Types of Gears (1/2)

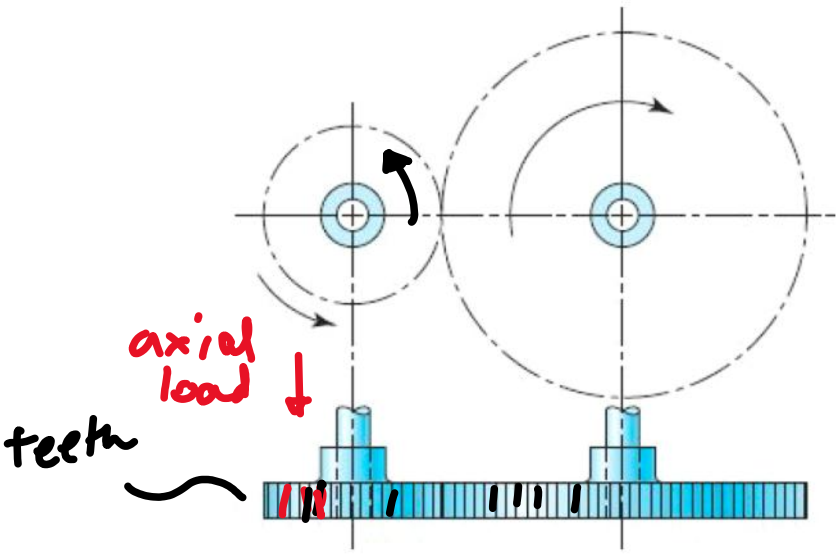


Figure 13-1
Spur gears are used to transmit rotary motion between parallel shafts.

Spur Gears

- have teeth parallel to the axis of rotation
- Transmits rotary motion between parallel shafts
- Easy to manufacture relative to helical.
- They don't resist axial loads.

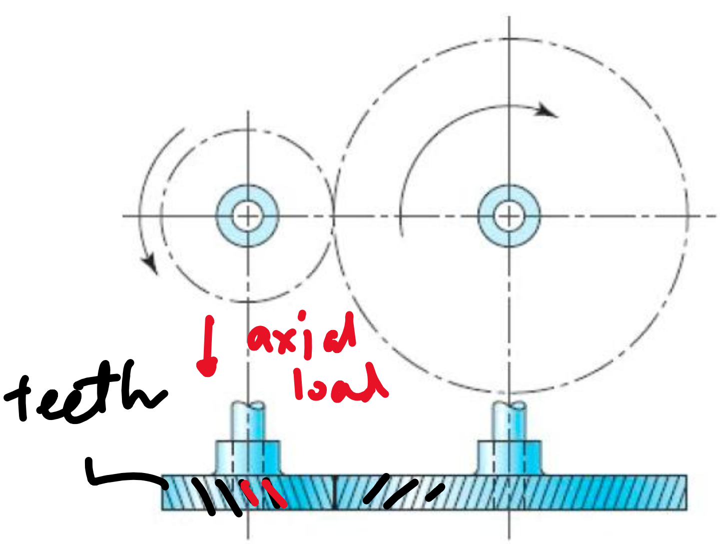


Figure 13-2
Helical gears are used to transmit motion between parallel or nonparallel shafts.

Helical Gears

- Have teeth inclined to the axis of rotation.
- Mostly used to transmit force between parallel shafts
- Gradual teeth engagement leads to less noise and vibration
- Can bear axial loads due to orientation of teeth.

Types of Gears (2/2)

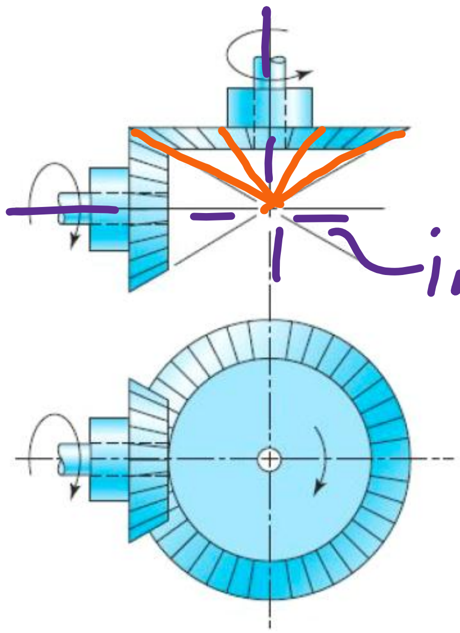
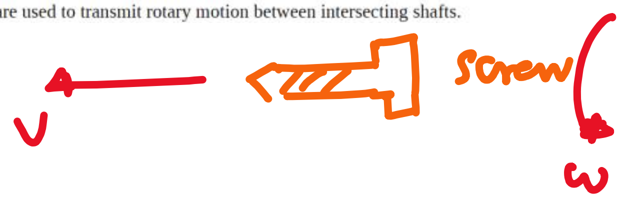


