SNS COLLEGE OF TECHNOLOGY
(AN AUTONOMOUS INSTITUTION)

Department of Mechatronics Engineering

Mechanics of Machines

Unit – III

Gears and Gear Trains

Classification of Toothed Wheels
&
Terms Used in Gears

Source: pinterest.com

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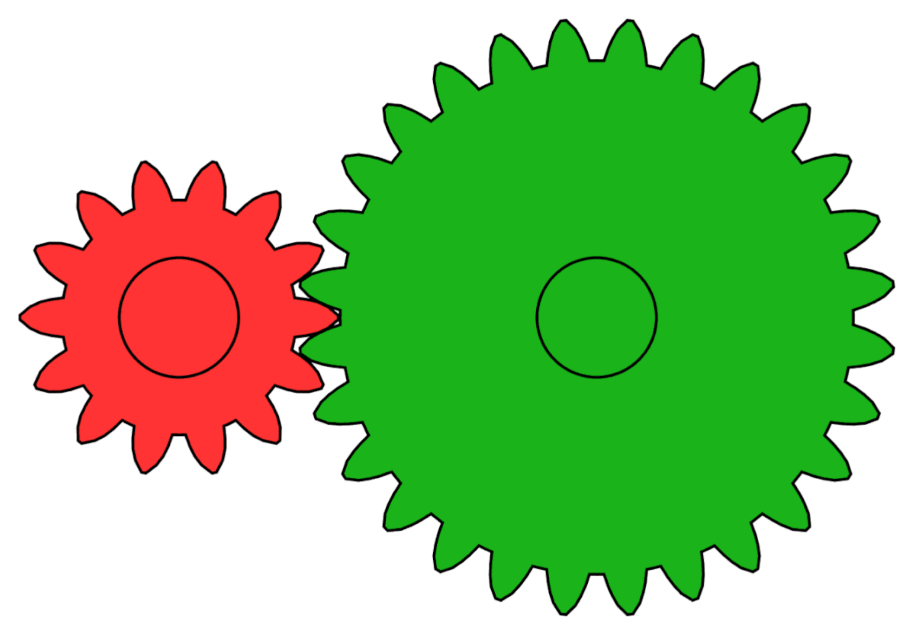
Classification of Toothed Wheels

- ***According to the position of axes of the shafts.*** The axes of the two shafts between which the motion is to be transmitted, may be

- Parallel
- Intersecting and
- Non-intersecting and non-parallel.



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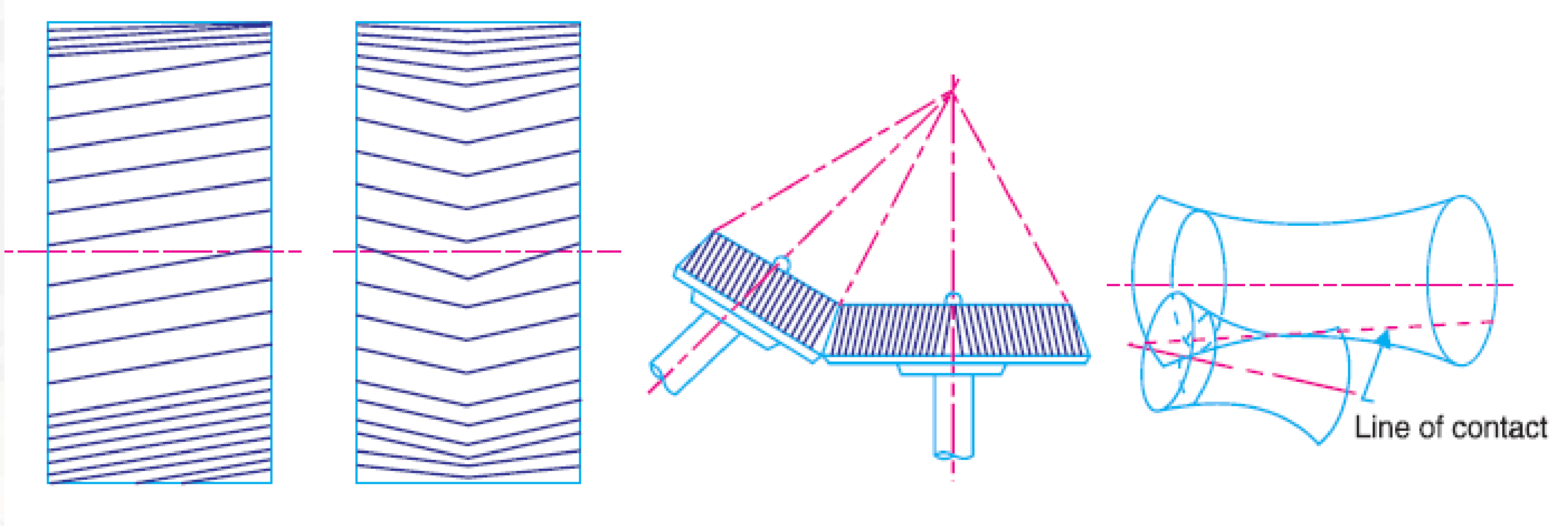
Classification of Toothed Wheels

