

- Avionic systems include communications, navigation, the display and management of multiple systems, and the hundreds of systems that are fitted to aircraft to perform individual functions.
- These can be as simple as a searchlight for a police helicopter or as complicated as the tactical system for an airborne early warning platform.

### 5. Overview of Some Components of Mechanical Actuation Systems

Actuation systems are the elements of control systems which are responsible for transforming the output of a microcontrollers or microprocessor or control system into a controlling action on machine or device. e.g., Pneumatic, hydraulic, mechanical, and electrical actuation systems.

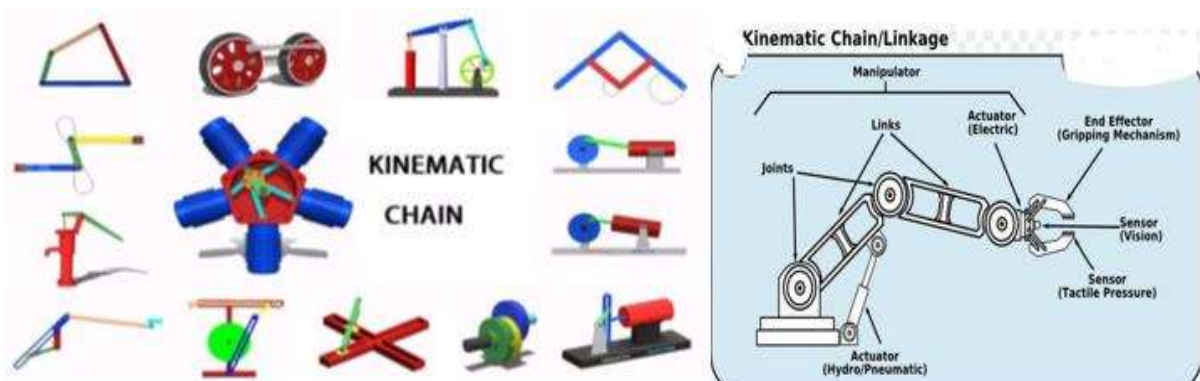
#### Mechanical Actuation System

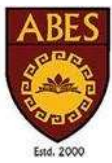
- Actuation systems are the elements of control systems which are responsible for transforming the output of a microprocessor or control system into a controlling action on a machine or device. There various components of mechanical actuation systems, which include kinematic chains, cam and followers, belt drives, train ratchet mechanism, ball bearings, various types of gears, etc.
- Generally, two types of actuation systems, namely pneumatic and hydraulic actuation systems, are used.
- Pneumatics is the term used when compressed air is used and hydraulics when a liquid, typically an incompressible dense oil.

#### Some mechanical components used for actuation purpose

##### Kinematic chain

- In mechanical engineering, a kinematic chain is an assembly of rigid bodies connected by joints to provide constrained (or desired) motion that is the mathematical model for a mechanical system. The motion of one link causes motion to the other connected links.





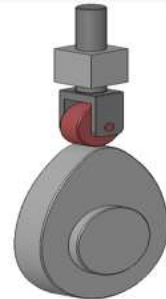
# ABES ENGINEERING COLLEGE, GHAZIABAD

## Subject: Fundamentals of Mechanical Engineering (BME101)

- As in the familiar use of the word chain, the rigid bodies, or links, are constrained by their connections to other links.
- The Kinematic Chain is also the combination of the Kinematic pairs.

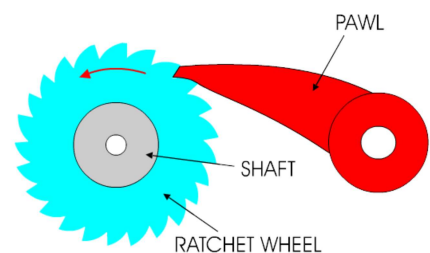
### Cam and Followers

- A cam is a rotating or sliding piece in a mechanical linkage used especially in transforming rotary motion into linear motion. It is often a part of a rotating wheel (e.g. an eccentric wheel) or shaft (e.g. a cylinder with an irregular shape) that strikes a lever at one or more points on its circular path.
- The cam can be a simple tooth, as is used to deliver pulses of power to a steam hammer, for example, or an eccentric disc or other shape that produces a smooth reciprocating (back and forth) motion in the follower, which is a lever making contact with the cam.
- The cam can be seen as a device that converts rotational motion to reciprocating (or sometimes oscillating) motion.



