

ME6401- KINEMATICS OF MACHINERY QUESTION BANK

Unit 1-BASICS OF MECHANISMS

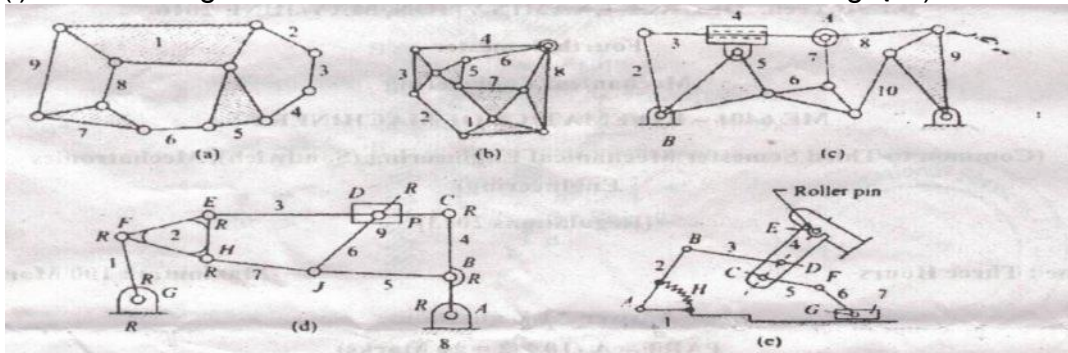
PART-A

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|----|--|-----|
| 1 | Classify kinematic pair based on nature of contact. Give examples. | BT1 |
| 2 | When a linkage become mechanism | BT1 |
| 3 | Classify the constrained motion | BT3 |
| 4 | List the inversion of four bar mechanism? | BT1 |
| 5 | Distinguish between kinematics and kinetics? | BT2 |
| 6 | Discuss toggle position? | BT2 |
| 7 | Describe pantograph? | BT1 |
| 8 | Illustrate the applications of single slider crank mechanism? | BT3 |
| 9 | Define kinematics pairs with example | BT1 |
| 10 | Discuss Elliptical trammel | BT2 |
| 11 | Define 'degrees of freedom' | BT1 |
| 12 | Explain transmission angle? | BT5 |
| 13 | Explain transmission angle? | BT6 |
| 14 | Describe Grashof's Law for a four bar mechanism? | BT2 |
| 15 | Define Kutzbach criterion for planar mechanism. | BT1 |
| 16 | Explain Grubler's criterion for spatial mechanism. | BT4 |
| 17 | Compare instantaneous center & instantaneous axis? | BT5 |
| 18 | Illustrate the types of links and define it. | BT3 |
| 19 | Distinguish between machine and mechanism. | BT2 |
| 20 | Describe spatial mechanism | BT2 |

PART-B

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|----|--|-----|
| 1. | a) Describe different types of Link. (8) | BT2 |
| | b) Classify and explain the Kinematic pair. (8) | |
| 2 | Draw and Describe inversion of four bar chain. | |
| 3 | Explain the inversion of Single Slider Crank Chain. | BT2 |
| 4 | Explain the inversion of Double Slider crank chain. | BT2 |
| 5 | a) Explain the offset slider crank mechanism. (8) | BT4 |
| | b) Explain Straight line mechanism with neat sketch (8) | |
| 6 | Describe the working of Oldham's coupling with a neat sketch and state its application | BT4 |
| 7 | Discuss the steering gear mechanism with neat sketch. | BT4 |
| 8 | Explain the working of Whitworth quick return mechanism with a neat sketch. | BT2 |

- 9 Explain the working of crank and slotted lever quick return motion mechanism with a neat sketch. BT4
- 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.(8) BT2
b) Sketch four-bar crank rocker mechanism in(8)
(1) Maximum transmission angle position and
(2) Toggle position where mechanical advantage is infinity.
- 11 (i) classify kinematic pairs based on degree of freedom(10) BT4
(ii) What is inversion and list its properties (6)
- 12 (i) Find the degree of freedom of the mechanism shown in fig. (10) BT4



- (ii) state the inconsistencies of Grubler criterion(6)
- 13 In a crank and slotter lever quick return mechanism, the distance between the BT6 centers in 150mm and the driving crank is 75mm long. Determine the ratio of the time taken on the cutting and the return strokes
- 14 The withworth quick return motion mechanism has the driving cark 150mm long. BT4
The distance between fixed centers is 100mm.the line of stoke of the ram passed through the centre of rotation of the slotted lever whose free end is connected to the ram by a connecting link. Find the ratio of time of cutting to time of return.

