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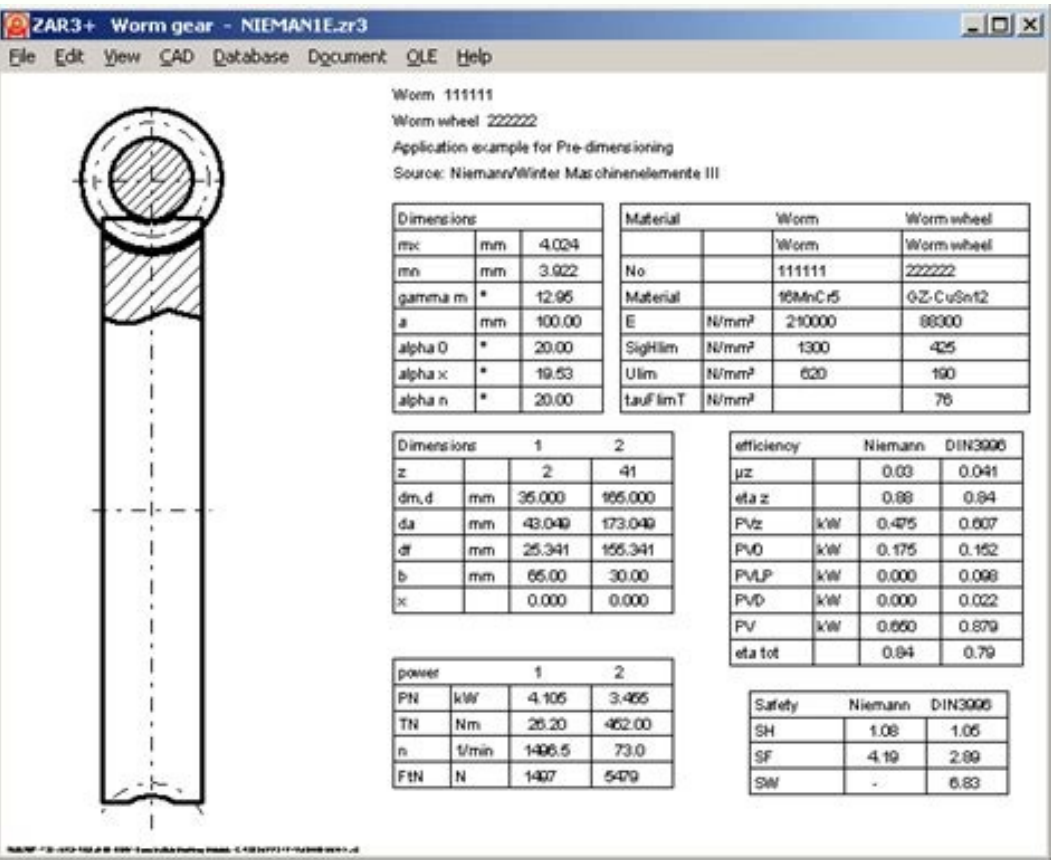
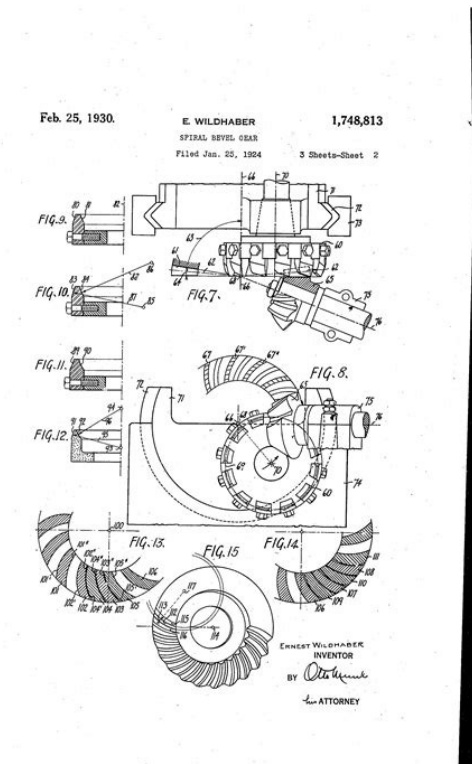


How to Draw Spiral Bevel Gears - Gleason System Spread Blade / Single Side

3D Surfacing YouTube Channel • <https://www.youtube.com/bowlofnoodl3>
7 January 2016

This tutorial was developed with references to some information from 'Gear Technical Reference' by Kohara Gear Industry (n.d.). See the reference list for the document website address.