- The two parallel and co-planar shafts connected by the gears is shown in Figure. These gears are called ***spur gears*** and the arrangement is known as ***spur gearing***
- These gears have teeth parallel to the axis of the wheel. Another name given to the spur gearing is ***helical gearing***, in which the teeth are inclined to the axis.
- The single and double helical gears connecting parallel shafts are shown in Figure (a) and (b).
- The double helical gears are known as ***herringbone gears***.
- A pair of spur gears are kinematically equivalent to a pair of cylindrical discs, keyed to parallel shafts and having a line contact

Classification of Toothed Wheels



(*a*) Single helical gear. (*b*) Double helical gear. (*c*) Bevel gear. (*d*) Spiral gear.

Source: R.S.Khurmi

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Classification of Toothed Wheels

- The two non-parallel or intersecting, but coplanar shafts connected by gears is shown in Figure (*c*). These gears are called ***bevel gears*** and the arrangement is known as ***bevel gearing***

- The bevel gears, like spur gears, may also have their teeth inclined to the face of the bevel, in which case they are known as ***helical bevel gears***

- The two non-intersecting and non-parallel *i.e.* non-coplanar shaft connected by gears is shown in Figure (*d*). These gears are called ***skew bevel gears*** or ***spiral gears***

- This type of gearing also have a line contact, the rotation of which about the axes generates the two pitch surfaces known as ***hyperboloids***.

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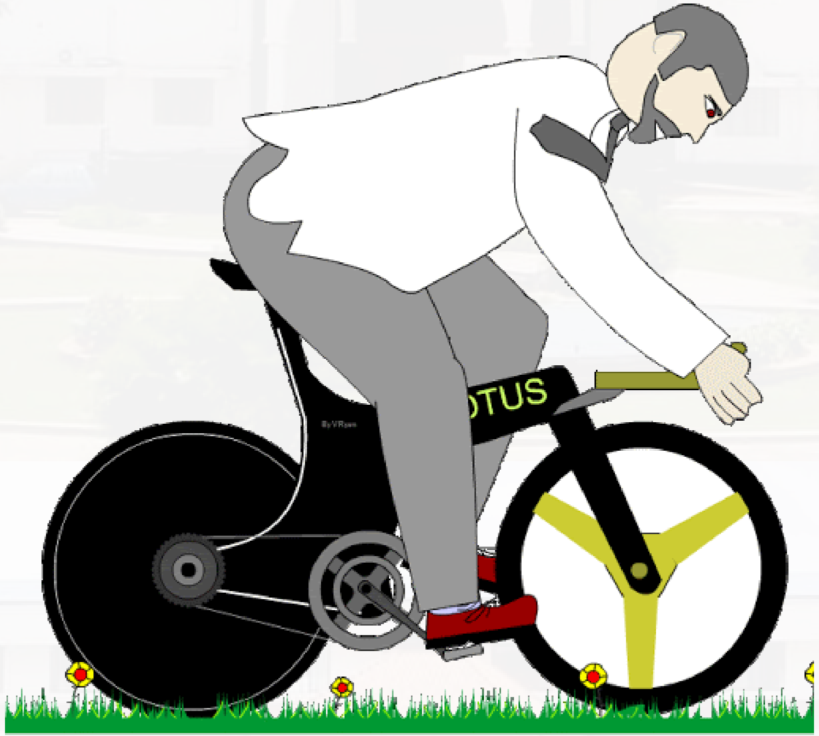
Classification of Toothed Wheels

