

19MCT203– MECHANICS OF MACHINES

2 Marks Q&A

Unit 1: **KINEMATICS OF MECHANICS**

1. Define 'degrees of freedom'.

It is defined as the number of input parameters which must be controlled independently in order to bring the device into a particular position.

The degrees of freedom of a mechanism (n) is given by

$$n = 3(L-1)-2j-h$$

L = Number of links

j = Number of joints

h = Number of higher pairs.

2. What is meant by spatial mechanism?

Spatial mechanism have special geometric characteristics in that all revolute axes are parallel and perpendicular to the plane of motion and all prism axes lie in the plane of motion.

3. Classify the constrained motion.

There are three types.

- 1) Completely constrained motion (eg. Square bar moving in a square hole)
- 2) In completely constrained motion (eg. Circular shaft in a hole)
- 3) Successfully constrained motion (eg. Piston and cylinder)

4. What is meant by number synthesis?

Expressing mobility or degree of freedom of a mechanism in terms of the number of links and the number of pair connections of a given type is known as number synthesis.

5. What are the some important inversions of four chain mechanism?

- 1) Crank-rocker mechanism.
- 2) Crank-crank mechanism.
- 3) Rocker-rocker mechanism.

6. What is toggle position?

It is the position of a mechanism at which the mechanical advantage is infinite and the sine of angle between the coupler and driving link is zero.

7. What is pantograph?

Pantograph is a device which is used to reproduce a displacement exactly in an enlarged or reduced scale. It is used in drawing offices, for duplicating the drawings, maps, plans, etc. It works on the principle of 4 bar chain mechanism.

8. What are the applications of single slider crank mechanism?

- 1) Rotary or Gnome engines.
- 2) Crank and slotted lever mechanism.
- 3) Oscillating cylinder engine.
- 4) Bull engine
- 5) Hand pump.

9. Give some examples for kinematics pairs.

- 1) Crank and connecting rod
- 2) Connecting and piston rod
- 3) Piston and engine cylinder.

10. Discuss Elliptical trammel

Elliptical trammel is an instrument used for drawing ellipses. It is the best example for first inversion of double slider crank chain.

11. What is movability?

It includes the 6 degree of freedom of the device as a whole, as though the ground link were not fixed, and this applies to a kinematic chain.

12. What is mobility?

It neglects these and considers only the internal relative motions, thus applying a mechanism.

13. What is meant by transmission angle?

In a four bar chain mechanism the angle between the coupler and the follower link is called as the transmission angle.

14. What is meant by Ackermann steering?

Ackermann steering is the one of the mechanism used in vehicles. It is obtained by inversion of four bar chain.

15. Write down the Grashof's Law for a four bar mechanism?

Grashof's law states that the sum of the shortest and longest links cannot be greater than the sum of the remaining two links lengths if there is to be continuous relative motion between two members.

16. Explain the working principle of bicycle bells.

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Bicycle bells are working on the principle of snap action mechanism or toggle mechanism or flip flop mechanism.

17. What is meant by motion adjustment mechanism?

The mechanism used to adjust or modify the motion of the link are known as motion adjustment mechanism. Motion adjustment is obtained by wedges, levers and rack and pinion.

18. Whether a cycle chain is kinematic chain or not?

A cycle chain is a combination of several links with turning pair. Hence it is not a kinematic chain.

19. Define instantaneous centre.

Instantaneous centre of a moving body may be defined as that centre which goes on changing from one instant to another.

20. What is instantaneous axis?

Instantaneous axis is a line drawn through an instantaneous centre and perpendicular to the plane of motion.

21. What is resistant body?

A body is said to be resistant if it is capable of transmitting the required force with negligible deformation. A link need not necessarily be a rigid body, but it must be a resistant body.

22. What is link?

A link or an element is defined as that part of a machine which has motion relative to some other part. A link need not to be a single unit, but it may consist of several parts which are manufactured as separate units.

23. What are the different types of links?

- 1) Rigid link.
- 2) Flexible link.
- 3) Fluid link.

24. What is meant by spatial mechanism?

Spatial mechanism have special geometric characteristics in that all revolute axes are parallel and perpendicular to the plane of motion and all prism axes lie in the plane of motion.

25. What is the use of oldham's coupling?

It is used for transmitting motion between two shafts which are parallel but not coaxial.

Unit 2: FORCE ANALYSIS

1. What is meant by dynamics?

The branch of mechanics that is concerned with the effects of forces on the motion of a body or system of bodies, especially of forces that do not originate within the system itself.

