

Mechanical Drawing II

Code: MAE227

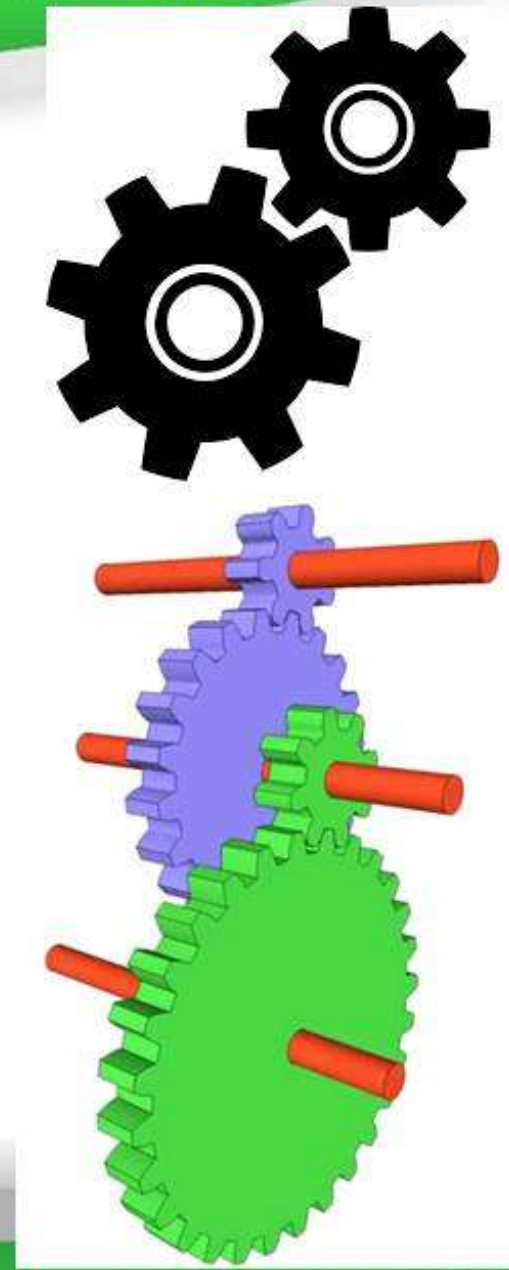
Gears

Gears:

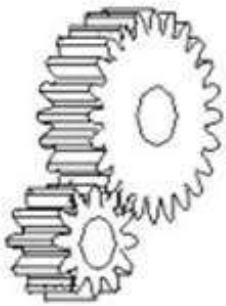
Gears are machine elements, which are used for power transmission between shafts, separated by small distance.

Irrespective of the type, each gear is provided with projections called teeth and intermediate depressions called tooth spaces.

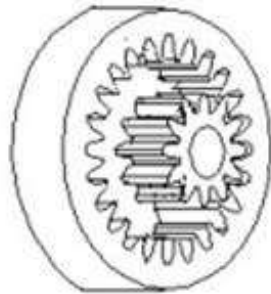
While two gears are meshing, the teeth of one gear enter the spaces of the other. Thus, the drive is positive and when one gear rotates, the other also rotates; transmitting power from one shaft to the other.



Gears types:



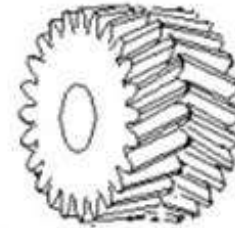
External
Spur Gears



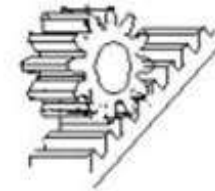
Internal



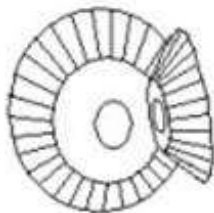
Parallel Helical



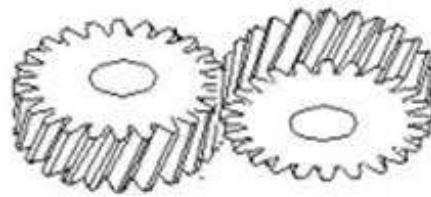
Double Helical
(Herringbone)



