SNS COLLEGE OF TECHNOLOGY

Coimbatore-35
An Autonomous Institution

Accredited by NBA – AICTE and Accredited by NAAC – UGC with 'A+' Grade
Approved by AICTE, New Delhi & Affiliated to Anna University, Chennai

DEPARTMENT OF MECHANICAL ENGINEERING

16 ME307 – DESIGN OF Transmission System

III YEAR VISEM

Spur and Helical Gear

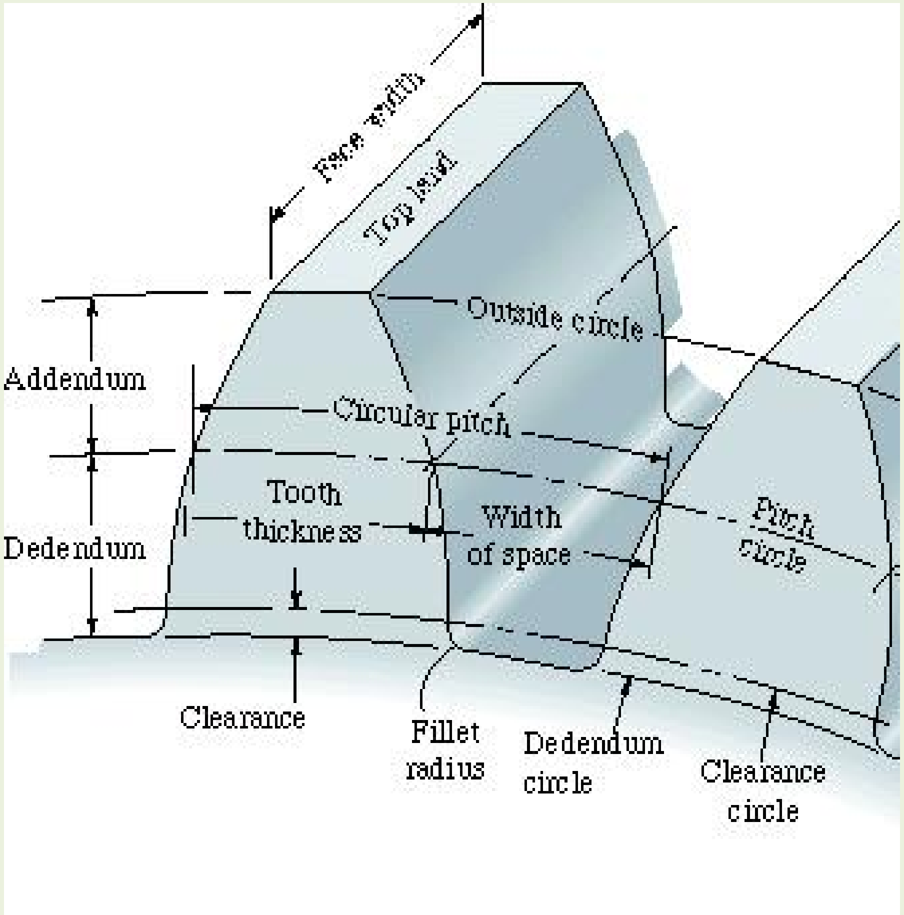
TOPIC 1 Basics of Gear

Introduction

- Gears are the most common means used for power transmission
- They can be applied between two shafts which are
  - Parallel
  - Collinear
  - Perpendicular and intersecting
  - Perpendicular and nonintersecting
  - Inclined at any arbitrary angle

Gear tooth

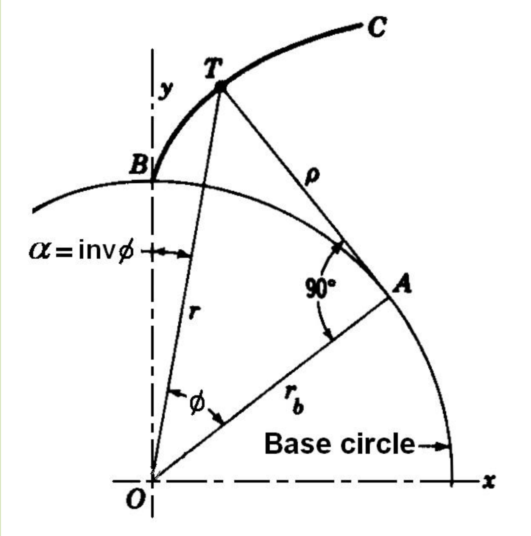
- Involute Profile
- Top land
- Addendum
- Dedendum
- Face width
- Pitch circle
- Dedendum circle
- Tooth thickness

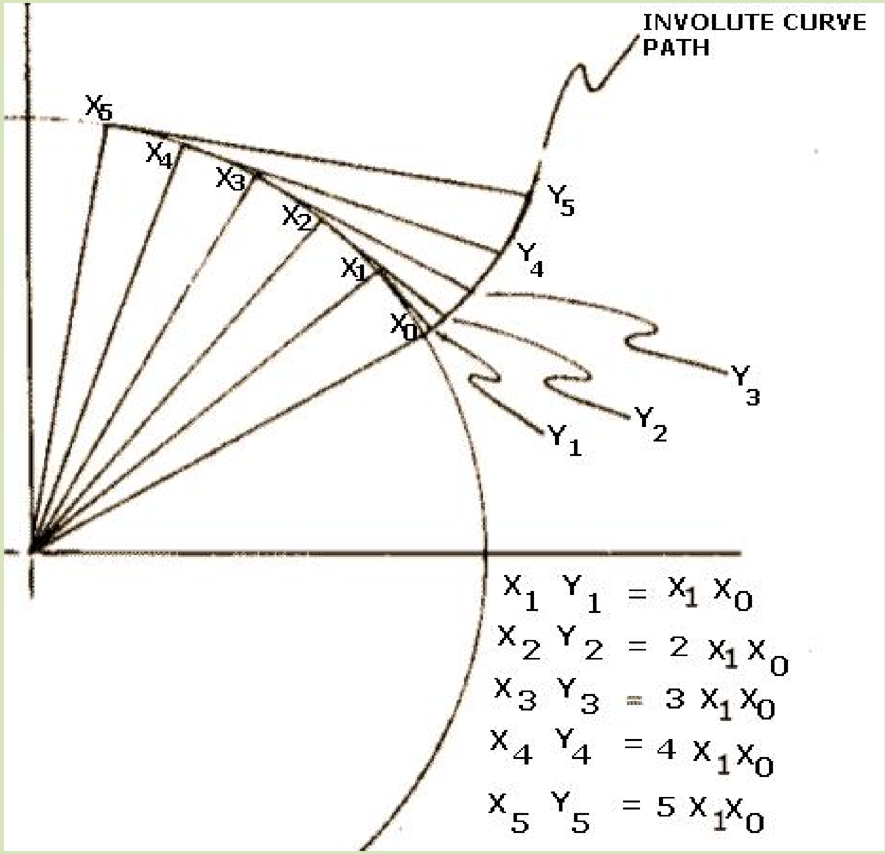


Involute profile

ADVANTAGES OF INVOLUTE PROFILE

- **Constant Velocity ratio**





Involute profile is generated from base circle.

Where is this base circle existing?

Major advantages of the involute curve

1. Conjugate action is independent of changes in center distance.

2. The form of the basic rack tooth is straight-sided, and therefore is relatively simple and can be accurately made; as a generating tool it imparts high accuracy to the cut gear tooth.

