MOHAMED SATHAK A J COLLEGE OF ENGINEERING

Chennai – 603103

DEPARTMENT OF MECHANICAL ENGINEERING

ME8492 - KINEMATICS OF MACHINERY

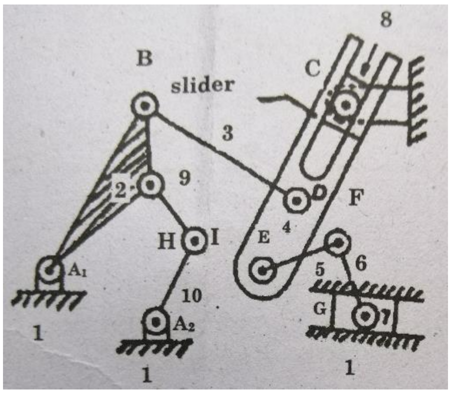
QUESTION BANK

PREPARED BY:

Mr. G.RAMESH
Associate Professor
Department of Mechanical Engineering
MSAJCE

UNIT – I – PART - A

1 **Determine the number of freedom of the mechanism shown in the figure below. Apr/May 2015**



2 **Define Gruebler's criteria for a mechanism. Nov/Dec 2015, Nov/Dec 2017**

Grasshof'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.

M=3L-2J-3G (2.1a)

where: M = degree of freedom or mobility
L = number of links
J = number of joints
G = number of grounded links

3 **Name any two inversions of the 4 bar chain Nov/Dec 2015**

Inversions of four bar mechanisms
First Inversion – Coupled wheels of locomotive – double crank
Second Inversion – Beam Engine - Crank and lever mechanism
Third Inversion – Watt's Engine Indicator – Double lever mechanism

4 **Classify kinematic pairs based on nature of contact. Give examples. May/June 2016, May/Jun 2018**

Kinematic pair is a joint of two links having relative motion between them. The types of kinematic pair are classified according to

1. Nature of contact (lower pair, higher pair)
2. Nature of mechanical contact (Closed pair, unclosed pair)
3. Nature of relative motion (Sliding pair, turning pair, rolling pair, screw pair, spherical pair)

5 **When a linkage becomes mechanism? May/June 2016**

The linkages become mechanism, if the DOF is positive and the links will have relative motion.

6 **Differentiate rigid and flexible links. Nov/Dec 2016, May/Jun 2019**

- **Rigid link**. A rigid link is one which does not undergo any deformation while transmitting motion. Strictly speaking, rigid links do not exist. However, as the deformation of a connecting rod, crank etc. of a reciprocating steam engine is not appreciable, they can be considered as rigid links.
- **Flexible link**. A flexible link is one which is partly deformed in a manner not to affect the transmission of motion. For example, belts, ropes, chains and wires are flexible links and transmit tensile forces only.

7 **Define Transmission angle of a four-bar mechanism. What are the maximum and minimum values of transmission angle? Sketch them. Nov/Dec 2016, May/Jun 2017, May/Jun 2019**

Transmission angle is the angle between the coupling member and the output member in a mechanism. The angle between the direction of absolute motion and direction of the relative motion of the point in which the driven member gets the motion impulse. Transmission angle lies between 40° to 140°

8 **What type of kinematic pair exists between human shoulder and arm based on nature of contact and nature of relative motion? May/Jun 2017**

Kinematic pair exist between human shoulders and arm is a Lower Pair by nature of contact, i.e. Surface Contact, and is a Spherical Pair based on nature of relative motion, since it is a Ball and Socket Joint with rotation about all the three axes, i.e.a three degrees of freedom pair.

9 **Name any two inversions of single slider crank chain. Nov/Dec 2017, May/Jun 2019**
Inversions of Single Slider Mechanism
- First Inversion – Reciprocating engine mechanism
- Second Inversion – Gnome Engine or Rotary Engine – Whitworth quick return mechanism
- Third Inversion – Quick return mechanism – Crank and slotted lever – Oscillating cylinder engine
- Fourth Inversion – Hand Pump

10 **Define kinematic pair and classify it according to the types of contact. May/Jun 2018**
The two links or elements of a machine, when in contact with each other, are said to form a pair. If the relative motion between them is completely or successfully constrained (i.e. in a definite direction), the pair is known as kinematic pair. It is classified according to the types of contact as 1. Lower pair and 2. Higher pair

11 **Sketch a crank-rocker mechanism and a slider crank mechanism indicating their input and output motions. May/Jun 2018**

12 **Name the inversions of a double slider crank mechanism. Nov/Dec 2018, May/Jun 2019**
Inversions of Double Slider Mechanism
First Inversion – Scotch Yoke mechanism
Second Inversion – Oldhams Coupling
Third Inversion – Elliptical trammel
Fourth Inversion – Hand Pump

13 **What is Pantograph? Nov/Dec 2018**
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.