PART-C

- 1 In a crank and slotter lever quick return mechanism, the distance between the BT3 fixed centers O and C is 200mm.the driving crank CP is 75mm long.the pin Q on the slotter lever,360mm for the fulcrum O, is connected by a link QR 100mm long, to a pin R on the ram. The line of stoke of R is perpendicular to OC and intersect OC produced at a point 150mm from C. determine ratio of times taken on the cutting and the return strokes.
- 2 Sketch and describe the working of two different types of quick return mechanism. BT2
Give examples of their application. Derive an expression for the ratio of time taken in forward and return stoke for one of this mechanism
- 3 In a crank and slotted lever quick return mechanism, as shown in Fig, the driving BT4 crank length is 75 mm. The distance between the fixed centers is 200 mm and the length of the slotted lever is 500 mm. Find the ratio of the times taken on the cutting and idle strokes. Determine the effective stroke also.

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- The diagram illustrates the geometric construction of a coupler curve for a slider-crank mechanism. On the left, a crank of length r rotates about a fixed pivot C . A slider of length l moves along a horizontal guide. The crank is shown in three positions: CA_1 , CA , and CA_2 . The slider is shown in two positions: P_1R_1 and P_2R_2 . The coupler curve is the path of point A as the crank rotates. The angle between the crank and the slider is $\beta/2$. The stroke length is the distance between R_1 and R_2 . The line of stroke is the horizontal line passing through R_1 and R_2 .

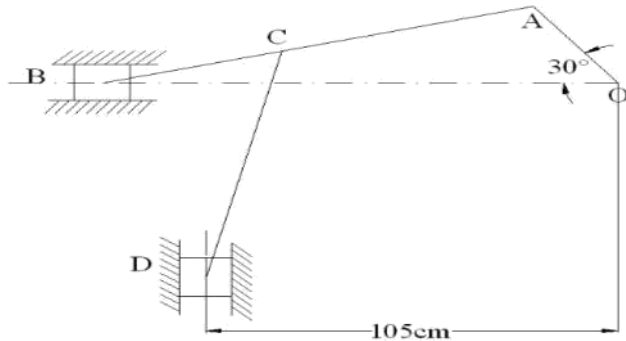
Unit 2- KINEMATICS OF LINKAGE MECHANISMS

1	Define kinematic analysis?	BT1
2	Explain Klein's construction.	BT2
3	What is a relative pole, with respect to velocity analysis?	BT2
4	Differentiate between complexity and incomplete constrained motion.	BT2
5	Illustrate the properties of instantaneous center	BT2
6	Explain Freudenstein's equation for four bar mechanism.	BT2
7	Define Kennedy's theorem	BT2
8	Describe low degrees of complexity	BT4
9	Describe the expression for velocity and acceleration of piston of reciprocating engine.	BT1

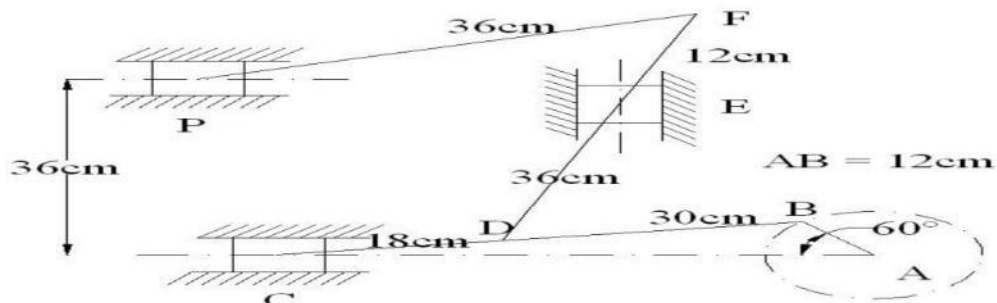
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| 10 | Define rubbing velocity. | BT1 |
| 11 | Deduce the expression for coriolis component of acceleration | BT4 |
| 12 | List out the various possible instantaneous center in a four bar chain mechanism. | BT1 |
| 13 | Classify the types of instantaneous center | BT1 |
| 14 | Define virtual center | BT1 |
| 15 | Describe angular velocity ratio theorem? | BT4 |
| 16 | Illustrate the space centrode and body centrode. | BT5 |
| 17 | Explain normal component of acceleration. | BT2 |
| 18 | Describe configuration diagram | BT3 |
| 19 | Explain body centrode? | BT6 |
| 20 | Compare the two components of acceleration | BT3 |