1. One cutter can generate all gear tooth numbers of the same pitch.

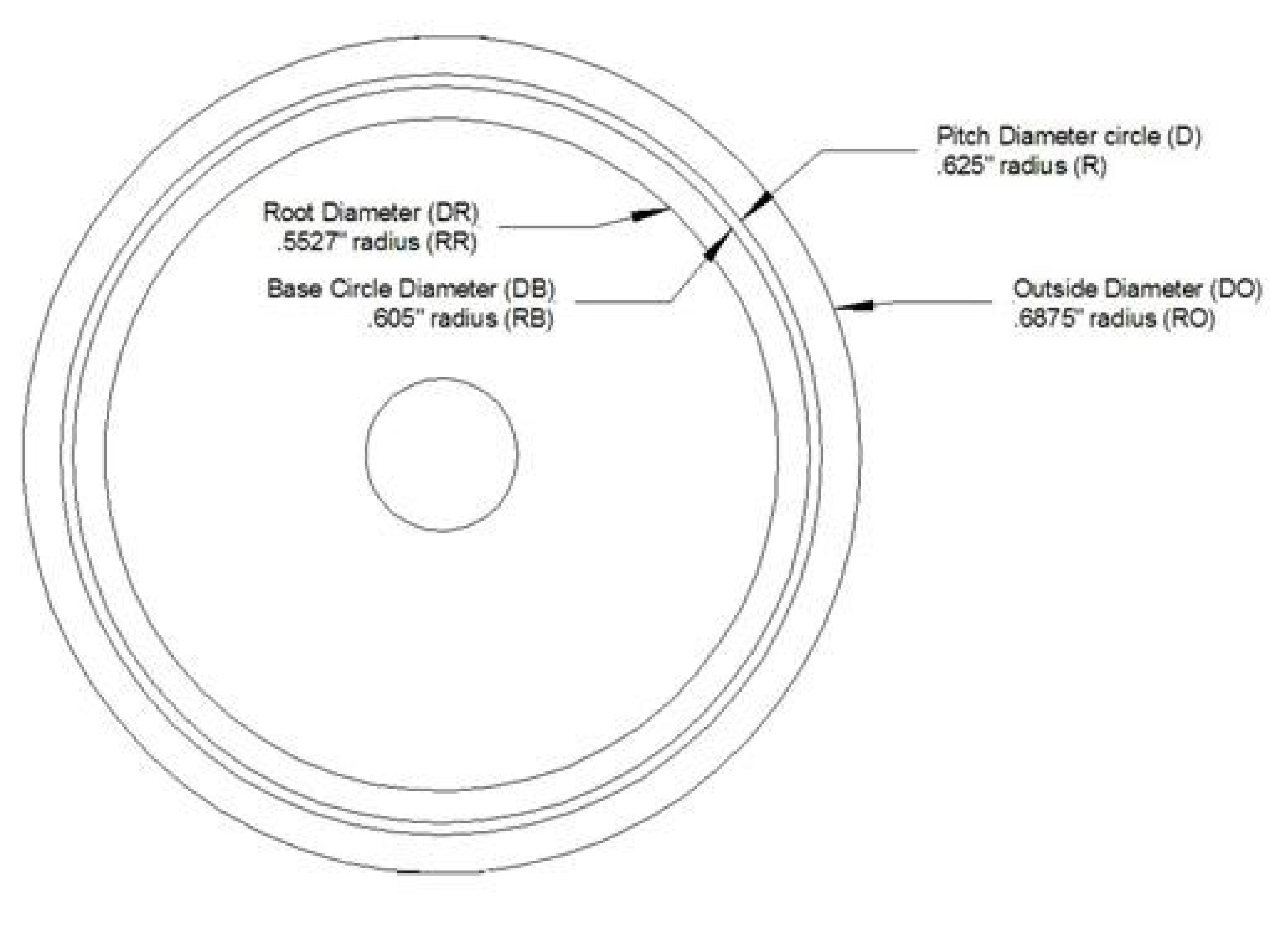
<u>Module, *m*</u>

This indicates the tooth size and is the number of mm of pitch circle diameter (p.c.d.) per tooth. For gears to mesh, their modules must be equal.

Gear ISO standards and design methods are now normally based on the module.

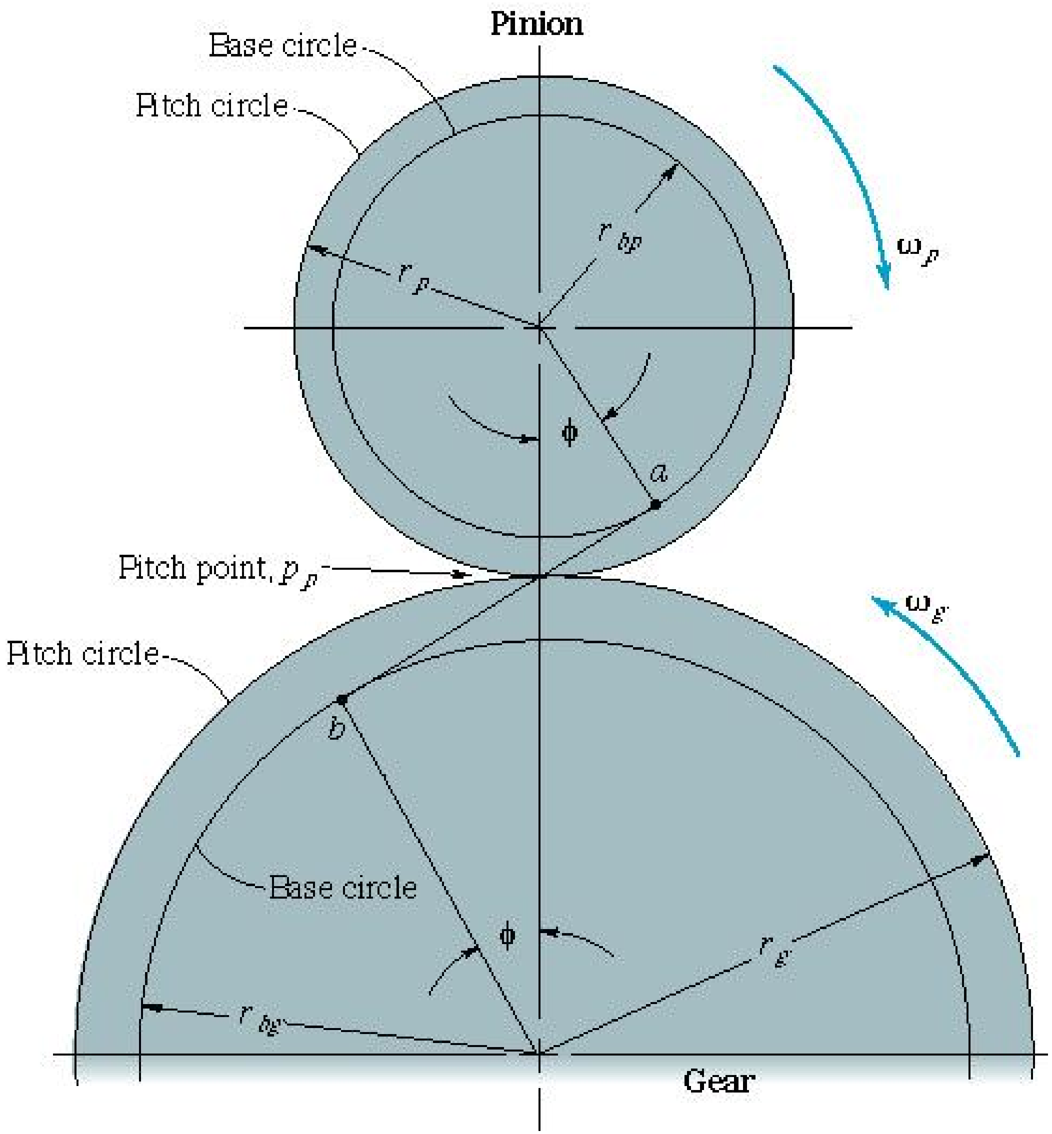
Eg. a gear of module 3 has 16 teeth, its pitch circle diameter is: 3 x 16 = 48 mm.

