Terminology & Formulas - The following is a list of terms and definitions commonly used in the gear industry.

Active Profile -
The part of the gear tooth profile which actually comes in contact with the profile of its mating tooth along the line of action.

Addendum -
The height by which a tooth of a gear projects beyond (outside for external, or inside for internal) the standard pitch circle or pitch line; also, the radial distance between the pitch diameter and the outside diameter

Angular Bevel Gears -
Are bevel gears in which the axes are not at a right angle.

Arc of Action -
The arc of the pitch circle through which a tooth travels from the time it first makes contact with a mating tooth until contact with mating tooth ceases.

Arc of Approach -
The arc of the pitch circle through which a tooth travels from the time it first makes contact with a mating tooth until it is in contact at the pitch point.

Axial Pitch -
The distance in an axial plane surface between corresponding adjacent tooth profiles.

Axial Pitch of Worm -
The distance parallel to the axis of the worm between corresponding sides of adjacent teeth. The term axial pitch is preferred to the term linear pitch.

Axial Plane - (of a pair of gears)
The plane that contains the two axes. In a single gear, an axial plane may be any plane containing the axis and a point of its diameter.

Axial PA of Worm -
The angle in a axial plane between the side of the thread and a line perpendicular to the axis.

Axial Thickness of Worms -
The distance parallel to the axis between two pitch line elements of the same tooth.

Back Angle -
In a bevel gear, the angle between an element of the back cone and a plane of rotation, usually equal to the pitch angle.

Back Cone -
In a bevel or hypoid gear, an imaginary cone tangent to the outer ends of the teeth, with its elements perpendicular to those of the pitch cone.

Back Cone Distance -
In a bevel gear, the distance along an element of the back cone from its apex to the pitch circle.

Backlash -
Is the amount by which the width of a tooth space exceeds the thickness of the engaging tooth on the pitch circles. In the context of gears, backlash is clearance between mating components, or the amount of lost motion due to clearance or slackness when movement is reversed and contact is re-established.

Backlash Variation -
The difference between the maximum and minimum backlash occurring in a whole revolution of the larger of a pair of mating gears.

Base Circular Thickness -
The length of arc on the base circle between two involute curves forming the profiles of a tooth.

Base Cylinder -
The cylinder of the same diameter as the base circle.

Base Lead Angle -
The lead angle on a base cylinder.

Base Diameter -
The diameter of the circle from which the involute is generated.

Base Helix Angle -
The helix angle on the base cylinder.

Base Pitch - (normal to involute)
The circular pitch taken in the circumference of the base circle, and is also the distance along the line of action between two successive and corresponding involute profiles.

Base Radius -
The radius of the circle from which the involute is generated.

Bevel Gears -
Gears of conical form designed to operate on intersecting axes.

Bottom Land -
The surface at the bottom of a gear tooth space adjoining the fillet.

Center Distance -
The shortest distance between non-intersecting axes of mating gears.

Central Plane of a Worm Gear -
The plane perpendicular to the gear axis and containing the common perpendicular of the gear and worm axes.

Chordal Addendum - (for tooth calipers)
The radial distance from the circular thickness chord to the top of the tooth.

Chordal Addendum - (normal)
The perpendicular distance from the normal thickness chord to the top of the tooth.

Chordal Thickness -
The length of the chord suspended by the circular thickness arc.

Circular Pitch -
The distance along the pitch circle or pitch line between corresponding profiles of adjacent teeth.

Circular Thickness -
The thickness of the tooth on the pitch circle.

Clearance -
The amount by which the dedendum in a given gear exceeds the addendum of its mating gear.

Composite Action -
The variation in center distance when two gears are rolled in tight mesh.

Cone Distance -
The distance along an element of the pitch cone from the apex to any given position along the length of a tooth.

Contact Ratio -
The ratio of the arc of action to the circular pitch.

Contact Ratio Face -
The ratio of the face advance to the circular pitch.

Contact Ratio Total -
The ratio of the sum of the arc of action and the face advance to the circular pitch.

Crossed Helical Gears -
Gears that operate on non-intersecting axes.

Crossing Point -
The point of intersection of bevel gear axes; also the apparent point of intersection of the axes in hypoid gears, crossed helical gears, worm-gears, and offset face gears, when projected to a plane parallel to both axes.

Crown Circle -
The circle of intersection of the back and face cones.

Crown Gear -
A bevel gear having a plane pitch surface.

Crowned Teeth -
Teeth having surfaces Modified in the lengthwise direction to prevent contact at their ends.

Cylindrical Worm -
A gear having one or more teeth in the form of screw threads.

Dedendum -
The radial or perpendicular distance between the pitch circle and the bottom of the tooth space.

Diametral Pitch -
The ratio of the number of teeth to the number of inches in the pitch diameter. There is a fixed relation between diametral pitch (P) and circular pitch (p), namely $p = n/P$.

Double-Enveloping Wormgearing -
The worm-gearing comprising an enveloping worm designed to operate with line contact with a mating enveloping wormgear.

Double-Helical Gear -
A gear of cylindrical form with two sections of teeth, one right hand and the other left hand, that engage simultaneously with the teeth of a similarly designed mating gear.

Effective (or Active) Face Width -
The width of face which comes actually into contact with a mating gear.

Enveloping Worm -
(Hourglass Worm) is a worm that increases in diameter from its middle portion toward both ends, conforming in its axial plane to the curvature of the gear.