PART-B

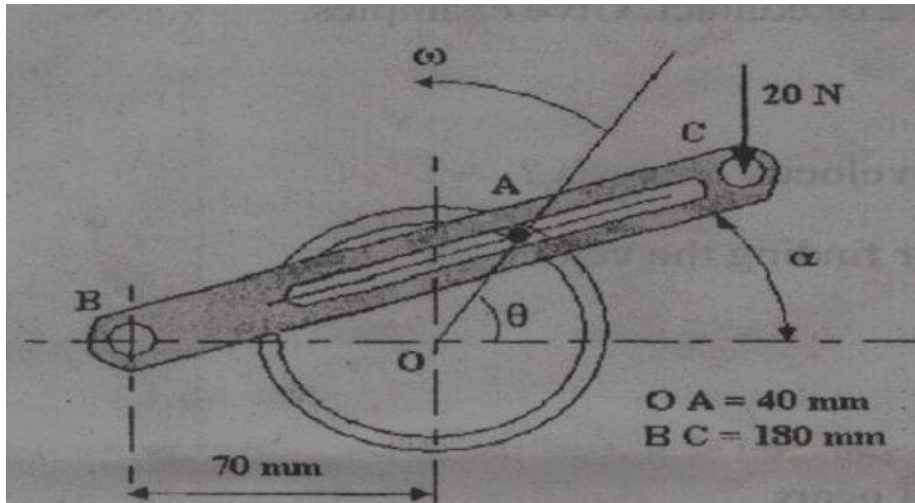
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|----|--|-----|
| 1. | The Crank of a slider crank mechanisms rotates clockwise at a Constant speed of 300 rpm. The crank is 125 mm and connecting rod is 600 mm long. Determine 1. Linear velocity and acceleration of the mid Point of the connecting rod, and 2. Angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position | BT3 |
| 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 $\angle DAB=90^\circ$, 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. | BT3 |
| 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 r.p.m. 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. | BT6 |
| 4 | a)Derive the expressions for Velocity and acceleration of piston in reciprocating steam engine mechanism with neat sketch (8)
b).Derive the expression for Coriolis component of acceleration with neat sketch (8) | BT4 |
| 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 r.p.m. clockwise. Using analytical method Determine (1) Velocity and acceleration of the slider, and (2) Angular velocity and angular acceleration of the connecting rod. | BT5 |
| 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' | BT5 |
| 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 | BT5 |



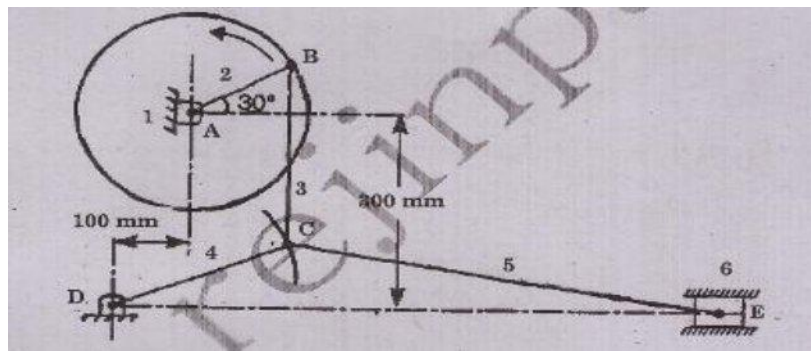
- 8 The crank and connecting rod of a theoretical steam engine are 0.5 m and 2m long respectively. The crank makes 180 rpm in the clockwise direction. When it has turned 45° from the inner dead centre position, determine : a) Velocity of piston b) Angular velocity of connecting rod. C) Velocity of point 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. BT4
- 9 A four-bar mechanism has the following link length in mm. Input, $A_0A = 25$, $AB = 70$, output $B_0B = 45$ and frame $A_0B_0 = 60$. Coupler point A is above and B is below the horizontal frame link A_0B_0 , respectively. When the input link is in an angular position of 105° counter clockwise from the frame link, draw the four bar mechanism and locate all the instantaneous centers .if the input link rotates With a constant angular velocity of 2.5 rad/sec clockwise, determine the linear velocity of B of the output link and the angular velocity of the output link. BT5
- 10 In a steam engine mechanism shown in figure a) the crank AB rotates at 200 rpm. The dimensions of various links are $AB = 12\text{cm}$, $BC = 48\text{cm}$, $CD = 18\text{cm}$ and $DE = 36\text{cm}$, $EF = 12\text{cm}$ and $FP = 36\text{cm}$. Find the velocities of C,D,E,F and P. BT4



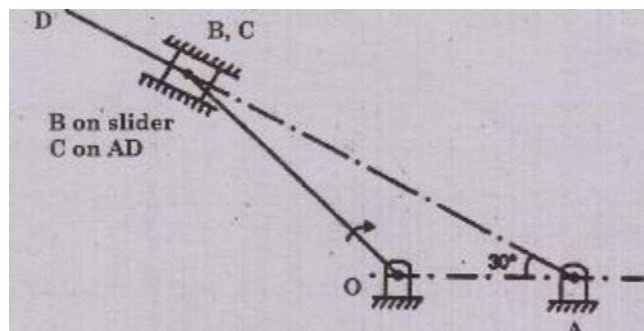
- 11 In a slider crank mechanism, the length of crank OB and connecting rod AB are 125mm and 500mm respectively. The centre of gravity G of the connecting rod is 275mm from the side A. the crank speed is 600rpm clockwise. When the crank has turned 45° from the inner dead centre position, determine: 1, velocity of a slider A, 2.velocity of point G, and 3. Angular velocity of the connecting rod AB. BT4
- 12 The diagram shows part of a quick return mechanism. The pin A slider in the slot when the disc is rotated. Calculated the angular velocity and acceleration of link BC when $\theta = 60^\circ$ and $\omega = 100\text{ rad/sec}$ BT5