14 **Define rigid link and give examples. May/Jun 2019**
The links which donot undergo an appreciable deformation while transmitting the required motion and forces are called rigid link. Ex.-Piston, Connecting rod.

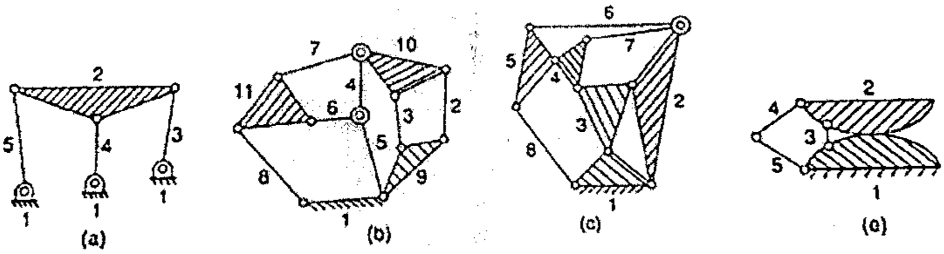
15 **Write the different types of kinematic pairs based on the relative motion between them. Nov/Dec 2019**
(a) Sliding pair, (b) Turning pair, (c) Rolling pair, (d) Screw pair and (e) Spherical pair

16 **Differentiate machine and structure. Nov/Dec 2019**

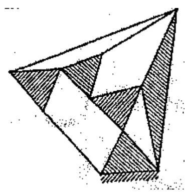
S.No	Machine	Structure
1	Relative motion exists between its parts.	No relative motion exists between its members.
2	It transforms available energy into useful work.	It does not convert the available energy into work.
3	Links are meant to transmit motion and force.	Members are meant for carrying loads having action.
4	Examples: Scooter, Car, Bus.	Examples: Roof trusses, bridges.

PART – B

1. State whether the following links shown in fig. (a, b, c and e) are mechanisms with one degree of freedom. If not make suitable changes but the number of links should not be varied more than one **NOV/DEC 2019**



2. For the kinematic linkage shown in Fig 11 (b) (i) calculate the total number of binary, ternary and quaternary links **NOV/DEC 2019** (ii) total number of links (iii) total number of joints or pairs (iv) the number of degrees of freedom. Comment on the kinematic linkage based on mobility. **NOV/DEC 2019**



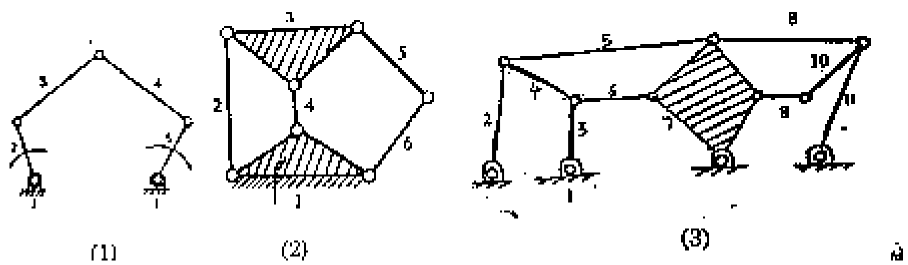
3. Explain how the Whitworth quick return mechanism and Crank and slotted lever mechanism are different from each other **NOV/DEC 2019**

4. Explain with new sketch, kinematic inversions of four bar chain. **APR/MAY 2019**

5. Draw with neat sketch, explain the crank and slotted lever quick return mechanism. **APR/MAY 2019**

6. What is a kinematic inversion? Discuss ant three applications of inversions of slider crank mechanism with suitable sketches. **APR/MAY 2019**

7. (i) Find the degree of freedom for the mechanism shown in Fig. **APR/MAY 2019, 2017**

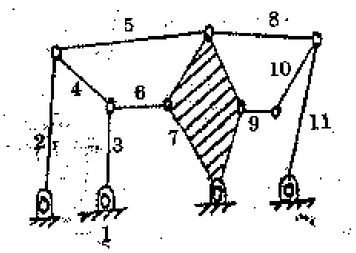


(ii) Explain mechanical advantage and transmission angle related to four bar mechanism. **APR/MAY 2019, 2017**

8. Sketch and describe the working of crank and slotted lever quick return mechanism. Derive an expression to find the length of the stroke for the quick return mechanism. **NOV/DEC 2018**

9. Describe the watt's parallel mechanism for straight line motion and derive the condition under which the straight line in traced. **NOV/DEC 2018**

10. State and brief the Kutzbach criterion for planar mechanisms and using this criterion, determine the arrangement shown in Fig. as structure or Constrained mechanism or an unconstrained mechanism **APR/MAY 2018**



