VETRI VINAYAHA COLLEGE OF ENGINEERING AND TECHNOLOGY
DEPARTMENT OF MECHANICL ENGINEERING
ME6401 - KINEMATICS OF MACHINERY
2 MARKS QUESTIONS AND ANSWERS BANK
UNIT 1 - BASICS OF MECHANISMS

1. What is Kinematics?

Kinematics is the study of motion (position, velocity, acceleration). A major goal of Understanding kinematics is to develop the ability to design a system that will satisfy Specified motion requirements. This will be the emphasis of this class.

2. What is Kinetics?

Kinetics is the study of effect of forces on moving bodies. Good kinematic design should produce good kinetics.

3. Define Link.

A link is defined as a member or a combination of members of a mechanism connecting other members and having relative motion between them. The link may consist of one or more resistant bodies. A link may be called as kinematic link or element. Example: Reciprocating steam engine.

4. Define Kinematic Pair.

Kinematic pair is a joint of two links having relative motion between them.

5. Classify the kinematic pair.

a. Nature of contact (lower pair, higher pair)
b. Nature of mechanical contact (Closed pair, unclosed pair)
c. Nature of relative motion (Sliding, turning, rolling, screw and spherical pairs)

6. Define Kinematic Chain

When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion it is called a kinematic chain.

7. Define Degrees of Freedom.

It is defined as the number of input parameters which must be independently controlled in order to bring the mechanism in to useful engineering purposes.

8. Define Pantograph.

Pantograph is used to copy the curves in reduced or enlarged scales. Hence this mechanism finds its use in copying devices such as engraving or profiling machines.

9. What is meant by spatial mechanism?

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

10. Classify the Constrained motion?

Constrained motions are classified into three types

1. Completely constrained motion.
2. Incompletely constrained motion and 3. Successfully constrained motion.

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11. 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.

12. What are the important applications of a single slider crank mechanism?

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

13. Give some examples for kinematic pairs.

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

14. What is meant by transmission angle?

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

15. What are the applications of inversion of double slider crank chain mechanism?

It consists of two sliding pairs and two turning pairs. There are three important inversions of double slider crank chain. 1) Elliptical trammel. 2) Scotch yoke mechanism. 3) Oldham's coupling. Give some examples for kinematic pairs.

16. 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.

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UNIT 2 - KINEMATICS OF MOTION

1. What are the important concepts in velocity analysis?

1. The absolute velocity of any point on a mechanism is the velocity of that point with reference to ground.

2. Relative velocity describes how one point on a mechanism moves relative to another point on the mechanism.

2. Define Instantaneous centre.

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

3. Define Instantaneous centre

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

4. How to represent the direction of linear velocity of any point on a link with respect to another point on the same link?

The direction of linear velocity of any point on a link with respect to another point on the same link is perpendicular to the line joining the points.

5. Define Kennedy's theorem.

The Kennedy's theorem states that if three bodies move relatively to each other, they have three instantaneous centers and lie on a straight line.

6. Define displacement.

It may be defined as the distance moved by a body with respect to a fixed certain fixed point. When there is no displacement in a body it is said to be at rest and when it is being displaced, it is said to be in motion.

7. What are the types of motions?

1. Rectilinear motion.
2. Curvilinear motion.
3. Circular motion.

8. What are the methods for determining the velocity of a body?

Important methods for determining the velocity of a body are:

1. Graphical method: i) Relative velocity method, ii) Instantaneous centre method
2. Analytical method.

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9. Define velocity.

Velocity may be defined as the rate of change of displacement of a body with respect to the time. Since the velocity has both magnitude and direction, therefore it is a vector quantity.

10. Define speed.

Speed may be defined as the rate of change of linear displacement of a body with respect to the time. Since the speed is irrespective of its direction, therefore it is a scalar quantity.

11. What is deceleration?

The negative acceleration is also known as deceleration or retardation.

12. Define Acceleration.

The rate of change of velocity with respect to time is known as acceleration.

13. Define coincident points.

When a point on one link is sliding along another rotating link, then the point.

14. Define centroid.

The locus of all instantaneous centres (i.e., I_1, I_2 …).

15. Define Axode.

The locus of all instantaneous axes.

16. Define Body centroid.

The locus of all instantaneous centre relative to the body itself.

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UNIT – III – KINEMATICS OF CAM

1. What is cam?

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

2. 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.