Pinion & Rack



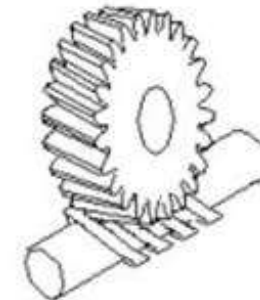
Straight Bevel



Crossed-Helical

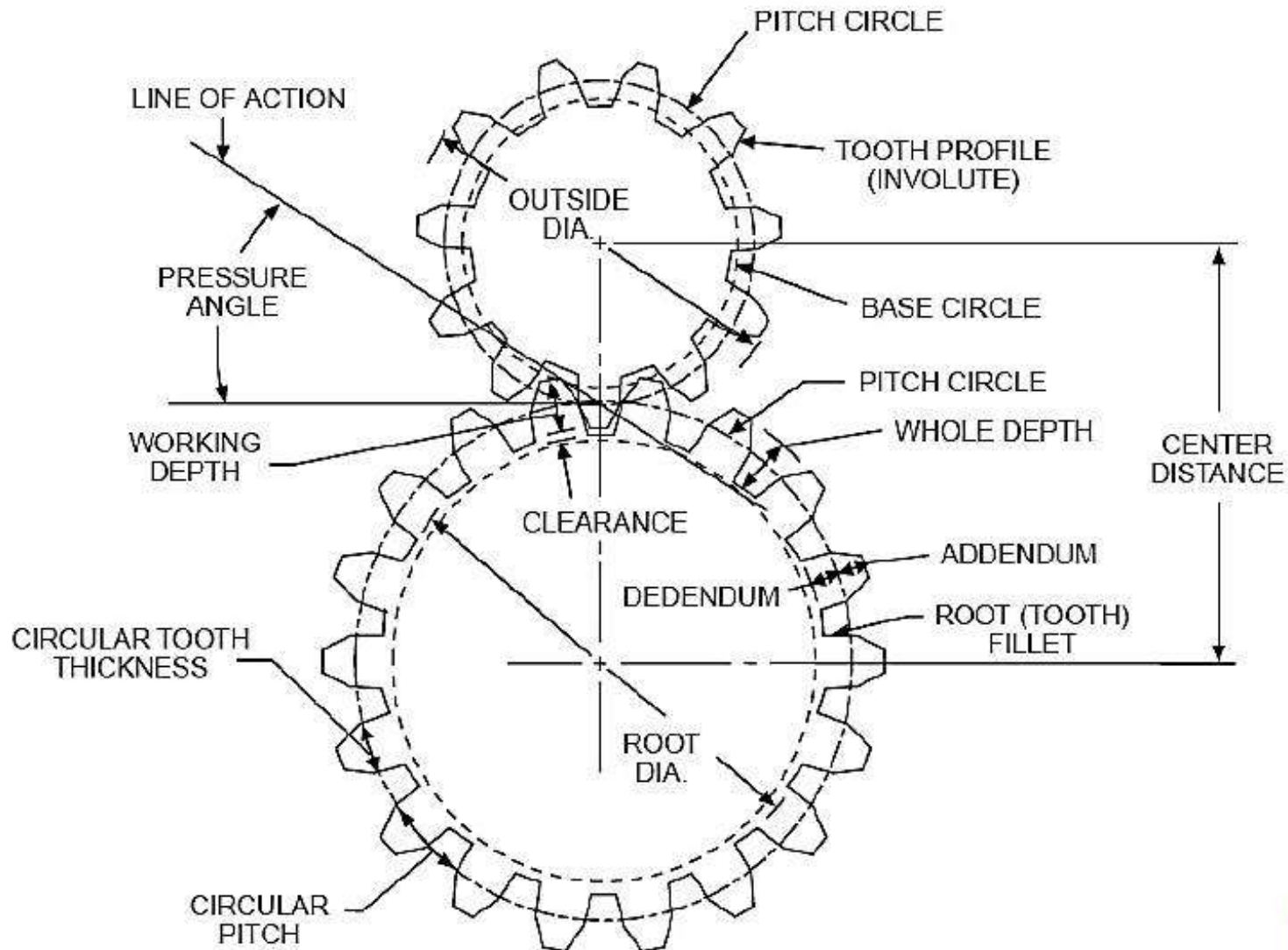


Hypoid Spiral Bevel
(Face Gear)



Worm & Worm Gear

Spur Gear nomenclature:

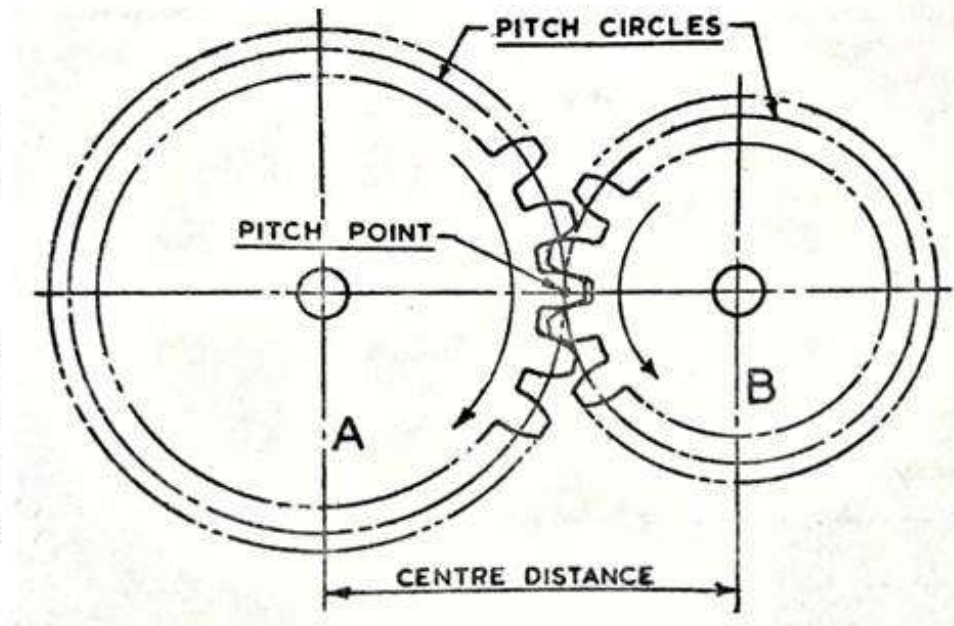


Spur Gear nomenclature:

Pitch Circle: In every pair of gears in mesh, the two circles representing the two plain wheels in contact are always assumed to exist. Each of these circles is called a pitch circle.