2. What is meant Free body diagram?

A free body diagram, also called a force diagram, is a pictorial representation often used by physicists and engineers to analyze the forces acting on a body of interest. A free body diagram shows all forces of all types acting on this body. Drawing such a diagram can aid in solving for the unknown forces or the equation of motion of the body.

3. What is meant by applied forces?

The external forces acting on a system of body from outside the system are called applied forces.

4. What is meant by constraint forces/

When two or more bodies are connected together to form a group of system, the pair of action and reaction forces between any two of the connected bodies are called constraint forces.

5. Write down the Newton's laws of motion.

First law: The velocity of a body remains constant unless the body is acted upon by an external force.

Second law: The acceleration a of a body is parallel and directly proportional to the net force F and inversely proportional to the mass m , i.e., $F = ma$.

Third law: The mutual forces of action and reaction between two bodies are equal, opposite and collinear.

6. Define Static equilibrium.

A system of particles is in static equilibrium when all the particles of the system are at rest and the total force on each particle is permanently zero.

7. Differentiate between static and dynamic equilibrium (or) what are the conditions for a body to be in static and dynamic equilibrium?

Necessary and sufficient conditions for static and dynamic equilibrium are:

- (i) Vector sum of all forces acting on a body is zero.
- (ii) The vector sum of the moments of all forces acting about any arbitrary points or axis is zero. First condition is the sufficient condition for static equilibrium together with second condition is necessary for dynamic equilibrium.

8. What do you mean by inertia?

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The property of matter offering resistance to any change of its state of rest or of uniform motion in a straight line is known as inertia.

9. Define inertia force.

The inertia force is an imaginary force, which when acts upon a rigid body, brings it in an equilibrium position.

10. Define the significance of inertia force analysis.

Inertia force analysis reduces the dynamic analysis problem into an equivalent static analysis problem by determining the required torque and the direction

11. Differentiate between static force analysis and dynamic force analysis.

If components of a machine accelerate, inertia forces are produced due to their masses. If the magnitudes of these forces are small compared to the externally applied loads, they can be neglected while analyzing the mechanism. Such an analysis is known as static force analysis. If the inertia due to the mass of the component is also considered, it is called dynamic force analysis.

12. Define piston effort.

The net force acting on the piston or cross-head pin along the line of stroke is known as piston effort.

13. Define crank effort and crank-pin effort.

Crank effort is the net effort (force) applied at the crank pin perpendicular to the crank, which gives the required turning moment on the crankshaft.

The component of force acting along the connecting rod perpendicular to the crank is known as crank-pin effort

14. State D'Alembert's principle.

D'Alembert's principle states that the inertia forces and torques, and the external forces and torques acting on a body together result in statical equilibrium.

15. State principle of superposition.

The principle of superposition states that for linear systems the individual responses to several disturbances or driving functions can be superposed on each other to obtain the total response of the system

Unit 3: GEARS AND GEAR TRAINS

1. What is an angle of obliquity in gear?

It is the angle between the common normal to two gear teeth at the point of contact and the common tangent at the pitch point. It is also called as pressure angle.

2. What is bevel gearing? Mention its types.

When the non-parallel or intersecting but coplanar shafts connected by gears, they are called bevel gears and the arrangement is bevel gearing.

Types.

- 1) Skew bevel gearing
- 2) Spiral gearing.

3. What is meant by arc of approach?

It is the portion of the path of contact from the beginning of the engagement to the pitch point.

4. What is meant by arc of recess?

It is the position of the path of contact from pitch point to the end of the engagement to the pitch point.

5. What is meant by Arc of contact?

It is the path traced by a point on the pitch circle from the beginning to the end of engagement of a pair of teeth.

6. State law of gearing.

The law of gearing states that for obtaining a constant velocity ratio, at any instant of teeth the common normal at each point of contact should always pass through a pitch point, situated on the line joining the centre of rotation of the pair of mating gears.

7. Define normal and axial pitch in helical gears.

Normal pitch is the distance between similar faces of adjacent teeth, along a helix on the pitch cylinder normal to the teeth.

Axial pitch is the distance measured parallel to the axis between similar faces of a adjacent teeth.

8. What are the methods to avoid interference?

1. The height of the teeth may be reduced.
2. The pressure angle may be increased.
3. The radial flank of the pinion may be cut back.

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9. What is the advantage when arc of recess is equal to arc of approach in a meshing gears?

When arc of recess equal to arc of approach, the work wasted by friction is minimum and efficiency of drive is maximum.

10. What do you know about tumbler gear?

Tumbler gears are those which are used in lathes for reversing the direction of rotation of driven gears.