Equal-Addendum Teeth -
Teeth of two engaging gears having same addendum.

Equivalent Number of Teeth -
That number of teeth contained in the whole circumference of a pitch circle corresponding to an equivalent pitch radius.

Equivalent Pitch Radius -
The radius of the pitch circle in a cross section of gear teeth in any plane other than a plane of rotation. It is properly the radius of curvature of the pitch surface in the given cross section.

Equivalent Diameter - (in normal plane)
The diameter of curvature of the pitch surface in the plane normal to the pitch line element.

External Gear -
A gear with the teeth formed on the outer surface of a cylinder or cone.

Face Advance -
The distance on the pitch circle that a gear tooth travels from the time pitch point contact is made at one end of the tooth until pitch point contact is made at the other end.

Face Cone -
The cones tangent to the tops of the teeth.

Face Contact Ratio -
The contact ratio in an axial plane, or the ratio of the face width to the axial pitch. For bevel and hypoid gears it is the ratio of face advance to circular pitch.

Face Gears -
A gear set consisting of a spur or helical pinion in combination with a conjugate gear of disc form, the axes being usually at right angles, either intersecting or non-intersecting.

Face Width -
The width of the pitch surface. For herringbone gears, this includes the width of the surface containing both of the helices and the groove width.

Fillet Curve -
The concave portion of the tooth profile where it joins the bottom of the tooth space.

Fillet Radius -
The radius of a circular arc approximating the fillet curve.

Front Angle -
The angle between an element of the front cone and a plane of rotation, usually equal to the pitch angle.

Front Cone -
An imaginary cone tangent to the inner ends of the teeth, with its elements perpendicular to those of the pitch cone.

Full-Depth Teeth -
Teeth in which the working depth equals 2.000 divided by normal diametral pitch.

Gear Center -
The center of the pitch circle.

Gear Ratio -
The ratio of the numbers of teeth in mating members.

Groove Depth -
The depth of the clearance groove between helice's of herringbone gears.

Groove Width -
The width of clearance groove between helice's of herringbone gears.

Heel -
The portion of the tooth surface near its outer end.

Helical Gear -
A cylindrical gear with helical teeth.

Helical Rack -
A rack having teeth that are oblique to the direction of motion.

Helix Angle -
The angle between a tangent to the helix and an element of the cylinder. Unless otherwise specified, the pitch helix is referred to.

Hourglass Worm -
See enveloping worm.

Hub Diameter -
The diameter of the central part of the gear body surrounding the bore and extending beyond the web, spokes, or body.

Hub Extension -
The distance that the hub extends beyond the face of the gear body.

Hypoid Gears -
Gears similar in general form to bevel gears but designed to operate on non-intersecting axes.

Inner Cone Distance -
The distance from the apex of the pitch cone to the inner ends of the teeth.

Inner Spiral Angle -
The spiral angle of a bevel gear at the inner ends of the teeth.

Inside Cylinder -
The surfaces that coincides with the tops of the teeth of an internal cylindrical gear.

Interference -
The contact between mating teeth at some other point than along the line of action.

Internal Diameter -
The diameter of that circle which contains the tops of the teeth of an internal gear.

Internal Gear -
A gear with the teeth formed on the inner surface of a cylinder or cone.

Involute Polar Angle -
The angle between a radius vector to a point on an involute curve and a radial line to the point where the curve touches the base circle.

Involute Roll Angle -
An angle whose arc on the base circle of radius unity equals the tangent of the PA at a selected point on the involute.

Involute Teeth of Gears - (helical gears, and worms)
Are those in which the active portion of the profile in the Transverse plane is the involute of a circle.

Lead -
The axial advance of a helix for one complete turn, as in the threads of cylindrical worms and teeth of helical gears.

Lead Angle -
The angle between a tangent to the pitch helix and a plane of rotation.

Length of Action -
The distance on an involute line of action through which the point of contact moves during the action of the tooth profiles.

Line of Action -
That portion of the common tangent to the base circles along which contact between the mating involute teeth occurs.

Line of Centers -
The straight line through the center of tangent pitch circles.

Line of Contact -
The line or curve along which two tooth surfaces are tangent to each other.

Long-and-Short Addendum Teeth -
The teeth of engaging gears (on a standard designed center distance), one of which has a long addendum and the other has a short addendum.

Mean Cone Distance (in Bevel Gears) **-**
The distance from the apex of the pitch cone to the middle of the face width.

Mean Spiral Angle -
The specific designation for the spiral angle at the mean cone distance in a bevel gear.

Miter Gears -
Mating bevel gears with equal numbers of teeth and with axes at right angles.

Modified Addendum Teeth -
The teeth of engaging gears, one or both of which have nonstandard addendum.

Modified Contact Ratio -
The contact ratio of Modified tooth surfaces

Module (m = D/N) - (metric)
The ratio of the pitch diameter in millimeters to the number of teeth.

Mounting Distance -
The distance, for assembling bevel gears or hypoid gears, from the crossing point of the axes to a location surface of a gear, which may be at either back or front.

Normal Base Pitch -
Distance on a normal base helix between corresponding involutes of adjacent teeth.

Normal Chordal Addendum -
Chordal addendum in a normal plane.

Normal Chordal Thickness -
The length of the normal thickness chord between pitch line elements of a tooth.