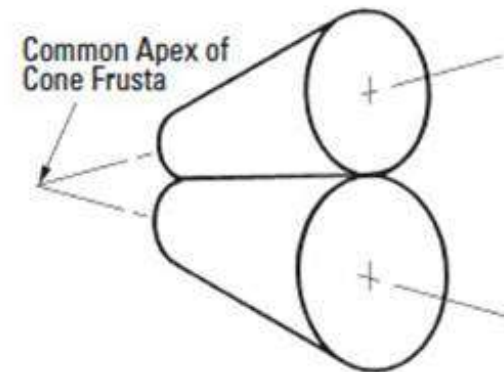
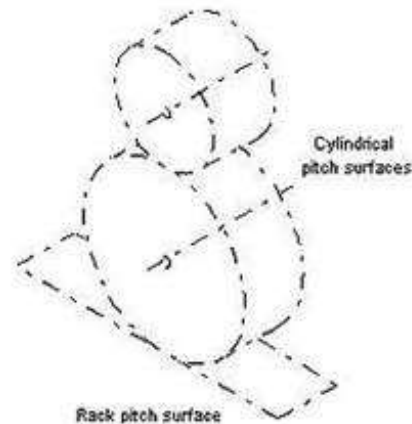
Pitch Point: The point of contact between the pitch circles of the two gears in mesh.

Centre Distance: The distance between the centres of a pair of mating gears and is equal to the sum of the radii of the pitch circle of the two gears.



Spur Gear nomenclature:

Pitch Surface: The surface of the imaginary rolling cylinder (cone, etc.) that the toothed gear may be considered to replace.



Spur Gear nomenclature:

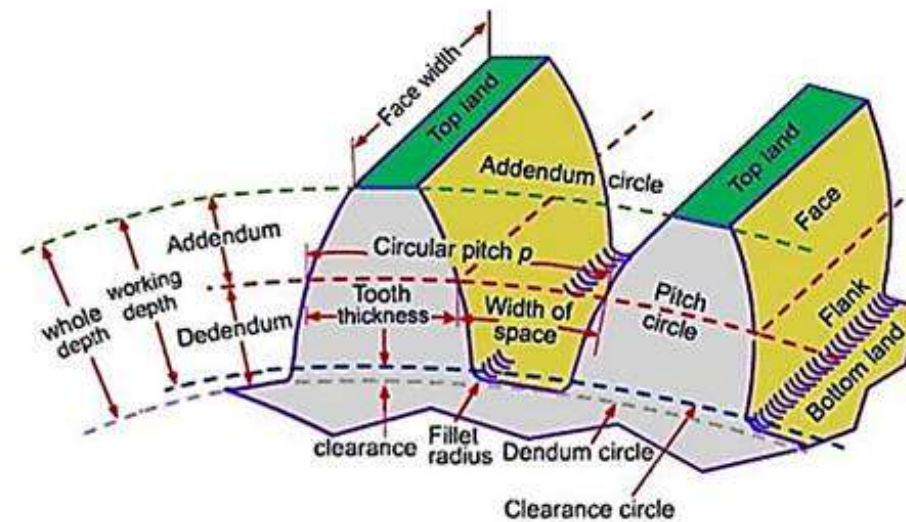
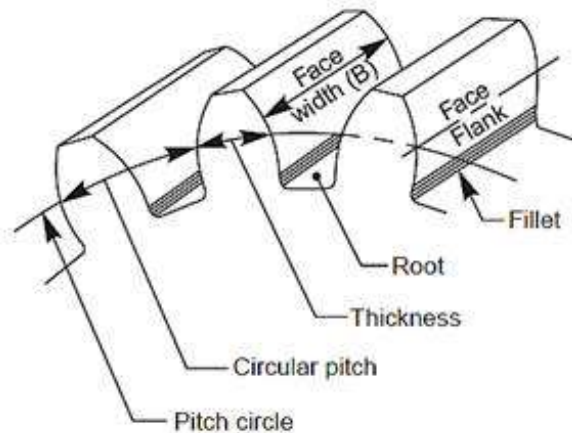
Tooth Face: That part of the tooth surface lying outside the pitch surface.

Tooth Flank: The part of the tooth surface lying inside the pitch surface.

Crest of Tooth (Top land): The outside surface of the tooth.

Root of Tooth (Bottom land): The junction of the tooth with the material at the bottom of the tooth space.

Tooth Thickness: The thickness of the tooth measures along the pitch circle.