- ***According to the peripheral velocity of the gears.*** The gears, according to the peripheral velocity of the gears may be classified as:

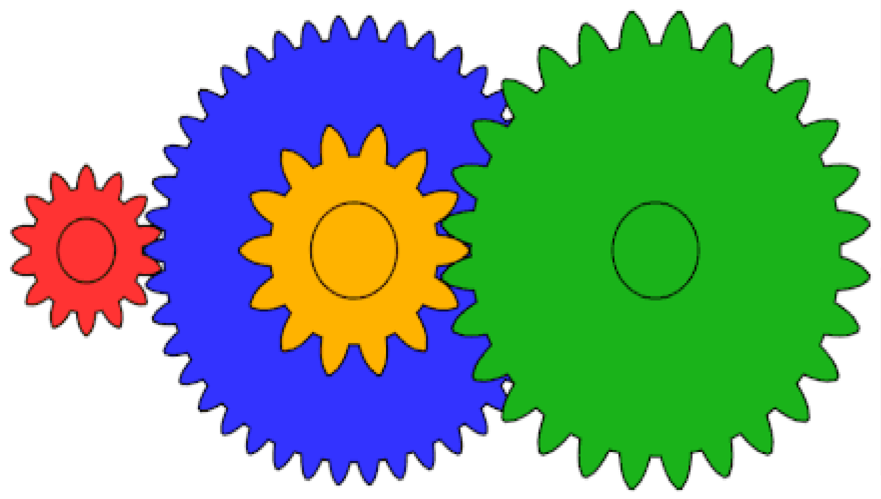
(*a*) Low velocity, **(*b*)** Medium velocity, and **(*c*)** High velocity.

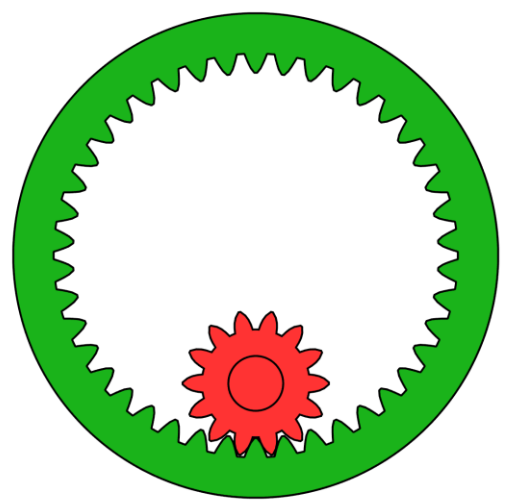


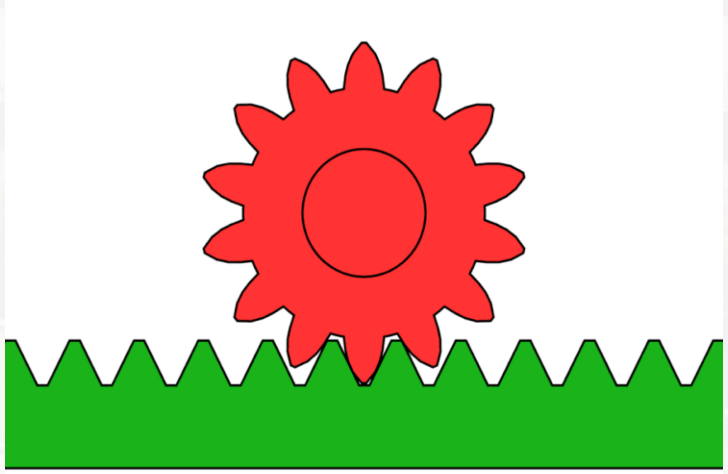
Source: technologystudent.com

Classification of Toothed Wheels

- ***According to the type of gearing***. The gears, according to the type of gearing may be classified as: (*a*) External gearing, (*b*) Internal gearing, and (*c*) Rack and pinion





