

**UNIT - 4**  
**FUNDAMENTALS OF THEORY OF MACHINES**

**1. Differentiate between Machine and Mechanism**

<b>Machine</b>	<b>Mechanism</b>
Machine is a mechanism or collection of mechanism which transmits force from the source of power to the resistance (load) to overcome and thus performs useful mechanical work.	Combination of rigid or resistant bodies connected that they move upon each other with definite relative motion
E.g Lathe, Shaping Machine etc	E.g single slider mechanism in IC engine

**2. Write down Kutzbach criterion to find the mobility of a planar mechanism.**

The Kutzbach criteria which calculates the mobility.

$$F = 3(n - 1) - 2j$$

Where, F- Degrees of freedom

n - number of links

j - number of joints

**3. Enumerate the difference between a Machine and a Structure.**

<b>Machine</b>	<b>Structure</b>
Machine is a mechanism or collection of mechanism which transmits force from the source of power to the resistance (load) to overcome and thus performs useful mechanical work.	Structure is the assemblage of resistant bodies without any relative motion between the links
E.g IC engine	E.g Bridges

**4. List out the inversions of a double slider crank chain.**

First Inversion – Scotch Yoke mechanism

Second Inversion – Oldham's Coupling

Third Inversion – Elliptical trammel

Fourth Inversion – Hand Pump

**5. State Grashof's law for a four-bar linkage.**

It states that for a planar four bar linkage, sum of the shortest and longest link – lengths must be less than or equal to the sum of the remaining two link-lengths, is there is to be a continuous relative motion between two members

$$S + L \leq P + Q$$

Where, S – Length of shortest link

L – length of longest link

P and Q – remaining two link lengths

**6. Define degree of freedom.**

It is defined as the minimum number of input parameters which must be independently controlled, in order to bring the mechanism into a useful engineering purpose.

**7. Define kinematic pair and illustrate any two types of constrained pair**

When two kinematic links are connected in such a way that their motion is either completely or successfully constrained, these two links are said to form a kinematic pair.

E.g foot step bearing, circular shaft in the circular slot

**8. Define Link and List the various type of link**

Link is a resistant body is one which is capable of transmitting the required motion and force with negligible deformation in the direction of force transmission.

Types of links: 1) Rigid Link 2) Flexible link 3) Fluid link

**9. Define the kinematic chain**

Kinematic chain is defined as the combination of kinematic pairs in which each link forms a pair of two kinematic pairs and the relative motion between the links is either completely constrained or successfully constrained.

When a number of links connected in space make relative motion of any point on a link with respect to any other point on the other link follow a definite law it is known as kinematic chain.

**10. Name the inversions of four bar mechanisms**

First Inversion – Coupled wheels of locomotive – double crank

Second Inversion – Beam Engine - Crank and lever mechanism

Third Inversion – Watt's Engine Indicator – Double lever mechanism

**11. Name the inversions of single slider mechanism**

First Inversion – Reciprocating engine mechanism

Second Inversion – Gnome Engine or Rotary Engine – Whitworth quick return mechanism

Third Inversion – Quick return mechanism – Crank and slotted lever – Oscillating cylinder engine

Fourth Inversion – Hand Pump

**12. Define Kinematic Pair**

When two links are in contact with each other it is known as a pair. If the pair makes constrain motion it is known as kinematic pair.

**13. Classify the kinematic pair based on the various characteristics**

Kinematic pairs are classified on the basis of the following characteristics

- 1) Type of relative motion between contacting elements
- 2) Type of contact between contacting elements
- 3) Number of degrees of freedom
- 4) Type of closure

**14. Define Higher and lower pair**

- Kinematic pairs in which there is a surface (area) contact between the contacting elements. All revolute pairs, sliding pairs, screw pairs, globular pairs, cylindrical pairs and flat pairs fall in this category.
- Kinematic pairs in which there is a point or line contact between the contacting elements are called as higher pair. Meshing gear teeth, cam and follower pair, wheel rolling on a surface, a ball and roller bearings and pawl and ratchet are of higher pair.
- When the two elements of a pair have a line or point contact when the relative motion takes place and the motion between the two elements is partly turning and partly sliding, then the pair is known as higher pair

**15. Define kinematic inversion**

A mechanism is formed by fixing one of the links of a chain. The process of choosing different links of a kinematic chain for becoming frame.