Normal Circular Thickness -
The circular thickness in the normal plane. In helical gears, it is an arc of the normal Helix.

Normal Circular Pitch - (normal to helix)
The shortest distance on the pitch surface between corresponding pitch line elements of adjacent teeth.

Normal Diametrical Pitch -
The diametrical pitch corresponding to the normal circular pitch and calculated in the normal plane.

Normal Helix -
The helix on a pitch cylinder normal to the pitch helix.

Normal Plane -
The plane perpendicular to a given straight line or to a tangent to a curved line.

Normal PA -
The PA in a plane normal to the pitch line element.

Normal Profile Angle -
The profile angle in a normal plane of a helical or spiral tooth.

Normal Tooth Profile -
The outline formed by the intersection of a tooth surface and a plane perpendicular to the pitch line element.

Number of Threads in Worm -
The number of starts, or separate threads on the worm.

Outside Diameter of Gear, Pinion or Worm -
The diameter of the circle which contains the tops of the teeth of an external gear.

Offset -
The perpendicular distance between the axes of hypoid gears or offset face gears.

Operating Pitch Diameters -
The pitch diameters determined from the numbers of teeth and the center distance at which gears operate.

Outer Cone Distance -
The distance from the apex of the pitch cone to the outer ends of the teeth.

Outer Spiral Angle -
The spiral angle of a bevel gear at the outer cone distance.

Outside Cylinder -
The surface that coincides with the tops of the teeth of an external cylindrical gear.

Outside Helix -
The helix formed by the intersection of a tooth surface and the outside cylinder.

Outside Helix Angle -
The helix angle on the outside cylinder.

Outside Lead Angle -
The lead angle on the outside cylinder.

Outside Radius of Gear or Pinion -
The radius of the circle which contains the tops of the teeth of external gears.

Path of Contact -
The curve on either tooth surface along which contact occurs in gears which normally engage with only single point contact.

Pinion -
A gear with a small number of teeth. Of two gears that run together the one with the smaller number of teeth is called the pinion.

Pitch Angle -
The angle between an element of a pitch cone and its axis.

Pitch Apex to Back - (Apex to Back)
In a bevel or hypoid gear, the distance in the direction of the axis from the apex of the pitch cone to a locating surface at back of the blank.

Pitch, Circular -
The distance on the circumference of the pitch circle between corresponding points of adjacent teeth.

Pitch Circle - (see pitch diameter and pitch radius)
The circle through the pitch point having its center of the axis of the gear.

Pitch Circle - (Circumference)
The circumference of the pitch circle.

Pitch Cone -
A cone whose apex is at the intersection of axes and whose base is a pitch circle.

Pitch Cylinder -
The imaginary cylinder in a gear that rolls without slipping on a pitch cylinder or pitch plane of another gear.

Pitch, Diametral - (in plane of rotation)
The ratio of the number of teeth to the number of inches in the pitch diameter. It indicates the number of teeth in the gear f or each inch of pitch diameter.

Pitch Diameter -
The diameter of the pitch circle. In parallel shaft gears, the pitch diameters can be determined directly from the center distance and the number of teeth by proportionality. Operating pitch diameter is the pitch diameter at which the gears operate.

Pitch Helix -
The helix formed by the intersection of the surface of a helical tooth or thread with the pitch cylinder.

Pitch Helix Angle -
The angle between any helix and an element of its cylinder.

Pitch Lead Angle -
The lead angle on a pitch cylinder.

Pitch Line Element -
A line curved or straight, formed by the intersection of the pitch surface and the tooth surface.

Pitch Plane -
The plane which is tangent to both the pitch cylinder of the worm and the pitch cylinder of the gear.

Pitch Radius of Gear or Pinion -
The radius of the pitch circle.

Pitch Point -
The intersection between the axes of the line of centers and the line of action.

Pitch Range -
The difference between the longest and the shortest pitches on a gear.

Pitch Surface -
The surface of the pitch cylinder, which rolls with the surface of the mating member.

Plane of Action -
A surface of action in involute parallel axis gears, tangent to their base cylinders.

Point of Contact -
The point at which two tooth profiles touch each other.

Plane of Rotation -
Is any plane perpendicular to a gear axis.

PA -
The angle between a tooth profile and the radial line at its pitch point. In involute teeth, PA is often described also as the angle between the line of action and the line of tangent to the pitch circle. Standard PAs are established in connection with standard gear-tooth proportions.

Profile Angle -
The angle between a tangent to a tooth profile and the radius from the gear axis to the tangent point. In gear cutting tools, the angle between a cutting edge and some principal direction in the tool.

Profile Control Diameter -
The diameter of the circle beyond which the tooth profile must conform to the specified involute curve.

Profile Radius of Curvature -
The radius of curvature of a tooth profile at a specified point.

Rack General -
A gear with teeth spaced along a straight line, and suitable for straight-line motion.

Revacycle Bevel Gears -
Straight bevel gears generated by a special process with a special tooth form.

Right-Hand Helical Gear -
A gear in which the teeth twist clockwise as they recede from an observer looking along the axis.

Right-Hand Spiral Bevel Gear -
A spiral bevel gear in which the other half of a tooth is inclined in the clockwise direction from the axial plane through the midpoint of a tooth as viewed by an observer looking at the face of the gear.

Root Angle -
The angle between an element of the root cone and its axis.

Root Circle -
The circle containing the bottom of the tooth spaces.