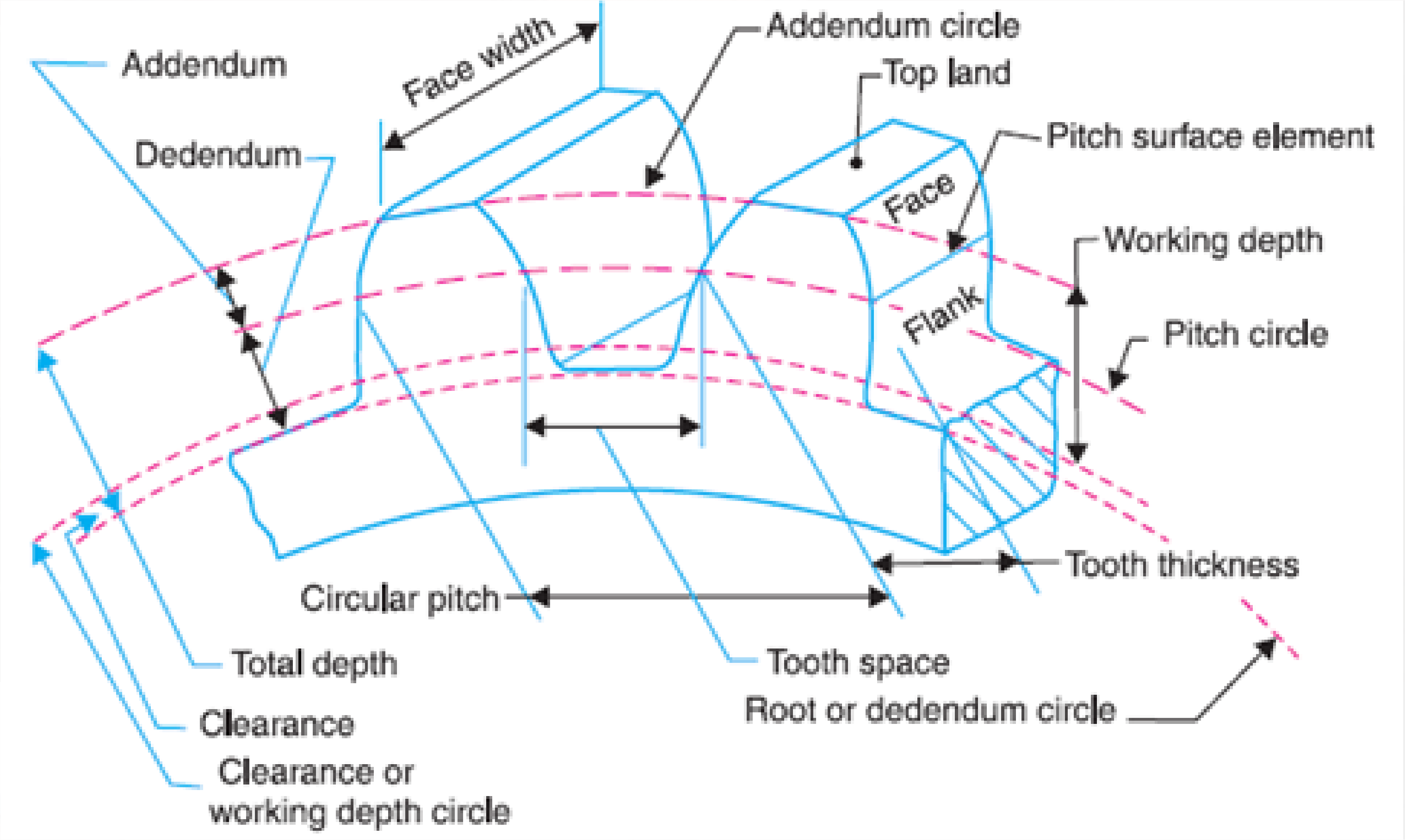


Source: commons.wikimedia.org

Classification of Toothed Wheels

- ***According to position of teeth on the gear surface***. The teeth on the gear surface may be
  - ✓ Straight
  - ✓ Inclined and
  - ✓ Curved
- The spur gears have straight teeth whereas helical gears have their teeth inclined to the wheel rim
- In case of spiral gears, the teeth are curved over the rim surface