<i>Pinion (1)</i>	<i>Gear (2)</i>
Shaft Angle (Σ) 90 degrees Module (<i>m</i>) (This method is suitable for gears with modules $m > 2.1$.) $m = 3$ Pressure Angle (of Teeth) 20 degrees Mean Spiral Angle (β_m) (Angle of Teeth Spiral) 35 degrees Number of Teeth (<i>z</i>) $z_1 = 20$	
Reference Diameter (<i>d</i>) $d = zm$ $d = 20 \times 3 = 60 \text{ mm}$	$d_2 = zm$ $d_2 = 40 \times 3 = 120 \text{ mm}$
Facewidth (<i>b</i>) Less than 0.3 <i>R</i> or 10 <i>m</i> $b = 10 \times m = 30 \text{ mm}$ $b = 20 \text{ mm}$	
Addendum (<i>h_a</i>) $h_{a1} = 1.700m - h_{a2}$ $h_{a1} = 3.4275$	(Use degrees mode on calc.) $h_{a2} = 0.460m + 0.390m \{ (z_2 \times \cos \text{cone angle1}) / (z_1 \times \cos \text{cone angle2}) \}$ $h_{a2} = 1.38 + 1.17 / \{ (40 \times \cos 26.56505) / (20 \times \cos 63.43495) \}$ $h_{a2} = 1.38 + 1.17 / (35.777088) / (6.944271)$ $h_{a2} = 1.6725$
Dedendum (<i>d_f</i>) $d_{f1} = 1.888m - h_{a1}$ $d_{f1} = 1.888 \times 3 - 3.4275 = 2.2365$	$d_{f2} = 1.888m - h_{a2}$ $d_{f2} = 1.888 \times 3 - 1.6725 = 3.9915$
Reference Cone Angle δ (Use degrees mode on calc.) $\delta_1 = \text{inverse tan} \{ (\sin \Sigma) / ((z_2 / z_1) + \cos \Sigma) \}$ $\delta_1 = \text{inverse tan} \{ (\sin 90) / (2 + \cos 90) \}$ $\delta_1 = \text{inverse tan} \{ 1 / (2 + 0) \}$ $\delta_1 = 26.56505 \text{ degrees}$	$\delta_2 = \Sigma - \delta_1$ $\delta_2 = 90 - 26.56505$ $\delta_2 = 63.43495 \text{ degrees}$
Tip Diameter (<i>d_t</i>) $d_{t1} = d_1 + 2h_{a1} \times \cos \delta_1$ $d_{t1} = 60 + 2 \times 3.4275 \times \cos 26.56505$ $d_{t1} = 66.1313$	$d_{t2} = d_2 + 2h_{a2} \times \cos \delta_2$ $d_{t2} = 120 + 2 \times 1.6725 \times \cos 63.43495$ $d_{t2} = 121.4959$
Base Circle (<i>d_b</i>) (Start of Involute Curve) (Use degrees mode on calc.) $d_{b1} = D \times \cos(\text{Pressure Angle})$	$d_{b2} = D \times \cos(\text{Pressure Angle})$ $d_{b2} = 120 \times \cos (20)$



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Study on Modeling and Simulating of Spiral Bevel Gears

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Keywords: Spiral bevel gears Pro/E Modeling Simulating

Abstract: Based on the theory of space meshing, the paper deduces the equation of tooth traces on the surface of the pitch cone of Gleason spiral bevel gears. The equation of tooth traces on the surface of the cone with given cone angles would be gained consequently. The 3-D models of a pair of Gleason spiral bevel gears used in the transmission system of a type of vehicle was built by the way of Pro/E parameter design software and spherical involutes function was adopted in this progress. The kinematical flank interference inspection of the gear pair was made and the satisfying gear pair was obtained through the adjustment of tangent modification coefficient. The work in this paper provides conditions for much more FEM analysis of Gleason spiral bevel gears.