Spur Gear nomenclature:

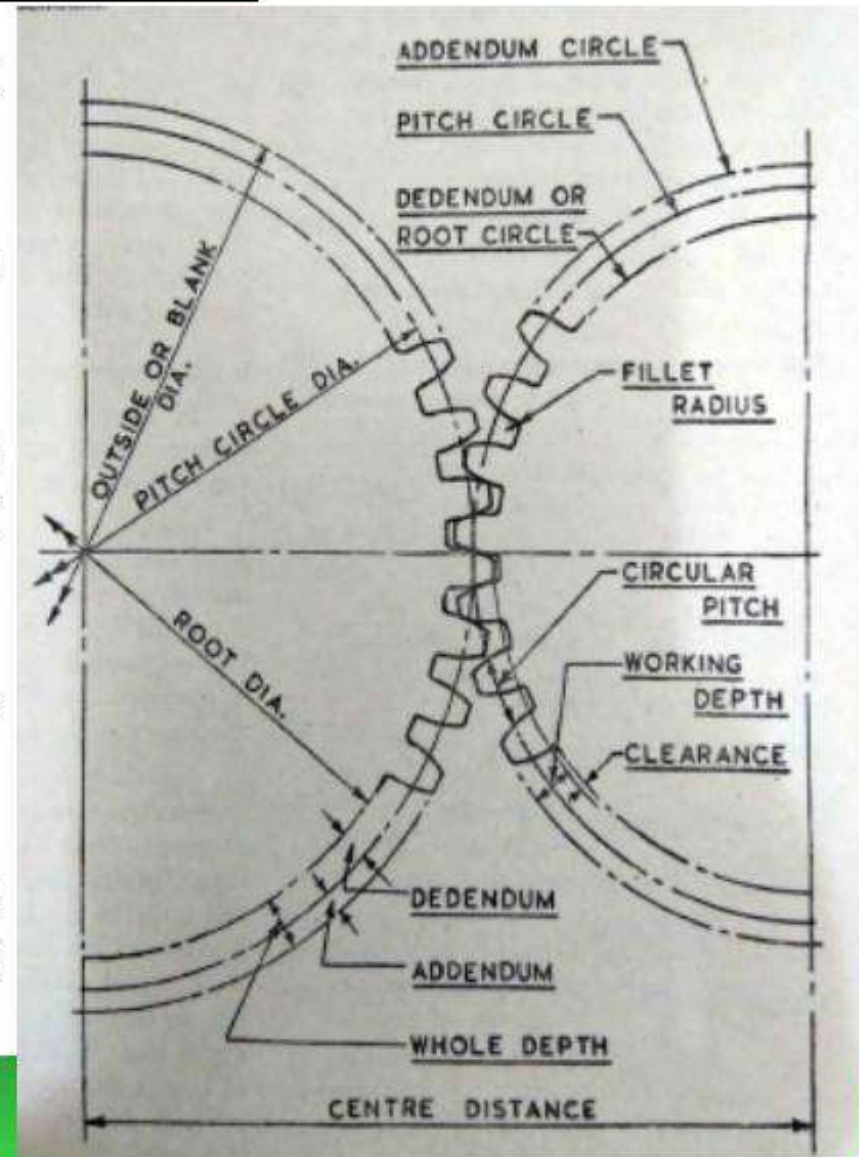
Addendum: That radial height of a tooth above the pitch circle.

Dedendum: That radial depth of a tooth below the pitch circle.

Clearance: The difference between the dedendum of one gear and the addendum of the mating gear.

Whole Depth: The sum the addendum and dedendum of a tooth.

Working Depth: The distance by which a tooth extends into the space of a mating gear (equal to twice the addendum).



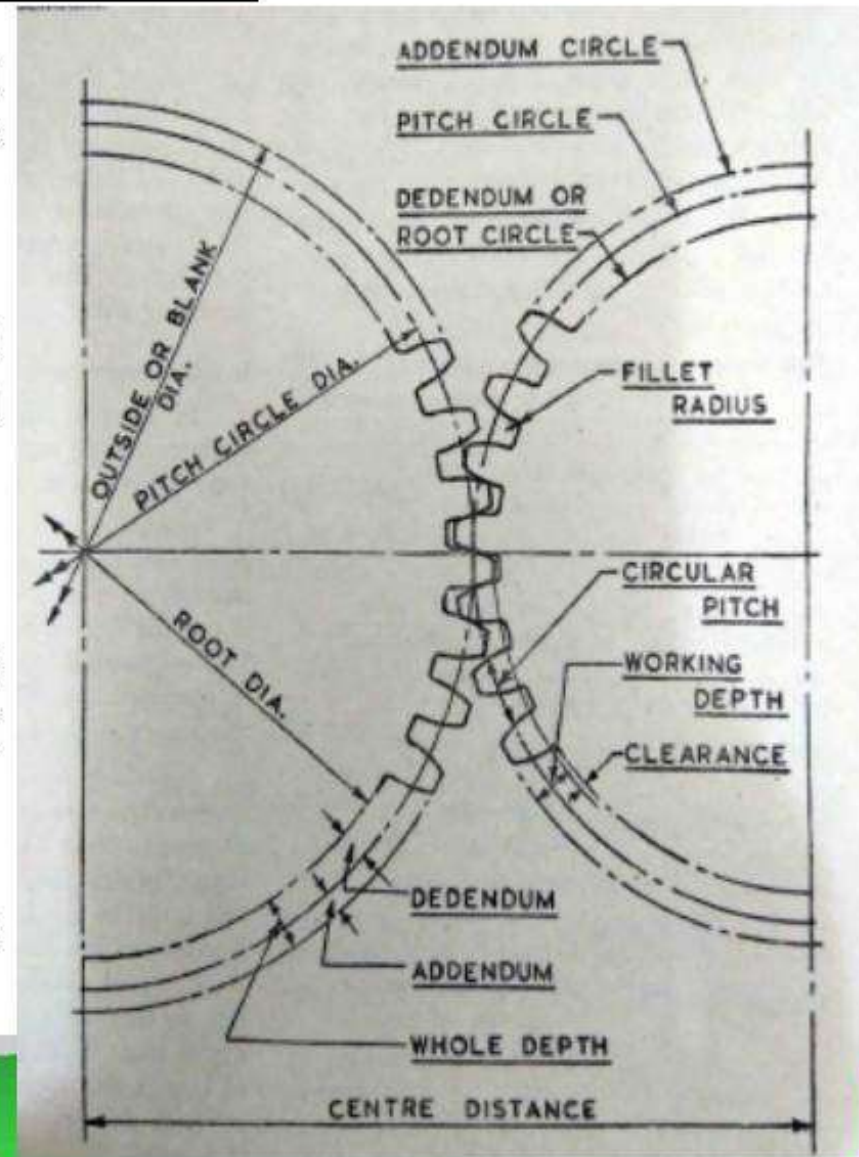
Spur Gear nomenclature:

