
بسم الله الرحمن الرحيم

Measurements and Metrology

Fayoum University

Faculty of Engineering
Industrial Engineering Dept.

Lecture (7)

on

Gear Measurement

By

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2015 - 2016

Gears

- Power transmission is the movement of energy from its place of generation to a location where it is applied to performing useful work
- A gear is a component within a transmission device that transmits rotational force to another gear or device

Types of Gears

According to the position of axes of the shafts gears can classified to three types:

1. Parallel

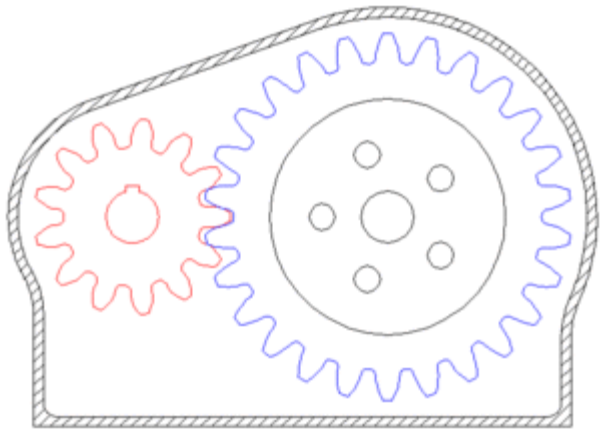
- Spur Gear
- Helical Gear
- Rack and Pinion