(ii) Define transmission angle of a four bar mechanism and explain its significance. Also, neatly sketch a Crank Rocker mechanism in its minimum and maximum transmission angle positions. **APR/MAY 2018**

11. (i) Define kinematic inversion and neatly sketch an elliptic trammel, ie, one of the inversion of a double slider crank chain. Also, prove or disprove that only all the points on the evolving link of the ellipse trammel will trace ellipses **APR/MAY 2018**
(ii) Sketch and brief Peaucellier exact straight line mechanism. **APR/MAY 2018**

12. Write in detail with not sketch, any three inversions of double slider crank chain. **NOV/DEC 2017**

13. Describe with neat sketch, the mechanism obtained by the inversion of four bar chain. **NOV/DEC 2017**

14. What kinematic inversion? Discuss any three applications of inversions of slider crank mechanism with suitable sketches. **APR/MAY 2017**

15. a) Explain different types of Link. **(8)**
b) Classify and explain the Kinematic pair. **(8)** **NOV/DEC 2013, NOV/DEC 2014**

16. a) Explain any two inversions of four bar chain. **(8)** **NOV/DEC 2015**
b) Explain the first inversion of Single Slider Crank Chain. **(8)** **NOV/DEC 2012, APRIL/MAY 2015**

17. Explain first inversion of Double Slider crank chain. **(8)**

18. Explain third inversion of double slider crank chain. **(8)** **NOV/DEC 2014, MAY/JUNE 2016**

19. a) Explain the offset slider crank mechanism. **(8)**
b) Explain Straight line mechanism with neat sketch **(8)** **NOV/DEC 2012**

20. 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.
MAY/JUNE 2014, NOV/DEC 2015

21. Sketch a four-bar crank rocker mechanism in (1) Maximum transmission angle position and (2) toggle position where mechanical advantage is infinity. **NOV/DEC 2013**

22. Write in detail with neat sketch, any three inversions of double slider Crank chain. **(NOV.2017)**

23. Describe with neat sketch, the mechanisms obtained by the inversions of four-bar chain. **(NOV.2017, MAY 2014)**

24. What is a kinematic inversion? Discuss any three applications of inversions of slider crank mechanism with suitable sketches. **(MAY 2017)**

25. Explain mechanical advantage and transmission angle related to four bar mechanism,
(i) Explain different types of constrained motion with suitable examples,
(ii) Describe the working of Peaucellier mechanism and Offset slider mechanism, **(DEC 2016)**

26. Describe Kutzbach criterion with neat sketches and explain the concept of plane mechanisms, **(MAY 2012)**

UNIT – I - PART C

1. (i) Identify the type of inversion of the four bar mechanism shown in Fig. stating the reasons for your answer. The figure indicates the dimensions in standard units of length is a = 1 unit b = d = 3 units c = 2 units. **NOV/DEC 2019**
(ii) Find the maximum and minimum transmission angle for the same mechanism graphically and analytically and compare them. **NOV/DEC 2019**
2. In order to form a four-bar kinematic chain, state and prove the assembly condition of link lengths by selecting suitable link lengths which are within the range of 35 mm to 175 mm and also, satisfying Grashof's law. **APR/MAY 2018**

UNIT – II - PART A

1 **Write the relation between the number of instantaneous centres and the number of links in a mechanism. Apr/May 2015**

N=n(n-1)/2, n-no of links

2 **What is the total number of instantaneous centres that are possible for a mechanism consisting 'n' links. Nov/Dec 2015, Nov/Dec 2019**

The various types of instantaneous centres are
1. Fixed
2. Permanent
3. Neither fixed or permanent

Formula to calculate the no of instantaneous centre is
n (n-1) / 2

3 **Name the mechanism in which Coriolis component of acceleration is taken into account. Nov/Dec 2015**

Coriolis component of acceleration is taken into account for Quick return motion mechanism.

4 **What is relative pole, with respect to velocity analysis? May/June 2016, May/Jun 2019**

Relative pole with respect to velocity analysis is always perpendicular to the line joining motion of a link velocity of any point on a link on the space diagram.

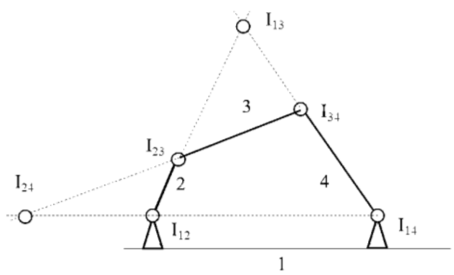
5 **What are the different methods used for finding the velocity? May/June 2016, May/Jun 2019**

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

6 **Find the resultant acceleration of an 80 mm radius crank rotating at a constant angular velocity of 10 rad/sec, at the crank – pin position. May/Jun 2017**

7 **Illustrate the instantaneous centres of a typical four bar mechanism. May/Jun 2017**

Instant centers of four-bar linkage



8 **State Arnold Kennedy theorem. Nov/Dec 2016, Nov/Dec 2017**

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

9 **How will you find out the total acceleration from its normal and tangential components? May/Jun 2018**

The total acceleration of a point on a link is the vector sum of their components of the radial acceleration and tangential acceleration.

