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Design of Helical Gears Formulas

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List of 55 Design of Helical Gears Formulas

Design of Helical Gears

Core Design Parameters

1) Actual Number of Teeth on Gear given Virtual Number of Teeth

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

[Open Calculator !\[\]\(de95854c7ee024cfadc48187bbb781b2_img.jpg\)](#)

$$ex \quad 40.19952 = (\cos(25^\circ))^3 \cdot 54$$

2) Addendum Circle Diameter of Gear

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

[Open Calculator !\[\]\(6a9b39b98eb945faa14c645ec99e4eaa_img.jpg\)](#)

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

3) Addendum Circle Diameter of Gear given Pitch Circle Diameter

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

[Open Calculator !\[\]\(f1c5da15572e3e09d343161be98f508d_img.jpg\)](#)

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



4) Addendum of Gear given Addendum Circle Diameter

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

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

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

5) Angular Velocity of Gear given Speed Ratio

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

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \quad 8.272727\text{rad/s} = \frac{18.2\text{rad/s}}{2.2}$$

6) Angular Velocity of Pinion given Speed Ratio

$$fx \quad n_p = i \cdot n_g$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

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

7) Center to Center distance between Two Gears

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

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \quad 99.30401\text{mm} = 3\text{mm} \cdot \frac{18 + 42}{2 \cdot \cos(25^\circ)}$$



8) Dedendum Circle Diameter of Gear given Pitch Circle Diameter

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

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95_img.jpg\)](#)

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

9) Normal Module of Helical Gear

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

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2_img.jpg\)](#)

$$ex \quad 3.081446\text{mm} = 3.4\text{mm} \cdot \cos(25^\circ)$$

10) Normal Module of Helical Gear given Addendum Circle Diameter

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

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7_img.jpg\)](#)

$$ex \quad 3.222418\text{mm} = \frac{138\text{mm}}{\frac{37}{\cos(25^\circ)} + 2}$$


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

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

[Open Calculator !\[\]\(899d8b7697d64725bf017d3296cfcf1b_img.jpg\)](#)

$$ex \quad 2.999879\text{mm} = 99.3\text{mm} \cdot \frac{2 \cdot \cos(25^\circ)}{18 + 42}$$




12) Normal Module of Helical Gear given Pitch Circle Diameter 

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

Open Calculator 


$$ex \quad 2.890387\text{mm} = 118\text{mm} \cdot \frac{\cos(25^\circ)}{37}$$

13) Normal Module of Helical Gear given Virtual Number of Teeth 

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

Open Calculator 

$$ex \quad 1.794898\text{mm} = \frac{118\text{mm}}{54} \cdot (\cos(25^\circ)^2)$$

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

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

Open Calculator 

$$ex \quad 17.99758 = 99.3\text{mm} \cdot \frac{2 \cdot \cos(25^\circ)}{3\text{mm}} - 42$$


15) Number of Teeth on Gear given Addendum Circle Diameter 

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

Open Calculator 

$$ex \quad 39.87754 = \left(\frac{138\text{mm}}{3\text{mm}} - 2 \right) \cdot \cos(25^\circ)$$



16) Number of Teeth on Gear given Pitch Circle Diameter 

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

Open Calculator 

$$ex \quad 35.64811 = 118\text{mm} \cdot \frac{\cos(25^\circ)}{3\text{mm}}$$

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



$$fx \quad z = Z_p \cdot i$$

Open Calculator 

$$ex \quad 44 = 20 \cdot 2.2$$

18) Number of Teeth on Pinion given Speed Ratio 

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

Open Calculator 

$$ex \quad 16.81818 = \frac{37}{2.2}$$

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

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

Open Calculator 

$$ex \quad 41.99758 = 99.3\text{mm} \cdot \frac{2 \cdot \cos(25^\circ)}{3\text{mm}} - 18$$



20) Pitch Circle Diameter of Gear given Addendum Circle Diameter

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

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 130mm = 138mm - 2 \cdot 4mm$$

21) Pitch Circle Diameter of Gear given Dedendum Circle Diameter

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

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 136mm = 126mm + 2 \cdot 5mm$$

22) Pitch Circle Diameter of Gear given Radius of Curvature at Point

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

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 118.2807mm = 2 \cdot 72mm \cdot (\cos(25^\circ))^2$$

23) Pitch Circle Diameter of Helical Gear

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

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19_img.jpg\)](#)