2. Intersecting

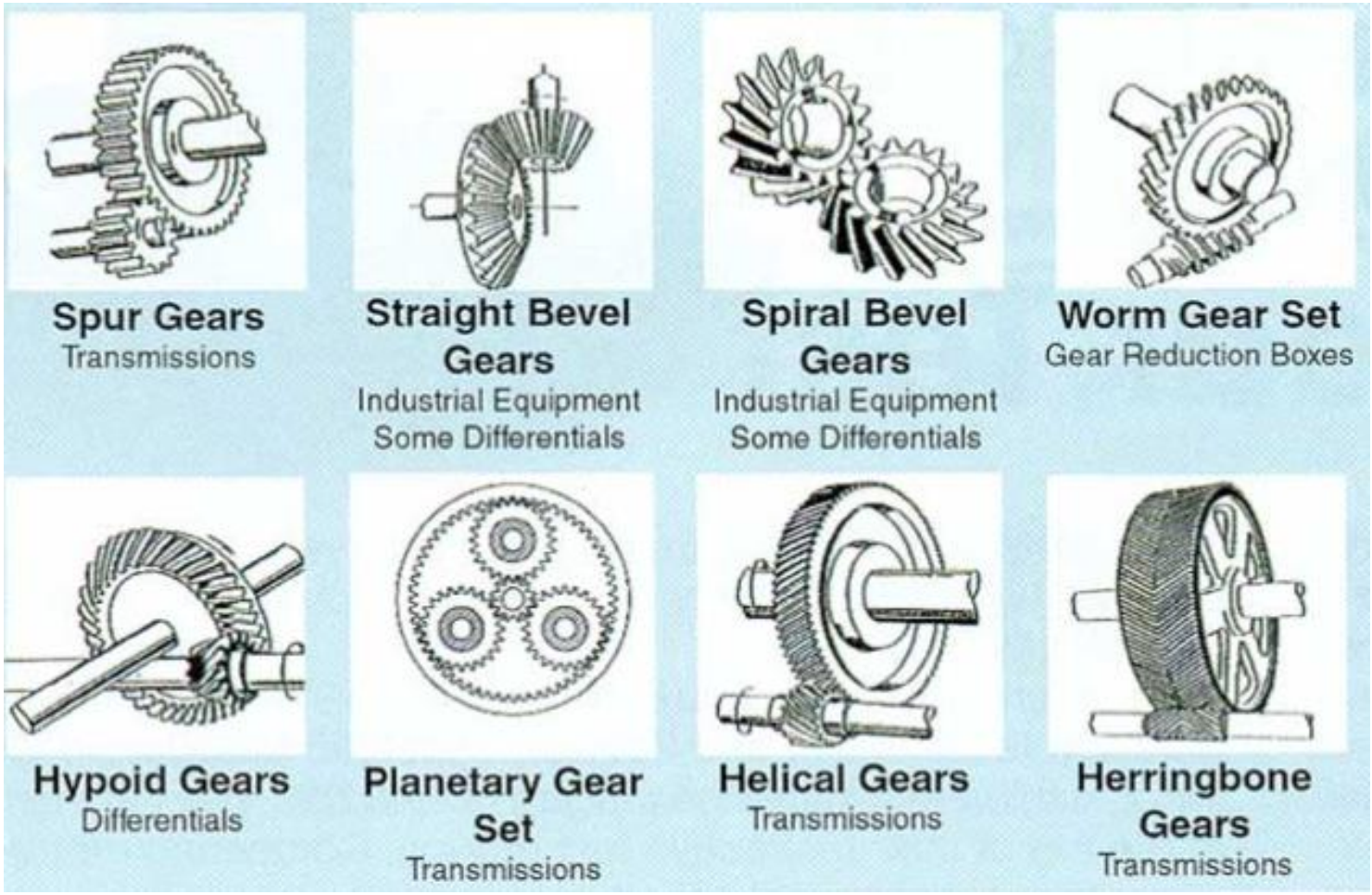
- Bevel Gear

3. Non-intersecting and Non-parallel

- Worm and worm gears



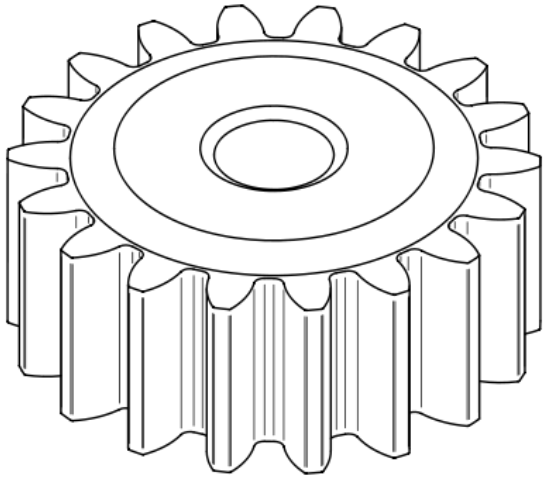
Gears


Spur Gears
Transmissions
Straight Bevel Gears
Industrial Equipment
Some Differentials
Spiral Bevel Gears
Industrial Equipment
Some Differentials
Worm Gear Set
Gear Reduction Boxes
Hypoid Gears
Differentials
Planetary Gear Set
Transmissions
Helical Gears
Transmissions
Herringbone Gears
Transmissions

Gears

Spur Gear

Spur gears or straight-cut gears are the simplest type of gear. They consist of a cylinder or disk with the teeth projecting radially, and although they are not straight-sided in form the edge of each tooth is straight and aligned parallel to the axis of rotation. These gears can be meshed together correctly only if they are fitted to parallel shafts



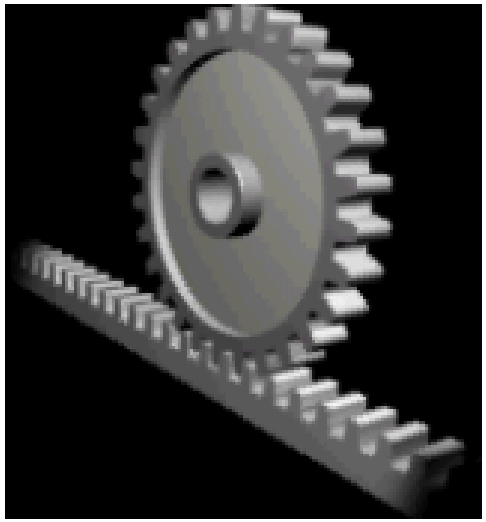
Gears

Helical Gear

- The teeth on helical gears are cut at an angle to the face of the gear
- This gradual engagement makes helical gears operate much more smoothly and quietly than spur gears
- One interesting thing about helical gears is that if the angles of the gear teeth are correct, they can be mounted on perpendicular shafts, adjusting the rotation angle by 90 degrees.