10 **Mention any two motives for doing acceleration analysis of mechanisms or machines. May/Jun 2018**

11 **Define instantaneous centre. Nov/Dec 2018**

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

12 What is meant by Coriolis component of acceleration? Nov/Dec 2017, Nov/Dec 2018

This tangential component of acceleration of the slider B with respect to the coincident point C on the link is known as coriolis component of acceleration and is always perpendicular to the link.

13 What is meant by normal component of acceleration? May/Jun 2019

Normal or radial component of acceleration is perpendicular to the velocity of the particle at the given instant. The magnitude is given by $a^r = \omega^2 r$

14 Define centrode. May/Jun 2019

Centrode, in kinematics, is the path traced by the instantaneous center of rotation of a rigid plane figure moving in a plane. There are two types of centrodes: a space centrode, and a body centrode.

15 Define rubbing velocity at a pin joint. Nov/Dec 2016, Nov/Dec 2019

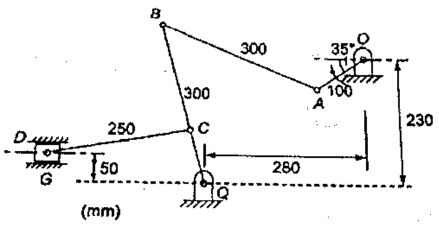
The rubbing velocity is defined as the algebraic sum between the angular velocities of the two links which are connected by pin joints, multiplied by the radius of the pin.

PART – B

1. (i) State and explain angular velocity ratio theorem **NOV/DEC 2019**

(ii) In a slider crank mechanism, the length of the crank and connecting rod are 200 mm and 800 mm respectively. Locate all the I-centers of the mechanism for the position of the crank when it has turned 30° from the inner dead center. Also find the velocity of the slider and the angular velocity of the connecting rod if the crank rotates at 40 rad/s, clockwise. **NOV/DEC 2019**

2. Fig. shows a mechanism in which OA=QC = 100 mm, AB = QB = 300 mm and CD = 250 mm. The crank OA rotates at 150 rpm in the clockwise direction. Determine the (i) velocity of the slider at D (ii) angular velocities of links QB and AB (iii) rubbing velocity at the pin B which is 40 mm in diameter **NOV/DEC 2019**



3. (i) State and prove the Kennedy's theorem of three instantaneous centers **APR/MAY 2019**
   (ii) Give the types of instantaneous centers with examples. **APR/MAY 2019**
   (iii) Give the procedure to be followed for location instantaneous centers for four bar mechanism. **APR/MAY 2019**

4. The crank of slider crank mechanism rotates clock wise at a constant speed of 300 rpm. The crank is 150 mm. and the connecting rod is 600 mm long, Determine:
(i) Linear velocity and acceleration of the midpoint of the connecting rod, and
(ii) Angular velocity and angular acceleration of the connecting rod, at a crank angle of 45° from inner dead centre position **APR/MAY 2019**

5. In four bar ABCD, AD is fixed and is 15 cm long. The crank AB 4 cm long and rotates at 120 rpm clockwise. while the link CD (whose length is 8 cm) oscillates about D. BC and AD are of equal length. Find the angular velocity of link CD when angle BAD = 60° **APR/MAY 2019**

6. The crank of a slider crank mechanism is 15 cm and the connecting rod is 60 cm long. The crank makes 300 rpm in the clockwise direction. When it has turned 45° from the inner dead centre position, determine (i) acceleration of the midpoint of the connecting rod and (ii) angular acceleration of the connecting rod. **APR/MAY 2019**

7. PQRS is a four bar chain with link PS fixed. The length of the links are PQ = 62.5 mm, QR = 175 mm, RS = 112.5 mm and PS 200 mm The crank PQ rotates at 10 rad/s clockwise. Draw the velocity and acceleration diagram when angle QPS = 60° and Q and R lie on the same side of PS Find the angular velocity and angular acceleration of links QR and RS. **NOV/DEC 2018**

8. In pin jointed four bar mechanism ABCD, length of links AB = 300 mm, BC = CD 360 mm and AD = 600 mm. The angle BAD = 60°. The crank AB rotates uniformly at 100 rpm. Locate all the instantaneous centre and find the angular velocity of link BC. **NOV/DEC 2018**