11. Define contact ratio.

It is the ratio of the length of arc of contact to the circular pitch is known as contact ratio. The value gives the number of pairs of teeth in contact.

12. Where will the interference occur in an involute pinion and gear are in mesh having same size of addendum?

There will be an interference between the tip of pinion and flank of gear.

13. Define interference.

The phenomenon when the tip of tooth undercuts the roots on its mating gear is known as interference.

14. What you meant by non standard gear teeth?

The gear teeth obtained by modifying the standard proportions of gear teeth parameters is known as non standard gear teeth.

15. Define cycloidel tooth profile and involute tooth profile.

A cycloid is the curve traced by a point on the circumference of a circle which rolls without slipping on a fixed straight line.

Involute profile is defined as the locus of a point on a straight line which rolls without slipping on the circumference of a circle.

16. Define Backlash.

It is the difference between the tooth space and the tooth thickness along the pitch circle.

$$\text{Backlash} = \text{Tooth space} - \text{Tooth thickness.}$$

17. What is gear train?

Two or more gears re made to mesh with each other to transmit power from one shaft to another. Such a combination is called a gear train.

18. What are the types of gear trains?

1. Simple gear train.
2. Compound gear train.
3. Reverted gear train.
4. Epicyclic gear train.

19. Write velocity ratio in compound train of wheels?

Speed of last follower- Product of teeth on drives.

Speed of first driver- Product of teeth on followers.

20. Define simple gear train.

When there is only one gear on each shaft, it is called as simple gear train.

21. What is meant compound gear train?

When there are more than one gear on shaft, it is called a compound gear train.

22. What is the advantage of a compound gear train over a simple gear train?

The advantage of a compound gear train over a simple gear train is that a much larger speed reduction from the first shaft to the last shaft can be obtained with small gears.

23. What is reverted gear train?

When the axes of the first and last wheels are co-axial the train is known as reverted gear train.

24. What are the externally applied torques used to keep the gear train in equilibrium?

1. Impart torque on the driving member.

2. Resisting or holding torque on the driven member.

3. Holding or braking torque on the fixed member.

25. Where the epicyclic gear trains are used?

The epicyclic gear trains are used in the back gear of lathe, differential gears of the automobiles, pulley blocks, wrist watches, etc.

Unit 4: CAMS AND FOLLOWERS

1. What is a cam?

A cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as follower.

2. Give some examples of cam.

- 1) Radial or disc cams.
- 2) Cylindrical or barrel cams.
- 3) End or face cams.
- 4) Wedge cams.

3. Define tangent cam.

When the flanks of the cam are straight and tangential to the base circle and nose circle the cam is known as tangent cam.

4. What are the different motions of the follower?

- 1) Uniform motion.
- 2) Simple harmonic motion.
- 3) Uniform acceleration and retardation.
- 4) Cycloidal motion.

5. How can high surface stress in flat faced follower be minimized?

High surface stress in the follower is minimized by machining the flat end of the follower to a spherical shape.

6. Where are the roller follower extensively used?

Roller followers are extensively used where more space is available such as in stationary gas oil engines, and aircraft engines.

7. Define dwell period?

The period during which the follower remains at rest is called dwell period.

8. Explain offset follower.

When the motion of the follower is along an axis away from the axis of the cam centre, it is called offset follower.

9. Define trace point.

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It is a reference point on the follower and is used to generate the pitch curve. In case of knife edge follower the knife edge represents the trace point and the pitch curve corresponds to the cam profile.

10. Define pressure angle with respect to cams.

It is the angle between the direction of the follower motion and a normal to the pitch curve. This angle is very important in designing a cam profile. If the pressure angle is too large, a reciprocating follower will jam in its bearings.

11. Define lift or stroke in cam.

It is the maximum travel of the follower from its lowest position to the topmost position.

12. Define undercutting in cam. How it occurs?

The cam profile must be continuous curve without any loop. If the curvature of the pitch curve is too sharp, then the part of the cam shape would be lost and thereafter the intended cam motion would not be achieved. Such a cam is said to be undercut.

Undercutting occurs in the cam because of attempting to achieve too great a follower lift with very small cam rotation with a smaller cam.

13. What do you know about nomogram?

In nomogram, by knowing the values of total lift of the follower and the cam rotation angle for each segment of the displacement diagram, we can read directly the maximum pressure angle occurring in the segment for a particular choice of prime circle radius.

14. How can you prevent undercutting in cam?

- 1) By decreasing the follower lift.
- 2) By increasing cam rotation angle.
- 3) By increasing the cam size.

15. What do you know about gravity cam?

In this type, the rise of the cam is achieved by the rising surface of the cam and the return by the force of gravity or due to the weight of the cam.