3. Distinguish radial and cylindrical cams.

Radial cam	Cylindrical cam
In this cam, the follower reciprocates (or) oscillates in a direction perpendicular to the axis.	In this the follower reciprocates (or) oscillates in a direction parallel to the cam axis.

4. What are the different motions of the follower?

(i) Uniform motion,
(ii) Simple harmonic motion,
(iii) Uniform acceleration and retardation, and
(iv) Cycloidal motion.

5. Compare Roller and mushroom follower of a cam.

S.No	Roller Follower	Mushroom Follower
1.	Roller followers are extensively used where more space is available.	The mushroom followers are generally used where space is limited.
2.	It is used in stationary gas engines, oil engines and aircraft valves in engines.	It is used in cams which operate the valves in automobile engines.

6. 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.

7. Define trace point in the study of cams.

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. In a roller follower the centre of the roller represents the trace point.

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8. 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.

9. Define Lift (or) Stroke in cam.

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

10. Define undercutting in cam. How is 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.

11. What do you know about Nomogram?

In Nomogram, by knowing the values of total lift of the follower (L) and the cam rotation angle (β) 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 (R_0).

12. What are the classifications of cam based on the follower movement?

1) Rise-Return-Rise (R-R-R) cams,
2) Dwell-Rise-Return-Dwell (D-R-R-D) cams,
3) Dwell-Rise-Dwell-Return-Dwell (D-R-D-R-D) cams,
4) Dwell-Rise-Dwell (D-R-D) cams.

13. What are the different types of cams?

1. Wedge (or) flat cams
2. Radial (or) Disc cams
3. Spiral cams
4. Cylindrical (or) Barrel (or) Drum Cams
5. Conjugate cams
6. Globoidal cams
7. Spherical cams

14. 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 of die to the weight of the cam.

15. Define 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.

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16. Define pressure angle.

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

17. Define Prime circle.

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

18. Define Angle of Ascent.

The angle of rotation of cam from the position when the follower begins to rise till it reaches its highest position is known as angle of ascent. It is also known as out stroke and is denoted by θ^0.

19. What is meant by Simple Harmonic Motion?

When a body rotates on a circular path with uniform angular velocity, its projection on the diameter will have simple harmonic motion. The velocity of the projection will be maximum at the centre of and zero at the ends of the diameter. In case of acceleration and retardation, the values will be zero at the centre and maximum at the ends of diameter.

20. What are the different shapes of high speed cams?

1. Circular Arc cam with flat faced follower
2. Tangent cam with reciprocating roller follower

21. Define cam angle.

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

22. What are the classifications of follower based on the follower movement?

i) Reciprocating (or) translating follower. ii) Oscillating (or) rotating follower.

23. Define Pitch curve.

The locus 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.

24. What are the classifications of the follower based on the path of motion of the follower?

a) Radial follower. b) Offset follower.

25. What are the classifications of cam base on the constraint of the follower?

a) Pre-loaded spring cams.
b) Positive drive cams. c) Gravity cams.

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UNIT 4 – GEARS AND GEAR TRAINS

1. 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.

2. Define normal and axial pitch in helical gears.

Normal pitch is the distance between similar face 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 an adjacent tooth.

3. What is the maximum efficiency in worm and worm gear?

$$\acute{\eta}_{max} = \frac{1-\sin\varphi}{1+\sin\varphi}$$

4. What are the advantages and limitations of gear drive? Write any two.

Advantages:

1. Since there is no slip, so exact velocity ratio is obtained.
2. It is more efficient and effective means of power transmission.

Limitations:

1. Manufacture of gear is complicated.
2. The error in cutting teeth may cause vibration and noise during operation.

5. Define interference.

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

6. Define cycloidal 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.

7. Define circular pitch and diametral pitch in spur gears.

Circular pitch: It is the distance measured along the circumference of the pitch circle from a point on one tooth to the corresponding point on the adjacent tooth.

Diametral pitch: It is the ratio of number of teeth to the pitch circle diameter.

8. Define Backslash.

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

Backslash = Tooth space – Tooth thickness

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9. What is gear train of train of wheels?

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 or train of wheels.

10. Write velocity ratio in compound train of wheels?

Speed of last follower / Speed of first driver = Product of teeth on drivers / Product of teeth on followers.

11. Define simple gear train.

When there is only one gear on each shaft.