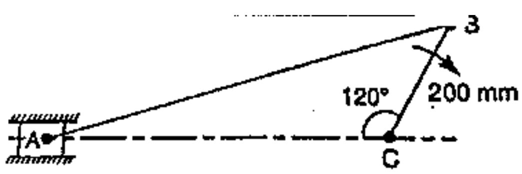
9. (i)A four-bar mechanism AoABBo has the following lengths:
Fixed link, AoBo-60 mm; Input link, AoA-30 mm; Coupler, AB-45 mm Output link, BBo-50mm.
Pivot Ao is left of pivot Bo and both pin joints A and B are above the horizontal fixed link. A point C is on the straight extension of the coupler, such that BC = 25 mm. Input link rotates at a constant speed of 20 rpm clockwise. Determine the linear Velocities of points B and C separately, and angular velocities of the coupler and the output link, when the input link is 60° counter clockwise from the fixed link. **APR/MAY 2018**
ii) What is Kinematic Synthesis? Name the three phases of kinematic synthesis and classify the linkage synthesis problems. **APR/MAY 2018**

10. (i)State and prove the Aronhold-Kennedy theorem related to instantaneous centres. **APR/MAY 2018**
ii) Explain in detail, the concept of Coriolis component of acceleration with neat sketches and equations. **APR/MAY 2018**

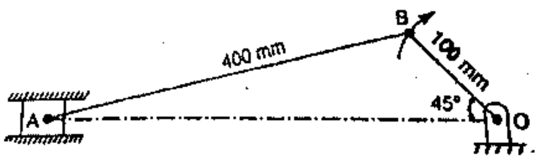
11. In a crank and slotted lever quick return motion mechanism, the distance between the fixed centres is 240 mm and the length of the driving crank is 120 mm. Find the inclination of the slotted bar with the vertical in the extreme position and the time ratio of cutting stroke to the return stroke. If the length of the slotted bar is 450 mm, find the length of the stroke if the line of stroke pause through the extreme positions of the free end of the lever. **NOV/DEC 2017**

12. Locate all the instantaneous centres of the slider crank mechanism. The crank (OA) is 160 mm and the connecting rod (AB) is 470 mm long. If the crank rotates clockwise with an angular velocity of 12 rad/s, Determine 1. Linear Velocity of slider (B) 2. Angular velocity of the connecting rod (AB), at a crank angle of 30° from inner dead centre position using instantaneous centre method. **NOV/DEC 2017**

13. An engine mechanism is shown in Fig. The crank CB = 200 mm and the connecting rod BA = 600 mm. In the position shown, the crankshaft has a speed of 50 rad/s and an angular acceleration of 800 rad/s^2. Find: (i) angular velocity of AB and (ii) angular acceleration of AB. **APR/MAY 2017**



14. Locate all the instantaneous centre of the slider crank mechanism as shown in Fig. The length of crank OB and connecting rod AB are 100 mm and 400 mm respectively. If the crank rotates clockwise with an angular velocity of 10 rad/s, find: (i) Velocity of the slider A, and (ii) Angular velocity of the connecting rod AB. **APR/MAY 2017**



15. The Crank of a slider crank mechanisms rotates clockwise at a Constant speed of 600 r.p.m. 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. **NOV/DEC 2013, MAY/JUNE 2014, APRIL/MAY 2015**

16. 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.

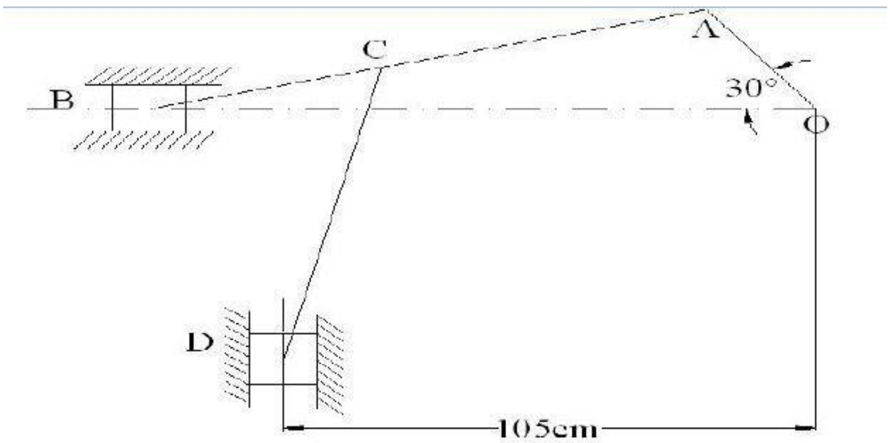
17. The dimensions of the various links of a mechanism, as shown in fig. are as follows: OA=300 mm;AB=1200; BC=450 mm and CD=450 mm. if the crank OA rotates at 20 r.p.m. in the anticlockwise direction and gives motion to the sliding blocks B and D, find, for given configuration: (1) Velocity of sliding at B and D, (2) Angular velocity of CD (3) Linear acceleration of D and (4) angular acceleration of CD.