Root Cone -
The imaginary cone tangent to the bottoms of the tooth spaces.

Root Cylinder -
The imaginary cylinder tangent to the bottoms of the tooth spaces in a cylindrical gear.

Root Diameter of Gear, Worm or Pinion -
The diameter of the circle which contains the roots of the teeth.

Root Radius -
The radius of the root circle.

Shaft Angle -
The angle between the axes of oppositely rotating portions of nonparallel shafts of mating gears.

Single-Helical Gears -
Helical gears that have teeth of only one hand on each gear.

Skew Bevel Gear -
Bevel gears for which the corresponding crown gear has teeth that are straight and oblique.

Space Bottom -
A line joining two fillets of adjacent tooth profiles in the same plane.

Spiral Angle -
The angle between a tooth trace and an element of the pitch cone.

Spiral Bevel Gear -
Bevel gears whose teeth are curved and oblique.

Spur Gears -
Gears cylindrical in form, with teeth that are straight and parallel, and that operate on parallel axes.

Spur Rack -
A rack with straight teeth that are at right angles to the direction of motion.

Straight Bevel Gears -
Bevel gears with straight tooth elements which, if extended, would pass through the point of intersection of their axes.

Stub Teeth -
Are those in which the working depth is less than 2.000 divided by normal diametral pitch.

Surface of Action -
The imaginary surface in which contact occurs between two engaging tooth surfaces. It is the summation of the paths of action in all sections of the engaging teeth.

Tangent Plane -
The plane tangent to a tooth surface at a point or line of contact.

Throat Diameter - (of Worm Gear)
The outside diameter of worm gear in central plane.

Throat Form Radius -
The radius of the throat surface of an enveloping wormgear, or of an hourglass worm, in an axial plane.

Teeth, Left Hand -
Are the teeth which twist to the left, or in a counterclockwise direction, as they recede from the observer.

Teeth, Right Hand -
Are the teeth which twist to the right or in a clockwise direction, as they recede from the observer.

Tip Radius -
The radius of the surface joining the top land (end cutting edge) and its adjacent addendum surface (side cutting edge) of a gear-cutting tool.

Tip Relief -
An arbitrary Modification of a tooth profile whereby a small amount of material is removed near the tip of the gear tooth.

Toe -
The portion of the tooth surface near its inner end.

Tooth Bearing -
The portion of the tooth surface which actually comes into contact.

Tooth Chamfer -
The bevel between the end of a tooth and the tooth surface, to break the sharp edge.

Tooth Face -
The surface between the pitch line element and the top of the tooth.

Tooth Fillet -
The curved surface of the tooth flank joining it to the bottom land.

Tooth Flank -
The surface between the pitch line element and the bottom land - it includes the fillet.

Tooth Profile -
The outline in a designated plane of a tooth between the addendum and root circles.

Tooth Surface -
The total area including the tooth face and the tooth flank.

Tooth Thickness on Base Circle -
The distance on the base circle between involutes of the same tooth.

Tooth-to-Tooth Composite Action -
The greatest amount of composite action within any single pitch or contact throughout an entire gear.

Tooth Top -
A line joining the outer ends of two adjacent tooth profiles in the same place, in internal gearing it is the inner ends of the teeth.

Top Land -
The (sometimes flat)surface of the top of the gear tooth.

Total Composite Action -
The total amount of composite action for an entire gear.

Total Contact Ratio -
The sum of the Transverse contact ratio and the face contact ratio.

Total Face Width -
The actual dimension of a gear blank that exceeds the effective face width, or as in double-helical gears where the total face width includes any distance separating right-hand and left-hand helices.

Transverse Circular Thickness -
The circular tooth thickness in the Transverse plane.

Transverse Contact Ratio -
The ratio of the arc of action to the Transverse circular pitch.

Transverse Diametral Pitch -
The ratio of the number of teeth to the number of inches in the Transverse pitch diameter. There is a fixed relation between Transverse diametral pitch (TP), and Transverse circular pitch (tp), namely tp = n/TP

Transverse Pitch -
The distance between corresponding pitch line elements of adjacent teeth in the plane of rotation.

Transverse Plane -
A plane that lies Perpendicular to the axial plane and to the pitch plane. In gears with parallel axes, the Transverse plane and plane of rotation coincide.

Transverse PA -
The PA in the Transverse plane.

Transverse Profile Angle -
The profile angle in a Transverse plane.

Undercut -
A condition in generated gear teeth when any part of the fillet curve lies inside of a line drawn tangent to the true involute form at its lowest point. Undercut may be deliberately introduced to facilitate finishing operations.

Whole Depth - (total depth)
The radial distance between the outside circle and the root circle.

Worm -
A gear with one or more teeth in the form of screw threads, a worm is meshed with a worm wheel, which looks similar to a spur gear.

Worm Gear -
A device consisting of a threaded shaft (worm) that mates with a gearwheel (worm wheel) so that rotary motion can be transferred between two shafts at right angles to each other

Wormgearing -
A gearing comprising worms and their mating gears, with axes usually at right angles.

Working Depth -
The greatest depth to which a tooth of one gear extends into the tooth space of the mating gear.

Zone of Action -
The rectangular area in a plane of action limited by the length of action and the face width.