Addendum Circle: The circle which contains the crests of the teeth (called the outside or blank diameter).

Dedendum Circle : The circle which contains the bottoms crests of the tooth spaces (called the root diameter).

Clearance: The difference between the dedendum of one gear and the addendum of the mating gear.

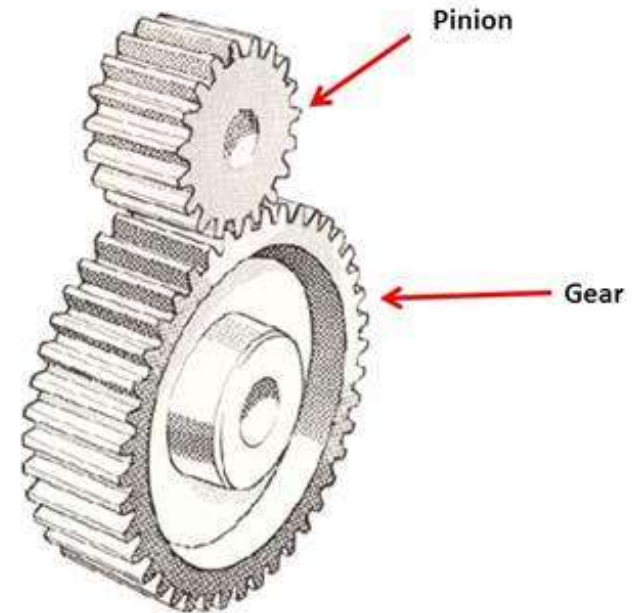
Fillet Radius: The radius of the curve at the root of the tooth.



Spur Gear nomenclature:

Pinion: It is the smaller of the two unequal gears in engagement.

Rack : It is a gear having a pitch circle of infinitely large radius (pitch circle is a straight line) circle which contains the bottoms crests of the tooth spaces (called the root diameter).

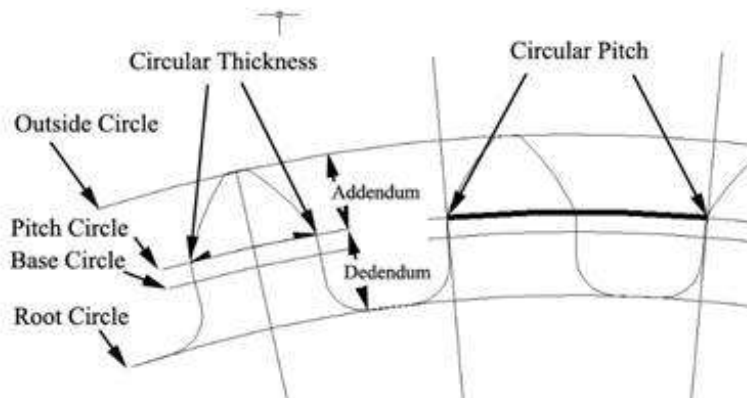


Spur Gear nomenclature:

Circular Pitch (C. P.): It is the distance, measured along the pitch circle, from a point on the tooth to a corresponding point on the adjacent tooth.

Diametral Pitch (D. P.): The number of teeth per unit length of the pitch circle. A toothed gear must have an integral number of teeth.

Module Pitch (M): The number of units (cm or mm) of pitch circle diameter per tooth.