Circles in the formation of gear tooth



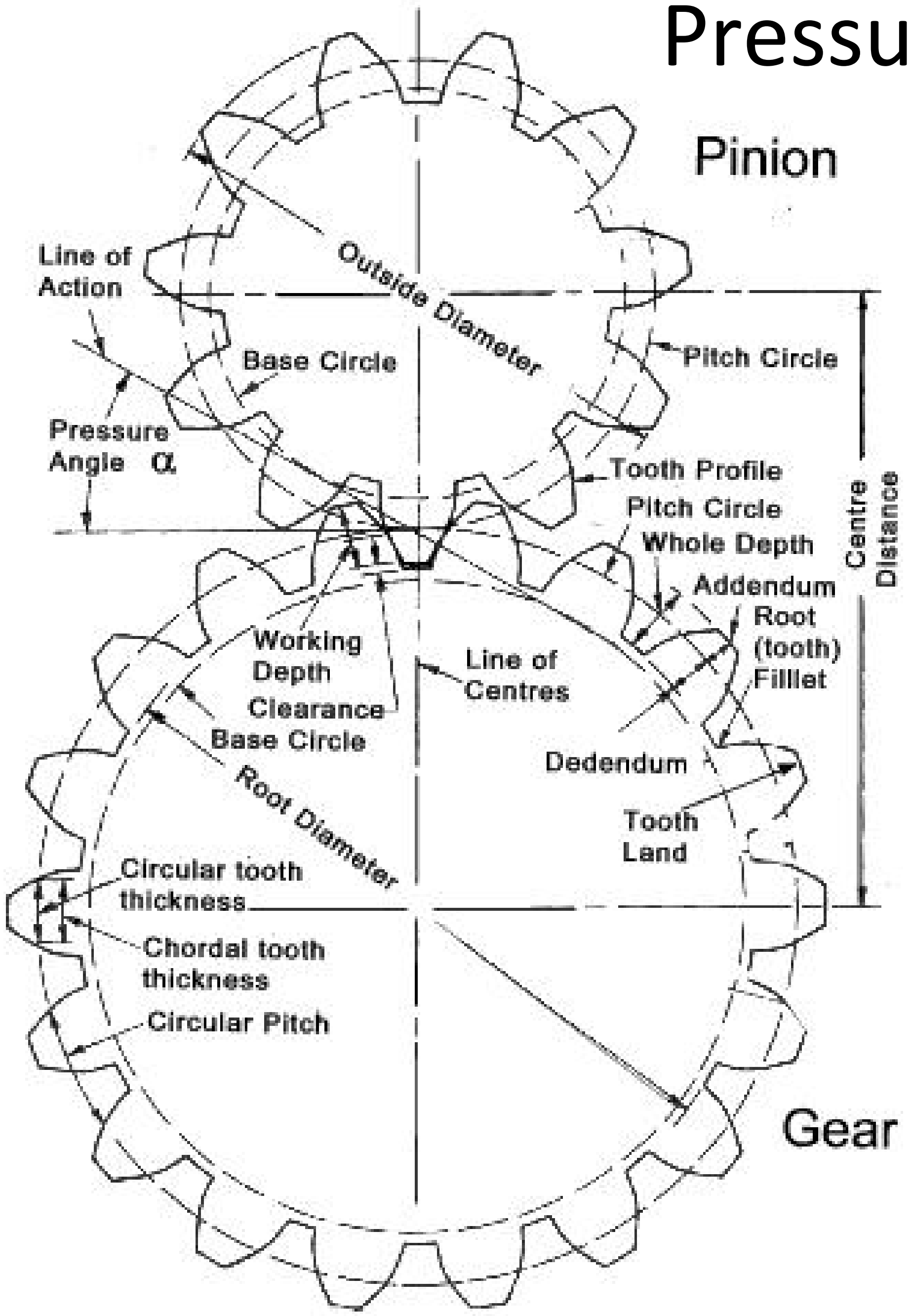
Base circle radius=Pitch circle radius x cos φ

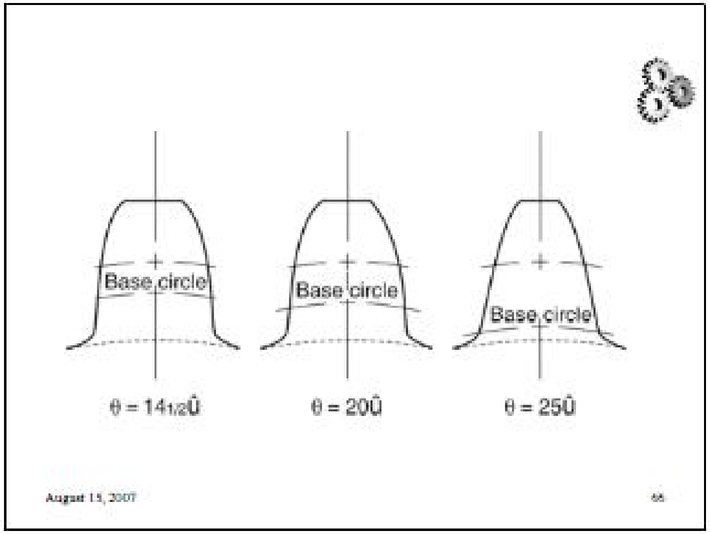
PITCH AND BASE CIRCLES



WORKSHEET

Pressure angle, Line of action





The Law of Gearing

"A common normal to the tooth profiles at their point of contact must, in all positions of the contacting teeth, pass through a fixed point on the line-of-centers called the pitch point."

Any two curves or profiles engaging each other and satisfying the law of gearing are conjugate Curves.