Figure 13-3
Bevel gears are used to transmit rotary motion between intersecting shafts.

Bevel Gears
- Teeth formed on conical surface
- Used for transmitting force between intersection shafts

v to w



Worm gears
- Similar to a screw
- Used for non-intersecting shafts with right angle axis.
- Used when speed ratios of the shafts are large (>3)

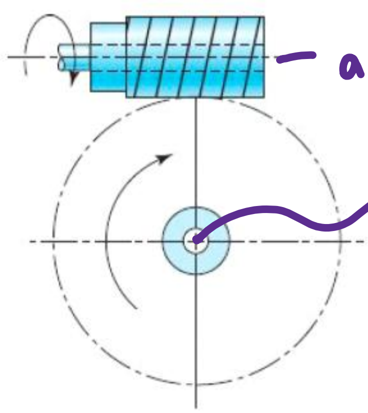
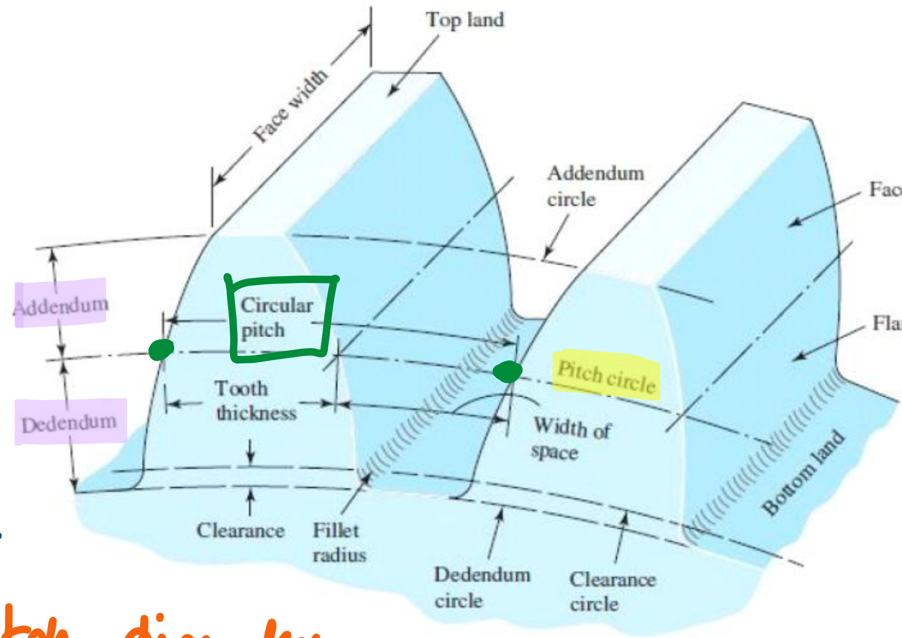
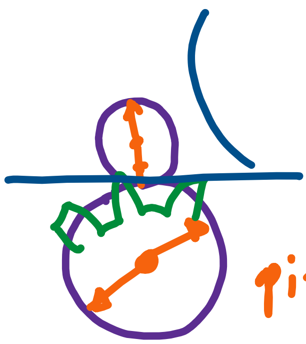


Figure 13-4
Worm gearsets are used to transmit rotary motion between nonparallel and nonintersecting shafts.

Terminology



tangent



pitch diameter

Pitch Circle / Pitch Diameter (d): Pitch Circle is the circle which will be used for all calculations. Two mating gears can be approximated to make contact at the common tangent to the pitch circles.