Symbols for Rules & Formulas

Addendum	**a**
Addendum Angle	α
Allowable Pitch Variation	**V**pA
Allowable Variation	**A**
Angular Pitch	0N
Arc of Action	**Q**t
Arc of Approach	**Q**a
Arc of Recess	**Q**r
Axial Base Pitch	**P**x
Axial Pitch	**P**X
Axial PA	Φ**X**
Axial Thickness	**t**x
Backlash	**B**
Base Circular Thickness	**t**b
Base Diameter	**D**b
Base Helix Angle	Ψ**b**
Base Lead Angle	λ**b**
Base Pitch	**P**b
Center Distance	**C**
Chordal Addendum	**a**c
Chordal Thickness	**t**c
Circular Pitch	**P**
Circular Tooth Thickness	**t**
Clearance	**c**
Contact Ratio	**m**c
Datum Circle	**m**F
Dedendum	**b**
Diametral Pitch (Transverse)	**P**d
Effective or Active Face Width	**F**e
Equivalent Number of teeth	**N**e
Face Contact Ratio	**m**F
Face Width	**F**
Features on a Gear	**G**
Features on a Pinion	**P**
Features on a Worm	**W**
Fillet Radius	**r**f
Gear Ratio	**m**G
Helix Angle, Spiral Angle	Ψ
Index Variation	**V**x
Internal Diameter	**D**i
Involute Polar Angle	0
Involute Roll Angle	ε
Lead	**L**
Lead Angle	λ
Length of Action	**Z**
Modified Contact Ratio	**m**o
Module	**m**
Normal Base Pitch	**P**N
Normal Chordal Addendum	**a**nc
Normal Chordal Thickness	**t**nc
Normal Circular Pitch	**P**n
Normal Circular Thickness	**t**n
Normal Diametral Pitch	**P**nd
Normal Module	**m**n
Normal Pitch Variation	**V**pn
Normal Plane	**n**
Normal PA	Φn
Number of teeth or threads	**N**
Operating Pitch Diameter	**d**p
Outside Diameter	**D**O
Outside Lead Angle	λo
Pitch Angle	Ѓ
Pitch Lead Angle	λp
Pitch Variation	**V**p
PA	Φ
Profile Radius of Curvature	**p**
Profile Tolerance	**V**ΦT
Profile Variation	**V**Φ
Quality Number	**Q**
Radial Runout	**V**r
Radial Runout Tolerance	**V**rT
Reference Standard Pitch Diameter	Ѓ **R**
Root Angle	
Root Diameter	**D**R
Shaft Angle	Σ
Spacing Variation	**V**s
Test Radius	**R**r
Throat Diameter	**D**t
Throat Form Radius	**r**t
Tip or Edge Radius of Tool	**r**T
Tolerance	
Tooth Alignment Tolerance	**V**ΨT
Tooth Alignment Variation	**V**Ψ
Tooth Thickness Tolerance	**t**T
Tooth-to-Tooth Composite Tolerance(double flank)	**V**qT
Tooth-to-Tooth Composite Variation (double flank)	**V**q
Total Accumulated Pitch Variation	**V**ap
Total Accumulated Pitch Variation within a sector of k Pitches	**V**apk
Total Composite Tolerance (double flank)	**V**cqt
Total Composite Variation (double flank)	**V**cq
Total Contact Ratio	**m**t
Total Face Width	**F**t
Transverse Circular Pitch	**P**t
Transverse Circular Thickness	**t**t
Transverse Contact Ratio	**m**p
Transverse Plane	**t**
Transverse PA Φt	
True Position Pitch	**P**m
Variable	**k**
Whole Depth(tooth depth)	**h**t
Working Depth	**h**k

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Diametral Pitch Spur Gear Formulas