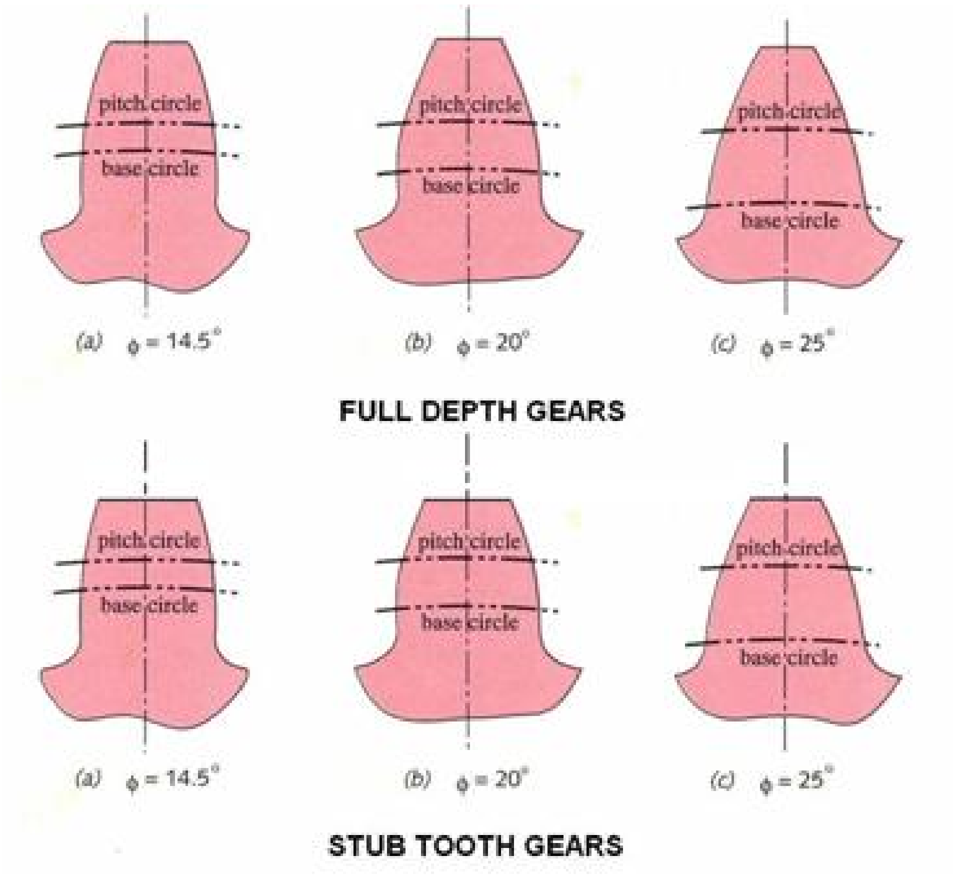
Interference

- Non conjugate contact

Remedies:

- Using More number of teeth
- Using large pressure angle
- Undercutting
- Increasing center distance
- Use of stub-tooth.

STUB TOOTH

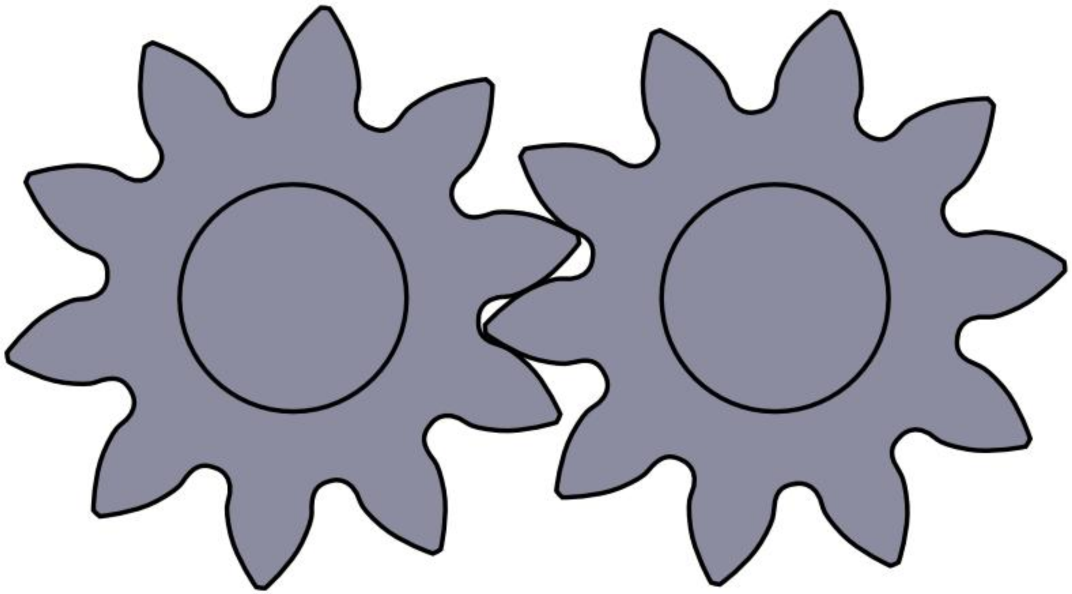


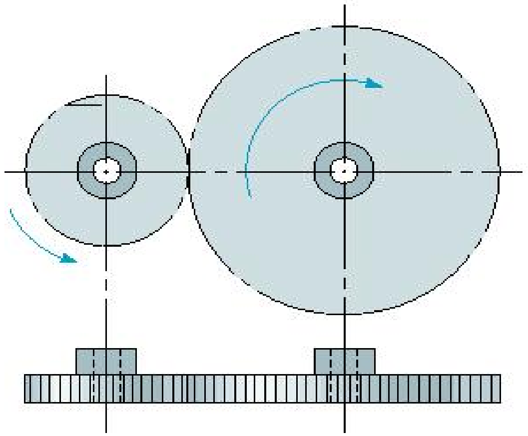
pitch circle
base circle
(a) ϕ = 14.5°
pitch circle
base circle
(b) ϕ = 20°
pitch circle
base circle
(c) ϕ = 25°
FULL DEPTH GEARS
pitch circle
base circle
(a) ϕ = 14.5°
pitch circle
base circle
(b) ϕ = 20°
pitch circle
base circle
(c) ϕ = 25°
STUB TOOTH GEARS

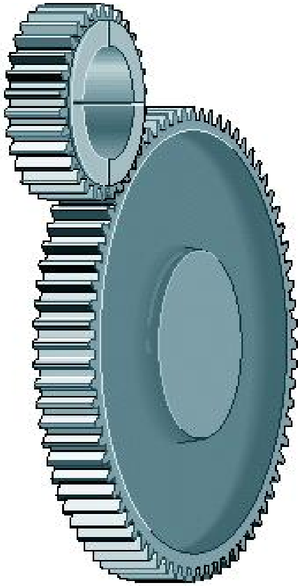
BACKLASH

- Difference between tooth gap and tooth thickness
- Intentionally designed and formed
- Not an error, but induces error in instruments/ devices where gear is used.