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



24) Speed Ratio for Helical Gears 

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

[Open Calculator !\[\]\(6605b201d6f14d9b3bcb8ab5f274d107_img.jpg\)](#)


$$ex \quad 2.219512 = \frac{18.2\text{rad/s}}{8.2\text{rad/s}}$$

25) Transverse Module of Helical Gear given Normal Module 

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

[Open Calculator !\[\]\(e8fb589d58dad1692debababa5e928b6_img.jpg\)](#)

$$ex \quad 3.310134\text{mm} = \frac{3\text{mm}}{\cos(25^\circ)}$$

26) Transverse Module of Helical Gear given Transverse Diametrical Pitch 

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

[Open Calculator !\[\]\(4688aadfd656ded00cd6bdfae55089a9_img.jpg\)](#)

$$ex \quad 3.448276\text{mm} = \frac{1}{0.29\text{mm}^{-1}}$$

27) Virtual Number of Teeth on Helical Gear 

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

[Open Calculator !\[\]\(4146d17f71dced09c6ad789cacceaa6d_img.jpg\)](#)

$$ex \quad 20.94395 = 2 \cdot \pi \cdot \frac{32\text{mm}}{9.6\text{mm}}$$



28) Virtual Number of Teeth on Helical Gear given Actual Number of Teeth



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

Open Calculator

$$ex \quad 49.70208 = \frac{37}{(\cos(25^\circ))^3}$$

Helix Geometry

29) Axial Pitch of Helical Gear given Helix Angle

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

Open Calculator

$$ex \quad 22.90333\text{mm} = \frac{10.68\text{mm}}{\tan(25^\circ)}$$

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



$$fx \quad \psi = a \cos \left(\left(\frac{z}{z'} \right)^{\frac{1}{3}} \right)$$

Open Calculator

$$ex \quad 28.16458^\circ = a \cos \left(\left(\frac{37}{54} \right)^{\frac{1}{3}} \right)$$



31) Helix Angle of Helical Gear given Addendum Circle Diameter

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

[Open Calculator !\[\]\(0f848bbd71cef6b345273b16f905912a_img.jpg\)](#)

$$\text{ex } 32.76376^\circ = a \cos \left(\frac{37}{\frac{138\text{mm}}{3\text{mm}} - 2} \right)$$

32) Helix Angle of Helical Gear given Axial Pitch

$$\text{fx } \psi = a \tan \left(\frac{p}{p_a} \right)$$

[Open Calculator !\[\]\(3211b5d1d968fc1665909b34f9f16010_img.jpg\)](#)

$$\text{ex } 25.59087^\circ = a \tan \left(\frac{10.68\text{mm}}{22.3\text{mm}} \right)$$


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

$$\text{fx } \psi = a \cos \left(m_n \cdot \frac{z_1 + z_2}{2 \cdot a_c} \right)$$

[Open Calculator !\[\]\(9c2e8d1b5bd77cb5c9f83b7a9cff79fd_img.jpg\)](#)

$$\text{ex } 24.99503^\circ = a \cos \left(3\text{mm} \cdot \frac{18 + 42}{2 \cdot 99.3\text{mm}} \right)$$



34) Helix Angle of Helical Gear given Normal Circular Pitch 

$$fx \quad \psi = a \cos \left(\frac{P_N}{p} \right)$$

Open Calculator 


$$ex \quad 25.98923^\circ = a \cos \left(\frac{9.6\text{mm}}{10.68\text{mm}} \right)$$

35) Helix Angle of Helical Gear given Normal Module 

$$fx \quad \psi = a \cos \left(\frac{m_n}{m} \right)$$

Open Calculator 

$$ex \quad 28.07249^\circ = a \cos \left(\frac{3\text{mm}}{3.4\text{mm}} \right)$$

36) Helix Angle of Helical Gear given Pitch Circle Diameter 

$$fx \quad \psi = a \cos \left(z \cdot \frac{m_n}{d} \right)$$

Open Calculator 

$$ex \quad 19.83427^\circ = a \cos \left(37 \cdot \frac{3\text{mm}}{118\text{mm}} \right)$$

37) Helix Angle of Helical Gear given Pressure Angle 

$$fx \quad \psi = a \cos \left(\frac{\tan(\alpha_n)}{\tan(\alpha)} \right)$$

Open Calculator 


$$ex \quad 25.07509^\circ = a \cos \left(\frac{\tan(20.1^\circ)}{\tan(22^\circ)} \right)$$



38) Helix Angle of Helical Gear given Radius of Curvature at Point Open Calculator 

$$fx \quad \psi = \sqrt{a \cos\left(\frac{d}{2 \cdot r'}\right)}$$

$$ex \quad 44.76246^\circ = \sqrt{a \cos\left(\frac{118\text{mm}}{2 \cdot 72\text{mm}}\right)}$$