$$\text{Circular pitch} = \frac{\text{pitch circle diameter} \times \pi}{\text{number of teeth}}$$

$$\text{i.e. } \text{C.P.} = \frac{\text{P.C.D.} \times \pi}{N}$$

$$\therefore N = \frac{\text{P.C.D.} \times \pi}{\text{C.P.}} \text{ and } \text{P.C.D.} = \frac{\text{C.P.} \times N}{\pi}$$

$$\text{Diametral pitch} = \frac{\text{number of teeth}}{\text{pitch circle diameter}}$$

$$\text{i.e. } \text{D.P.} = \frac{N}{\text{P.C.D.}}$$

$$\therefore N = \text{P.C.D.} \times \text{D.P.} \text{ and } \text{P.C.D.} = \frac{N}{\text{D.P.}}$$

$$\begin{aligned} \text{C.P.} \times \text{D.P.} &= \frac{\text{P.C.D.} \times \pi}{N} \times \frac{N}{\text{P.C.D.}} \\ &= \pi \end{aligned}$$

$$\therefore \text{C.P.} = \frac{\pi}{\text{D.P.}} \text{ and } \text{D.P.} = \frac{\pi}{\text{C.P.}}$$

$$\text{Module pitch, } M = \frac{\text{pitch circle diameter}}{\text{number of teeth}}$$

$$\text{i.e. } M = \frac{\text{P.C.D.}}{N} = \frac{1}{\text{D.P.}}$$

$$\text{C.P.} = \frac{\pi}{\text{D.P.}} = \pi \times \frac{1}{\text{D.P.}} = \pi \times M.$$

Spur Gear nomenclature:

Tooth proportions:

$$\text{Tooth thickness} = \frac{\text{C.P.}}{2} \text{ or } 0.5 \text{ C.P.}$$

$$\text{Width of space} = \frac{\text{C.P.}}{2} \text{ or } 0.5 \text{ C.P.}$$

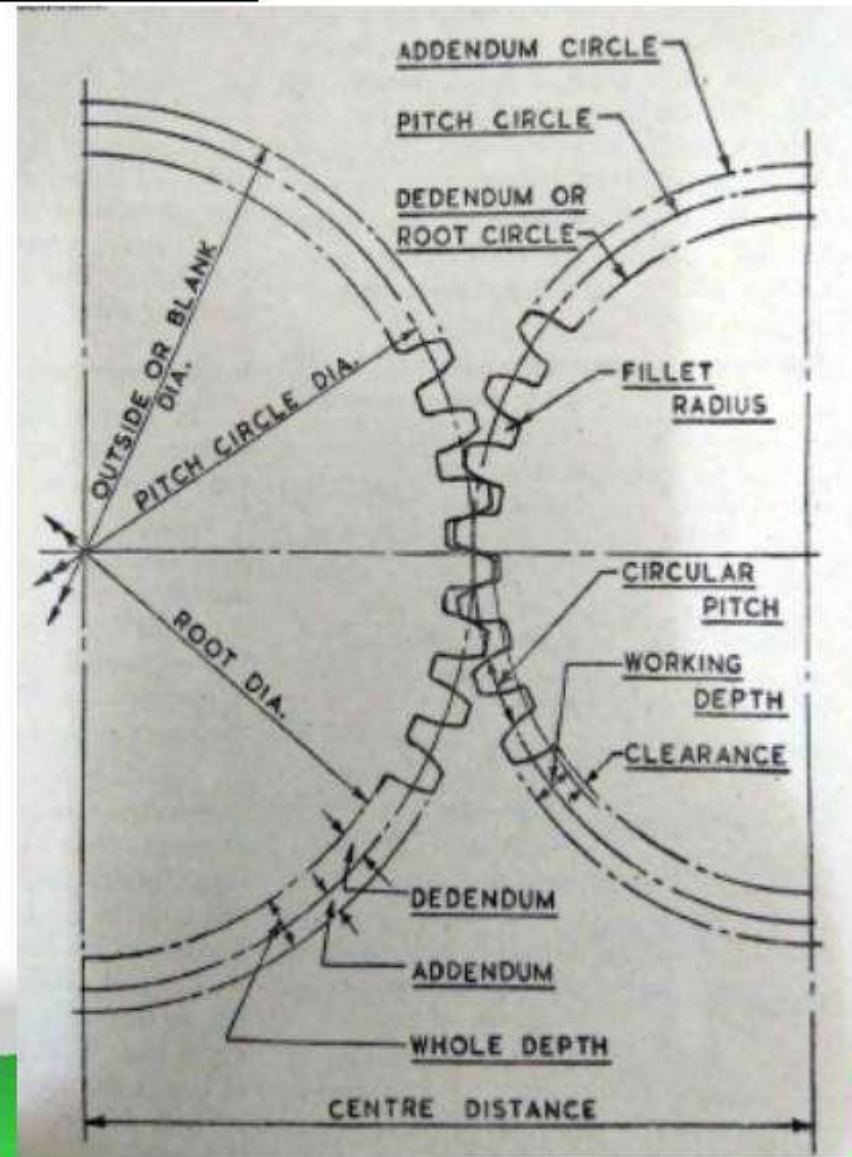
$$\text{Addendum} = \frac{1}{\text{D.P.}} = \frac{\text{C.P.}}{\pi} = 0.3183 \text{ C.P.}$$

$$\text{Clearance} = \frac{\text{C.P.}}{20} = 0.05 \text{ C.P.}$$

$$\text{or} = \frac{\pi}{\text{D.P.}} \times \frac{1}{20} = \frac{0.157}{\text{D.P.}}$$

$$\begin{aligned} \text{Dedendum} &= \text{addendum} + \text{clearance} \\ &= 0.3183 \text{ C.P.} + 0.05 \text{ C.P.} \\ &= 0.3683 \text{ C.P.} \end{aligned}$$