- 13 Locate all the instantaneous centers of the mechanism as shown in the fig. the length of various links are $AB=150$, $BC=300$ mm, $CD=225$ mm and $CE=500$ mm. when the crank AB rotates in the anticlockwise direction at a uniform speed of 240 rpm. find (i) velocity of the slider E (ii) angular velocity of the link BC and CE (16)

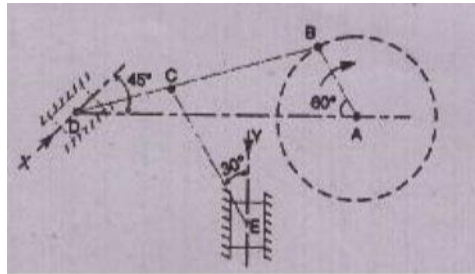


- 14 A single cylinder rotary engine is shown in the fig shows below. OA is the fixed link, 200 mm long, OB is the connection rod is 520 mm long. the line of the stroke is along AD and the instant is inclined at 30° to the vertical. The body of the engine consisting of cylinder rotates at the uniform speed of 400 rpm and about fixed centre A. determine the acceleration of slider B and the angular acceleration of connecting rod (16)

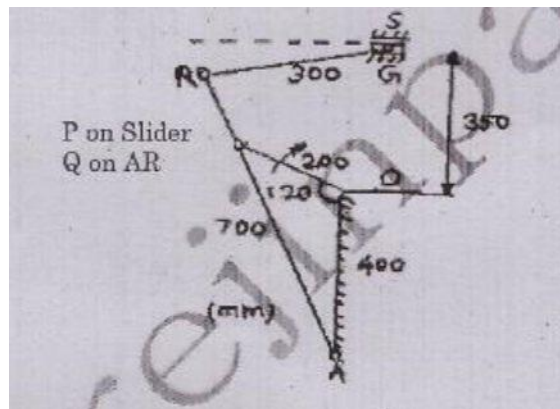


PART-C

- 1 The dimension of the mechanism as shown in the figure $AB=0.45\text{m}$, $BD=1.5\text{m}$ BT5
 $BC=CE=0.9\text{m}$ the crank AB turns uniformly at 180rpm in the clock wise direction and the block at D and E are working in frictionless guide. Draw the velocity diagram for the mechanism and find the velocity of the slides D and E in their guide. also determine the turning moment at A if a forced of 50N at on the direction of arrow X and a force of 750N act on E in the direction of arrow Y



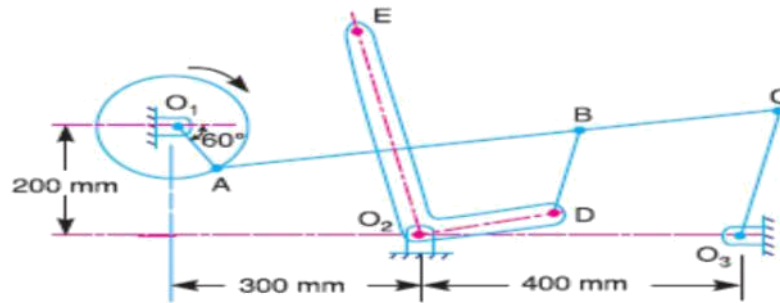
- 2 By analytical method, derive the velocity and acceleration for the reciprocating BT6
steam engine
- 3 Show the link mechanism of a quick return mechanism of the slotted lever type, the BT3
various dimension of which are $OA=400\text{mm}$, $AR=700\text{mm}$, $RS=300\text{mm}$. for the configuration shown determine the acceleration of the cutting tool at S and the angular acceleration of the link RS . the crank OP rotates at 210rpm .



- 4 The mechanism of a wrapping machine, as shown in fig, has the following dimensions BT4

$O1A = 100\text{ mm}$; $AC = 700\text{ mm}$; $BC = 200\text{ mm}$; $O3C = 200\text{ mm}$; $O2E = 400\text{ mm}$; $O2D = 200\text{ mm}$ and $BD = 150\text{ mm}$.

The crank $O1A$ rotates at a uniform speed of 100 rad/s . Find the velocity of the point E of the bell crank lever by instantaneous centre method.



