

# Parallel-Axis Gear Terminology

For more detailed coverage of this subject, consult ANSI/AGMA Standard 1012-F90;  
Gear Nomenclature, Definitions with Terms and Symbols

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

**Addendum-** the radial or perpendicular distance between the pitch circle and the tip of the teeth.

**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.

**Arc of Recess –** the arc through which the tooth moves from the time when the contact is at the pitch point until it ceases to be in contact with its mating tooth.

**Arc Space Width-** see Circular Space Width

**Arc Tooth Thickness –** see Circular Thickness

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

**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.

**Backlash-** the amount by which the width of a tooth space exceeds the thickness of the engaging tooth on the pitch circles.

**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 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.

**Basic Rack-** For every pair of conjugate involute profiles there is a basic rack. This basic rack is the profile of the conjugate gear of infinite pitch radius.

**Bottom Land-** the surface of the gear between the flanks of adjacent teeth.

**Center Distance-** the shortest distance between nonintersecting axes of mating gears.

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

**Chordal Thickness-** the length of the chord subtending the circular thickness arc.

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

**Circular Space Width-** internal spline specifications use circular space width, rather than circular tooth thickness dimensions. Circular space width is equal to circular pitch minus circular tooth thickness.

**Circular Thickness-** the length of the arc on the pitch circle between the two sides of a gear tooth.

**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.

**Conjugate Curves-** gear teeth are a series of cam surfaces that act on similar surfaces of the mating gear. Curves that act on each other with a smooth driving action and with a constant driving ratio are called *conjugate curves*.

**Conjugate Action-** a smooth driving action that produces a constant angular velocity in the driven member.

**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.

**Crowned Teeth-** teeth having surfaces modified in the lengthwise direction; in gears, to prevent contact at their ends. In splined couplings crowning accommodates slight angular misalignments.

**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  $p = \pi/P$ .

**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 that actually comes into contact with a mating gear.

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

**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 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 Width-** the length of teeth in the axial plane.

**Face Width, Effective-** the width of the face that may actually come in contact with mating teeth.

**Face Width, Total-** (for double helical gears) the width of the pitch 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.

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

**Gear Blank-** the work piece used for the manufacture of a gear, prior to machining the gear teeth.

**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 helices of double helical gears.

**Groove Width-** the width of the clearance groove between helices of double helical gears.

**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.

**Herringbone Gears** – a type of double helical gear, having no clearance groove.

**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.

**Inside Cylinder-** the surfaces that coincide with the tops of 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 teeth of an internal gear.

**Involute Curve-** the curve that is described by the end of a line that is unwound from the circumference of a circle. The circle from which the line is unwound is called the *base circle*.

**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 pressure angle 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-** the path of contact in involute gears; the straight line passing through the pitch point and tangent to the base circles of mating gears

**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 a short addendum.

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

**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 tooth 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 Pressure Angle-** the pressure angle in 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.

**Outside Diameter of Gear**- the diameter of the circle, which contains the tops of the teeth of an external gear.

**Operating Pitch Diameters**- the diameter of the circle on a gear which is proportional to the gear ratio and the actual center distance at which the gear pair will operate.

**Operating Pressure Angle**- determined by the center distance at which the gears operate; it is the pressure angle at the operating pitch diameter.

**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, 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 on the axis of the gear.

**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 for each inch of pitch diameter.

**Pitch Diameter (standard)**- the circle which intersects the involute at the point where the pressure angle is equal to the profile angle of the basic rack. In parallel axis gearing, the standard pitch diameter of a gear is determined by dividing the number of teeth in the gear by the transverse diametral pitch.

**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 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**- any plane perpendicular to a gear axis.

**Pressure Angle**- the angle between a tooth profile and the radial line at its pitch point. The pressure angle is often described as the angle between the line of action and a line tangent to the pitch circle. Standard pressure angles 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 instantaneous radius of a tooth profile at a specified point.

**Protuberance-** tooth form modification on the gear-generating tool to remove material below the form diameter on the gear tooth to allow clearance for finishing by grinding or shaving.

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

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

**Root Circle-** the circle containing the bottom 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.

**Single-Helical Gears-** helical gears having teeth of only one hand on each gear.

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

**Spur Gears-** gears that are 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.

**Stub Teeth-** teeth having a working depth 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.

**Tip Relief-** an arbitrary modification of a tooth profile whereby a small amount of material is removed near the tip of the gear tooth.

**Tolerance, Tooth Alignment-** the permissible amount of tooth alignment variation; values are normal to the tooth surface.

**Tolerance, Tooth Thickness-** the permissible amount of tooth thickness variation.

**Tooth Bearing-** that 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 Variation-** the greatest change in center distance while the gear being tested is rotated through any angle of  $360^\circ/N$  during double flank composite action testing.

**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 surface on the top of the 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; in double-helical gears, the total face width includes any distance separating right-hand and left-hand helices.

**Transverse Circular Thickness-** the circular tooth thickness in the plane of rotation.

**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.

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

**Transverse Plane-** perpendicular to the axial plane and to the pitch plane. In gears with parallel axes, the transverse plane and plane of rotation coincide.

**Transverse Pressure Angle-** the pressure angle in the plane of rotation.

**Transverse Profile Angle-** the profile angle in a transverse plane.

**Trochoid-** a curve which is traced on a rotating plane by a designated point on a second plane. This is commonly the form of a generated root fillet.

**Undercut-** a condition in generated gear teeth when 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.

**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.