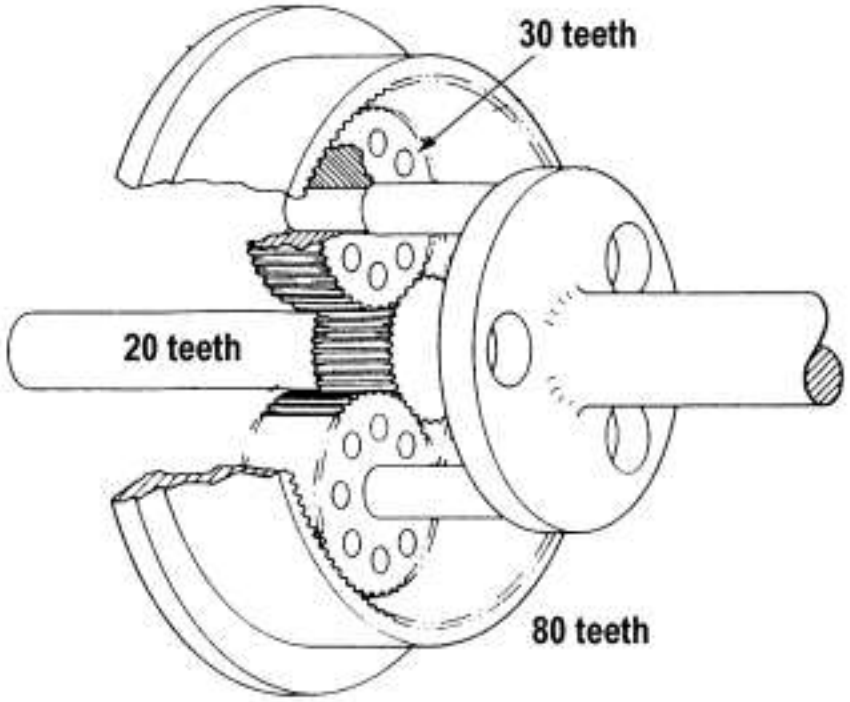
Design of Gears



- **Gears are toothed cylindrical wheels used for transmitting mechanical power from one rotating shaft to another.**
- **Several types of gears are commonly used and are available as stock items from original equipment suppliers worldwide.**
- **This chapter introduces various types of gears and gear transmission and details the design, specification, and selection of spur gears, in particular, based on the consideration of failure due to bending using the Lewis equation**

Gears can be divided into several broad classifications.

1. **Parallel axis gears**:
a. Spur gears.
b. Helical gears, and
c. Internal gears.
2. **Nonparallel co-planar gears (intersecting axes):**
a. Bevel gears.
b. Face gears, and
c. Conical involute gearing.
3. **Nonparallel noncoplanar gears (nonintersecting axes):**
a. Crossed axis helical.
b. Cylindrical worm gearing.
c. Single enveloping worm gearing,

Helical Gear

Spur Gear

Bevel Gear

Crossed Axis Helical Gear

Worm Gear

Spur Gear

- Spur gears are the least expensive of all types for parallel shaft applications.
- Their straight teeth allow running engagement or disengagement using sliding shaft and clutch mechanisms.
- Typical applications of spur gears include automatic motor vehicle gearboxes, machine tool drives, conveyor systems, electric motor gearboxes.
- The majority of power gears are manufactured from hardened and case-hardened steel. Other materials used include iron, brass, bronze, and polymers such as polyamide (e.g. nylon)

Materials Selection

Table 8.1: Typical material matches for gears and pinions.