Unit 3- KINEMATICS OF CAM MECHANISMS

PART-A

- | | |
|---|-----|
| 1 Define cam? | BT1 |
| 2 Classify various types of cam. | BT4 |
| 3 Define tangent cam and state its advantages. | BT1 |
| 4 Point out the different motions of the follower | BT5 |
| 5 Criticize, high surface stress in flat faced follower be minimized? | BT2 |
| 6 Evaluate the suitable follower for high speed cam with reason. | BT5 |
| 7 Define dwell period, pitch circle, cam angle? | BT1 |
| 8 Explain offset follower. | BT5 |
| 9 Define prime circle | BT4 |
| 10 Define pressure angle with respect to cams. | BT1 |
| 11 Define undercutting in cam. How it occurs? | BT1 |
| 12 Summarize about nomogram? | BT1 |
| 13 Define undercutting in cam and how to prevent it? | BT5 |
| 14 Describe the basic requirements for high speed cam? | BT1 |
| 15 Write the procedure to draw the cam profile. | BT2 |
| 16 Write the different types of follower? | BT2 |
| 17 Explain base circle? | BT2 |
| 18 Define trace point? | BT3 |
| 19 Define pitch curve? | BT1 |
| 20 Define the term jump speed of the cam. | BT1 |

PART-B

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|---|-----|
| 1. A cam is to give the following motion to a knife edged follower: | BT3 |
| (a) Outstroke during 60° of cam rotation | |
| (b) Dwell for the next 30° of cam rotation | |
| (c) Return stroke during next 60° 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: BT3
 - (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 r.p.m., determine the maximum velocity and acceleration of the follower during the outward stroke and return stroke. (16)
 - 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 r.p.m. (16) BT4
 - 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. (16) BT5
 - 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 50° of cam rotation, (iii) Follower to return to its initial position during 90° of cam rotation, (iv) Follower to dwell for remaining period 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. (16) BT4
 - 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. BT5
 - 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. BT5
 - 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 BT6

- =1200; angle during the follower after rise = 300; angle during the follower return period = 1500. Angle during which follower dwell after return= 600; 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 in 1/3rd of a revolution, keep it fully raised through 1/12th of a revolution and to lower it with SHM in 1/6th of a revolution. The valve remain 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. BT6
 - 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
b) Sketches neatly the displacement, velocity and acceleration curves of a cycloidal motion follower. Why is it superior over other motion curves? BT5
 - 11 The following particulars relate to symmetric circular cam operating a flat faced follower: least radius=25mm, roller radius=8mm, lift of the valve=10mm, angle of the action=120°, cam shaft speed=1000rpm. determine the flank radius, the maximum velocity, acceleration and retardation of the follower. If the mass of follower and the value with which it is in contact is 4kg, find the minimum force to be exerted by the spring to overcome inertia of the valve parts BT6
 - 12 A cam, with a minimum radius of 25 mm, rotating clockwise at a uniform speed, is designed to give motion to a roller follower. At the end of valve rod as described below:
(i) to rise the valve through 50mm during 120° rotation of the cam.
(ii) To keep the valve fully raised through next 30°
(iii) To lower the valve during next 60°
(iv) to keep the valve closed during rest of the revolution
The dia of the roller is 20mm and the dia of the cam shaft is 25mm. the line of stroke is offset by 15mm from the axis of the cam shaft. The displacement of the valve while being raised and lowered is to take place with SHM. draw the displacement diagram. Sketch roughly the space of velocity and acceleration diagrams, draw the profile of cam BT2
 - 13 In a system tangent cam operating a roller follower. The radius of the cam is 30mm and roller radius is 17.5mm. the angle of ascent is 75° and the total lift is 17.5mm. the speed of the cam is 600rpm. assume that there is no dwell between ascent and descent.
(i) calculate the principal dimension of the cam
(ii) find the acceleration of follower at the beginning of the lift
(iii) draw the profile of the cam. BT4
 - 14 (i) draw the displacement, velocity and acceleration curves, when the follower moves with simple harmonic motion and derive the expression for maximum velocity and maximum acceleration
(ii) Depict the type of cam (3) BT6

PART-C

- 1 Follower type=roller follower, lift=25mm, base circle radius=20mm, roller radius=5mm, out stroke with UARM, for 120° cam rotation, dwell for 60° cam BT4

rotation. Return stroke with UARM, for 90° cam rotation, dwell of the remaining period. Determine max velocity and acceleration during out stroke and return stroke if the cam rotates at 1200rpm in counter clockwise direction. Draw the cam profile for condition with follower off set to right to cam center by 5mm

- 2 A cam is designed for a knife follower with the following data. BT5
 - (i) Cam lift=40mm during 90° of cam rotation with SHM
 - (ii) Dwell for the next 30
 - (iii) During the next 60° of cam rotation, the follower returns to original position with SHM.
 - (iv) Dwell for the remaining 180°