12. What is reverted gear train?

When the axes of the first and last wheels are co-axial.

13. 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.

14. Write down the difference between involute and cycloidal tooth profile.

S.No	Involute Tooth Profile	Cycloidal Tooth Profile
1.	Variation in centre distance does not affect the velocity ratio.	The centre distance should not vary.
2.	Pressure angle remains constant throughout the teeth.	Pressure angle varies. It is zero at the pitch point and maximum at the start and end of engagement.
3.	Interference occurs.	No interference occurs.
4.	Weaker teeth.	Stronger teeth.

15. Define Contact Ratio.

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

16. What is an angle of obliquity in gears?

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 called as pressure angle.

17. 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. It is of two types namely skew bevel gearing and spiral gearing.

18. 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 (undercutting).

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

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

20. 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.

21. What you meant by non-standard gear teeth?

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

22. What is meant by compound gear train?

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

23. 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.

24. State the methods to find the velocity ratio of epicyclic gear train. Two methods are:

1) Tabulation method.
2) Algebraic method.

25. What is 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.

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UNIT 5 - FRICTION

1. What is meant by slope of a thread?

It is the inclination of the thread with horizontal.

Slope of thread = $\tan^{-1}$[Lead screw/Circumference of screw]

2. What are the effects of limiting angle of friction?

1. If limiting angle of friction (φ) is equal to $\tan^{-1}\mu$, then the body will move over the plane irrespective of the magnitude of the force (F) (Limiting force of friction).

2. If $\varphi < \tan^{-1}\mu$, then no motion of body on plane is possible irrespective of how large the magnitude of F may be.

3. Define co-efficient of friction (μ).

It is defined as the ratio of the limiting friction (F) to the normal reaction (R_N) between the two bodies.

μ = Limiting force of friction/Normal reaction = F/R_N

4. Differentiate coefficient of friction in square thread and V-thread.

(a) In square thread, $\mu = F/R_N$

(b) In V thread, $\mu_1 = \mu/\cos\beta$

Where F = Limiting force of friction,
R_N = Normal reaction, and
2β = Angle of 'V' in a 'V' thread.

5. What is the efficiency of inclined plane?

The efficiency of an inclined plane is defined as the ratio between effort without friction (P_0) and the effort with friction (P).

6. Why self- locking screws have lesser efficiency?

Self-locking needs some friction on the thread surface of the screw and nut hence it needs higher effort to lift a body and hence automatically the efficiency decreases.

7. What are the functions of clutches?

1. It supplies power to the transmission system.
2. It stops the vehicle by disconnecting the engine from transmission system.
3. It is used to change the gear and idling the engine.
4. It gives gradual increment of speed to the wheels.

8. What is the difference between cone clutch and centrifugal clutch?

Cone clutch works on the principle of friction alone. But centrifugal clutch uses principle of centrifugal force in addition with it.

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9. Why friction is called as 'necessary evil'?

Friction is the important factor in engineering and physical applications such as belt and ropes, jibs, clutches and brakes, nut and bolts, so it is the necessary one. If the friction exceeds certain value it will cause heat, damage and wear when applied. So it is called 'necessary evil'.

10. What are the belt materials?

1. Leather,
2. Cotton or fabric,
3. Rubber,
4. Balata, and
5. Nylon.

11. State the law of belting?

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

12. What you meant by 'Crowing in pulley"?

The process of increasing the frictional resistance on the pulley surface is known as crowning. It is done in order to avoid slipping of the belt.

13. What is meant by initial tension in belts?

In order to increase the frictional grip between the belt and pulleys, the belts is tightened up. Due to this the belt gets subjected to some tension even when the pulleys are stationary. This tension in the belts is called initial tension (T_0).

14. List out the commonly used breaks.

1. Hydraulic brakes: e.g., Pumps or hydrodynamic brake and fluid agitator.
2. Electric brakes: e.g., Eddy current brakes.
3. Mechanical brakes: e.g., Radial brakes and axial brakes

15. What do you mean by a brake?

Brake is a device by means of which motion of a body is retarded for slowing down (or) to bring it to rest which works on the principle of frictional force, it acts against the driving force.

16. Explain velocity ratio.

It is defined as the ratio between velocity of the driver and the follower (or) driven.

17. State the law of belting?

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

18. What is the centrifugal effect on belts?

During operation, as the belt passes over a pulley the centrifugal effect due to its weight tends to lift the belt from the pulley surface. This reduces the normal reaction and hence the frictional resistance. The centrifugal force produces additional tension in the belt.