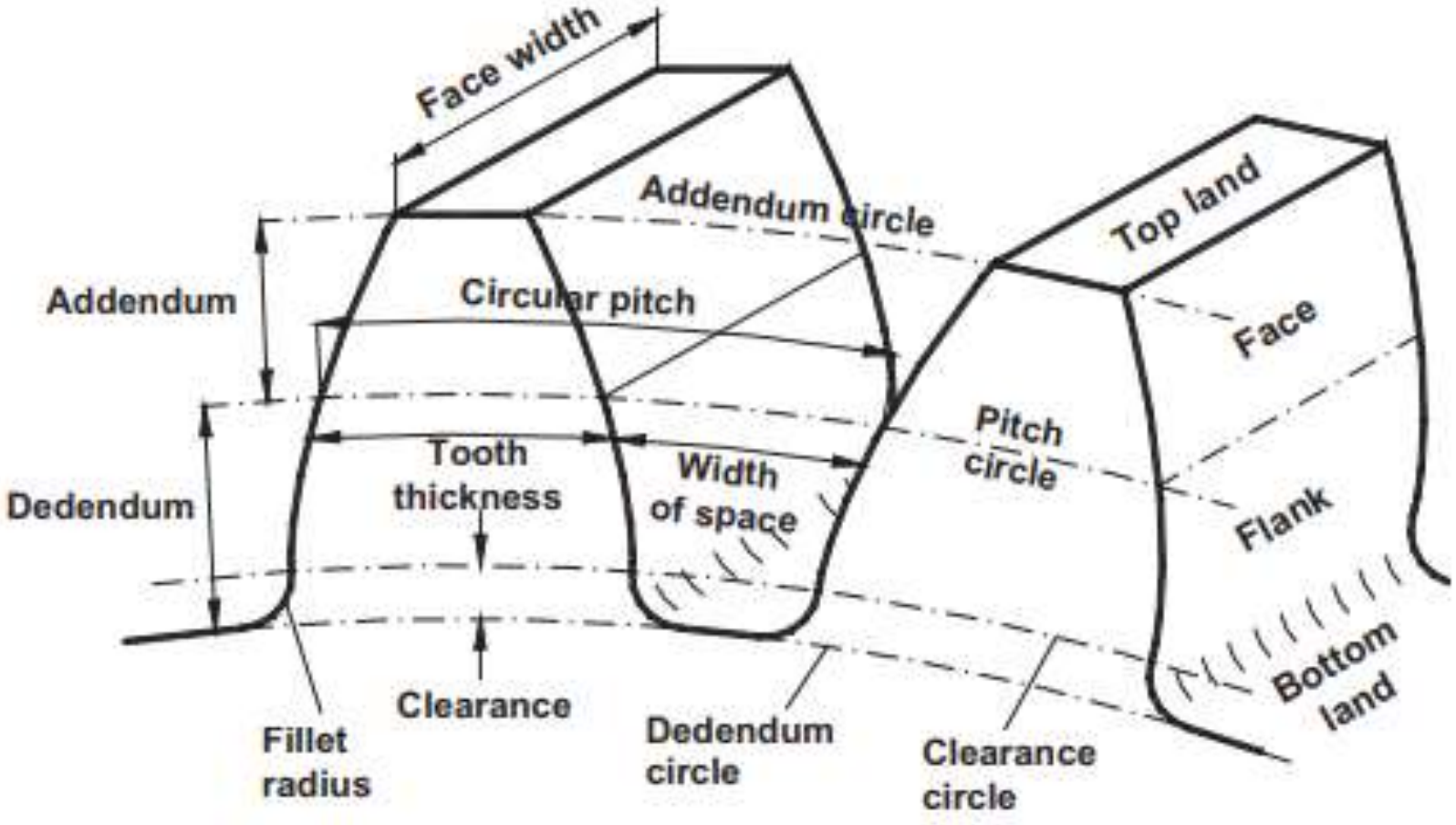
Gear material	Pinion material
Cast iron	Cast iron
Cast iron	Carbon steel
Carbon steel	Alloy steel
Alloy steel	Alloy steel
Alloy steel	Case hardened steel

Useful Range of Gear ratios

Table 8.2: Useful range of gear ratios.