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Module	Diametral Pitch	Divide 25.4 by the diametral Pitch	$m = \frac{25.4}{Pd}$
Diametral Pitch	Module	Divide 25.4 by the module	$Pd = \frac{25.4}{m}$
	Circular Pitch	Divide π by the circular pitch	$Pd = \frac{\pi}{P}$
	Pitch Diameter and Number of Teeth	Divide the # of Teeth by Pitch Diameter	$Pd = \frac{N}{D}$
	Outside of Gear and Number of Teeth	Divide the # of Teeth plus 2 by the outside diameter	$Pd = \frac{N+2}{Do}$
	Base Pitch and Pressure Angle	Divide the base pitch by the cosine of the pressure angle then divide by π	$Pd = \frac{\pi \cdot \cos\Phi}{Pb}$
Operating Diametral Pitch	Center Distance between 2 gears and # of teeth in both	Add the # of Teeth in both gears and divide by 2, then divide by center distance	$dp = \frac{(n1 + n2)}{C}$
Pressure Angle	Base Diameter and Pitch Diameter	Divide the base diameter by pitch diameter	$\cos\Phi = \frac{Db}{D}$
	Base Pitch and Diametral Pitch	Divide π by diametral pitch, then divide by the base pitch	$\cos\Phi = \frac{Pd \cdot Pb}{\pi}$
	Base Pitch and Circular Pitch	Divide the Base Pitch by the circular pitch = cosine pressure angle	$\cos\Phi = \frac{Pb}{P}$
Pitch Diameter	# of Teeth & Diametral Pitch	Divide the # of Teeth by Diametral Pitch	$D = \frac{N}{Pd}$
	# of Teeth & Outer Diameter	Divide the product of the outer diameter and # of Teeth by # of Teeth plus two	$D = \frac{N \cdot Do}{(N+2)}$
	Addendum and # of Teeth	Multiply addendum by # of Teeth	$D = a \cdot n$
	Base Diameter and Pressure Angle	Divide the Base Diameter by the cosine of the pressure angle	$D = \frac{Db}{\cos\Phi}$
Outside Diameter	# of Teeth and Diametral Pitch	Divide the # of Teeth plus two by the diametral pitch	$Do = \frac{N+2}{Pd}$
	Pitch Diameter and Diametral Pitch	Add the Pitch Diameter to the quotient of 2 divided by the diametral pitch	$Do = D + \frac{2}{Pd}$
	Pitch Diameter and # of Teeth	Divide the # of Teeth plus 2 by the quotient of # of teeth divided by the pitch diameter	$Do = D + \frac{2D}{N}$
	# of Teeth and Addendum	Multiply the # of Teeth plus 2 by addendum	$Do = (N + 2)\, a$
Number of Teeth	Pitch Diameter and Diametral Pitch	Multiply pitch diameter by the diametral pitch	$N = D \cdot Pd$
	Outside Diameter and Diametral Pitch	Multiply outside diameter by the diametral pitch and subtract 2	$N = Do \cdot Pd - 2$
Std. Thickness of Tooth	Diametral Pitch	Divide 1.5708 by the diametral pitch	$t = \frac{1.5708}{Pd}$
Std. Addendum	Diametral Pitch	Divide 1 by the diametral pitch	$a = \frac{1}{Pd}$
Std. Dedendum	Diametral Pitch	Divide 1.157 (or 1.25) by the diametral pitch	$b = \frac{1.157}{Pd}$
Std. Whole Depth	Diametral Pitch	Divide 2.157 (or 2.25) by the diametral pitch	$ht = \frac{2.157}{Pd}$
Clearance	Diametral Pitch	Divide .157 (or .250) by the diametral pitch	$c = \frac{.157}{Pd}$
Center Distance	Normal Diametral Pitch and # of Teeth in both gears	Add # of teeth in both gears together and divide by 2, then divide result by the normal diametral pitch.	$C = \frac{(N1 + N2)}{2 \cdot Pnd}$
Operating Center Distance	Operating Diametral Pitch and # of Teeth in both gears	Add # of teeth in both gears together and divide by 2, then divide result by operating diametral pitch.	$C = \frac{(N1 + N2)}{2 \cdot Pod}$
Base Diameter	Pitch Diameter and Pressure Angle	Multiply the pitch diameter by cosine of the pressure angle	$Db = D \cdot \cos\Phi$
Base Pitch	Diametral Pitch and Pressure Angle	Divide the diametral pitch by π, then multiply by cosine of pressure angle	$Pb = \cos\Phi \cdot \frac{\pi}{Pd}$

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Circular Pitch Spur Gears

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Module	Circular Pitch	Divide the Circular Pitch by .12368	$m = \frac{P}{0.12368}$
Circular Pitch	Diametral Pitch	Divide p by the diametral pitch	$P = \frac{\pi}{Pd}$
	Module	Multiply the Modules by .12368	$P = m \cdot 0.12368$
	Pitch Diameter and # of Teeth	Divide pitch diameter by the product of .3183 and # of Teeth	$P = \frac{D}{0.3183} \cdot N$
	Outside diameter and # of Teeth	Divide outside diameter by the product of .3183 and number of teeth plus 2	$P = \frac{D}{0.3183} (N + 2)$
Pitch Diameter	# of Teeth and Circular Pitch	The continued product of the number of teeth, the circular pitch and .3183	$D = N \cdot 0.3183p$
	Outside Diameter and Circular Pitch	Subtract from the outside diameter the product of the circular pitch and .6366	$D = D - (0.6366p)$
Outside Diameter	# of Teeth and Circular Pitch	Divide # of Teeth plus 2 by π divided by circular pitch	$Do = \frac{(N + 2) \cdot P}{\pi}$
	Pitch Diameter and Circular Pitch	Add to the pitch diameter the product of the circular pitch and .6336	$Do = D + 0.6336p$
Number of Teeth	Pitch Diameter and Circular Pitch	Divide the product of pitch diameter and π by the circular pitch	$N = \frac{\pi \cdot D}{P}$
Circular Tooth Thickness	Circular Pitch	One-half the circular pitch	$t = \frac{P}{2}$
Std. Addendum	Circular Pitch	Multiply the circular pitch by .3183	$a = 0.3183 \cdot P$
Std. Dedendum	Circular Pitch	Multiply the circular pitch by .3683	$b = 0.3683 \cdot P$
Whole Depth (2.157/DP)	Circular Pitch	Multiply the circular pitch by .6866	$h_t = 0.6866 \cdot P$

