Outline

- Gear Theory
  - Fundamental Law of Gearing
  - Involute profile
- Nomenclature
- Gear Trains

Fundamental Law of Gearing

Functionally, a gearset is a device to exchange torque for velocity

\[ P = T \omega \]

The angular velocity ratio of the gears of a gearset must remain constant throughout the mesh.

What gear tooth shape can do this?

\[ m_p = \frac{m_{out}}{m_{pin}} = \frac{r_{out}}{r_{pin}} \]

Pitch circle, pitch diameter, pitch point

Towards the Involute Profile

A belt connecting the two cylinders

Line of action, pressure angle \( \phi \)

The Involute Profile

Figure 11-3

Meshing

Pressure angle, line of action, length of action, addendum

Nomenclature

Figure 11-8
**Pitches, Etc.**

- Circular pitch (mm, in.) \( p_c = \frac{\pi d}{N} \)
- Base pitch (mm, in.) \( p_b = p_c \cos \phi \)
- Diametral pitch (teeth/in.) \( p_d = \frac{N}{d} \)
- Module (mm/teeth) \( m = \frac{d}{N} \)

**Velocity Ratio**

Pitches must be equal for mating gears, therefore

\[
m_V = \pm \frac{r_{out}}{r_{in}} = \pm \frac{N_{out}}{N_{in}}
\]

**Contact Ratio**

Average number of teeth in contact at any one time

\[
m_p = \frac{p_d Z}{\pi \cos \phi}
\]

\[
Z = \sqrt{(r_p + a_p)^2 - (r_p \cos \phi)^2} + \sqrt{(r_g + a_g)^2 - (r_g \cos \phi)^2} - C \sin \phi
\]

where \( C = \text{center distance} = (N_g + N_p) \frac{1}{p_d} \frac{1}{2} \)

**Minimum # of Teeth**

Minimum # of teeth to avoid undercutting with gear and rack

\[
N_{min} = \frac{2}{\sin^2 \phi}
\]

**Outline**

- Gear Theory
  - Fundamental Law of Gearing
  - Involute profile
- Nomenclature
- Gear Trains

**Simple Gear Trains**
Simple Gear Train

- Fine for transmitting torque between shafts in close proximity
- When \( m_r \) does not need to be too large
- Use third gear ("idler") only for directional reasons (not for gear reduction)

Reverse on a Car

Actual Manual Transmission