19. Write down the disadvantage of V-belt drive over flat belt?

1. V belt cannot be used in large distance.
2. It is not as durable as flat belt.
3. Since the V belt subjected to certain amount of creep therefore it is not suitable for constant speed applications such as synchronous machines, and timing devices.
4. It is a costlier system.

20. When is the cross belt used instead of open belt?

1. Cross belt is used where the direction of rotation of driven pulley is opposite to driving pulley.
2. Where we need more power transmission there we can use cross belt drive.

21. Why lubrication reduces friction?

In practical all the mating surfaces are having roughness with it. It causes friction. If the surfaces are smooth then friction is very less. Lubrication smoothens the mating surface by introducing oil film between it. The fluids are having high smoothness then solids and thus lubrication reduces friction.

22. What you meant by 'crowning in pulley'?

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23. What is meant by initial tension in belts?

In order to increase the frictional grip between the belt and pulleys, the belt is tightened up. Due to this belt gets subjected to some tension even when the pulleys are stationary. This tension in the belt is called initial tension (T_0).

24. Where does the P.I.V. drive system used?

P.I.V. (Positive Infinitely variable) drive is used in an infinitely varying speed system.

25. When the intensity of pressure acting brake shoe is is assumed to uniform?

The intensity of pressure is assumed to be constant when the break shoe has small angle of contact. For large angle of contact, it is assumed that the rate of wear of the shoe remains constant.

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Unit – I - BASICS OF MECHANISMS

1. a) Explain different types of Link.
   b) Classify and explain the Kinematic pair.
2. a) Explain any two inversion of four bar chain.
   b) Explain the first inversion of Single Slider Crank Chain.
3. Explain first inversion of Double Slider crank chain.
4. Explain third inversion of double slider crank chain.
5. a) Explain the offset slider crank mechanism.
   b) Explain Straight line mechanism with neat sketch
6. With the help of a neat sketch explain the working of Oldham's coupling.
7. Explain steering gear mechanism with neat sketch
8. With the help of a neat sketch explain the working of Whitworth quick return mechanism.
9. With the help of a neat sketch explain the working of Single slider and double slider crank chain mechanism.
10. a) Design a four-bar crank rocker quick return mechanism to give a time ratio of 1.25 with rocker swing angle as 75° clockwise. Assume the output link (rocker) length as 50 mm and in the left extreme position it is vertical.

    b) Sketch a four-bar crank rocker mechanism in (1) Maximum transmission angle position and (2) toggle position where mechanical advantage is infinity.

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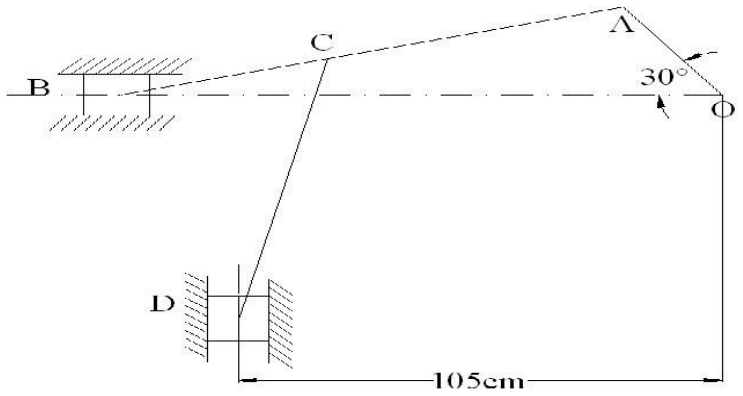
Unit – II - KINEMATICS OF LINKAGE MECHANISMS

