile given Radius of Curvature at Point Formula

Formula

$$b = \frac{a^2}{r'}$$

Example with Units

$$5.2812 \text{ mm} = \frac{19.5 \text{ mm}^2}{72 \text{ mm}}$$

Evaluate Formula 

2.26) Transverse Diametrical Pitch of Helical Gear given Transverse Module Formula

Formula

$$P = \frac{1}{m}$$

Example with Units

$$0.2941 \text{ mm}^{-1} = \frac{1}{3.4 \text{ mm}}$$

Evaluate Formula 

2.27) Transverse Pressure Angle of Helical Gear given Helix Angle Formula

Formula

$$\alpha = \text{atan}\left(\frac{\tan(\alpha_n)}{\cos(\psi)}\right)$$

Example with Units

$$21.9878^\circ = \text{atan}\left(\frac{\tan(20.1^\circ)}{\cos(25^\circ)}\right)$$

Evaluate Formula 



Variables used in list of Design of Helical Gears Formulas above

- **a** Semi Major Axis of Helical Gear Teeth (Millimeter)
- **a_c** Center to Center Distance of Helical Gears (Millimeter)
- **b** Semi Minor Axis of Helical Gear Teeth (Millimeter)
- **d** Diameter of Pitch Circle of Helical Gear (Millimeter)
- **d'** Pitch Circular Diameter of Helical Virtual Gear (Millimeter)
- **d_a** Addendum Circle Diameter of Helical Gear (Millimeter)
- **d_f** Dedendum Circle Diameter of Helical Gear (Millimeter)
- **d_h** Dedendum of Helical Gear (Millimeter)
- **h_a** Addendum of Helical Gear (Millimeter)
- **i** Helical Gear Speed Ratio
- **m** Transverse Module of Helical Gear (Millimeter)
- **m_n** Normal Module of Helical Gear (Millimeter)
- **n_g** Speed of Helical Gear (Radian per Second)
- **n_p** Speed of Pinion Helical Gear (Radian per Second)
- **p** Pitch of Helical Gear (Millimeter)
- **P** Transverse Diametrical Pitch of Helical Gear (1 per Millimeter)
- **P_a** Axial Pitch of Helical Gear (Millimeter)
- **P_N** Normal Circular Pitch of Helical Gear (Millimeter)
- **r'** Radius of Curvature of Helical Gear (Millimeter)
- **r_{vh}** Virtual Pitch Circle Radius for Helical Gear (Millimeter)
- **z** Number of Teeth on Helical Gear
- **z'** Virtual Number of Teeth on Helical Gear
- **z₁** Number of Teeth on 1st Helical Gear
- **z₂** Number of Teeth on 2nd Helical Gear
- **z_p** Number of Teeth on Helical Pinion

Constants, Functions, Measurements used in list of Design of Helical Gears Formulas above

- **constant(s):** pi, 3.14159265358979323846264338327950288
Archimedes' constant
- **Functions:** **acos**, acos(Number)
The inverse cosine function, is the inverse function of the cosine function. It is the function that takes a ratio as an input and returns the angle whose cosine is equal to that ratio.
- **Functions:** **atan**, atan(Number)
Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.
- **Functions:** **cos**, cos(Angle)
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Functions:** **sqrt**, sqrt(Number)
A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.
- **Functions:** **tan**, tan(Angle)
The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Angle** in Degree (°)
Angle Unit Conversion 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s)
Angular Velocity Unit Conversion 
- **Measurement:** **Reciprocal Length** in 1 per Millimeter (mm⁻¹)
Reciprocal Length Unit Conversion 



- α Transverse Pressure Angle of Helical Gear
(Degree)
- α_n Normal Pressure Angle of Helical Gear
(Degree)
- ψ Helix Angle of Helical Gear (Degree)



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