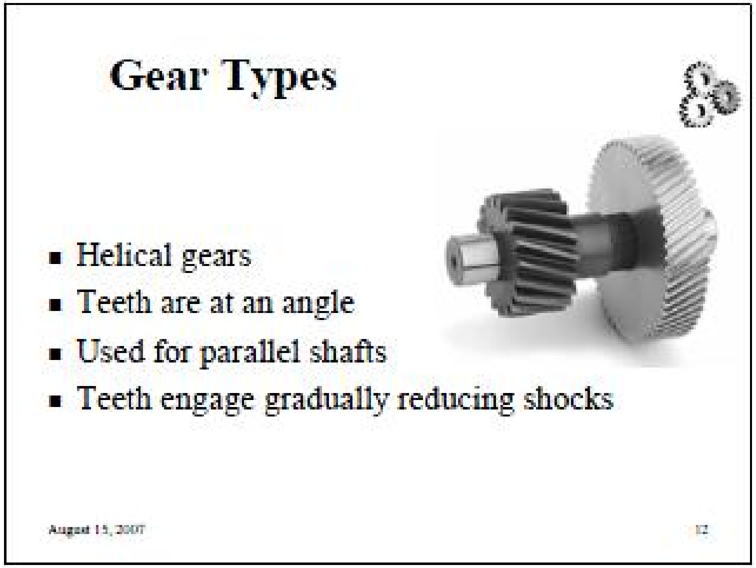
SPUR GEARS







Helical gears



Helical and Herringbone gears

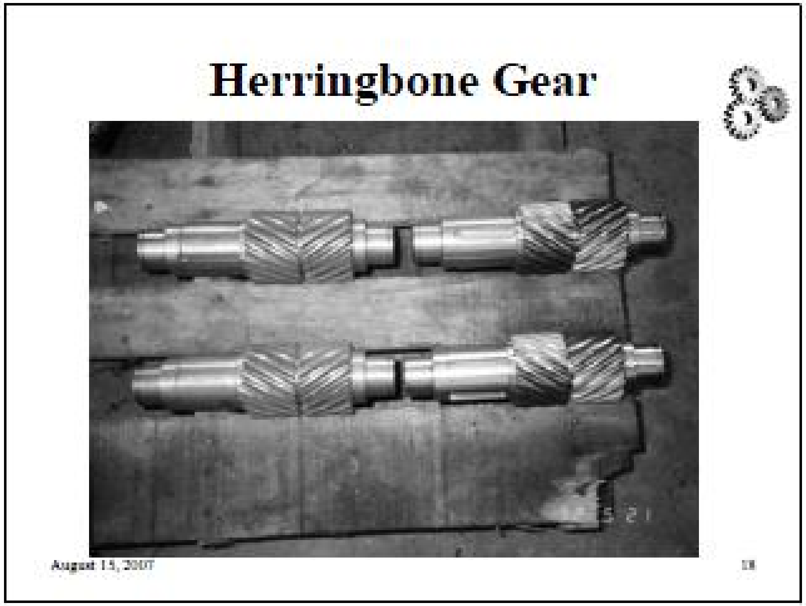
Helical Gear Characteristics

- Helix angle 7 to 23 degrees
- More power
- Larger speeds
- More smooth and quiet operation
- Used in automobiles
- Helix angle must be the same for both the mating gears
- Produces axial thrust which is a disadvantage

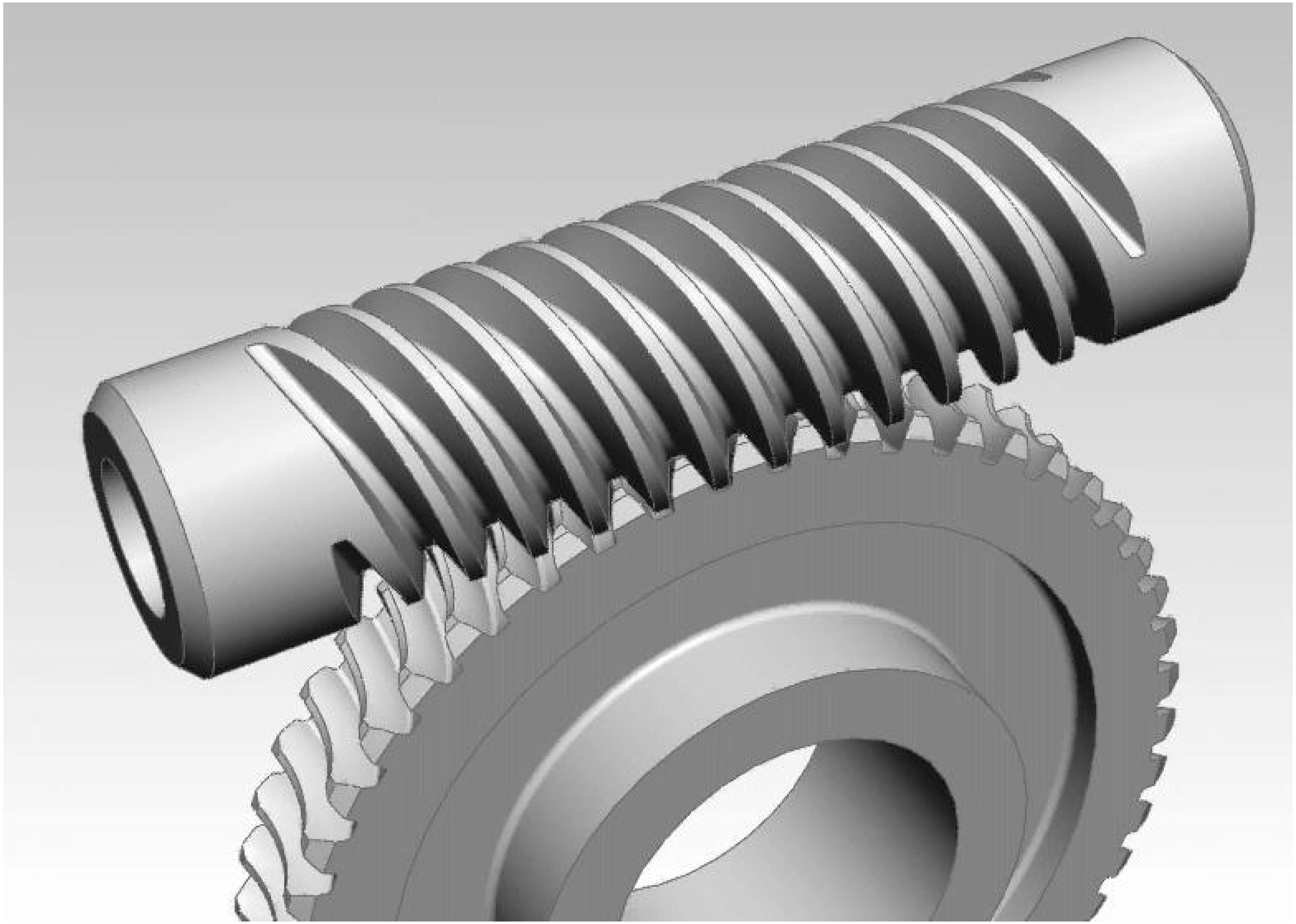
Herringbone Gears

- Two helical gears with opposing helical angles side-by-side
- Axial thrust gets cancelled