1. The Crank of a slider crank mechanisms rotates clockwise at a Constant speed of 600 rpm. The crank is 125 mm and connecting rod is 500 mm long. Determine 1. Linear velocity and acceleration of the mid-Point of the connecting rod, and 2. Angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position.
2. In a four link mechanism, the dimensions of the links are AB=200 mm, BC=400mm, CD=450 mm and AD=600mm. At the instant when DAB=90°, the link AB has angular velocity of 36 rad/s in the clockwise direction. Determine (i) The velocity of point C, (ii) The velocity of point E on the link BC When BE =200 mm (iii) the angular velocities of links BC and CD, iv) Acceleration of link of link BC.
3. The dimensions of the various links of a mechanism, as shown in fig. are as follows: OA=300 mm; AB=1200; BC=450 mm and CD=450 mm. if the crank OA rotates at 20 rpm. in the anticlockwise direction and gives motion to the sliding blocks B and D, find, for given configuration: (1) Velocity of sliding at B and D, (2) Angular velocity of CD (3) Linear acceleration of D and (4) angular acceleration of CD.
4. a) Derive the expressions for Velocity and acceleration of piston in reciprocating steam engine mechanism with neat sketch and b) Derive the expression for Coriolis component of acceleration with neat sketch.
5. In a slider crank mechanism, the length of the crank and the connecting rod are 100 mm and 400 mm respectively. The crank [position is 45° from IDC; the crank shaft speed is 600 rpm clockwise. Using analytical method Determine (1) Velocity and acceleration of the slider, and (2) Angular velocity and angular acceleration of the connecting rod.
6. Locate all instantaneous centers of the slider crank mechanism; the length of crank OB and Connecting rod AB are 125 mm and 500 mm respectively. The crank speed is 600 rpm clockwise. When the crank has turned 45° from the IDC. Determine (i) velocity of slider' A' (ii) Angular Velocity of connecting rod 'AB'.
7. In the mechanism shown in figure, the crank OA rotates at 20 rpm anticlockwise and gives motion of sliding blocks B and D. The dimensions of various links are OA = 300mm, AB = 1200 mm, BC = 450 mm and CD = 450 mm. For the given configuration determine i) velocities of sliding at B and D, ii) angular velocity of CD iii) Linear acceleration of D and iv) angular acceleration of CD.



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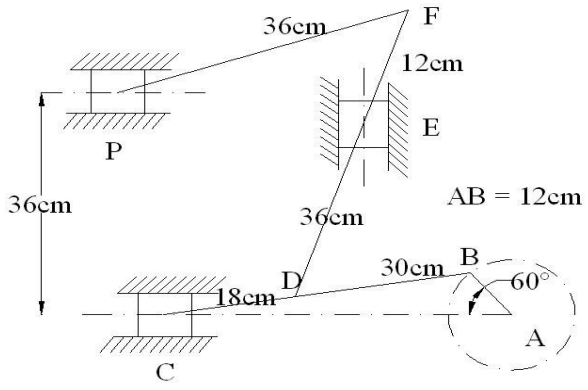
8. The crank and connecting rod of a theoretical steam engine are 0.5 m and 2m long respectively. The crank makes 180 rpm in the clockwise direction. When it has turned 450 from the inner dead centre position, determine: a) Velocity of piston b) Angular velocity of connecting rod. c) Velocity of point E on the connecting rod 1.5m from the gudgeon pin. d) Velocity of rubbing at the pins of the crank shaft, crank and crank cross head when the diameters of their pins are 50mm and 60mm and 30mm respectively.

9. In a steam engine mechanism shown in figure a) the crank AB rotates at 200rpm. The dimensions of various links are AB = 12cm, BC = 48cm, CD = 18cm and DE =36cm, EF = 12 cm and FP = 36cm. Find the velocities of C, D, E, F and P.



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Unit – III - KINEMATICS OF CAM MECHANISMS