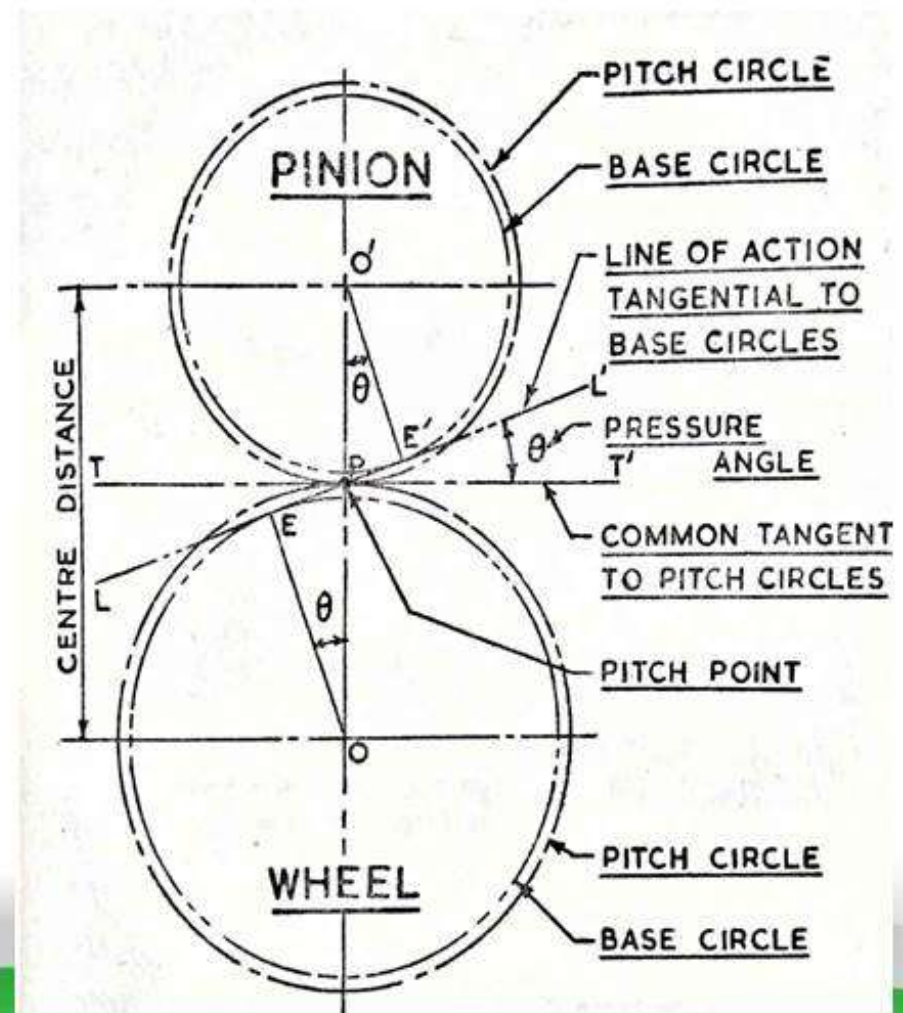
$$\text{or} = \frac{1}{\text{D.P.}} + \frac{0.157}{\text{D.P.}} = \frac{1.157}{\text{D.P.}}$$



Spur Gear nomenclature:

Line of Action or Pressure Line: The force, which the driving tooth exerts at point of contact of the two teeth. This line is also the common tangent at the point of contact of the mating gears and is known as the line of action or the pressure line.

Pressure Angle or Angle of Obliquity: The angle between pressure line and the common tangent to the pitch circles is known as the pressure angle or the angle of obliquity.



Spur Gear nomenclature:

For a gear having 24 teeth and D.P. equal to 1.2 find:
 P.C.D., C.P., Addendum, Add. Circle diameter, Clearance, Dedendum,
 Ded. Circle Dia. And tooth thickness.
 (Take cm as unit length)

Calculations:

$$\text{P.C.D.} = \frac{N}{\text{D.P.}} = \frac{24}{1.2} = 20 \text{ cm} = 200 \text{ mm.}$$

$$\text{C.P.} = \frac{\text{P.C.D.} \times \pi}{N} \text{ or } \frac{\pi}{\text{D.P.}} = \frac{3.1416}{1.2} = 26.18 \text{ mm.}$$

$$\text{Addendum} = \frac{1}{\text{D.P.}} = \frac{1}{1.2} = 8.33 \text{ mm.}$$

$$\begin{aligned} \text{Add. circle dia.} &= \text{P.C.D.} + 2 \times \text{add.} \\ &= 200 + 2 \times 8.33 = 216.66 \text{ mm.} \end{aligned}$$

$$\text{Clearance} = \frac{\text{C.P.}}{20} = \frac{26.18}{20} = 1.309 \text{ mm.}$$

$$\begin{aligned} \text{Dedendum} &= \text{Addendum} + \text{clearance} \\ &= 8.33 + 1.309 = 9.639 \text{ mm.} \end{aligned}$$

$$\begin{aligned} \text{Ded. circle dia.} &= \text{P.C.D.} - 2 \times \text{ded.} \\ &= 200 - 2 \times 9.639 \\ &= 180.722 \text{ mm.} \end{aligned}$$

$$\text{Tooth thickness} = \frac{\text{C.P.}}{2} = \frac{26.18}{2} = 13.09 \text{ mm.}$$