Worm Gears

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Linear Pitch (circular axial)	Lead and # of threads in worm	Divide the lead by the # of threads in worm	$Px = \frac{L}{Nw}$
Normal Diametral Pitch	Axial diametral pitch & worm hear helix angle	Divide the axial diametral pitch by the cosine of the worm helix angle	$Pnd = \frac{Pxd}{Cos.\Psi}$
Axial Diametral Pitch	Normal diametral pitch & worm helix angle	Multiply normal diametral outch by the cosine of the worm helix angle	$Pxd = Pnd \cdot Cos.\Psi$
	# of teeth in wormwheel & Pitch diameter of wormwheel	Divide the # of Teeth in the wormwheel by pitch diameter of the wormwheel	$Pxd = \frac{NG}{D}$
Helix Angle of Worm	Worm pitch diameter & lead	Multiply the worm pitch diameter by π, and divide the product by the lead. The quotient is the co-tangent of the helix angle of worm	$CoTan\Psi = \pi \cdot \frac{Dw}{L}$
	Normal diametral pitch & axial diametral pitch	Divide the axial diametral pitch by the normal diametral pitch	$Cos.\Psi = \frac{Pxd}{Pnd}$
Pitch Diameter of Worm	Pitch diameter of wormwheel & center distance	Subtract the pitch diameter of the wormwheel from twice the center distance	$Dw = 2C-DG$
	Outside diameter & addendum	Subtract twice the addendum from the outside diameter	$Dw = D-2a$
Pitch Diameter of Wormwheel	Linear pitch & number of teeth	Multiply the # of teeth in the wheel by the linear pitch of the worm, then divide by π	$DG = NG \cdot \frac{PG}{\pi}$
	Pitch Diameter of worm & center distance	Divide the worm pitch diameter by 2 minus the center distance, multiplied by 2	$DG = ((Dw/2) - C) \cdot 2$
Center Distance between worm and wormwheel	Pitch Diameter of worm & wormwheel	Add pitch diameter of worm & wormwheel, then divide the sum by 2	$C = \frac{(Dw + DG)}{2}$

WORM GEARS (Continued)

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Addendum of Worm Tooth	Axial Circular Pitch	Multiply the pitch by 0.318	$a = 0.3183 \cdot PX$
Whole Depth of Worm Tooth	Axial Circular Pitch	Multiply linear pitch by 0.6866	$W = 0.68866 \cdot PX$
Root Diameter of Worm	Whole Depth and O.D	Subtract twice the whole depth of tooth from the outside diameter	$Dr = Do-(2 \cdot ht)$
Point Width of Thread Tool (14.5 PA)	Normal Circular Pitch	Multiply the linear pitch by 0.31	$T = 0.31 \cdot Pn$
Throat Diameter of Worm Wheel	Wormwheel PD and worm addendum	Add twice the addendum of the worm tooth	$Dt = D \cdot 2a$
Outside Diameter of Worm	Pitch Diameter and addendum	Add together the pitch diameter and two times the addendum	$Do = D + 2a$
Lead Angle	Worm lead and circumference of the pitch circle of worm	Divide the lead of the worm by the circumference of the pitch circle of the worm. Multiply the result with the arctangent.	$\lambda = \arctan\left(\frac{L}{\pi \cdot Dw}\right)$
Lead of Worm	Linear pitch and number of threads in worm	Multiply the linear pitch by the number of threads in the worm.	$L = Px \cdot Nw$
Worm PD	Lead and Lead angle of worm	Divide the lead of worm by the tangent of the helix angle then divide by π	$Dw = \frac{L / \tan\lambda}{\pi}$
Lead of Worm	Worm PD and Helix angle of worm	Multiply the worm PD by π, then multiply by the tangent of the lead angle.	$L = D_w \cdot \pi \tan\lambda$
Ratio	# of teeth in wormwheel and number of threads in worm	Divide the # of Teeth in the wormwheel by the # of teeth in the worm	$mG = \frac{NG}{NW}$