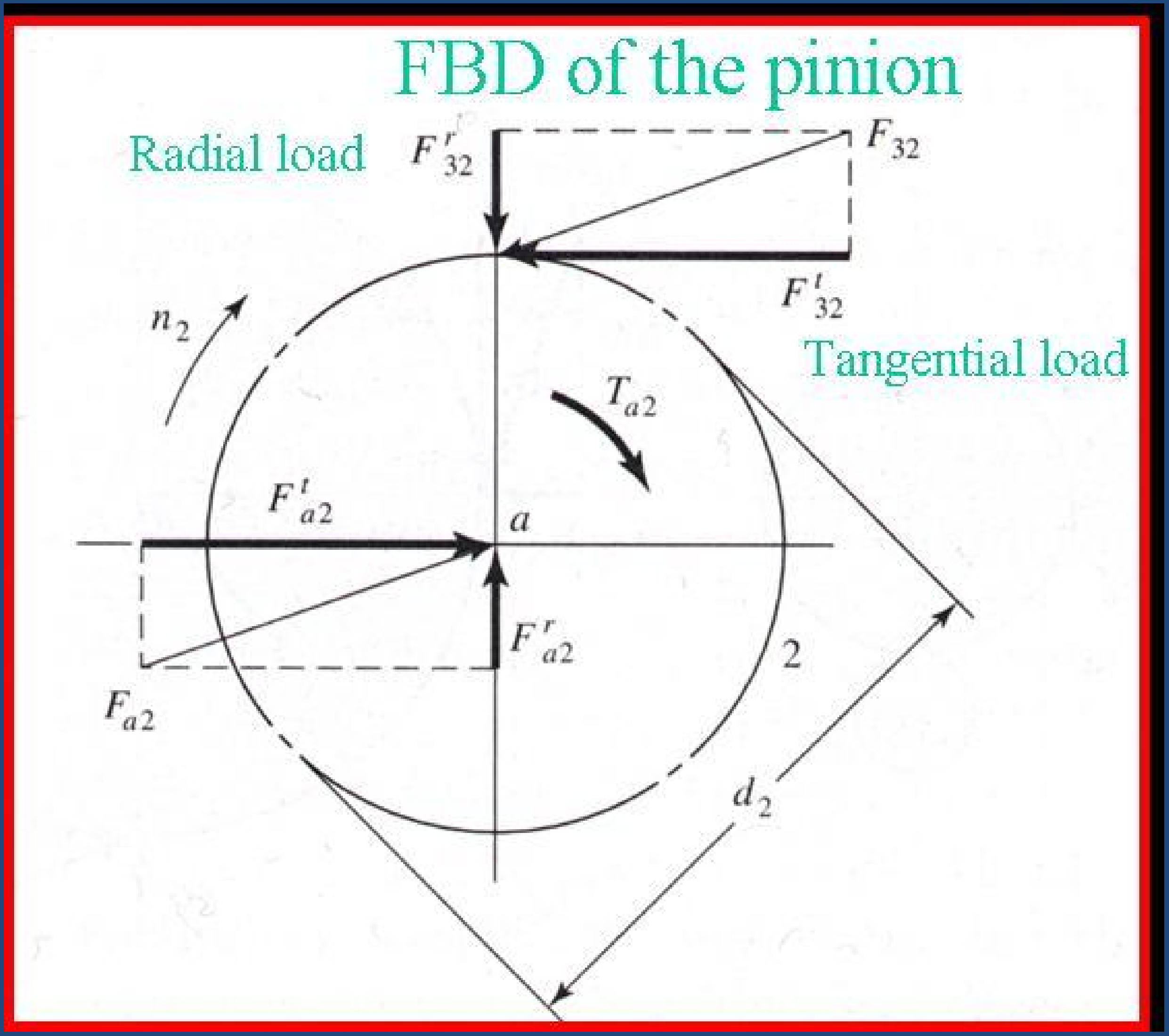
HERRINGBONE GEARS



WORM AND WHEEL



FORCES IN SPUR GEARS



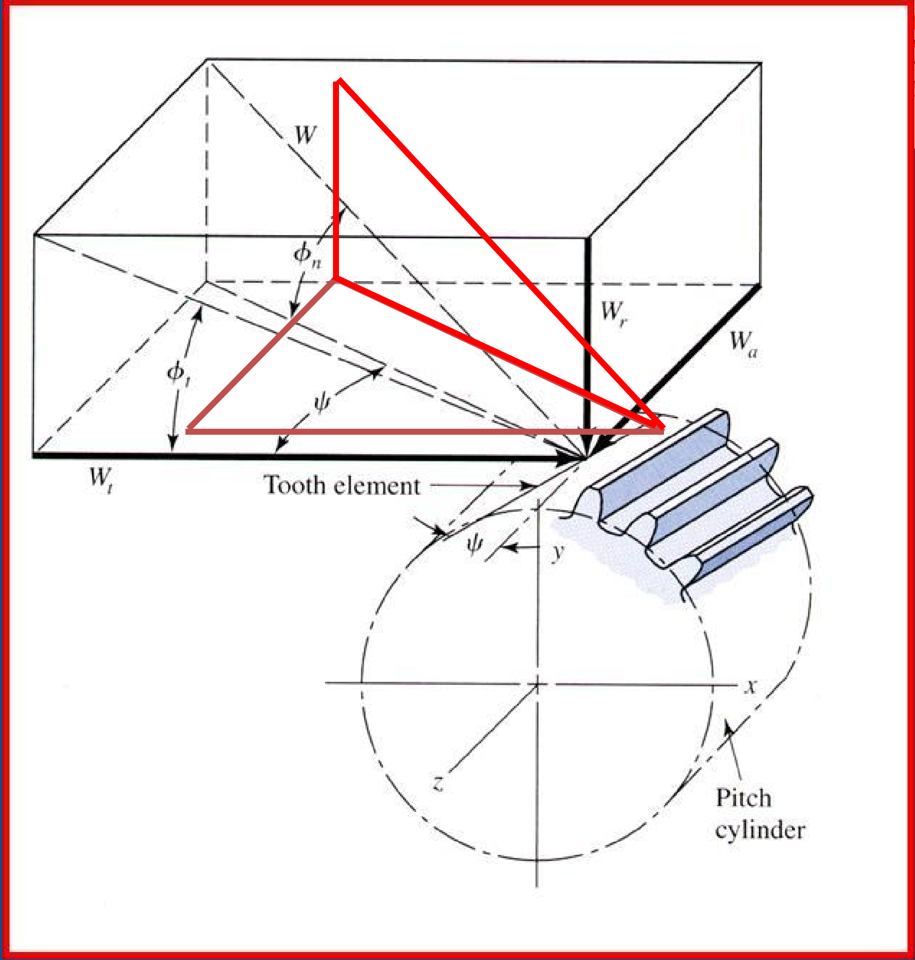
Force Analysis – Helical Gears

φ_n = normal pressure angle

φ_t = tangential pressure angle

ψ = helix angle

$$\tan \varphi_n = \tan \varphi_t \cos \psi$$



$W_r = W \sin \varphi_n$

$W_t = W \cos \varphi_n \cos \psi$

$W_a = W \cos \varphi_n \sin \psi$

Where W = total force

W_r = radial component

W_t = tangential component (transmitted load)

W_a = axial component (thrust load)