Gears

Rack and pinion



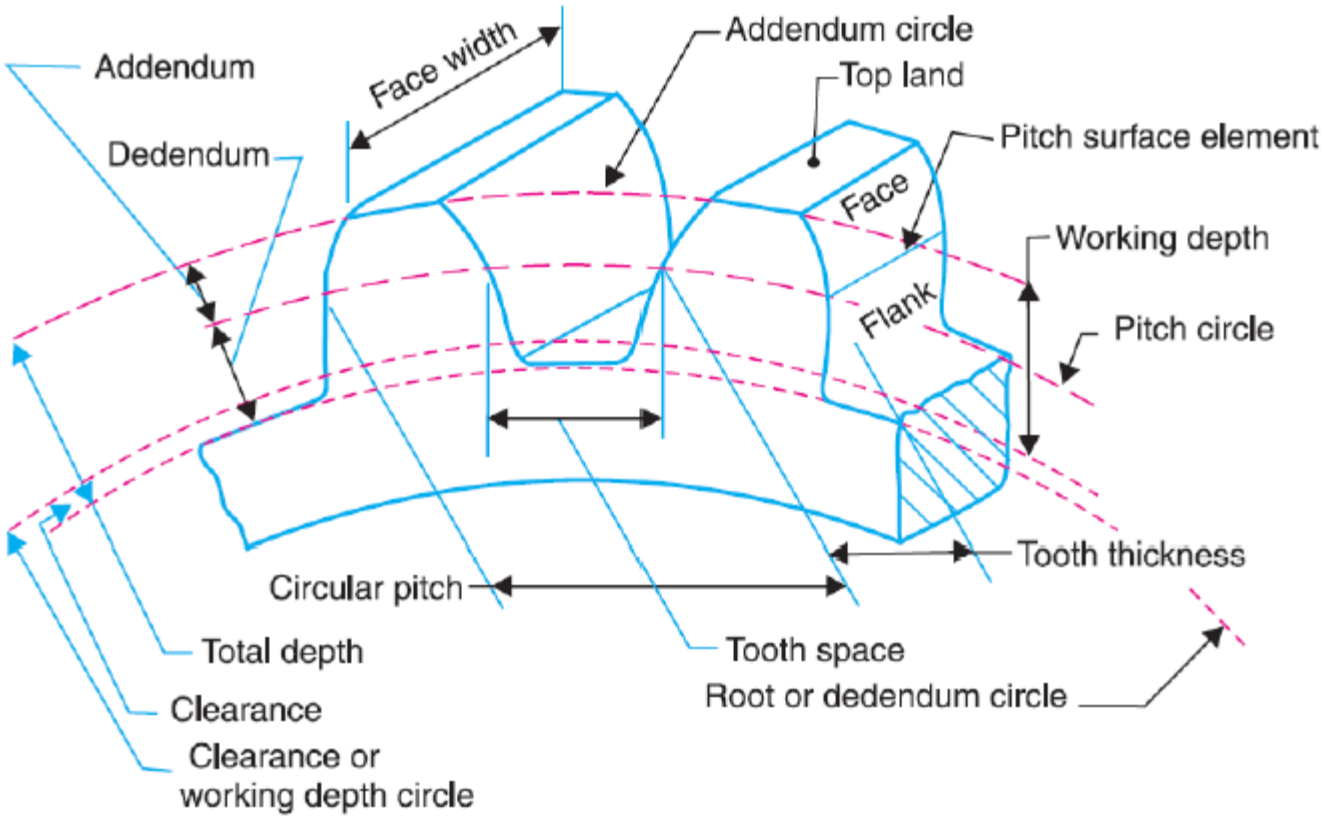
- Rack and pinion gears are used to convert rotation (From the pinion) into linear motion (of the rack).

- A perfect example of this is the steering system on many cars

Straight and Spiral Bevel Gears

Worm and Worm Gear

Gear Terminology



Gear Terminology

1. **Tooth profile:** It is the shape of any side of gear tooth in its cross section.
2. **Base circle:** It is the circle of gear from which the involute profile is derived. Base circle diameter Pitch circle diameter x Cosine of pressure angle of gear
3. **Pitch circle diameter (PCD):** The diameter of a circle which will produce the same motion as the toothed gear wheel.
4. **Pitch circle:** It is the imaginary circle of gear that rolls without slipping over the circle of its matiug gear.
5. **Addendum circle:** The circle coincides with the crests (or) tops of teeth.
6. **Dedendum circle (or) Root circle:** This circle coincides with the roots (or) bottom on teeth.
7. **Pressure angle (a):** It is the angle making by the line of action with the common tangent to the pitch circles of mating gears.