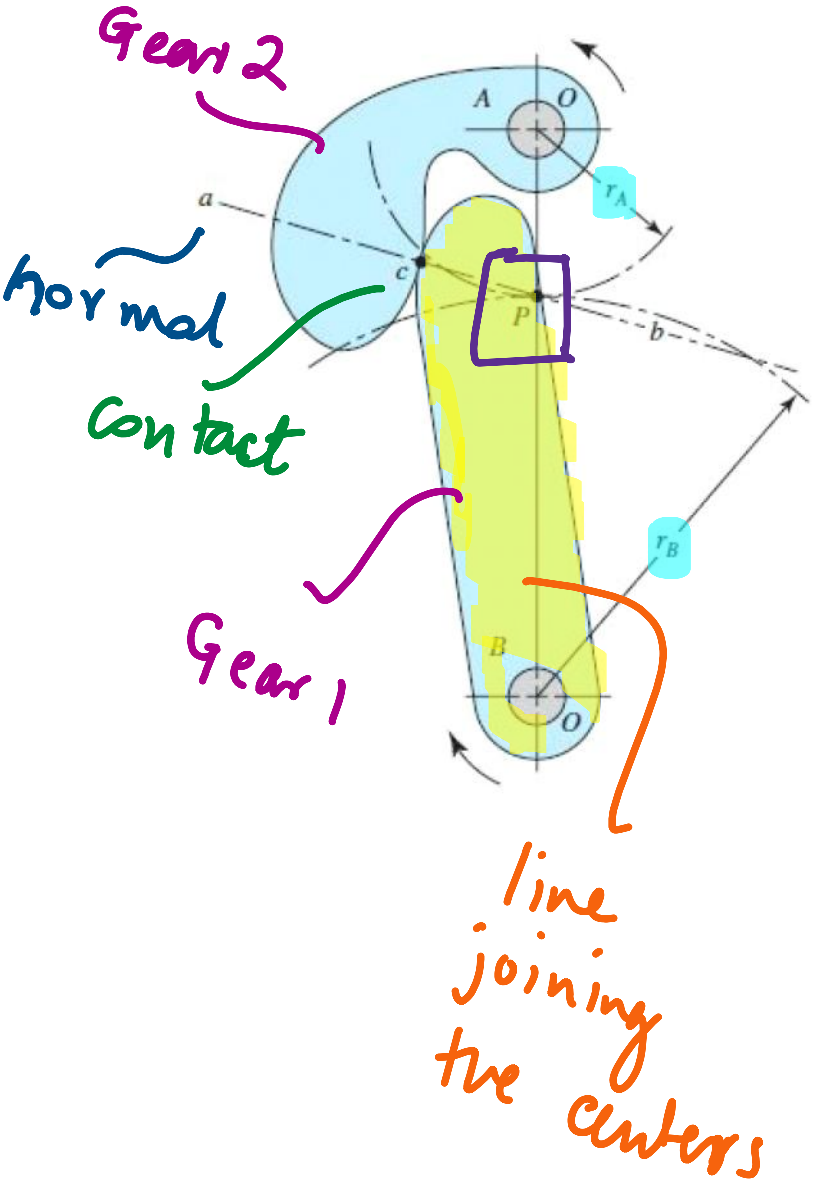
p P

Circular pitch (p): Distance along the pitch circle between the same points on adjacent teeth.
Module (m): Ratio of the pitch diameter (d) to the number of teeth (N).
Diametral pitch (P) is the inverse of the module. (P)