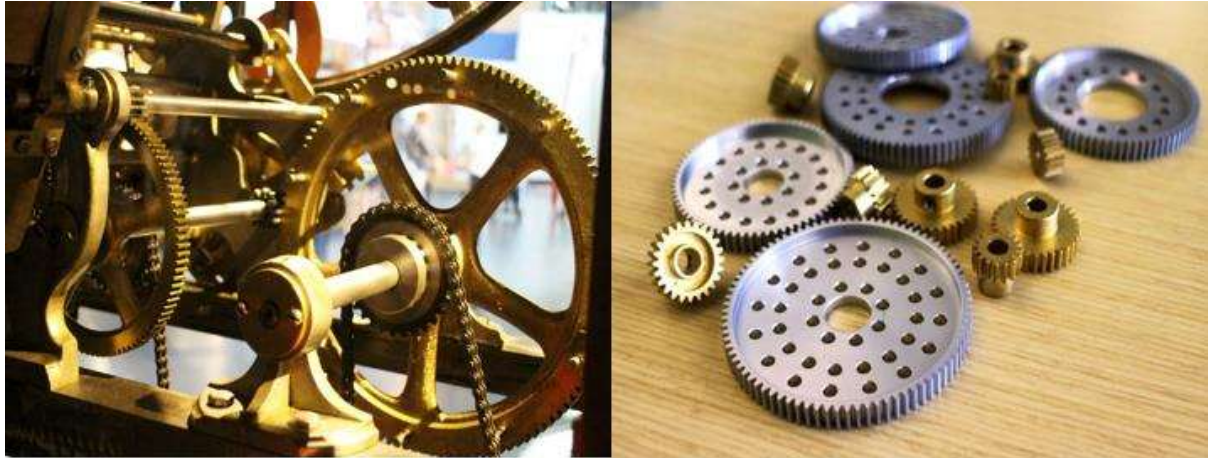
### Train Ratchet Mechanism

- A ratchet is a fairly simple mechanism that only allows a gear to turn in one direction.
- A ratchet system consists of a gear (sometimes the teeth are different than the standard profile) with a small lever or latch that rotates about a pivot point and catches in the teeth of the gear.
- The latch is designed and oriented such that if the gear were to turn in one direction, the gear could spin freely and the latch would be pushed up by the teeth, but if the gear were to spin in the other direction, the latch would catch in the teeth of the gear and prevent it from moving.
- Ratchets are useful in a variety of applications, because they allow force to be applied in one direction but not the other.
- Bicycles, some wrenches, screw gauge, etc.



### Gears and its types

A gear is a wheel with teeth around its circumference. Gears are usually found in sets of two or more, used to transmit rotation from the axis of one gear to the axis of another.



- The teeth of a gear on one axis mesh with the teeth of a gear on another, thus creating a relationship between the rotation of the two axes.
- When one axis is spun, the other will too. Two gears of different sizes will make their two axes spin at different speeds.

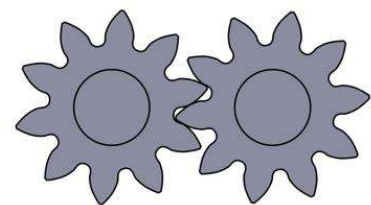
### Why Use Gears?

- Gears are a very useful type of transmission mechanism used to transmit rotation from one axis to another.
- You can use a system of gears to reduce the speed (and likewise increase the torque) so that the output shaft spins at half the speed of the motor.
- Gears are commonly used in high load situations because the teeth of a gear allow for more fine, discrete control over movement of a shaft, which is one advantage gears have over most pulley systems.

**Types of Gears :** Spur gears, bevel gears, helical gears, herringbone gears, worm and worm-wheel gears, hypoid gears, etc.

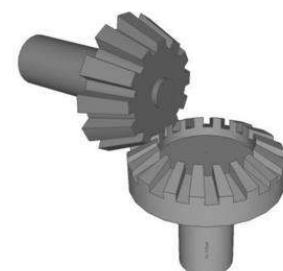
### Spur Gears

Spur gears are the most common and simplest type of gear. Spur gears are used to transfer motion from one shaft to a parallel shaft. The teeth are cut straight up and down, parallel to the axis of rotation.