Gear Terminology

8. **Module(m):** It is the ratio of pitch circle diameter to the total number of teeth. Where, d = Pitch circle diameter. n = Number f teeth.
9. **Circular pitch:** It is the distance along the pitch circle between corresponding points of adjacent teeth.
10. **Addendum:** Radial distance between tip circle and pitch circle. Addendum value = 1 module.
11. **Dedendum:** Radial distance between itch circle and root circle, Dedendum value = 1 .25module.
12. **Clearance (C):** Amount of distance made by the tip of one gear with the root of mating gear. Clearance = Difference between Dedendum and addendum values.
13. **Blank diameter:** The diameter of the blank from which gear is out. Blank diameter = PCD + 2m
14. **Face:** Part of the tooth in the axial plane lying between tip circle and pitch circle.
15. **Flank:** Part of the tooth lying between pitch circle and root circle.
16. **Top land:** Top surface of a tooth.
17. **Lead angle:** The angle between the tangent to the helix and plane perpendicular to the axis of cylinder.
18. **Backlash:** The difference between the tooth thickness and the space into which it meshes. If we assume the tooth thickness as t_2 and width 't_1 then Back lash = t_{1-} t_1

Gear Errors

1. **Profile error:** The maximum distance of any point on the tooth profile form to the design profile.
2. **Pitch error:** Difference between actual and design pitch
3. **Cyclic error:** Error occurs in each revolution of gear
4. **Run out:** Total range of reading of a fixed indicator with the contact points applied to a surface rotated, without axial movement, about a fixed axis.
5. **Eccentricity:** Half the radial run out
6. **Wobble:** Run out measured parallel to. the axis of rotation at a specified distance from the axis
7. **Radial run out:** Run out measured along a perpendicular to the axis of rotation.
8. **Undulation:** Periodical departure of the actual tooth surface from the design surface.
9. **Axial run out:** Run out measured parallel to the axis of rotation at a speed.
10. **Periodic error:** Error occurring at regular intervals.

Gear Measurement

The Inspection of the gears consists of determine the following elements in which manufacturing error may be present:

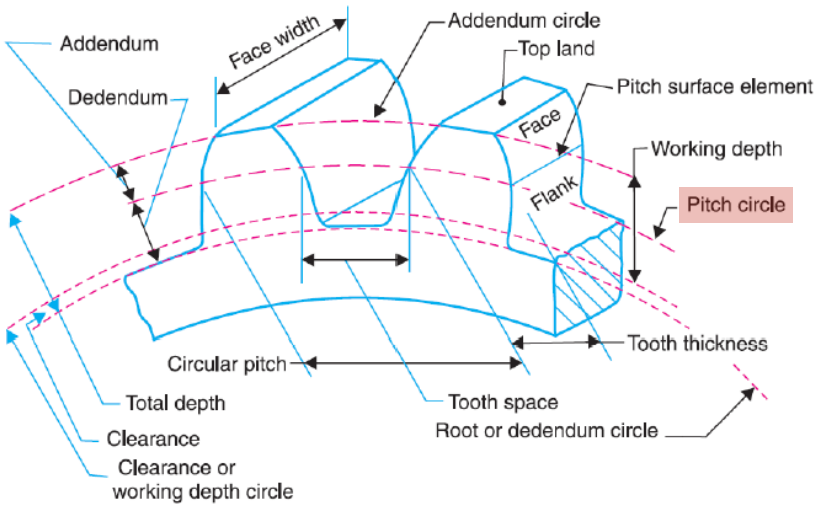
1. Runout.
2. Pitch
3. Profile
4. Lead
5. Back lash
6. Tooth thickness
7. Concentricity
8. Alignment

Gear Measurement

1. Gear Runout Measurement

It means eccentricity in the pitch circle. It will give periodic vibration during each revolution of the gear. This will give the tooth failure in gears. The run out is measured by means of eccentricity testers.