Draw the profile of the cam when the line of stroke is offset 20mm from the axis of the cam shaft
- 3 In a cam with translating roller follower, the follower axis is offset to the right of BT2 cam hinged by 12mm. the roller is 10mm and the cam rotates in counter clockwise direction. Layout the rise portion of the cam profile to meet the following specification. Rise taken place during 180° of the cam rotation of which for the first 90° the rise is with constant acceleration and the rest is with constant radiation., taken seven station point only. the lift of cam is 30mm and the least radius of the cam is 25mm
- 4 A cam rotation clockwise a uniform speed of 200rpm is required to move an offset BT3 roller follower with a uniform and equal acceleration and retardation on both the outward and return strokes. The angle of ascent, the angle of dwell and angle of descent is 120° , 60° and 90° respectively. The follower dwells for the rise of cam rotation. The least radius of the cam is 50mm. the lift of follower is 25mm and the dia of roller is 10mm. the line of stroke of the follower is offset by 20mm from the axis of the cam. Draw the cam profile and find the maximum velocity and acceleration of the follower during the outstroke

Unit 4 – GEARS AND GEAR TRAINS

PART-A

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|---|-----|
| 1. Define angle of obliquity in gear. | BT1 |
| 2. Describe undercutting in gears. | BT2 |
| 3. Define arc of approach and arc of recess. | BT1 |
| 4. Define module of gear and give its relation with circular pitch. | BT1 |
| 5. Distinguish velocity and gear ratio. | BT2 |

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| 6. Define law of gearing & contact ratio | BT1 |
| 7. Write short note on differential. | BT2 |
| 8. List out the methods to avoid interference? | BT4 |
| 9. Analyze the reason for choosing cast iron in manufacturing gears. | BT4 |
| 10. List out the externally applied torques used to keep the gear train in equilibrium? | BT4 |
| 11. Define interference & Backlash. | BT1 |
| 12. Distinguish between cycloidal tooth profile and involute tooth profile. | BT4 |
| 13. List out the non-metallic materials used in gear manufacturing. | BT1 |
| 14. Define simple gear train and compound gear train | BT1 |
| 15. Define reverted gear train. | BT1 |
| 16. Compare compound gear train over a simple gear train? | BT4 |
| 17. Where the epicyclic gear trains are used and list out its advantages | BT5 |
| 18. Classify the types of gear trains? | BT3 |
| 19. Formulate the velocity ratio in compound train of wheels? | BT6 |
| 20. A pitch circle of a spur gear is 120 mm, module 4 mm, calculate number of teeth on the gear. | BT3 |

PART-B

1. A pinion having 30 teeth drives a gear having 80 teeth. The profile of the gear is involute with 20 degree pressure angle, 12 mm module and 10 mm addendum. Find the length of path of contact, arc of contact and the contact ratio. BT1

2. Two involute gears of 20 degree pressure angle are in mesh. The number of teeth on pinion is 20 and the gear ratio is 2. If the pitch expressed in module is 5 mm and the pitch line speed is 1.2 m/s, assuming addendum as standard and equal to one module, find a). The angle turned through by pinion when one pair of teeth is in mesh and b). The maximum velocity of sliding. BT1

3. A pair of gears having 40 and 20 teeth respectively are rotating in mesh, the speed of the smaller being 2000 rpm. Determine the velocity of sliding between the gear teeth faces at the point of engagement, at the pitch point and at the point of disengagement if the smaller gear is the driver. Assume that the gear teeth are 20 degree involute form, addendum length is 5 mm and the module is 5 mm. Also find the angle through which the pinion turns while any pairs of teeth are in contact. BT2

4. The following data relate to a pair of 20 degree involute gears in mesh. Module = 6 mm, Number of teeth on pinion = 17, Number of teeth on gear = 49, Addendum on pinion and gear wheel = 1 module. Find the number of pairs of teeth in contact, the angle turned through by the pinion and the gear wheel when one pair of teeth is in contact and 3. The ratio of sliding to rolling motion when the tip of a tooth on the larger wheel (i) is just making contact (ii) is just leaving contact with its mating tooth and is (iii) at the pitch point.

BT2

5. a) Two mating spur gear with module pitch of 6.5 mm have 19 and 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. (8) BT3

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. (8) BT3

6. a) Two 20° involute spur gears have a module of 10 mm. The addendum is one module. The larger gear has 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? (8) BT4

b) Two mating involute spur gears 16° pressure angle have a gear ratio of 2. The number of teeth on the pinion is 15 and its speed is 240 rpm. The module pitch of the teeth is 5 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. (8) BT4

7. (a) A pair of spur gear with involute teeth is to give a gear ratio of 4:1. The arc of approach is not be 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? (8) BT5

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. (8) BT5

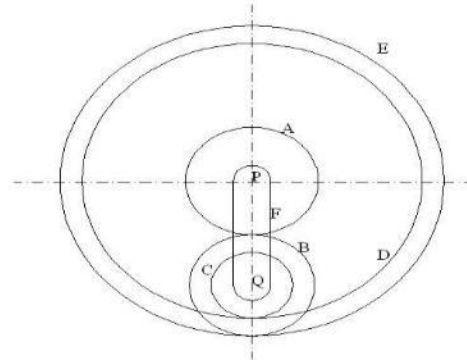
8. Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form; module=6mm, addendum=one module, pressure angle 20° . The pinion rotates at 90 rpm. Determine (1) the number of teeth on the pinion to avoid interference on it and the corresponding number of teeth on the wheel, (2) The length of path and arc of contact, (3) the number of pairs of teeth in contact.(4) Maximum velocity of sliding (16) BT6