39) Helix Angle of Helical Gear given Virtual Number of Teeth Open Calculator 

$$fx \quad \psi = a \cos\left(\left(\frac{d}{m_n \cdot z'}\right)^{\frac{1}{2}}\right)$$

$$ex \quad 31.40991^\circ = a \cos\left(\left(\frac{118\text{mm}}{3\text{mm} \cdot 54}\right)^{\frac{1}{2}}\right)$$

40) Normal Circular Pitch of Helical Gear Open Calculator 

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


$$ex \quad 9.679367\text{mm} = 10.68\text{mm} \cdot \cos(25^\circ)$$

41) Normal Circular Pitch of Helical Gear given Virtual Number of Teeth Open Calculator 

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

$$ex \quad 3.723369\text{mm} = 2 \cdot \pi \cdot \frac{32\text{mm}}{54}$$



42) Normal Pressure Angle of Helical Gear given Helix Angle 

$$f_x \alpha_n = a \tan(\tan(\alpha) \cdot \cos(\psi))$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)


$$ex \ 20.11132^\circ = a \tan(\tan(22^\circ) \cdot \cos(25^\circ))$$

43) Pitch Circular Diameter of Gear given Radius of Curvature 

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

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)


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

44) Pitch Circular Diameter of Gear given Virtual Gear 

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

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

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

45) Pitch Circular Diameter of Gear given Virtual Number of Teeth 

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

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

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

46) Pitch of Helical Gear given Axial Pitch 

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

[Open Calculator !\[\]\(4a7b4ce770af8456e11a71f9565c8c2b_img.jpg\)](#)

$$ex \ 10.39866\text{mm} = 22.3\text{mm} \cdot \tan(25^\circ)$$




47) Pitch of Helical Gear given Normal Circular Pitch 

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

[Open Calculator !\[\]\(d3fb9f94af8b26d1c844efa9a98805b0_img.jpg\)](#)

$$ex \quad 10.59243mm = \frac{9.6mm}{\cos(25^\circ)}$$

48) Radius of Curvature at Point on Helical Gear 

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

[Open Calculator !\[\]\(e1d6102fe77919492c04879c8450f1f5_img.jpg\)](#)

$$ex \quad 69.13636mm = \frac{(19.5mm)^2}{5.5mm}$$

49) Radius of Curvature at Point on Virtual Gear 

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

[Open Calculator !\[\]\(ab4e2b3fc7e7887b7a72f548aa6f5e60_img.jpg\)](#)

$$ex \quad 71.82913mm = \frac{118mm}{2 \cdot (\cos(25^\circ))^2}$$

50) Radius of Curvature of Virtual Gear given Pitch Circular Diameter 

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

[Open Calculator !\[\]\(5abce1a84a655b073239ab33e1199487_img.jpg\)](#)

$$ex \quad 71.5mm = \frac{143mm}{2}$$



51) Radius of Curvature of Virtual Gear given Virtual Number of Teeth 

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

Open Calculator 

$$ex \quad 82.50592\text{mm} = 54 \cdot \frac{9.6\text{mm}}{2 \cdot \pi}$$

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

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

Open Calculator 


$$ex \quad 19.89975\text{mm} = \sqrt{72\text{mm} \cdot 5.5\text{mm}}$$

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

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

Open Calculator 

$$ex \quad 5.28125\text{mm} = \frac{(19.5\text{mm})^2}{72\text{mm}}$$


54) Transverse Diametrical Pitch of Helical Gear given Transverse Module 

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

Open Calculator 

$$ex \quad 0.294118\text{mm}^{-1} = \frac{1}{3.4\text{mm}}$$



55) Transverse Pressure Angle of Helical Gear given Helix Angle [Open Calculator](#) 

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

$$\text{ex } 21.98782^\circ = a \tan \left(\frac{\tan(20.1^\circ)}{\cos(25^\circ)} \right)$$



Variables Used




- **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



- Z_1 Number of Teeth on 1st Helical Gear
- Z_2 Number of Teeth on 2nd Helical Gear
- Z_p Number of Teeth on Helical Pinion
- α Transverse Pressure Angle of Helical Gear (Degree)
- α_n Normal Pressure Angle of Helical Gear (Degree)
- ψ Helix Angle of Helical Gear (Degree)



Constants, Functions, Measurements used


- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **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.
- **Function:** **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.
- **Function:** **cos**, `cos(Angle)`
Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.
- **Function:** **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.
- **Function:** **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 



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- [Design of Helical Gears Formulas](#) 

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