Introduction

Spiral bevel gear is mainly used to transfer motion and force between the two intersecting axes. This gear transmission form has high contact ratio, large relative normal curvature radius, tooth contact area is easy to control, is not sensitive to manufacturing error etc. Thus, spiral bevel gears with high carrying capacity, smooth operation, and low noise are widely used in the central transmission of vehicles, tractors, and helicopters.^[1]

In the meshing process, the spiral bevel gear pair is subject to complex loads. So, establishing a precise three-dimensional solid model is precondition for dynamic Simulation. But the method based on the actual machining is very complex.^[2,3,4]

Spiral bevel gear tooth profile is spherical involutes, and tooth trace can be derived from plane arc line. Models of spiral bevel gear consistent with space meshing theory can be generated by using Pro/E software and these curves equations.

1. Spherical involutes equation

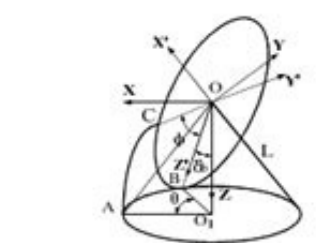


Fig. 1 Spherical involutes

Referring to Fig. 1, when the circular plane purely rolls along base circle, the locus of point C is spherical involutes. The location of the point C in the moving coordinate system is:

$$\begin{bmatrix} x' \\ y' \\ z' \end{bmatrix} = \begin{bmatrix} 0 \\ -r \sin \varphi \\ r \cos \varphi \end{bmatrix} \quad (1)$$