Terms Used in Gears



Source: R.S.Khurmi

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Terms Used in Gears

1. ***Pitch circle***. It is an imaginary circle which by pure rolling action, would give the same motion as the actual gear

2. ***Pitch circle diameter***. It is the diameter of the pitch circle. The size of the gear is usually specified by the pitch circle diameter. It is also known as ***pitch diameter***.

3. ***Pitch point***. It is a common point of contact between two pitch circles.

4. ***Pitch surface***. It is the surface of the rolling discs which the meshing gears have replaced at the pitch circle.

5. ***Pressure angle or angle of obliquity***. It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. It is usually denoted by φ. The standard pressure angles are 14.5^o & 20^o

6. ***Addendum.*** It is the radial distance of a tooth from the pitch circle to the top of the tooth.

7. ***Dedendum.*** It is the radial distance of a tooth from the pitch circle to the bottom of the tooth.

8. ***Addendum circle***. It is the circle drawn through the top of the teeth and is concentric with the pitch circle.

9. ***Dedendum circle***. It is the circle drawn through the bottom of the teeth. It is also called root circle.

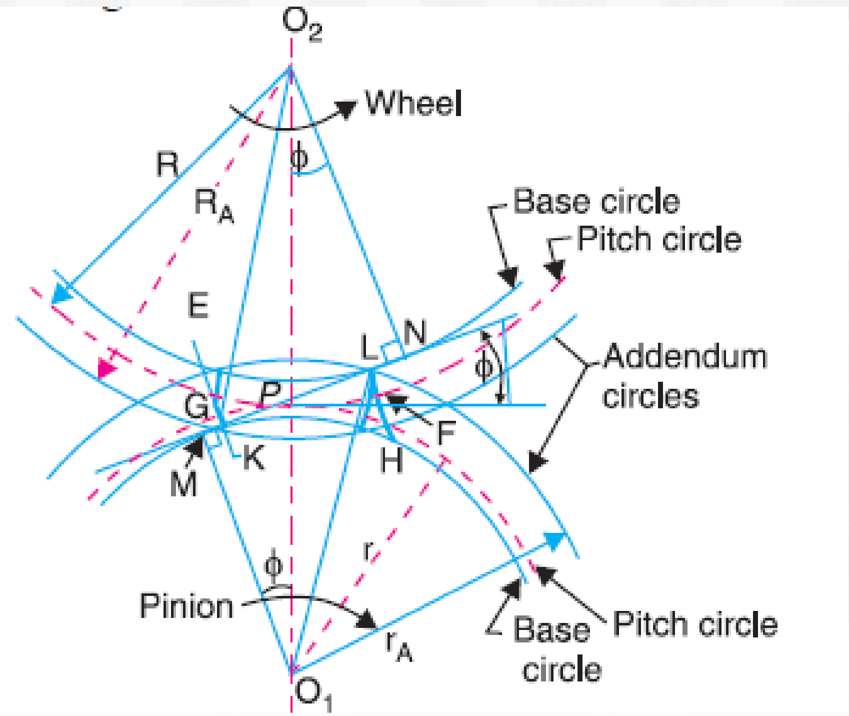
10. ***Circular pitch***. It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth

Length of Path of Contact

Let $r_A = O_1L$ = Radius of addendum circle of pinion,

$R_A = O_2K$ = Radius of addendum circle of wheel,

$r = O_1P$ = Radius of pitch circle of pinion, and



Source: R.S.Khurmi

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Length of Path of Contact

$R = O_2P =$ Radius of pitch circle of wheel.