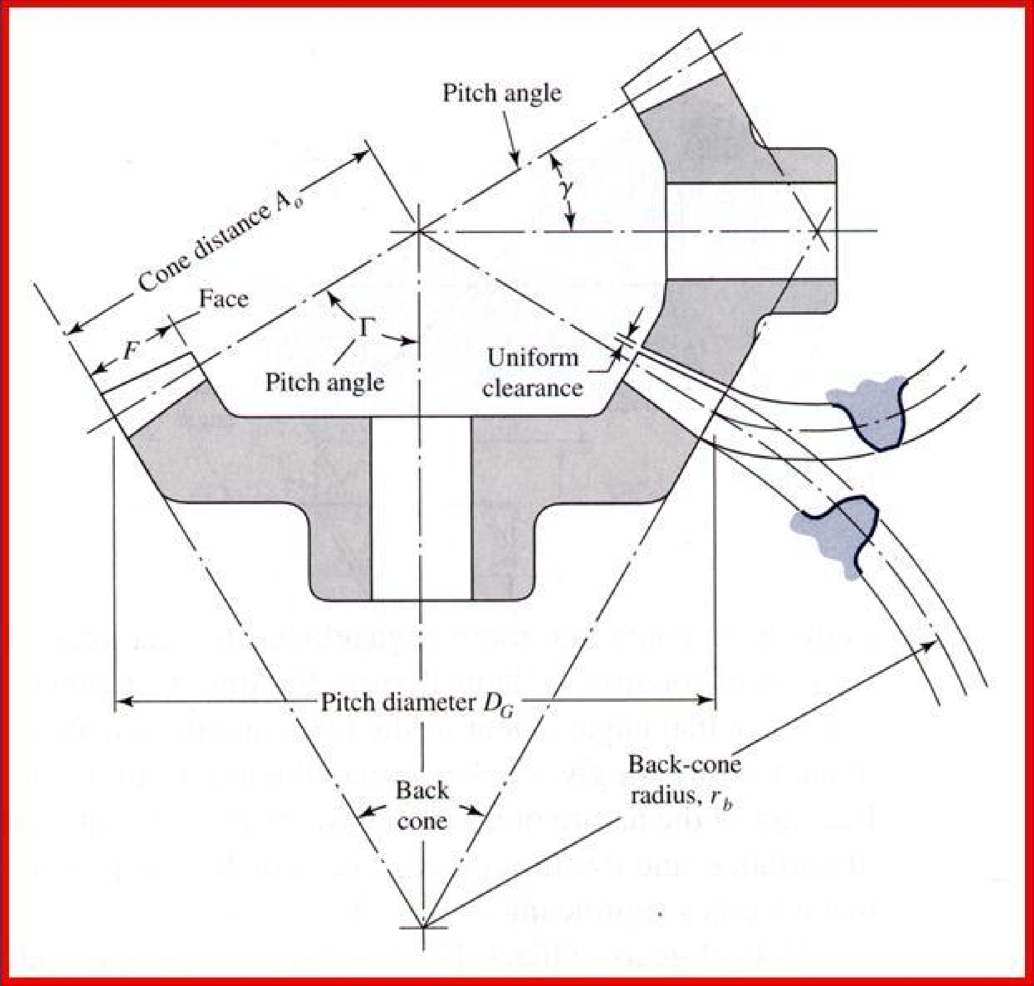
$W_r = W_t \tan \varphi_t$

$W_a = W_t \tan \psi$

φ_t = pressure angle (20° or 25°)

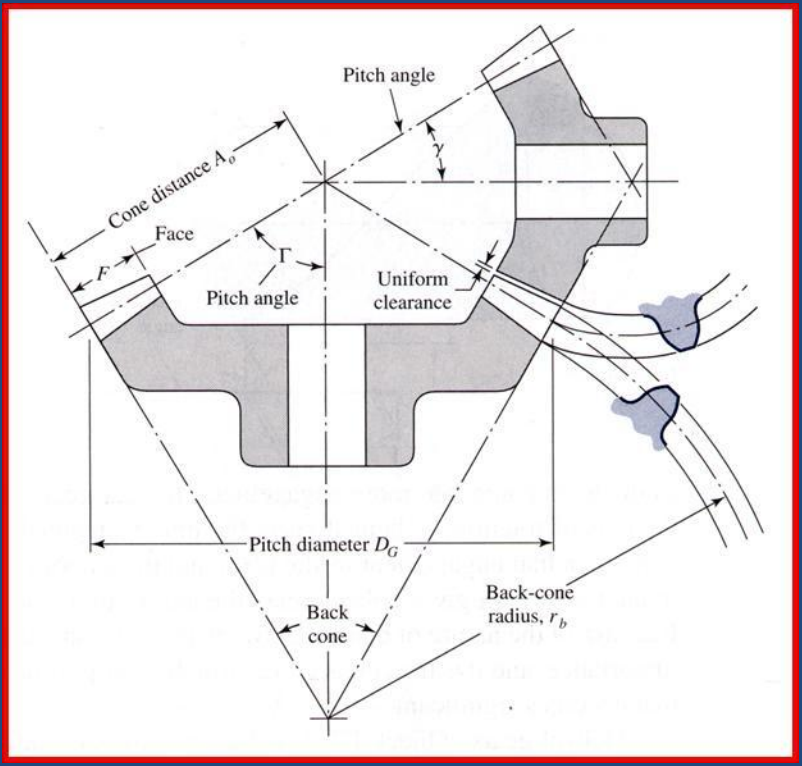
ψ = helix angle (10, 20, 30, or 40°)

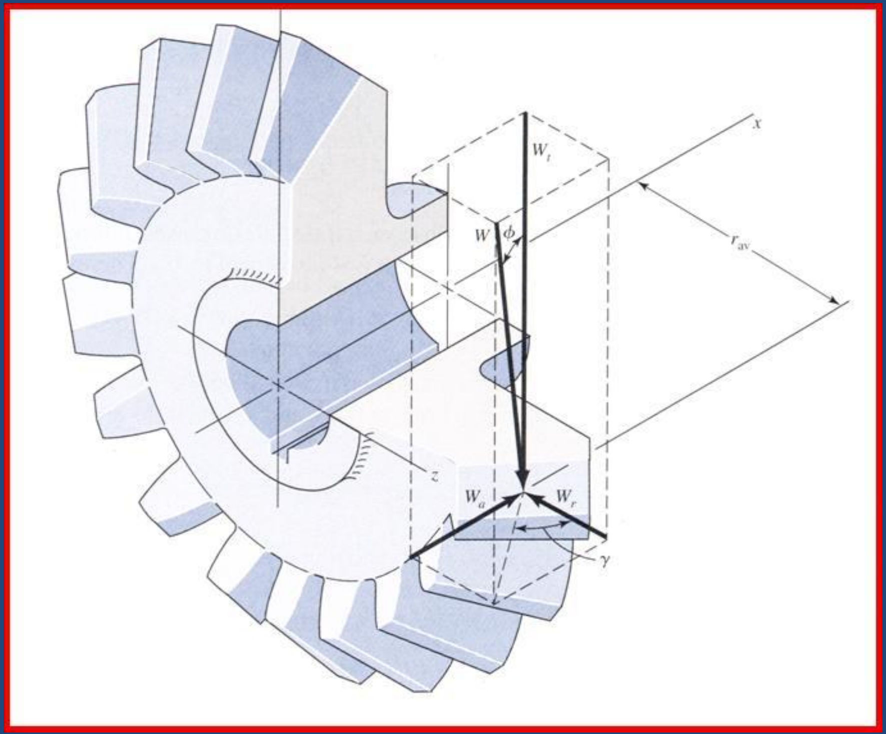
Bevel Gears



Pitch angle
Cone distance A_o
γ
Face
F
Γ
Pitch angle
Uniform clearance
Pitch diameter D_G
Back cone
Back-cone radius, r_b

Force Analysis – Bevel Gears





$$\tan \gamma = \frac{N_P}{N_G} \qquad \tan \Gamma = \frac{N_G}{N_P}$$

$$W_r = W_t \tan \phi \cos \gamma$$

$$W_a = W_t \tan \phi \sin \gamma$$

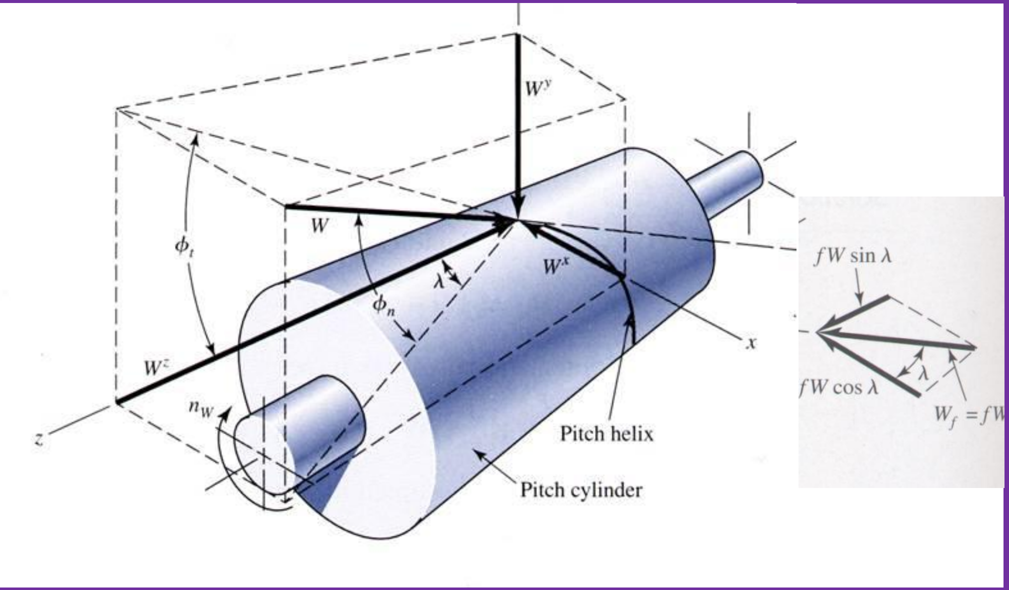
φ = Pressure angle (20^o)