16. Write the different types of follower.

- 1) Knife edge follower
- 2) Roller follower
- 3) Mushroom or flat faced follower
- 4) Spherical faced or curved shoe follower.

17. What is cam profile?

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The surface of cam which comes into contact with follower, is known as cam profile.

18. What is base circle?

It is the smallest circle that can be drawn to the cam profile. The radius of the base circle is called the least radius of the cam.

19. What is trace point?

It is a reference point on the follower to trace the cam profile. In case of a knife edge follower, the knife edge itself is a tracing point and in roller follower, the centre of the roller is the tracing point.

20. What is pitch curve?

The locus or path of the tracing point is known as the pitch curve. For the purpose of laying out the cam profiles, it is assumed that the cam is fixed and the follower rotates around it.

21. What is prime circle?

The smallest circle drawn tangent to the pitch curve is known as prime circle.

22. What is pressure angle?

It is the angle between the direction of the follower motion and a normal to the pitch curve. This angle is very important in cam design as it represents steepness of the cam profile.

23. What is pitch point?

It is the point on the pitch curve at which the pressure angle is maximum.

24. What is pitch circle?

It is the circle passing through the pitch point and concentric with the base circle.

25. What is cam angle?

It is the angle of rotation of the cam for a definite displacement of the follower.

26. Define unbalance and spring surge.

Unbalance: A disc cam produces unbalance because its mass is not symmetrical with the axis of rotation. Spring surge: Spring surge means vibration of the retaining spring

27. Define windup. What is the remedy for camshaft windup?

Twisting effect produced in the camshaft during the raise of heavy load follower is called as windup.

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Camshaft windup can be prevented to a large extent by mounting the flywheel as close as possible to the cam.

28. What are the effect and causes of windup?

The effect of windup will produce follower jump or float or impact. Causes of windup are:

When heavy loads are moved by the follower,
When the follower moves at a high speed, and
When the shaft is flexible.

Unit 5: **BALANCING**

1. Write the importance of balancing?

If the moving part of a machine are not balanced completely then the inertia forces are set up which may cause excessive noise, vibration, wear and tear of the system. So the balancing of machine is necessary.

2. Why balancing of dynamic forces are necessary?

If dynamic forces are not balanced, they will cause worse effects such as wear and tear on bearings and excessive vibrations on machines. It is very common in cam shafts, steam turbine rotors, engine crank shafts and centrifugal pumps etc.

3. Write the different types of balancing.

- Balancing of rotating masses
 1. Static Balancing
 2. Dynamic balancing
- Balancing of reciprocating masses.

4. Define static balancing.

A system of rotating masses is said to be in static balance if the combined mass centre of the system lies on the axis of rotation.

5. State the condition for static balancing.

The net dynamic force acting on the shaft is equal to zero. This requires that the line of action of their centrifugal forces must be same.

6. Dynamic balancing implies static balancing . Justify.

Condition for dynamic balancing are

1. The net dynamic force acting on the shaft is equal to zero. This is the condition for static balancing.
2. The net couple due to dynamic forces acting on the shaft is zero.

From the above it is understood that dynamically balanced system must be initially statically balanced one.

7. Write the condition for complete balancing.

1. The resultant centrifugal force must be zero.

2. The resultant couple must be zero.

8. Differentiate static and dynamic balancing

S. No Static Balancing Dynamic Balancing

1 The dynamic forces as a result of the unbalanced masses are balanced by introducing balancing masses in the plane of

rotation or diff planes The net dynamic force acting on the shaft is made zero.

The arrangement made in static balancing gives rise to a couple which tends to rock the shaft in the bearing.

Dynamic balancing considers the net couple as well as net dynamic force to do complete balancing.

2 It deals with only balancing of dynamic forces.

It deals with balancing of dynamic force and balancing couple due to dynamic force.

9. The product of rotating mass and perpendicular distance between the rotating mass and reference plane is called as

.

(Ans: Mass Moment).

10. Write the equation for balancing a single rotating mass by a single mass. $m_1 r_1 = m_2 r_2$

11. Define Dalby's method of balancing masses.

Dalby's method is used for balancing several masses rotating in different planes. In this method several forces acting on several planes are transferred to a single reference plane.

12. Write the phenomenon of transferring forces from one plane to another.

Transferring a force (F) from one plane to another plane having a distance 'l' is equivalent to transfer of same force 'F' in magnitude and direction in the reference plane is accompanied by a couple of magnitude 'Fl'.

13. Whether grinding wheels are balanced or not. If so Why?

Yes. The grinding wheels are properly balanced by inserting some low density materials.