18 a)Derive the expressions for Velocity and acceleration of piston in reciprocating steam engine mechanism with neat sketch. **MAY/JUNE 2014**
b).Derive the expression for Coriolis component of acceleration with neat sketch **MAY/JUNE 2014**

19. 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. **NOV/DEC 2012**

20. 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**'.**

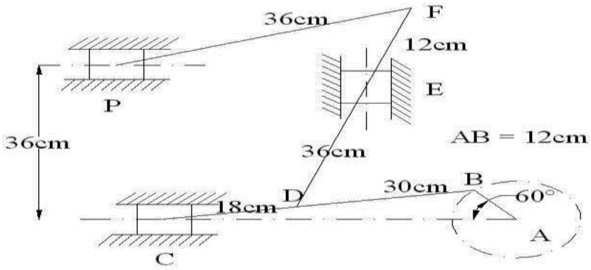
21. In the mechanism shown in figure, the crank OA rotates at 20 rpm anticlockwise and gives motion of sliding blocks B and D. The dimensions of various links are OA = 300mm, AB = 1200 mm, BC = 450 mm and CD = 450 mm. For the given configuration determine i) velocities of sliding at B and D, ii) angular velocity of CD iii) Linear acceleration of D and iv) angular acceleration of CD. **APRIL/MAY 2015, MAY/JUNE 2016, NOV/DEC 2016**



22. 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. **NOV/DEC 2013, NOV/DEC 2015**

23. A four-bar mechanism has the following link length in mm. Input, A0A = 25, AB = 70, output B0B = 45 and frame A0B0 = 60. Coupler point A is above and B is below the horizontal frame link A0B0, respectively. When the input link is in an angular position of 1050 counter clockwise from the frame link, draw the four bar mechanism and locate all the instantaneous centres. 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. **NOV/DEC 2012**

24. In a steam engine mechanism shown in figure a) the crank AB rotates at 200 rpm. 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. **NOV/DEC 2014, NOV/DEC 2015, NOV/DEC 2016**



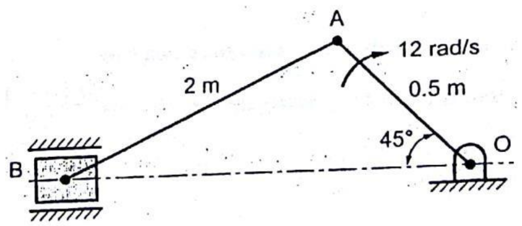
25. In a four-link mechanism, the dimensions of the links are as under:
AB = 50mm; BC= 66 mm; CD = 56 mm;_AD = 100 mm. At an instant when BDAB = 60°, the link AB has an angular velocity of 10.5 rad/s in counter clock wise direction; determine:
(i) The velocity of point C;
(ii) The velocity of point E on the link BC when BE = 40 mm;
(iii) The angular velocity of the links BC and CD;
(iv) The velocity of an offset point F on the link BC, if BF = 45 mm, CF = 30 mm and BCF is read clockwise;
(v) The velocity of an offset point G on the link CD if CG = 24 mm, DG = 44 mm and DCG is read clockwise; and
(vi)The velocities of rubbing at pins A,B,C and D. The radii of the pins are 30,40, 25 and 35 mm respectively. (**MAY 2013)**

26. The crank of a slider-crank mechanism is 15 cm and the connecting rod is 60 cm long. The crank makes 300 r.p.m. in the clockwise direction. When it has turned 450 from the inner dead centre position, determine:
(i) Velocity of slider,
(ii) Angular velocity of connecting rod,
(iii)Linear velocity of mid-point of the connecting rod. **(NOV.2015, MAY 2014)**

27. ABCD is a four bar chain with link AB fixed. The lengths of the links are AB = 62.5 mm; BC = 175 mm; CD = 112.5 mm; and AD = 200mm. The crank AB rotates at 10 rad.ls clockwise. Draw the velocity and acceleration diagram when angle BAD = 600 and B and C lie on the same side of AD. Find the angular velocity and angular acceleration of links BC and CD. (**NOV.2015, NOV.2009, NOV.2004, NOV.2002)**

28. In a small steam engine running at 600 radlmin clockwise, length of crank is 80 mm and ratio of connecting rod length to crank radius is 3. For the position when crank makes 45^0 to horizontal to horizontal, determine:
(i) The velocity and acceleration of the piston;
(ii) The angular velocity and angular acceleration of the connecting rod; and
(iii) The linear velocity and acceleration of appoint X on connecting rod 80 mm from crank pin **(MAY 2017, NOV. 2006)**