**16. Define Mechanical Advantage**

It is defined as the ratio of the output torque, supplied by the driven link, to the input torque, required to be supplied to the driver link.

**17. Define Instantaneous centre of rotation**

- Instantaneous centre of rotation (Kinematics), in a plane or in a plane figure which has motions both of translation and of rotation in the plane, is the point which for the instant is at rest.
- Instantaneous axis of rotation (Kinematics), in a body which has motions both of translation and rotation, is a line, which is supposed to be rigidly united with the body, and which for the instant is at rest. The motion of the body is for the instant simply that of rotation about the instantaneous axis

**18. State and explain the Kennedy's theorem**

It states that if three bodies are in relative motion with respect to one another, the three relative instantaneous centres of velocity are collinear.

**19. What is the expression for radial and tangential component of acceleration?**

Radial component

$$a_r = \omega^2 \cdot OB$$

Tangential component

$$a_t = \alpha \cdot OB$$

Where,  $\omega$  = Angular velocity of link OB

$\alpha$  = Angular acceleration of link OB  $OB$  = Length of link OB.

**20. Define Inversion of mechanism.**

The method of obtaining different mechanism by fixing different links in a kinematic chain is known as inversion of mechanism.

## UNIT – 5

## DESIGN OF TRANSMISSION SYSTEMS

**1. Define (a) Module (b) Diametral Pitch of gears.**

**Module (m):** is the ratio of pitch diameter to the number of teeth on the gear.  $m = D/T$ ,  
where D- pitch circle diameter, T – no of teeth

**Diametrical Pitch:** It is the number of teeth per unit pitch circle.  $= T/D$

**2. What is axial pitch of a helical gear?**

It is the distance, parallel to the axis, between similar faces of adjacent teeth. It is same as circular pitch and is therefore denoted by pc. The axial pitch may also be defined as the circular pitch in the plane of rotation or the diametral plane.

**3. List out the applications of epicyclic gear train.**

Epicyclic gear trains are used in the differential gear box of an automobile, wrist watches, hoists, pulley blocks, back gear of lathe machine, in aircrafts etc.

**4. Define epicycles gear train.**

In a gear train when the axes of shafts over which the gears are mounted move relative to a fixed axis is called epicyclic gear train.

**5. Define velocity ratio.**

Velocity ratio of a simple gear train is defined as the ratio of the angular velocity of the first gear in the train to the angular velocity of the last gear.

**6. Define circular pitch.**

It is the distance measured on the circumference of the pitch circle from a point of one tooth to the corresponding point on the next tooth. It is denoted by Pc

$$\text{Circular pitch } P_c = \pi/D$$

**7. State and prove law of gearing**

The common normal at the point of contact between a pair of teeth must always pass through the pitch point for all positions of the mating gears.

**8. What are the types of flat drives?**

The types of flat drives are:

Compound belt drive.

Stepped or cone pulley drive.

Fast and loose pulley.

**9. Define slip.**

Slip is defined as the relative motion between the belt and pulley.

**10. Define law of belting.**

Law of belting states that the centre line of the belt, as it approaches the pulley lie in a plane perpendicular to the axis of that pulley or must lie in the plane of the pulley, otherwise the belt will run off the pulley.

**11. What is the use of rope drive?**

The rope drives are widely used when large power is to be transmitted continuously from one pulley to another over a considerable distance. One advantage of rope drives is that a number of separate driver may be from the driving pulley.

**12. What is the use of belt drive?**

Belt drive is commonly used for transmission of power when exact velocity ratio is not required. Generally, belt drives are used to transmit power from one pulley to another, when the two pulleys are not more than 10 meters apart.

**13. What are the types of ropes?**

The types of ropes are:

Fibre ropes,

Wire ropes.

**14. What are the advantages of V-belt?**

Power transmitted is more due to wedging action in the grooved pulleys.

V-belt is more compact, quiet and shock absorbing.

The V-belt drive is positive because of negligible slip between the belt and the groove.

High velocity ratio may be obtained.

**15. What are the disadvantages of V-belt?**

It cannot be used with large centre distances.

It is not as durable as flat belt.

It is a costlier system.