$$\boxed{m = \frac{1}{P} = \frac{d}{N}}$$

$$\boxed{p = \pi m = \frac{\pi}{P} = \frac{\pi d}{N}}$$

Conjugate Action



Common normal c-P-b passes through a fixed point on line joining centers A-B

P is that point

Conjugate action ensures that

$$\boxed{\frac{\omega_A}{\omega_B} = \frac{r_B}{r_A} = \text{constant}}$$

$$\underbrace{V_p}_{\text{constant}} = \omega_A r_A = \omega_B r_B$$

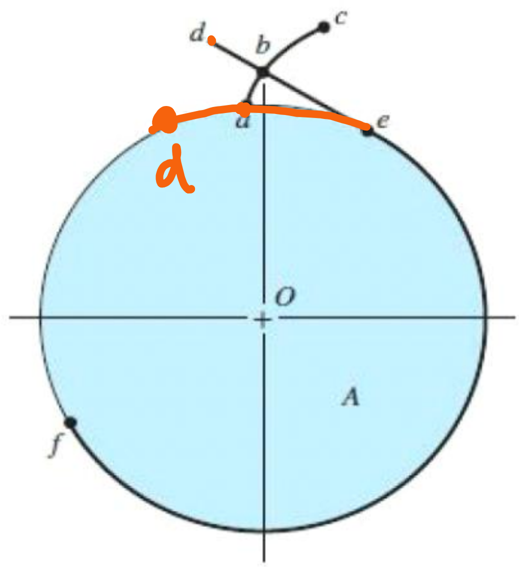
P intersection of

1) Line normal

2) Line joining the centers

Involute Property

base



Circle is called base circle.

Consider a string (base) wrapped on a circle

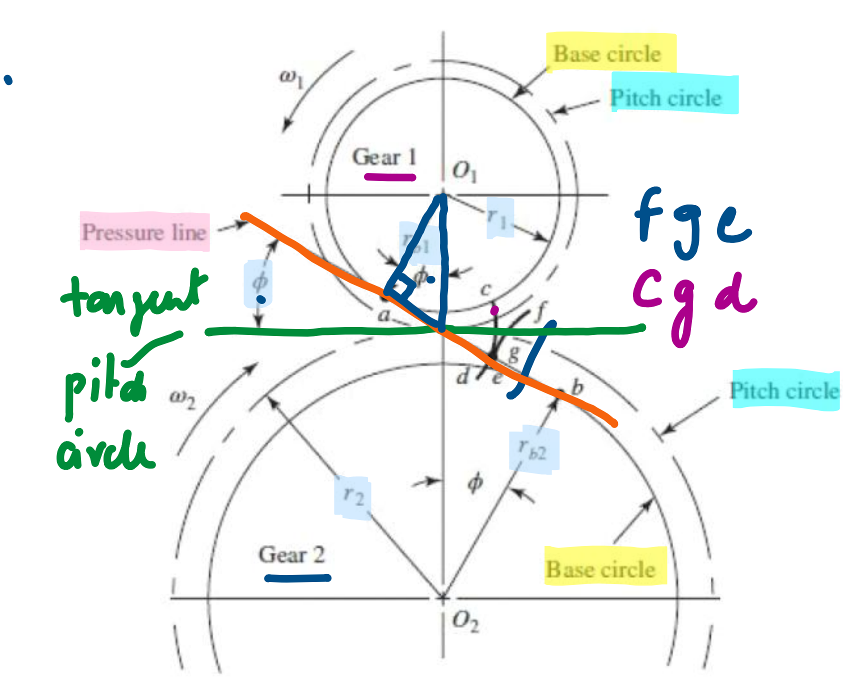
We hold 'd' and start to unwind it.

As it is unwound, the point 'a' move to 'b' then 'c'. The curve

a-b-c is the involute curve.

Gears are shaped using the curve a-b-c. This allows them to maintain conjugate action or constant speed ratio

Pressure Angle / Pitch / Radius



The string a-g-b is drawn with 2 mating gears

involute c-g-d generated on Gear 1

involute e-g-f generated on Gear 2

The 2 mating gears make contact along line a-g-b known as the pressure line

ϕ - angle between pressure line and tangent to pitch circle (pressure angle)