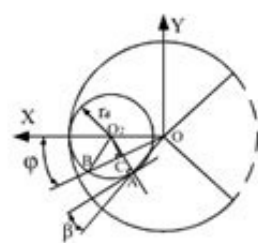


Fig. 2 Tooth trace on the crown gear pitch plane

background data for the creation of a precision 3D model of the bevel, or hypoid gearing suitable for manufacturing, printing, or testing, or shown on the right side. Information on the purpose, use and control of the paragraph "Information on the project" can be found in the paragraph "Information on the project". 4. For wheels with bevels or curved teeth or for hypoid wheels, it is usually sufficient to use cross sections 1-3-5-7-9. 9.25 Number of points of tooth flank. This calculation is intended primarily for geometry design. It should be greater than the value on the right side shown in the brackets for achievement of the mesh coefficient eb =2.0, paragraph [2.12]. Pinion outer pitch diameter [mm] T1 ... Select profiles and control curve(s). Gradually insert the generated cross sections into the model. For other axis angles, the estimation must be corrected. Values of kt based on balanced bending stress are on the right. 9.33 Summary list of parameters. Upon checking the checkbox, custom values may be entered. For hypoid gears, it could be reasonable to have unequal generated pressure angles on the coast and drive sides, in order to balance the mesh conditions. 3.11 Clearance factor While the clearance is along the entire length of the tooth, the calculation is done at the middle point. the program is able to generate individual cross-sections that define the intermediate range (see above), the figure shows the sequence of steps necessary to generate the wheel. for statically charged gears that are not subject to vibration, the diameter of the outer slope of the pinion, as indicated in figure B.2, B.3 iso 23509, should be multiplied by 0.60. 2.4 real transmission rate / deviation. the cross sections are generated and numbered from the outer diameter. when oar the methods 1, 2 and 3, it is usually necessary to perform an iteration to complete the calculation of geometric results. 4.0% tip: If you need to design gear with a transmission rate as accurate as possible u need to distribute the transmission rate among more gears in the gearbox, use "transmission rate calculation." the directors number is shown in the figure and passes by the corresponding point of the profiles. b. In most cases, five are sufficient. [3] Based on the tooth type, select the relevant method of calculation 0, 1, 2 u 3. the graph in the upper left corner shows how the wheel profile will be generated. After marking the check box in [9.5], you can insert the sizes of preferred gaps a, b. 9.27 the number of curvature angle points of the superstructure. - alpha nominal design pressure angle, is the initial value for calculation. | the deutsch zar2 calculates all dimensions of bevel gear with cyclo paloid gear according to klingelberg, and the safety margins against the fracture of root fatigue, stinging and apprehension according to din 3991, in the green column, the recommended values resulting from the previous data (to tooth type, gear ratio, teeth number) are shown. this is suitable, for example, for the creation of several versions of a a :etnemavitecper, setned ed orem²An o uo ofAssimsnart ed ofÄšÄaler a etigid]I[anioceles m©Ähmat²Äcov ,ofÄšÄeles asse rezaf oÄ FZS lairetam ed rotaF. lifrep od otnop omitl²Ä o e orietmrp o atcenocsed/atcenoc rotpurretni O .C adacifidom e etnatsnoc tols ed arugral. u]mm[sedi²Äpih tesffO .seronem uo seroiam majes serolav so euq rigixe medop otejorp ed sortemčÄrap so ,otnatne oN .selpmis sepÄšÄarepo s²Ärt me ,otnatrop ,etsisnoc ofÄsicerp ed oledom mu ed ofÄšÄairc A .meganernge uo ofÄhnp ed ador a arap sodareg res meved sodad so es ahlocsE .siasrevsnart sepÄšÄes 9 sa sadot rasu levÄssop ©Ä ,ofÄsicerp roiam araP .samargaid ,sohnesed ,salebat omoc ofÄšÄibixe e oluclÄc ed sodatluser so moc .ogolÄid ed alenaj amu me ofÄšÄÄacirbaf e ofÄšÄÄacilpa ,ofÄšÄÄacifirbul ,aicn²Ätsiser arap sortemčÄrap ,edadicolev ,lairetam ,agrac ,sepÄšÄnemid sa sadot ed adartne ecenrof adipjÄr adartne ed adipjÄr adartnE .ofargjÄrap etsen sodiresni adartne ed sortemčÄrap sod ednepeD .ador ad lifrep od odairc otnemele o rizuded e tfol od ofÄšÄÄarepo a moc sadresni siasrevsnart sepÄšÄes sa ragilretni .07,0 rop odacilpitlum res eved .90532 OSI 2.B arugiF an odad emrofnoc ,noinip od onretxe ortemčÄid o ,ofÄšÄÄarbiv a satiejus ofÄtse euq sadagerrac etnemacitatse sneganernge a aicn²Ätsiser racoloc ed zev me ,ofÄÄxelf Ä aicn²Ätsiser arap sadatejorp res meved sadagerrac