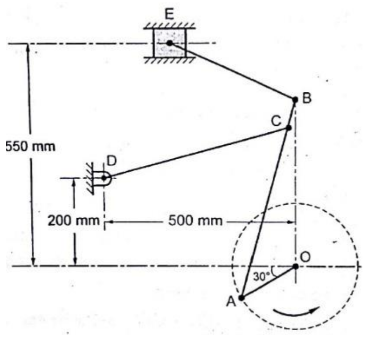
29. Locate all the instantaneous centres of the slider crank mechanism shown in Fig., Find:
(i) Velocity of piston, and
(ii) Angular velocity of connecting rod. **(NOV 2017, MAY 2017, NOV. 2013)**



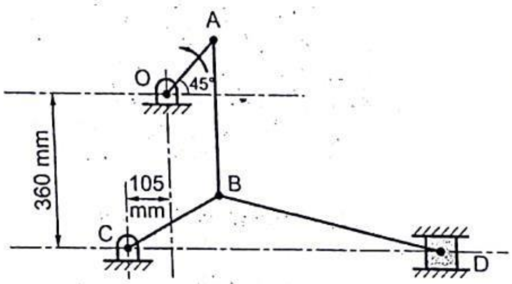
30. In a reciprocating engine mechanism, the lengths of the crank and connecting rod are I50 mm and 600 mm respectively. The crank position is 60° from inner dead centre. The crank – shaft speed is 450 rpm (clockwise). Using analytical method, determine: (1) the velocity of the piston; (ii) the acceleration of the piston, and (m) the crank angle for maximum velocity of the piston and the corresponding velocity. **(NOV.2012)**

31. The following Fig. shows the mechanism of a radial valve gear. The crank OA turns uniformly at 150 rpm and is planned at A to rod AB. The point C in the rod is guided in the circular path with D as centre and DC as

radius. The dimensions of various links are: OA = 150 mm; AB = 550 mm; AC = 450 mm; DC = 500 mm; BE = 350 mm. Determine velocity and acceleration of the ram E for the given position of the mechanism. **(NOV.2006)**

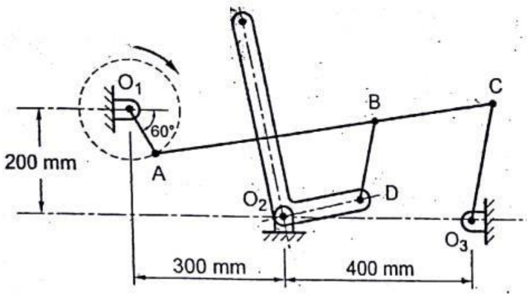


32. ln the toggle mechanism shown in Fig., the slider D is constrained to move on a horizontal path, The crank OA is rotating in the counter clockwise direction at a speed of 180 rpm increasing at the rate of 50 radis^2. The dimensions of the various links are as follows: OA = 180 mm; CB = 240 mm; AB = 360 mm; and BD = 540 mm. For the given configuration, determine: (i) the velocity of the slider D; (ii) the angular velocity and angular acceleration of links AB, BC and BD; and the linear acceleration of the slider D. **(NOV.2007, MAY 2007)**



33. The-mechanism of a warping machine, as shown in Fig, has dimensions as follows: O_1A = 100 mm; AC = 700 mm; BC = 200 mm; BD = 150 mm; O_2D=200 mm; O_2E=400 mm, O_3C=200 mm. The Crank O_1A rotates at a uniform speed of 100 radis. For the given configuration, determine:

(1) linear velocity of the point E on the bell crank lever, (ii) acceleration of the points E and B, and (m) angular acceleration of the bell crank lever. **(NOV.2016, MAY 2010, NOV.2008)**

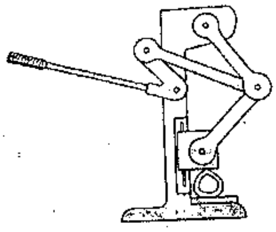


PART – C

1. In crank and slotted lever quick return motion mechanism, the distance between the fixed centers is 240mm and the length of the driving crank is 120 mm. Determine the inclination of the slotted bar with the vertical in the extreme position and the time ratio If the length of the slotted bar is 450mm, find the length of the stroke if the line of stroke passes through the extreme positions of the free end of the lever. **APR/MAY 2019**