9. The arm of an epicyclic gear train rotates at 100 rpm in the anticlock 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). BT6

10. In a reverted epicyclic train, the arm A carries two gear B and C and a compound gear D-E. Wheel B meshes with gear E and gear C meshes with gear D. The number of teeth on gear B, C and D are 75, 30, and 90. Find the speed and direction of gear C, when gear B is fixed and arm A makes 100 rpm clockwise. BT4

11. 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 100 rpm in anticlockwise direction and the gear D rotates at 450 rpm clockwise. Find the speed and direction of the arm and the gear E.

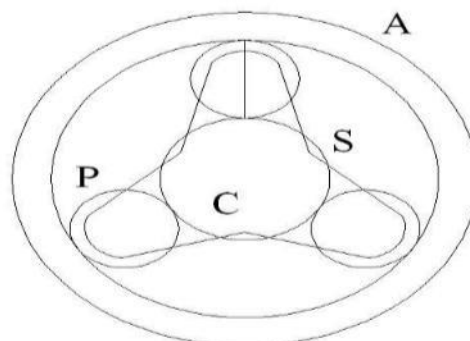


12. The sun planet gear of an epicyclic gear train, the annular D has 100 internal teeth, the sun gear A has 50 external teeth and planet gear B has 25 external teeth. The gear B meshes with gear D and gear A. The gear B is carried on arm E, which rotates about the centre of annular gear D. If the gear D is fixed and arm rotates at 20 rpm, then find the speeds of gear A and B.

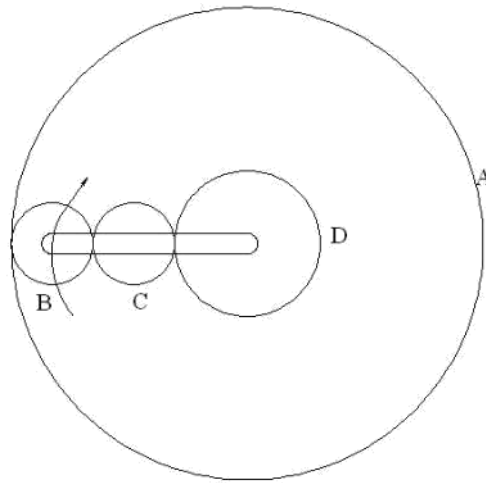
BT5

13. 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 1450 rpm. 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.

BT5



14. An epicyclic gear train as shown in figure is composed of a fixed annular wheel A having 150 teeth. The wheel A is meshing with wheel B which drives wheel D through an idle wheel C, D being concentric with A. The wheels B and C are carried on an arm which revolves clockwise at 100 rpm about the axis of A and D. If the wheels B and D have 25 and 40 teeth respectively, determine the number of teeth on C and speed and sense of rotation of wheel C. BT4



PART-C

1. Two mating gears have 20 and 40 involute teeth of module 10mm and 20 degree pressure angle. The addendum on each wheel is to be made of such a length that the line of contact on each side of the pitch point has half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact, arc of contact and contact ratio.

BT3

2. A pair of 20 degree full depth involute spur gears having 25 and 45 teeth respectively of module 3mm are in mesh. The smaller gear rotates at 900 rpm. Determine sliding velocities at engagement and at disengagement of pair of a teeth and contact ratio.

BT4

3. A pair of spur wheels with involute teeth is to give a gear ratio of 3 to 1. The arc of approach is not to be less than the circular pitch and the smaller wheel is the driver. The pressure angle is 20 degree. What is the least number of teeth that can be used on each wheel? What is the addendum of the wheel in terms of the circular pitch?

BT5

4. Two spur gears of 24 teeth and 36 teeth of 8mm module and 20 degree pressure angle are in mesh. Addendum of each gear is 7.5mm. The teeth are of involute form. Determine the angle through which the pinion turns while any pair of teeth are in contact and the velocity of sliding between the teeth when the contact on the pinion is at a radius of 102mm. The speed of the pinion is 450 rpm. BT6