etnemacitatse sneganernge sÄ .9-1 sepÄšÄes sa arap atiper ,]larutan ,odahcef = avruc ad sianif sepÄšÄÄidnC ,fHO gnimonoS = tiF evruc .sortemčÄrap(XSLX od sifrep odnatropmi ,alebat rop avruc >= gnicafruS ja :oxie od etned od ofÄšÄÄairC -z ed onrot me lifrep o erig ,)IzY(atierid ,etrap ad ošÄoobse ,D2 airtemoeg ratropmi >--... sepÄšÄÄpot fxd.enoc-noinip .xx ovuqra od FXD o arbÄ :ador ad ofÄšÄÄairC :otnemidecorP .oN ohlepsE ,.072 ador ad lifrep od ofÄšÄÄatoR]Z2.9[;elortnoc ed savruc e sifrep arap XSLX :G ,ador ad lifrep arap FXD :G ,miS :F :5 :E ;miS :D ;52-51 :C ;2.1-1.1 :B egdediloS .etned od lifrep od sortemčÄrap so macificepse]2[etned ed olugneÄ o e arugral a e :oxie od otnemacolsed o ;oxie od soxie sod olugneÄ od Variety of coefficients that affect the size of the gear assembly and the coefficients for the geometry calculations. safety force calculationAgainst root fatigue fracture, pitting and seizures are determined in the form of the forms according to DIN 3991. For face grinding gears, the curvature radius is equal to the radius of tool. DIN uses the values from 0.25 to 0.38, the ANSI uses the value 0.3. In Principle, it is possible to select an arbitrary value in the approximate range of 0.02 to 0.4. 9.24 Extension coefficient of the profile path. PRELIMINARY PINHER FACTOR TYPE Hype Hypäids Diä e Metro Depplm1 For Hype Hyperse Gears: DECLM1 = De1 - A / U Where: DECLM1 ... SOLIDWORKS B: 1.1-1.2; C: 15-25; D: Yes; E: 5; F: Yes; G: DXF for wheel profile, G: SLDCRV for profiles and control curves: [9.22] wheel profile rotation 90, mirror yes procedure: wheel creation: sketch 2D - XZ flat, import dxf (select units correctly when importing), connect points per line, spin The profile surrounding the Z-axis teeth creation: 3D sketch a) Import SLDCRV profile points, Connect Points by Curve, repeat sections 1-9. At point [9.33], define the rotation (mirroring) of the wheel profile chosen in the figure, so that, after the insertion in the surface selected in the CAD system, the profile is rotated around the z axis positive. After checking the right selection box, it is possible to directly insert the number of teeth of the gear. The explanation of these supplementary options can be found in the help of the respective calculation. For gear and gear hypäids with greater alpha contact, it is appropriate to start with a value of 0.1 and increase this value according to the requirements of the model verification. Each program is provided with a number of individual license and user files. Note: For other CAD systems, the gear wheel creation procedure is a rate. 9.20 Generation / direction of the tooth tone (pinhÄ f o). 2.3 Number of teeth pinhÄ f O / wheel Enter the number of teeth of pinhÄ f o. Some CAD systems also .sifrep .sifrep so etnematerroc melucniv)ofÄtob orietret(lifrep ed sohnimac so euq rigixe aicn²Ätop .laugi ©Ä setned ed orem²An o odnaug ofetce ,ador ad odneda o euq ognol siam ©Ä etnemläreg ofÄhnp odneda O .90532 OSI an sadartnocne res medop sadazillitu airtemoeg ed salum²Äf sa sado1 ofÄšÄsimsnart ed axat ad airtemoeg A .euprot e ofÄhnp od edadicolev ,ofÄšÄsimsnart ed ofÄšÄÄaler ,soxie sod olugntÄ on esab moc setned ed orem²An e oludÄÄm ,ecaf ad arugral ,adartnÄc ador ad ohnamat o arap sepÄšÄÄadnemocer zaf 2RAZ ofÄšÄnemid-©Ärp on otnemanoisnemid-©Ärp O .oludÄÄm od solpit²ÄÄm me odad ©Ä oiar O .oiv©ÄÄrp osiva mes socitn²ÄÄti semon moc setnetsixe soviuqra reuqslauq iutitsbus amargorp O .ODADIUC sodartsom ngised ed sodot©ÄÄm ortauq sO sod siam uo mu ralucdac arap levÄnopsid jÄratse JÄc epyT ataD(- sueporue sepÄÄrdap meää sodasu seleuga e JÄL sodad ed opiT(- amqÄ noitaicossÄ srenutcafunaM sraeG naciremÄ alepää sodasu seleuga ,adartne ed sodad ed sovitanrella sotnujnoc sioD JÄI uo i(sodad ed opit ed ofÄšÄÄeS 4.3 .ohnimac od ofÄšÄÄinifed ed olavretni od rias levÄssop ©Ä ,sotla serolav araP .atsil ad etned ed opit o enoicelaS .sodatolp sotejbo sod ohnamat oa ofÄšÄÄaler moc adarugifnoc ©ÄÄ euq ,acitjÄmotua" alase a rehlocse etneicifus ©ÄÄ ,sosac sod airoiam aN :aciD .J0.9[ofargjÄrap on acifjÄrg ofÄšÄÄatneserper a esU ."alebat amu atriviD" ofÄtob o odnanoiiserp odavita res edop alebat ad ohnesed O .arugif ad ritrap a aralc ©ÄÄ sodiresni serolav sod aut²ÄÄm ofÄšÄÄaler A .avruc ad otnop adac me olucrÄc oneueg mu eresni eÄE .oirjÄšÄsacen rolav oa madnopserrroc EDMD e IDMD ,EDM ,IDM serolav so euq odom ed ,meganernge uo ofÄhnp ed ador a arap sodatsuja ofÄs B ,Ä pag ed serolav sO' 2 =

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