HELICAL GEARS
Rules and Formulas

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Normal DP	Transverse DP and Helix Angle	Divide the Transverse DP by the cosine of the helix angle	$P_{nd} = \frac{P_d}{\cos \Psi}$
Transverse DP	Normal DP and helix angle	Multiply normal DP by the cosine of the helix angle	$Pd = Pnd \cdot \cos \Psi$
Normal P.A.	Transverse P.A. and helix angle of gear	Multiply the tangent of the Transverse P.A. by the cosine of the helix angle = INV/tan normal P.A.	$\Phi n = \frac{inv}{\tan} (\tan \Phi t \cdot \cos \Psi)$
Transverse P.A.	Normal P.A. and helix angle of gear	Divide the tangent of NPA by the cosine of the helix angle = TAN trans. P.A.	$\tan \Phi_t = \frac{\tan \Phi_n}{\cos \Psi}$
Pitch Diameter	Number of teeth, normal pitch and tooth angle Number of teeth plus Transverse diameter pitch	Divide the number of teeth by the product of the normal pitch and the cosine of the tooth angle Divide the number of teeth in the gear by the Transverse diametral pitch	$D = \frac{NG}{P_{nd} \cos \Psi}$ $D = \frac{N}{Pd}$
Normal Circular Pitch	Transverse CP and Helix Angle	Multiply the Transverse CP by the cosine of the helix angle	$P_n = P_t \cos. \Psi$
Lead of Helical Gear	Pitch Circumference and Helix Angle Normal CP, #of Teeth and Helix Angle	Divide the pitch circumference by the tangent of the helix pitch. Divide the product of the number of teeth times the normal CP by the sine of the helix angle.	$L = \frac{\pi \cdot D}{\tan \Psi}$ $L = \frac{n \cdot P_n}{\sin \Psi}$
Helix Angle	Normal CP and Transverse circular pitch Pitch Diameter plus lead Normal and Trans P.A.	Divide the normal CP by the Transverse circular pitch, the quotient will be the cosine of the helix angle. Multiply the pitch diameter by π, divide the results by the lead. Divide the tangent of the normal PA by the tangent of the Transverse PA = cosHA	$\cos \Psi = \frac{Pt}{Pn}$ $\tan \Psi = \frac{D \cdot \pi p}{L}$ $\cos \Psi = \frac{\tan \Phi}{\tan \Phi_t}$
Outside Diameter	Pitch Diameter and Addendum	Add twice the addendum to the pitch diameter	$D_O = 2 \cdot a + D$
Center Distance	Pitch Diameters of both gears	Add together the pitch diameter of the two gears and divide the sum by 2.	$C = \frac{D_1 + D_2}{2}$
Lead	Pitch Diameter and Helix Angle	Multiply the pitch diameter by π, times the cotangent of the tooth angle.	$L = \pi \cdot D \cot an \Psi$
Addendum	Normal DP	Divide 1 by the normal diametral pitch	$a = \frac{1}{P_{nd}}$
Whole Depth of Tooth	Normal DP	Divide 2.157(or 2.25) by the normal diametral pitch	$h_t = \frac{2.15}{P_{nd}}$
Normal Tooth Thickness at pitch line	Normal DP	Divide 1.571 by the normal diametral pitch	$T_n = \frac{1.571}{P_{nd}}$
Operating Transverse Diametral Pitch	Number of Teeth in both gears plus operating center distance	Add the number of teeth in both gears together, divide by two, then divide by the operating center distance.	$P_{od} = \frac{(N1 + N2)/2}{C}$
Operating Center Distance	Number of Teeth in both gears plus the operating Transverse diametral pitch	Add the number of teeth in both gears together, divide by two, then divide by the operating Transverse diametral pitch.	$C = \frac{(N1 + N2)/2}{P_{od}}$
Number of Teeth in Gear	Pitch Diameter plus Transverse diametral pitch	Multiply the pitch diameter by the Transverse diametral pitch	$N = D \cdot P_d$
Transverse DP	Pitch Diameter and Number of Teeth	Divide TPD by # of teeth	$P_d = \frac{N}{P_d}$
Base Diameter	Pitch Diameter and Transverse P.A.	Multiply the Pd by trans. PA	$D_b = D \cdot \cos \Phi_t$

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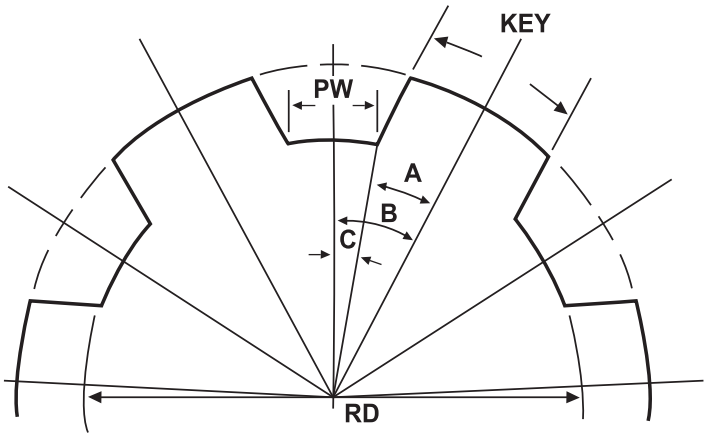
INVOLUTE SPLINES AND SERRATIONS 30° PA

TO GET	GIVEN / INPUTS	CALCULATION RULE	FORMULA
Diametral Pitch	Outer diameter and number of teeth	Divide number of teeth plus 1 by the outer diameter	$Pd = \frac{N+1}{DO}$
Pitch Diameter	Outer diameter and number of teeth	Divide the product of outer diameter and number of teeth by number of teeth plus 1	$D = \frac{N\,DO}{(N+1)}$
Outer Diameter	Diametral pitch and number of teeth	Divide the number of teeth plus 1 by the quotient of number of teeth divided by pitch diameter	$Do = D + \frac{D}{N}$
Diametral Pitch	Minor diameter and number of teeth	Divide number of teeth minus 1 by the Minor diameter	$Do = D - \frac{D}{N}$
Minor Diameter	Diametral pitch and number of teeth	Divide number of teeth minus 1 by the diametral pitch	$Di = \frac{(N-1)}{Pd}$

STANDARD S.A.E PARALLEL KEY SPLINE

# of KEYS	SPACE WIDTH INTERNAL	A FIT Permanent Fit		B FIT To Slide Not Under Load		C FIT To Slide Under Load		NOMINAL MAJOR DIAMETER
		WD	Minor	WD	Minor	WD	Minor	
4	0.241D	0.075 D	0.850D	0.125D	0.750D			To 3
6	0.250D	0.050D	0.900D	0.075D	0.850D	0.100D	0.800D	To 3
10	0.156D	0.045D	0.910D	0.070D	0.860D	0.095D	0.810D	To 6
16	0.098D	0.045D	0.910D	0.070D	0.860D	0.095D	0.810D	To 6

POINT WIDTH CONVERSION FOR STRAIGHT SIDED SPLINE



N = Number of Keys
B = 180°/N
SIN A = KW/RD
C = B-A
PW = RD X SIN C
N = 6
KW = .371
RD = 1.271

EXAMPLE:
B = 180/6 = 30°
SIN A = .2919
A = 16.97151°
C = 13.02849
SIN C = .22543
W = 1.271•.22543
PW = .2865