In the testing the gears are placed in the mandrel and the dial indicator of the tester possesses special tip depending upon the module of the gear and the tips inserted between the tooth spaces and the gears are rotated tooth by tooth and the variation is noted from the dial indicator.



Gear Measurement

2. Gear Pitch Measurement

There are two ways for measuring the pitch:

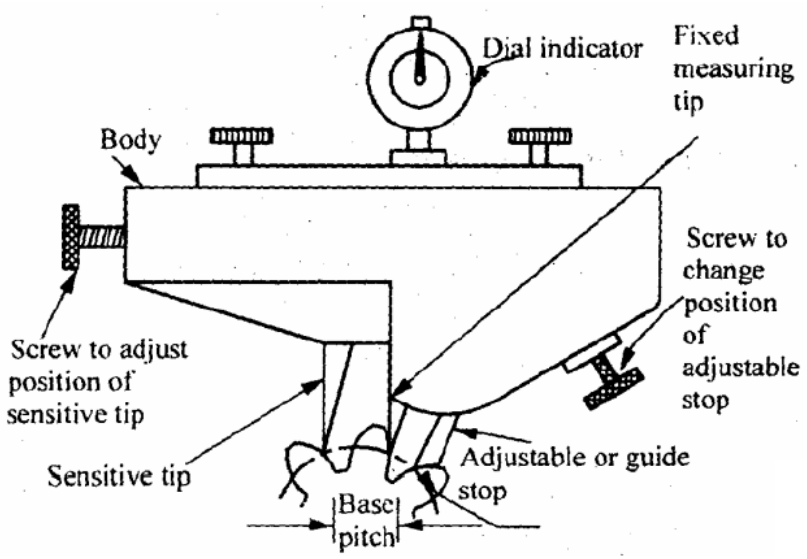
1. Point to point measurement (i.e. One tooth point to next toot point)
2. Direct angular measurement

Gear Measurement

2. Gear Pitch Measurement

1. Tooth to tooth measurement

The instrument has three tips. One is fixed measuring tip and the second is sensitive tip, whose position can be adjusted by a screw and the third tip is adjustable or guide stop. The distance between the fixed and sensitive tip is equivalent to base pitch of the gear. All the three tips are contact the tooth by setting the instrument and the reading on the dial indicator is the error in the base pitch.



2. Direct Angular Measurement

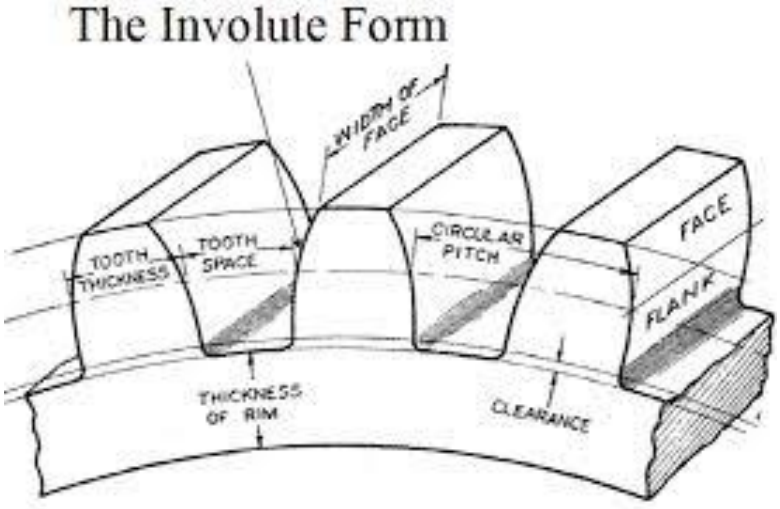
It is the simplest method for measuring the error by using set dial gauge against a tooth. in this method the position of a suitable point on a tooth is measured after the gear has been indexed by a suitable angle. If the gear is not indexed through the angular pitch the reading differs from the original reading. The difference between these is the cumulative pitch error.

Gear Measurement

3. Gear profile checking

The methods used for profile checking is

1. Optical projection method.
2. Involute measuring machine.



Gear Measurement

3. Gear profile checking

1. Optical projection method

- In this method an optical comparator and profile projector are used to magnify the profile of the gear under test and then it is compared with the master profile as shown in fig.
- This method is quick and suitable for checking the profile of small thin instrument gears.