$$\boxed{r_{bi} = r_i \cos\phi}$$

spec r_b, ϕ

r_{bi} ϕ r_i

r_{b_i}, r_i — radius of base circle, pitch circle

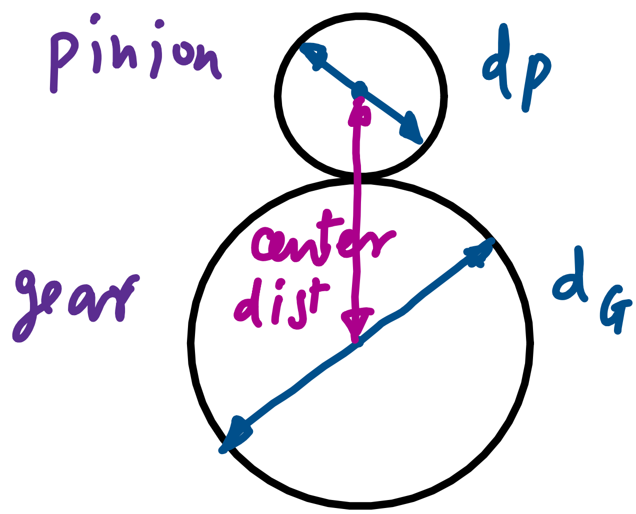
Conjugate action $$\boxed{\left|\frac{w_1}{w_2}\right| = \frac{r_2}{r_1}}$$

Based on pitch circle

Q1

A gearset consists of a 16-tooth pinion driving a 40-tooth gear. The diametral pitch is 2 and the addendum and dedendum are 1/P and 1.25/P respectively. The pressure angle is 20 degrees.
(a) Compute the circular pitch, center distance, and radii of the base circles
(b) If the center distance from (a) is increased by (1/4) inch, compute the new values of the pressure angle and pitch circle diameters

d_p, d_G are pitch diameters of pinion and gear



$P = 2$

$\phi = 20^\circ$

(a) $p = \frac{\pi}{P} = \frac{\pi}{2}$ $\boxed{p = 1.571 \text{ in}}$ (circular pitch)

$$\boxed{\text{Center distance} = \frac{1}{2}(d_p + d_G) = 14 \text{ in}}$$

$d_p = \frac{N_P}{P} = \frac{16}{2} = 8 \text{ in}$; $d_G = \frac{N_G}{P} = \frac{40}{2} = 20$

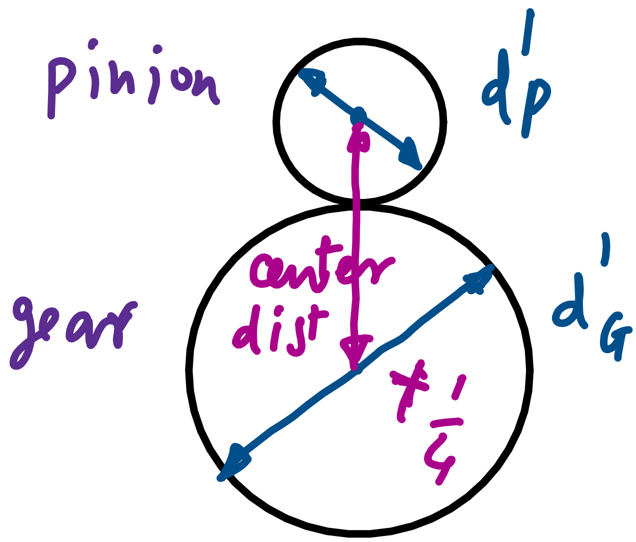
$$\boxed{(r_b)_{pinion} = \frac{d_p}{2}\cos\phi = \frac{8}{2}\cos 20^\circ}$$

$$\boxed{(r_b)_{pinion} = 3.759 \text{ in}}$$

$$(r_b)_{gear} = \frac{d_G}{2}\cos\phi = \frac{20}{2}\cos 20^\circ$$

$$\boxed{(r_b)_{gear} = 9.397 \text{ in}}$$

(b)



$$d_p' + d_G' = 14 + \frac{1}{4} \qquad -(1)$$

$$\frac{d_p'}{N_p} = \frac{d_G'}{N_G} = \frac{1}{P} \Rightarrow \frac{d_p'}{16} = \frac{d_G'}{40} \qquad -(2)$$

Solve for d_G' and d_p' from (1) and (2)

$$\boxed{\begin{aligned} d_p' &= 8.143 \text{ in} \\ d_G' &= 20.357 \text{ in} \end{aligned}}$$

pitch circle diameters

Changing the center distance will have no effect on the base circle.

$$(r_b)_{pinion} = \frac{d_p'}{2} \cos\phi'$$

new pressure angle

$$3.759 = \frac{8.143}{2} \cos\phi' \qquad \boxed{\phi' = 22.59^\circ}$$

You will get the same answer if you use $(r_b)_{gear} = \frac{d_G'}{2} \cos\phi'$