Unit 5- FRICTION IN MACHINE ELEMENTS

PART-A

- | | |
|---|-----|
| 1. Define anti-friction bearing. | BT1 |
| 2. Differentiate multi plate clutch and cone clutch | BT2 |
| 3. Compare sliding friction and rolling friction. | BT5 |
| 4. State the laws of dry friction. | BT1 |
| 5. State the laws of fluid friction. | BT1 |
| 6. Define angle of repose? | BT1 |
| 7. Grade the advantage of V-belt over flat belt drive. | BT5 |
| 8. Define Co-efficient of friction. | BT1 |
| 9. Compare the advantage of wire rope over fabric rope. | BT4 |
| 10. Explain the significance of friction in braking. | BT5 |
| 11. List out the functions of clutches? | BT1 |
| 12. Distinguish between cone clutch and centrifugal clutch? | BT2 |
| 13. Explain crowning in pulley? | BT4 |
| 14. List out the belt materials? | BT1 |
| 15. Explain velocity ratio. | BT5 |
| 16. State the law of belting. | BT1 |
| 17. Explain the term slip & creep? | BT4 |
| 17. Define wipping? | BT1 |
| 18. Explain self energizing brake. | BT4 |
| 19. State the centrifugal effect in belt drive? | BT2 |
| 20. Why is the cross belt used instead of open belt? | BT4 |

PART-B

1. A shaft rotates at a constant speed of 160 rpm is connected by belting to a parallel shaft 720 mm apart, which has to run at 60, 80 and 100 rpm. The smallest pulley on the driving shaft is 40 mm in radius. Determine the remaining radii of the two stepped pulleys for a crossed belt and an open belt. Neglect belt thickness and slip.

BT1

2. A shaft rotating at 200 rpm drives another shaft at 300 rpm and transmits 6 kW through a belt. The belt is 100 mm wide and 10 mm thick. The distance between the shafts is 4 m. The smaller pulley is 0.5 m in diameter. Calculate the stress in the belt, if it is an open belt drive and a cross belt drive. Take $\mu = 0.3$. BT1

3. The leather belt is required to transmit 6.5 kW from a pulley 1.0 m in diameter running at 300 rpm. The angle embraced is 155 degree and the co-efficient of friction between the belt and the pulley is 0.2. If the safe working stress for the leather belt is 1.3 MPa, density of leather 1.3

Mg/m³ and thickness of the belt 13 mm, determine the width of the belt taking centrifugal tension into account. BT2

4. An open flat belt drive connects two parallel shafts 1.2 m apart. The driving and driven shafts rotate at 350 rpm and 140 rpm respectively and the driven pulley is 400 mm in diameter. The belt is 5 mm thick and 80 mm wide. The co-efficient of friction between the belt and pulley is 0.3 and the maximum permissible tension in the belting is 1.4 MN/m². Determine the diameter of the

driving pulley, maximum power that may be transmitted by the belting and required initial belt tension. BT3

5. 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. (8) BT4

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 centrifugal tension into account. (8) BT3

6.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/m². 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. (8) BT3

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 1600 and 450 respectively. If coefficient of friction is 0.3, find the number of ropes required. (8) BT4

7.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 n 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. (16) BT4

8.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 165° 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/m³ and thickness of belt is 10 mm. Determine the width of the belt taking Centrifugal tension into account. (8) BT5

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. (8) BT4

9. Two shaft 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 mm² cross sectional area of the belt is 2.1 MPa. The density of the belt is 1100 kg/ mm³ coefficient of friction is 0.28. Estimate number of belts required. (16)

BT5

10. a) Prove or disprove the following statement – “Angle of friction is equal to angle of repose”
b) Briefly explain the following: 1) Slip of the belt 2) Creep of the belt. BT4

11. 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° 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.

BT5

12. A single plate clutch is required to transmit 8 KW at 1000 rpm. The axis pressure is limited to 70 KN/m². 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.

BT4

13. 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/mm² 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. BT4

14.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. BT5

PART-C

1. An open belt running over two pulleys 240mm and 600mm diameter connects two parallel shafts 3 metres apart and transmits 4kW from the smaller pulley that rotates at 300 rpm. Co-efficient of friction between the belt and the pulley is 0.3 and the safe working tension is 10kN per mm width. Determine minimum width of the belt, initial belt tension and the length of the belt required. BT3

2.A belt drive consists of two V belts in parallel on grooved pulleys of the same size. The angle of the groove is 30 degree. The cross sectional area of each belt is 750mm² and $\mu=0.12$. The density of the belt material is 1.2 Mg/m³ and the maximum safe stress in the material is 7 MPa. Calculate the power that can be transmitted between the pulleys 300mm diameter rotating at 1500 rpm. Find also the shaft speed in rpm at which the power transmitted would be maximum.

BT4

3.A rope drive transmits 600kW from a pulley of effective diameter 4m, which runs at a speed of 90rpm. The angle of the lap is 160 degree and the angle of the groove is 45 degree, the co-efficient of friction is 0.28, the mass of rope 1.5kg/m and the allowable tension in each rope 2400N. Find the number of ropes required.

BT5

4. A pulley used to transmit power by means of ropes has a diameter of 3.6m and has 15 grooves of 45 degree angle. The angle of contact is 170 degree and the co-efficient of friction between the ropes and the grooves sides is 0.28. The maximum possible tension in the ropes is 960N and the mass of the rope is 1.5kg per metre length. What is the speed of pulley in rpm and the power transmitted if the condition of maximum power prevails.? BT6