1. A cam is to give the following motion to a knife edged follower: (a) Outstroke during 60° of cam rotation (b) Dwell for the next 45° of cam rotation (c) Return stroke during next 90° of cam rotation and (d) Dwell for the remaining of cam rotation. The stroke of the follower is 40 mm and the minimum radius of the cam is 50 mm. The follower moves with uniform velocity during both the outstroke and return strokes. Draw the profile of the cam when (a) the axis of the follower passes through the axis of the cam shaft, and (b) the axis of the follower is offset by 20 mm from the axis of the cam shaft.
2. Draw the profile of a cam operating a Knife-edged follower from the following data: (a) Follower to move outward through 40 mm during 60° of a cam rotation; (b) Follower to dwell for the next 45° (c) Follower to return its original position during next 90° (d)Follower to dwell for the rest of cam rotation. The displacement of the follower is to take place with simple harmonic motion during both the outward and return strokes. The least radius of the cam is 50mm. If the cam rotates at 300 rpm, determine the maximum velocity and acceleration of the follower during the outward stroke and return stroke.
3. A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to give a knife-edged follower the motion as described below: (a) To move outwards through 40 mm during 100° rotation of the cam; (b) to dwell for next 80° (c) To return to its starting position during next 90 ° and (d) To dwell for the rest period of revolution. Draw the profile of the cam (i) When the line of stroke of the follower passes through the centre of the cam shaft and (ii) When the line of stroke of the follower is to take place with Uniform acceleration and uniform retardation. Determine the maximum velocity and acceleration of the follower when the cam shaft rotates at 900 rpm.
4. Draw the profile of a cam operating a roller reciprocating follower and with the following data: Minimum radius of cam =25 mm; lift=30mm; Roller diameter= 15mm. The cam lifts the follower for 120° with SHM, followed by a dwell period of 30°. Then the follower lowers down during 150° of cam rotation with uniform acceleration and retardation followed by a dwell period. If the cam rotates at a uniform speed of 150 RPM. Calculate the maximum velocity and acceleration of follower during the descent period.
5. It is required to set out the profile of a cam to give the following motion to the reciprocating follower with a flat mushroom contact surface: (i) Follower to have a stroke of 20 mm during 120° of cam rotation, (ii) Follower to dwell for 30° of cam rotation, (iii) Follower to return to its initial position during 120° of cam rotation, (iv) Follower to dwell for remaining 90° of cam rotation. The minimum radius of the cam is 25 mm. The out stroke of the follower is performed with SHM and return stroke with equal uniform acceleration and retardation.
6. A tangent cam to drive a roller follower through a total lift of 12.5 mm for a cam rotation of 75°. The cam speed is 600 rpm. The distance between cam centre and follower centre at full lift is 45 mm and the roller is 20 mm in diameter. Find the cam proportions and plot displacement, velocity and acceleration for one full cycle.
7. Construct a tangent cam and mention the important terminologies on it. Also derive the expression for displacement, velocity, acceleration of a reciprocating roller follower when the roller has contact with the nose.

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8. Layout the profile of a cam operating a roller reciprocating follower for the following data. Lift of follower = 30mm; Angle during the follower rise period =120^0; angle during the follower after rise = 30^0; angle during the follower return period = 150^0. Angle during which follower dwell after return = 60^0; minimum radius of cam = 25mm; Roller diameter =10mm. The motion of follower is uniform acceleration and deceleration during the rise and return period.

9. Design a cam to raise a valve with simple harmonic motion through 15mm is $1/3^{rd}$ of a revolution, keep it fully raised through $1/12^{th}$ of a revolution and to lower it with SHM in $1/6^{th}$ of a revolution. The valve remains closed during the rest of the revolution. The diameter of the roller is 20mm and the minimum radius of the cam is 25mm. The axis of the valve rod passes through the axis of the cam shaft. If the cam shaft rotates at uniform speed of 100 rpm; find the maximum velocity and acceleration of the valve during raising and lowering. Also draw the profile of the cam.

10. a) Classify with neat sketches the cam follower according to their shape, location and motion. State also their advantages, if any, with respect to other followers and b) Sketches neatly the displacement, velocity and acceleration curves of a cycloidal motion follower. Why is it superior over other motion curves?

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Unit – IV – GEARS AND GEAR TRAINS