Gear	Ratio range	Pitch line velocity (m/s)	Efficiency
Spur	1:1 to 6:1	25	98–99%
Helical	1:1 to 10:1	50	98–99%
Double helical	1:1 to 15:1	150	98–99%
Bevel	1:1 to 4:1	20	
Worm	5:1 to 75:1	30	20–98%
Crossed helical	1:1 to 6:1	30	

Spur gear schematic showing principal terminology



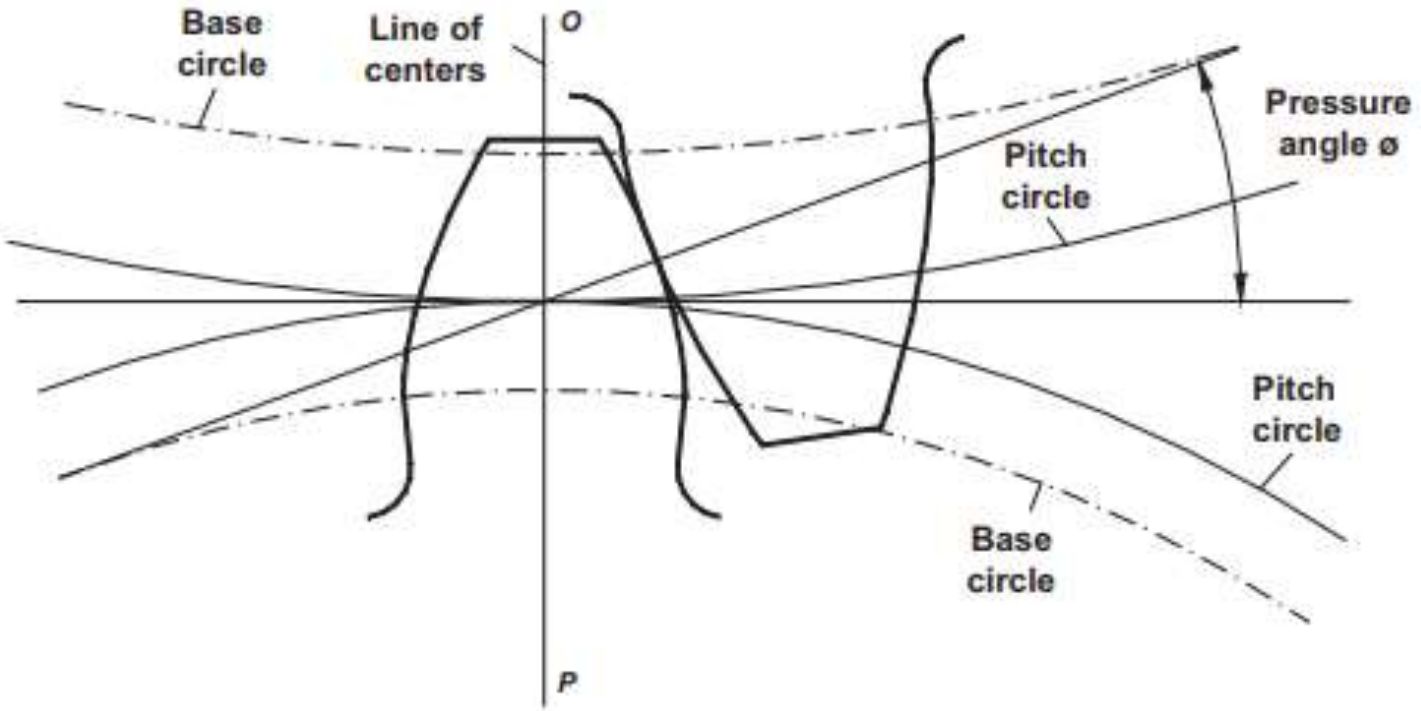
- ***Circular pitch***: This is the distance from a point on one tooth to the corresponding point on the adjacent tooth measured along the pitch circle.

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

- where **p** is the circular pitch (mm), **m** is the module, **d** is the pitch diameter (mm), and **N** is the number of teeth.
- ***Module***: This is the ratio of the pitch diameter to the number of teeth. The unit of the module should be in millimeters (mm). The module is defined by the ratio of pitch diameter and number of teeth. Typically the height of a tooth is about 2.25 times greater than the module.

$$m = \frac{d}{N}$$

- ***Addendum a***: This is the radial distance from the pitch circle to the outside of the tooth;
  Dedendum b: This is the radial distance from the pitch circle to the bottom land; and



- ***Diametral pitch*** is the ratio of the number of teeth in the gear to the pitch diameter.

$$P_d = N/d$$

- ***Pressure Angle (φ)***: is the generating line or line of action in which the resulting forces actins along this line.