### Bevel Gears

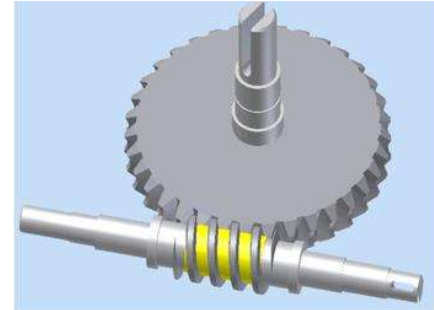
Bevel gears are a type of gear used to transmit power from one axis to another non-parallel axis. Bevel gears have slanted teeth, which actually makes the shape of their "pitch diameter" a cone. This is why most bevel gears are classified based on the



distance from the rear face of the gear to the imaginary tip of the cone that the gear would form if its teeth extended out.

### Worm Gears

A worm gear is a gear driven by a worm, which is a small, screw-like piece that meshes with the gear. The gear rotates on an axis perpendicular, but on a different plane than, the worm. Worm gears can thus be used to drastically reduce the speed and increase the torque of a system in only one step in a small amount of space. A worm gear mechanism could create a gear ratio of 100:1.



### Helical Gears

Helical gears are a more efficient type of spur gear. The teeth are set at an angle to the axis of rotation, so they end up curving around the gear instead of straight up and down like spur gears. Helical gears can be mounted between parallel axes, but can also be used to drive non-parallel axes as long as the angled teeth mesh.

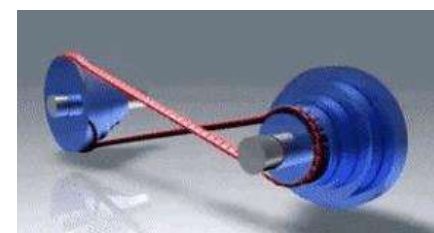


### Belt Drives

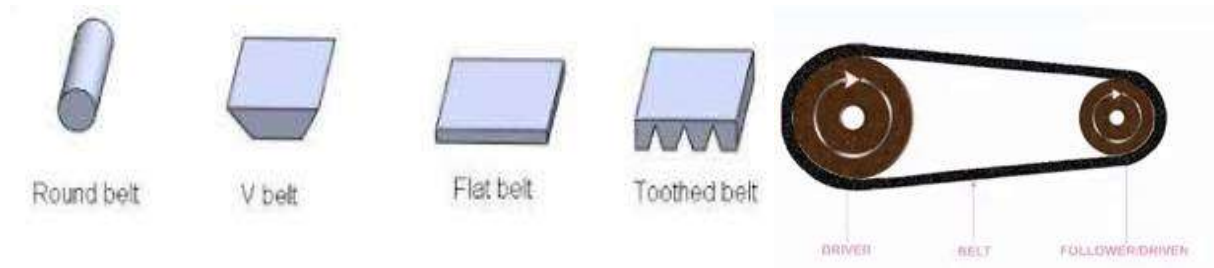
- A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel.
- Belts may be used as a source of motion, to transmit power efficiently or to track relative movement.
- Belts are looped over pulleys and may have a twist between the pulleys, and the shafts may or may not be parallel.
- Belt drives may be classified as: **open belt drive** and **crossed belt drive**.
- Another classification is : **Flat belt**, **V-belt** drives, round belt (rope) drive and toothed belt drive.



As comparative to flat belt, V-belts provide better grip and hence, faster speeds can be attained. For even further faster speeds, multiple V-belts can be used in a parallel arrangement.







### Bearings

- A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts.
- Bearings support the rotating shafts of the wheels, gears, turbines, rotors, etc. in those machines, allowing them to rotate more smoothly. These are of following types : (1) Ball bearing, (2) Roller bearings, (3) Needle bearings, (4) Tapered Roller bearings, etc.
- They fulfil the following two major functions.



Function 1: Reduce friction and make rotation more smooth

Function 2: Protect the part that supports the rotation, and maintain the correct position for the rotating shaft.

## 6. Hydraulic and Pneumatic Actuation System

### Hydraulic systems

- It is a kind of enclosed fluid-based system using pressurized incompressible liquids as transmission media. And is called as hydraulic system. The hydraulic system works on the principle of Pascal's law.
- Enclosed fluid systems can provide both linear as well as rotary motions.
- The hydraulic systems consists of storage tank, filter, hydraulic pump, non-return valve, accumulator, pressure regulator, direction control valves, hydraulic cylinder, piston, and leak-proof fluid flow pipelines.

The storage/fluid tank is a reservoir for the liquid used as a transmission media. The liquid used is generally high-density incompressible oil. It is filtered to remove dust or any other unwanted particles and then pumped by the hydraulic pump operated by a motor. The capacity of the pump depends on the hydraulic system design.