

Experiment - I Mechanical Components

Aim:- Study of basic mechanical components used in Robotics.

Components/apparatus required:- Nut bolt, Screw, Gear, shaft, keys, couplings, chain, & sprocket, Springs

Theory :- There are following mechanical components which are mostly found in any mechanical system.

1. Nut-Bolt:- A nut is a type of fastener with a threaded hole. Nuts are almost always in conjunction with a bolt to fasten multiple parts together. Nut is hollow hexagonal shaped component having threads along its inner rim & always used with a bolt which is having threads along its length. Both have a hexagonal or circular head. Bolts with circular head & hexagonal depth in it are called Allen bolts. To fasten such bolts, Allen key is used. Allen key is L shaped component having hexagon shape throughout its length. Its shorter length is hard-anodised used to fasten the bolt whereas longer length is used as a jack for both fastening. Nut Bolt & Screw both can have left or right threads. In case of right-handed threads, nut rotates in clockwise direction when fastened on the bolt whereas for left-handed threads nut rotates in anticlockwise direction while fastening.

2. Screw :- Screw is a mechanical component same in design as that of bolt with a pointed bottom end. Screw may not need a nut for fastening as that of bolt. It is mostly used with wooden & plastic materials.

3. Shaft :- Shaft is a member of circular cross-section used to support gears, sprockets, wheels, rotors, etc. on it is used to transmit power from one machine to the other. Shafts are made up of alloy ~~sheet~~ such as nickel chromium or chromium vanadium.

4. Key :- Key is fitted in an axial direction half in shaft and half into the mating member such as pulleys, gears, etc. Key prevents the relative rotation between the shaft & mating member. Tapered keys are used when allows easy entry into the key way when hammered.

5. Couplings :- Couplings are used to join two rotating shafts to each other for the purpose of transmitting power & to remove the misalignment between them. Muff couplings is the basic type of coupling. It consists of a pipe whose bore is decided on base of shaft used to hold two shafts coupling in position together. Flange coupling consists of two flanges and are connected firmly by means of nut bolts. Other types are jaw coupling, Oldham coupling etc.

Jaw coupling uses a rubber spider to bear the friction, Oldham coupling is used when the shafts are parallel & not perfectly aligned.

6. Gears :- A gear is a mechanical component in which teeth are cut around cylindrical shaped surface with equal spacing & depth. Gears are hosted on shaft by means of key. Gears transmit power by means of successively engaging of the teeth.

Smaller gear of the pair is known as pinion & larger is known as gear. In Spur gears the teeth are parallel to the axis of the gear. Spur gears have teeth parallel to each other. But in Helical gears are smooth & quiet due to gradual tooth engagement. Angular engagement allows greater transmission of power transmission for given gear size. Helical gears are costlier compared to spur gears. Bevel gears are used when the power is to be transmitted at right angle.

In Rack & pinion, the rotational motion is converted into linear motion. Here rack can be considered as a gear of infinite radius. In worm & worm wheel meshes with a worm wheel. Worm & worm wheel have self-locking property which prevents reverse motion hence are mostly used in cranes, lifts etc.

7. Chain & Sprocket :- In chain-sprocket mechanism, two sprockets & one chain are used. Chains are used to transmit motion & force.

one sprocket to another. Sprocket is a toothed wheel that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits onto a shaft. It is prevented from rotating on the shaft by a key that fits into keyways in the sprocket & shaft chain is used to connect two sprocket. One sprocket which drives the mechanism is called the driven sprocket. Chain drive has a backlash effect in it & thus is not considered as a perfect drive.

8. Belt drivers:- Belt is strip made up of rubber embedded with steel wires used to link two or more rotating shafts located at the farther distances. The power is transmitted through the friction between the belt & pulley. The belt drives are divided into two types as open belt drive & crossed belt drive. Open belt drive is used to rotate the driven pulley in the same direction of driving pulley. A crossed belt driver is used to rotate driving pulley. Belt drives are very economical preferred for longer distances. They require less maintenance cost. Their disadvantage is they get heated up because of friction.

9. Bearings :- All mechanical systems have moving parts that transmit motion need bearings. Friction occurs between various parts of the mechanism resulting in heat generation. This causes wearing of surfaces in contact & loss of efficiency of the system in overall.