From Fig. 12.11, we find that radius of the base circle of pinion,

$$O_1M = O_1P \cos\phi = r\cos\phi$$

and radius of the base circle of wheel,

$$O_2N = O_2P\cos\phi = R\cos\phi$$

Now from right angled triangle O_2KN,

$$KN = \sqrt{(O_2K)^2 - (O_2N)^2} = \sqrt{(R_A)^2 - R^2\cos^2\phi}$$

and $$PN = O_2P\sin\phi = R\sin\phi$$

∴ Length of the part of the path of contact, or the path of approach,

$$KP = KN - PN = \sqrt{(R_A)^2 - R^2\cos^2\phi} - R\sin\phi$$

Similarly from right angled triangle O_1ML,

$$ML = \sqrt{(O_1L)^2 - (O_1M)^2} = \sqrt{(r_A)^2 - r^2\cos^2\phi}$$

and $$MP = O_1P\sin\phi = r\sin\phi$$

∴ Length of the part of the path of contact, or path of recess,

$$PL = ML - MP = \sqrt{(r_A)^2 - r^2\cos^2\phi} - r\sin\phi$$

∴ Length of the path of contact,

$$KL = KP + PL = \sqrt{(R_A)^2 - R^2\cos^2\phi} + \sqrt{(r_A)^2 - r^2\cos^2\phi} - (R + r)\sin\phi$$

Source: R.S.Khurmi

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Length of Path of Contact

We know that the length of the arc of approach (arc *GP*)

$$= \frac{\text{Length of path of approach}}{\cos\phi} = \frac{KP}{\cos\phi}$$

and the length of the arc of recess (arc *PH*)

$$= \frac{\text{Length of path of recess}}{\cos\phi} = \frac{PL}{\cos\phi}$$

Since the length of the arc of contact *GPH* is equal to the sum of the length of arc of approach and arc of recess, therefore,

Length of the arc of contact

$$= \text{arc } GP + \text{arc } PH = \frac{KP}{\cos\phi} + \frac{PL}{\cos\phi} = \frac{KL}{\cos\phi}$$

$$= \frac{\text{Length of path of contact}}{\cos\phi}$$

Source: R.S.Khurmi

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Length of Path of Contact - Problems

Problem 1. *A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gears is involute with 20° pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio.*

Solution. Given : $t = 30$; $T = 80$; $\varphi = 20°$; $m = 12$ mm ; Addendum = 10 mm

Length of path of contact

We know that pitch circle radius of pinion,

$r = m.t / 2 = 12 \times 30 / 2 = 180$ mm

and pitch circle radius of gear,

$R = m.T / 2 = 12 \times 80 / 2 = 480$ mm

∴Radius of addendum circle of pinion,

$r_A = r +$ Addendum $= 180 + 10 = 190$ mm

and radius of addendum circle of gear,

$R_A = R +$ Addendum $= 480 + 10 = 490$ mm

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$$KP = \sqrt{(R_A)^2 - R^2 \cos^2 \phi} - R \sin\phi$$ ...(Refer Fig. 12.11)

$$= \sqrt{(490)^2 - (480)^2 \cos^2 20°} - 480 \sin 20° = 191.5 - 164.2 = 27.3 \text{ mm}$$

and length of the path of recess,

$$PL = \sqrt{(r_A)^2 - r^2 \cos^2 \phi} - r \sin\phi$$

$$= \sqrt{(190)^2 - (180)^2 \cos^2 20°} - 180 \sin 20° = 86.6 - 61.6 = 25 \text{ mm}$$

We know that length of path of contact,

$$KL = KP + PL = 27.3 + 25 = 52.3 \text{ mm}$$ **Ans.**

Length of arc of contact

We know that length of arc of contact

$$= \frac{\text{Length of path of contact}}{\cos\phi} = \frac{52.3}{\cos 20°} = 55.66 \text{ mm}$$ **Ans.**

Contact ratio

We know that circular pitch,

$$p_c = \pi . m = \pi \times 12 = 37.7 \text{ mm}$$

$$\therefore \quad \text{Contact ratio} = \frac{\text{Length of arc of contact}}{p_c} = \frac{55.66}{37.7} = 1.5 \text{ say } 2$$ **Ans.**

Source: R.S.Khurmi

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