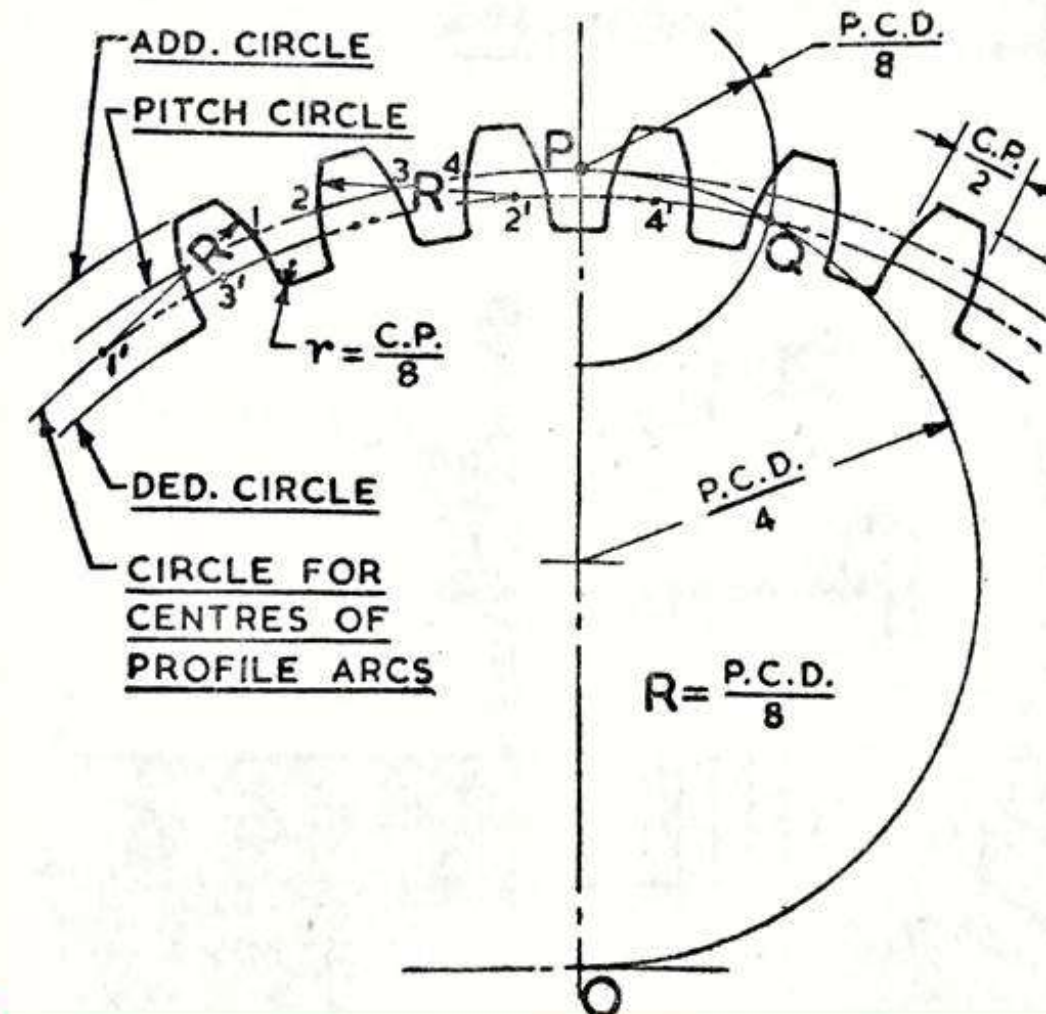
Approximate construction of teeth profile:

Case 1 Number of teeth is **30 and above**

1. With O as centre, draw arcs representing dedendum, pitch and addendum circles.
2. At any point on the pitch circle, mark a point P.
3. With OP as diameter, draw a semi-circle.
4. With centre P and radius equal to $0.125 \times$ pitch circle diameter (P.C.D.), draw an arc, intersecting the semi-circle at Q.
5. With O as centre and radius OQ, draw an arc. The centres of arcs for the tooth profiles, lie on this arc and the radius for the arc is $0.125 \times$ P.C.D.
6. On the pitch circle, mark points 1, 2, 3, 4, etc., separated by a distance equal to half the circular pitch (C.P.).
7. With each of these points as centres, and radius equal to $0.125 \times$ P.C.D., locate the centres 1', 2', 3', 4', etc., for arcs, on the circle for centres (passing through Q).
8. With 1', 2', 3', 4', etc., as centres and radius equal to R ($R = 0.125 \times$ P.C.D.), draw arcs, passing through the points 1, 2, 3, 4, etc.
9. Add the top lands and join the arcs with the bottom land, by a fillet of radius r , equal to 0.125 C.P.

Approximate construction of teeth profile:

Case 1 Number of teeth is 30 and above



Approximate construction of teeth profile:

Case 1 Number of teeth is **less than 30**

1. Follow the steps 1 to 8 as described before (teeth is 30 and above).
2. From O, draw lines, tangential to the above arcs.
3. Add the top lands and join the above lines with the bottom land, by a fillet of radius equal to $0.125 C.P.$

Approximate construction of teeth profile:

Case 1 Number of teeth is less than 30