1. a) Two mating spur gear with module pitch of 6.5 mm have 19 ad 47 teeth of 20° pressure angle and 6.5 mm addendum. Determine the number of pair of teeth and angle turned through by the larger wheel for one pair of teeth in contact. Determine also the sliding velocity at the instant (i) engagement commences (ii) engagement terminates. When the pitch line velocity is 1.2 m/s. and b) The number of teeth on each of the two spur gears in mesh is 40. The teeth have 20° involute profile and the module is 6mm. If the arc of contact is 1.75 times the circular pitch. Find the addendum.
2. a) Two 20° involute spur gears have a module of 10 mm. The addendum is one module. The larger gears have 50 teeth and pinion 13 teeth. Does the interference occur? If it occurs, to what value should the pressure angle be changed to eliminate interference? and b) Two mating involute spur gears 20° pressure angle have a gear ratio of 2. The number of teeth on the pinion is 20 and its speed is 250 rpm. The module pitch of the teeth is 12 mm. if the addendum on each wheel recess on each side are half the maximum possible length each, find (1) the addendum for pinion and gear wheel (2) the length of arc of contact (3 the maximum velocity of sliding during approach and recess. Assume pinion to be driver.
3. a) A pair of spur gear with involute teeth is to give a gear ratio of 4:1. The arc of approach is not being less than the circular pitch and the smaller wheel is the driver. The angle of pressure is 14.5. What is the least number of teeth can be used on each wheel? What is the addendum of the wheel in terms of circular pitch? and b) A pair 20° full depth involute spur gear having 30 and 50 teeth respectively module 4 mm arc in mesh, the smaller gear rotates at 1000 rpm. Determine (a) Sliding velocities at engagement and disengagement of a pair of teeth and (b) Contact ratio.
4. In an epicyclic gear train the internal wheels A and B and compound wheels C and D rotate independently about axis O. The wheels E and F rotate on pins fixed to the arm G. E gears with A and C. Wheel F gear with B and D. All the wheels have the same module and the numbers of teeth are: T_C =28 T_D=26; T_E = T_F=18. (1) Sketch the arrangement, (2) Find the number of teeth on A and B, (3)If the arm G makes 100 rpm clockwise and A is fixed, find the speed of B , and (4) If the arm G makes 100 rpm clockwise and wheel A makes 10 rpm counter clockwise; Find the speed of wheel B.
5. Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form; module=6mm, addendum=one module, pressure angle= 20°. The pinion rotates at 90 rpm. Determine (1) the number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel, (2) The length of path and arc of contact, (3) the number of pairs of teeth in contact.
6. The arm of an epicyclic gear train rotates at 100 rpm in the anti-clock wise direction. The arm carries two wheels A and B having 36 and 45 teeth respectively. The wheel A is fixed and the arm rotates about the centre of wheel A. Find the speed of wheel B. What will be the speed of B, if the wheel A instead of being fixed, makes 200 rpm (clockwise).
7. In a reverted epicyclic train, the arm F carries two wheels A and D and a compound wheel B-C. Wheel A meshes with wheel B and Wheel D meshes with wheel C. The numbers of teeth on wheel A, D and C are 80, 48, and 72. Find the speed and direction of wheel D, when wheel A is fixed and arm F makes 200 rpm clockwise.

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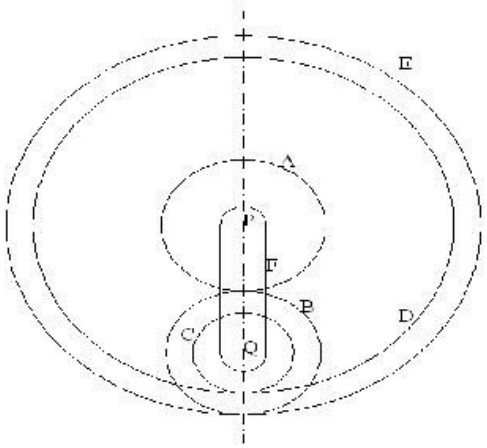
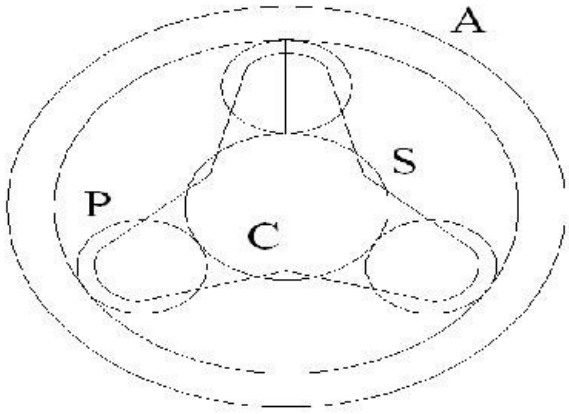
8. A compound epicyclic gear is shown in figure. The gears A, D and E are free to rotate on axis P. The compound gears B and C rotate together on the axis Q at the end of arm F. All the gears have equal pitch. The number of external teeth on gears, A B and C are 18, 45 and 21 respectively. The gears D and E are annulus gears. The gear A rotates at 100rpm in anticlockwise direction and the gear D rotates at 450rpm clockwise. Find the speed and direction of the arm and the gear E.



9. An epicyclic gear train for an electric motor is shown in figure. The wheel S has 15 teeth and is fixed to motor shaft rotating at 1450rpm. The planet P has 45 teeth, gears with fixed annular A and rotates on a spindle carried by an arm which fixed to output shaft. The planet P also gears with the sun when S. Find the speed of output shaft. If motor is transmitting 2 KW find the torque required to fix the annular.