φ = Pressure angle (20^o)

Force Analysis – Worm Gear Sets

Three orthogonal components of *W* without considering friction

$$W^x = W \cos \phi_n \sin \lambda$$
$$W^y = W \sin \phi_n$$
$$W^z = W \cos \phi_n \cos \lambda$$



considering friction

$$W^x = W(\cos \phi_n \sin \lambda + f \cos \lambda)$$
$$W^y = W \sin \phi_n$$
$$W^z = W(\cos \phi_n \cos \lambda - f \sin \lambda)$$

Relations between forces acting on the worm and the gear

$$W_{Wt} = -W_{Ga} = W^x$$
$$W_{Wr} = -W_{Gr} = W^y$$
$$W_{Wa} = -W_{Gt} = W^z$$

Involumetry

3.4 INVOLUTOMETRY

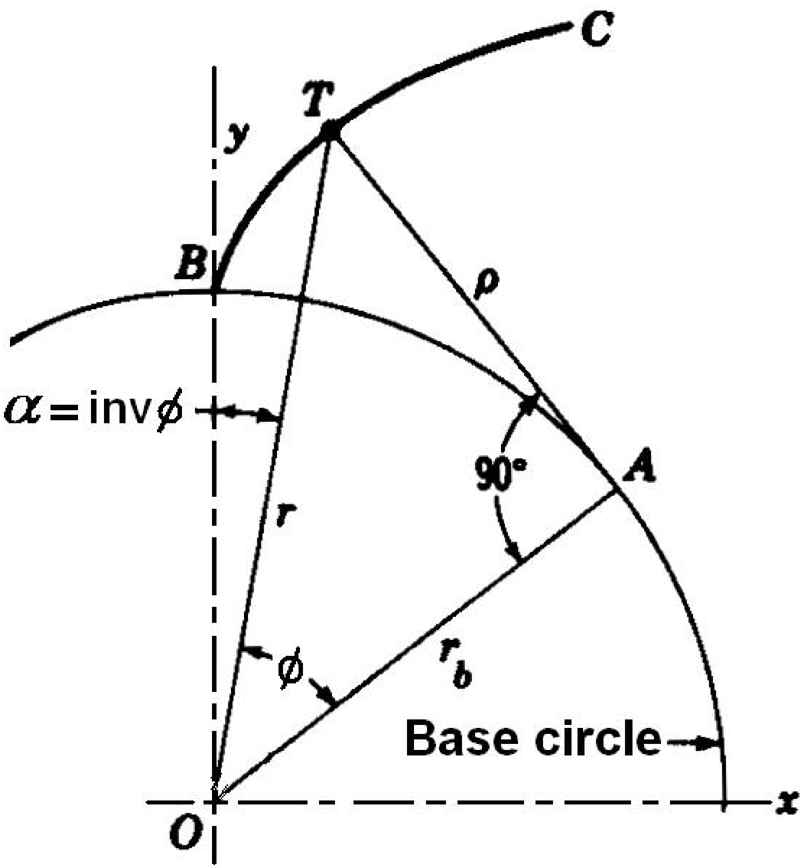
Involutometry is the study of involute geometry. In Fig. 3.6, at T, the generating line length, $\rho = r_b \tan\phi$, also $\rho = r_b(\alpha + \phi)$

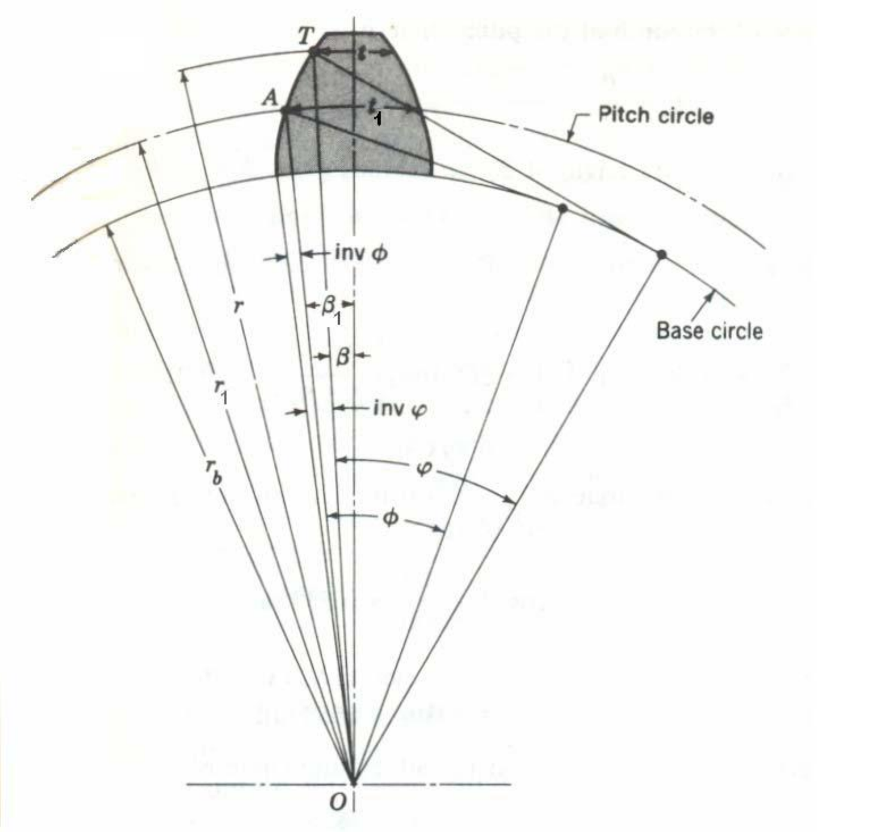
From the above relationship, $\alpha = \tan\phi - \phi$

Which is also written as $inv\,\phi = \tan\phi - \phi$

From the Fig.3.6 ,

$$r = \frac{r_b}{\cos\phi} \qquad (3.1)$$





In order to derive the relationship between tooth thickness and it distance r from the centre refer to the Fig. 3.7. The half tooth thickness at A and T are given by:

$$\frac{t_1}{2} = \beta_1 r_1 \qquad (3.2), \qquad \frac{t}{2} = \beta r \qquad (3.3)$$

So that

$$\beta_1 = \frac{t_1}{2r_1} \qquad (3.4), \qquad \beta = \frac{t}{2r} \qquad (3.5)$$

Thanks!