If not the required surface finish

won't be obtained and the vibration will cause much noise.

14. Whether your watch needles are properly balanced?

Yes my watch needles are properly balanced by providing so

me extra projection in the opposite direction.

15. Why complete balancing is not possible in reciprocating masses?

Balancing of reciprocating masses is done by introducing the balancing mass opposite to the crank. The vertical component of the dynamic force of this balancing mass gives rise to hammer

blow. In order to reduce hammer blow, a part of the reciprocating mass is balanced. Hence complete balancing is not possible.

16. What are the various cases of balancing revolving masses?

1. Balancing of single rotating mass by a single mass rotating in the same plane.

2. Balancing of single rotating mass by a two masses rotating in the diff plane.

3. Balancing of several rotating masses in single plane.

4. Balancing of several rotating masses in different plane.

17. Why cranks of a locomotive are generally at right angles to one another?

In order to facilitate the starting of locomotive in any position the cranks of a locomotive are generally at right angles to one another.

18. What are the effects of unbalanced primary force along the line of stroke of two cylinder locomotive?

1. Variation in tractive force along the line of stroke

2. Swaying couple.

19. Define tractive force.

The resultant unbalanced force due to the 2 cylinders along the line of stroke, is known as tractive force.

20. Define swaying couple.

The unbalanced force acting at a distance between the line of stroke of 2 cylinders constitute a couple in the horizontal direction. This couple is called as swaying couple.

21. What is the effect of hammer blow and what is the cause it?

The effect of hammer blow is to cause the variation in pressure between the wheel and the

rail, such that vehicle vibrates vigorously. Hammer blow is caused due to the effect of unbalanced primary force acting perpendicular to the line of stroke.

22. What are in-line engines?

Multi-cylinder engines with the cylinder centre lines in the same plane and on the same side of the centre line of the crankshaft are known as in-line engine

23. Explain the function of governors.

The function of a governor is to maintain the speed of an engine within specified limits whenever there is a variation of load. Governors control the throttle valve and hence the fuel supply to cater the load variations on engines.

24. What is the principle of working of centrifugal governors?

The centrifugal governors are based on balancing of centrifugal force on the rotating balls by an equal and opposite radial force.

25. Differentiate the functions of flywheel and governor.

S. No Flywheels Governors

1 The function of flywheel is to reduce the fluctuations of speed during a cycle above and below the mean value for constant

load from the prime mover.

Governors function is to control the mean speed over a period for output load variations

2. It works continuously from cycle to cycle.

Its works intermittently i.e. only when there is change in the load.

3. It has no influence on mean speed of the prime mover.

It has no influence over cyclic speed fluctuations.

26. What is the principle of inertia governors?

In inertia governors, the balls are so arranged that the inertia forces caused by an angular acceleration or retardation of the shaft tend to alter their position.

27. What is equilibrium speed?

The speed at which the governor balls arms, sleeve etc, are in complete equilibrium and there is no upward or downward movement of the sleeve on the spindle is known as equilibrium speed.

28. Explain controlling force?

An equal and opposite force to the centrifugal force acting radially inwards (i.e. centripetal force) is termed as controlling force of a governor.

29. Explain governor effect?

The mean force acting on the sleeve for a given percentage change of speed for lift of the sleeve is known as governor effect.

30. Define power of governor.

The power of governor is the work done at the sleeve for a given percentage change of speed. It is the product of the mean value of the effort and the distance through which the sleeve moves. Power = Mean effort X Lift of sleeve.

31. Explain sensitiveness of governors?

The sensitiveness is defined as the ratio of the mean speed to the difference between the maximum and minimum speeds.

Sensitiveness = $\frac{N}{N_1 - N_2} = \frac{2(N_1 + N_2)}{(1 - N_2)N_1 - \text{Max Speed} : N_2 - \text{Min Speed}}$

32. Define the coefficient of sensitiveness.

It is the ratio between range of speed and mean speed.

Coefficient of sensitiveness = Range of speed/mean Speed
 $= \frac{N_1 - N_2}{N}$

33. What is meant by hunting?

The phenomenon of continuous fluctuation of the engine speed above and below the mean speed is termed as hunting. This occurs in over sensitive governors.

34. Explain the term stability of governor?

A governor is said to be stable if there is only one radius of rotation for all equilibrium speeds of the balls within the working range. If the equilibrium speed increases the radius of

governor ball must also increase.

35. What is controlling force diagram?

When the graph is drawn between the controlling force as ordinate and radius of rotation of the balls as abscissa, the graph so obtained is called controlling force diagram.