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Unit – V – FRICTION IN MACHINE ELEMENTS

1. a) For a flat belt, prove that $T_1/T_2=e^{\mu\Theta}$ Where T_1 and T_2 = Tension in the tight and slack sides of the belt, Θ = Angle of contact between the belt and the pulley, and μ= Coefficient of friction between the belt and the pulley and b) An open belt running over two pulley of 1.5 m and 1.0 m diameters connects two parallel shafts 4.8 m apart. The initial ten in the belt is 3000 N. The smaller pulley is rotating at 600 rpm. The mass of belt is 0.6703 kg/m length. The coefficient of friction between the belt and pulleys is 0.3. Find (1) the exact length of the belt required (2) the power transmitted taking c.f tension into account.
2. a) A multi-plate disc clutch transmits 55 KW of power at 1800 rpm. Coefficient of friction for the friction surfaces is 0.1. Axial intensity at pressure is not to exceed 160 KN/m^2. The internal radius is 80 mm and is 0.7 times the external radius. Find the number of plates needed to transmit the required torque and b) A rope drive is required to transmit 230 KW from a pulley of 1m diameter running at 450 rpm. The safe pull in each rope is 800 N and the mass of the rope is 0.4 kg per meter length. The angle of lap and groove angle 160^0 and 45^0 respectively. If coefficient of friction is 0.3, find the number of ropes required.
3. The mean diameter of the screw jack having pitch of 10 mm is 50 mm. A load of 20 KN is lifted through a distance of 170 mm. Find the work done in lifting the load and efficiency of the screw jack when (i) the load rotates with the screw, and (ii) the load rests in the loose head which does not rotate with screw. The external and internal diameter of the bearing surface of the loose head is 60 mm and 10mm respectively. The coefficient of friction for the screw as well as the bearing surface may be taken as 0.08.
4. a) A leather belt is required to transmit 7.5 kW from a pulley 1.2 m in diameter, running at 250 rpm. The angle entranced is 1650 and the coefficient of friction between the belt and the pulley is 0.3. If safe working stress for the leather belt is 1.5 Mpa, density of leather is 1 kg/ m^3 end thickness of belt is 10 mm. Determine the width of the belt taking C.F tension into account and b) Two pulley one 450 mm diameter and other 200mm diameter are on parallel shaft 2.1 m apart and are connected by a cross belt. The larger pulley rotates at 225 rpm. The maximum permissible tension in the belt is 1 KN and the coefficient of friction between the belt and the pulley is 0.25. Find the length of the belt required and the power can be transmitted.
5. Two shafts whose centers are 1m apart are connected by a V belt drive. The driving pulley is supplied with 100 kW and has an effective diameter of 300 mm. It runs at 375 rpm. The angle of groove on the pulley is 400. The permissible tension in 400 mm^2 cross sectional area of the belt is 2.1 Mpa. The density of the belt is 1100 kg/ mm^3 coefficient of friction is 0.28. Estimate number of belts required.
6. a) Prove or disprove the following statement – "Angle of friction is equal to angle of repose" and b) Briefly explain the following: 1) Slip of the belt 2) Creep of the belt.
7. A conical pivot bearing supports a vertical shaft of 200mm diameter. It is subjected to a load of 30kN. The angle of cone is 120^0 and the co-efficient of friction is 0.025. Find the power lost in friction when the speed is 140 rpm assuming i) Uniform pressure and ii) Uniform wear.
8. A single plate clutch is required to transmit 8 KW at 1000 rpm. The axis pressure is limited to70 kN/m^2. The mean radius of the plate is 4.5 times the radial width of the friction surface. If both the sides of the plate are effective and the coefficient of friction is 0.25. Find a) the inner and the outer radius of the plate and the mean radius, b) the width of the friction lining.

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9. A shaft has a number of collars integral with it. The external diameter of the collars is 400mm and the shaft diameter is 250mm. If the uniform intensity of pressure is 0.35N/mm^2 and its coefficient of friction is 0.05, estimate i) power absorbed in overcoming friction when the shaft runs at 105 rpm and carries a load of 150kN and ii) number of collars required.

10. a) Derive an expression for braking torque on the drum of simple band brake.

b) Deduce the expression for the friction moment of a collar thrust bearing, stating clearly the assumption made.