Bearings are required to be lubricated frequently depending upon the usage. There are mainly 3 types of bearings which are mostly used as, bush bearing, ball bearing and roller bearing. Bush bearing is nothing but a tube like sleeve. Bush bearings are made from materials of low cost. Bush bearing are used where very high accuracy and precision is not expected. Ball bearing has 4 elements in total as inner race, outer race, balls & ball cage.

Bush bearing uses ball to maintain the separation between the bearing races. Ball cage holds the balls at their places not letting them to fall out. Ball bearing supports radial & axial loads. In most applications, one race is stationary and other is attached to the rotating assembly. Ideally the contact area between the rotating part and the stationary part is a point & this creates more pressure in the balls, hence ball bearings get damaged frequently. Roller bearing consists of tampered rolls held in a cage between the inner & outer races. Roller bearing ball cage holds the balls at their places not letting them to fall out. Ball bearing supports radial & axial loads. In most applications, one race is stationary & the other is attached to the rotating assembly.

Ideally the contact area between the rotating part & the stationary part is a point & this creates more pressure in the balls, hence ball bearings get damaged frequently. Roller bearing consists of tapered rollers held in a cage between the inner & outer races. Roller bearings have a high loadbearing capacity due to the line contact between the inner & outer races. Taper roller bearings can support radial & axial loads better than ball bearings. This tapered roller provides larger contact area than ball bearings hence roller bearings give better performance.

10. Spring :- Spring is a coil with uniform spacing between each turn. When a force is applied on it, the spring deforms & stores the energy and get back to its normal shape & size. There are two types of springs

1. Compression & 2. Extension.

Compression operates with a compressive force & is found that it shock absorbers, spring mattresses etc. Extension spring operates with a tensile force & found in luggage scales, like stand, bicycle stand & garage mechanism.

-* Exercise *-

Q.1) If a nut is to be fitted on a right handed bolt what type of thread will be on inner rim of the nut?

→ The thread on the inner rim is also right-handed for a right-handed bolt.

Q.2) Can we have a shaft of same diameter as that of inner diameter of the gear to be fitted upon it? If not, what are different mechanical components that can be used to assemble a shaft & a gear?

→ No, gear are hosted on by means of keys.

Q.3. What do you mean by a differential gear? Where is it used? Explain what kind of gear is differential gear? option.

a) Spur

b) Rack & Pinion

c) Helical Bevel

d) Worm & worm wheel

→ Differential gear is a gear train with 3 shafts that rotate with the average of the speed of the averages. It is used in vehicles/automobiles while turning, the vehicle's outer wheel has to go through a longer distance than the inner wheel at the same amount of time hence the speed varies. The differential gear is a mechanism that takes power from the engine & equal to the inner & outer wheel. Helical-bevel gear is used in differential.

Q.4 What is advantage of self-locking of worm & worm wheel? State few applications of this property?

- The advantages of self-locking property are :-
- 1. Large reduction ratio can be achieved for the same size.
- 2. While loading against the gravitational force is required, self locking worm gear is used.
- 3. While input & output shaft are perpendicular to each other, self locking worm gears

* Applications of this property :-

Used in cranes since they are used for weight against gravitation.

Q.5) Why ball bearings are frequently damaged?

Why roller bearing sustains more load and has better durability?

- Ball bearing are frequently because of wear & tear.

Roller bearings are cylindrical in shape. The contact between the outer & inner roller are not a fixed point but a straight line. There is a greater contact than ball bearings because load is spread out over a larger area. Roller bearings bear a much load than ball bearing.

Q.6. Which type of spring is used in bicycle stand and ball pin? Explain with reasons.

→ Extension spring is the type of spring used in bicycle stand.

Extension spring are used to absorb and store energy as well as create a resistance to a pulling force.

Compression spring operates with a compressed force & is found in shock absorbers, spring mattresses, mechanical parts, ball pens etc.

7. Why the rear sprocket in bicycle has free motion in reverse direction & locked motion in forward direction? When you pedal the bicycle in forward direction, it moves ahead but when you pedal it in reverse direction, the bicycle does not run backwards. Why?

→ The mechanism called "FREE WHEEL" is the reason behind the kind of motion.

A sprocket is fitted over the free wheel, which is pulled / rotated by the chain.

When you move forward, the link pawl acts like a hook & gets locked with the teeth called ratchet & transmit the torque. Thus it is called Ratchet & Pawl.

But when it is reversed, it gets free.

q. Draw a neat sketch explaining working of cam. State the application area.