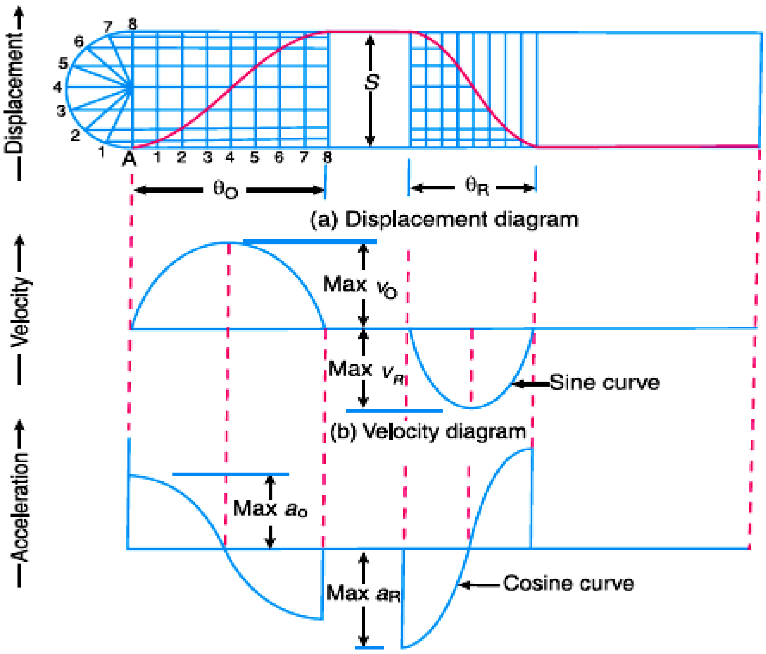
2. ABCD in a four bar chain with link AD fixed. The length of the links are AB = 190 mm, BC = 280 mm, CD = 280 mm, and AD = 500 mm. The crank AB has an angular velocity of 10 rad/s clockwise. Draw the velocity and acceleration diagram when angle BAD 55° and B and C lie on same side of AD. Find the acceleration and angular acceleration of links BC and CD. **NOV/DEC 2017**

3. Figure show a mechanical press used to exert large forces to insert a small part into a larger one. Draw a kinematic diagram, using the end of the handle as a point of interest. Also compute the degrees of freedom. **APR/MAY 2017**



UNIT – III – PART A

1 Draw the displacement, velocity and acceleration diagrams for a follower when it moves with simple harmonic motion. Apr/May 2015



2 Why a roller follower is preferred to that of a knife –edge follower? Apr/May 2015

1. Smooth operation
2. More accuracy
3. Less friction
4. More contact surface on cam profile

3 Define the following with respect to cam and follower mechanism (a) Pressure angle (b) Pitch circle. Nov/Dec 2015

(a) Pressure angle represents the included angle at any point on the pitch curve between the line of motion of follower and normal to that point on the cam profile. This angle is of great importance in designing the cam profiles.

(b) It is a circle drawn from the centre of the cam through the pitch points.

4 State the reasons for providing offset in a cam follower mechanism. Nov/Dec 2015

Offsets are required in cam and followers to reduce wear and side thrust.

5 Define trace point of a cam. May/June 2016

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.

6 **Define tangent cam. What are its applications? May/June 2016, Nov/Dec 2018**

When the flanks of the cam are straight and tangential to the base circle and nose circle, then the cam is known as a **tangent cam,** Tangent cams are used to operate inlet and exhaust valves.

7 **What is maximum velocity and acceleration of the follower on both the strokes of uniform acceleration and retardation? Nov/Dec 2016**

$$v_O = \frac{2S}{t_O} = \frac{2\omega S}{\theta_O} \qquad v_R = \frac{2\omega S}{\theta_R} \qquad a_O = \frac{4\omega^2 S}{(\theta_O)^2} \qquad a_R = \frac{4\omega^2 S}{(\theta_R)^2}$$

8 **Classify cams based on their physical shape. Nov/Dec 2016**

- Wedge (or) flat cams
- Radial (or) Disc cams
- Spiral cams
- Cylindrical (or) Barrel (or) Drum Cams
- Conjugate cams
- Globoid cams
- Spherical cams

9 **Which type of cam follower motion is preferred for high speed engine? Why? May/Jun 2017, May/Jun 2019**

Off set follower. Since with high speed engines, maximum acceleration is required and that is possible only through cycloidal motion.

10 **Give any two applications of cam mechanism in IC engines. May/Jun 2017, May/Jun 2019**

1. To operate the Inlet and outlet valve
2. Timing gears
3. Injection pump
4. Distributor in petrol engine

11 **Differentiate between radial cam and cylindrical cam. Nov/Dec 2017, May/Jun 2019**

Radial Cam	**Cylinderical Cam**
In radial ams, the follower reciprocates or oscillates in a direction perpendicular to the cam axis.	In cylindrical cams, the follower reciprocates or oscillates in a direction parallel to the cam axis

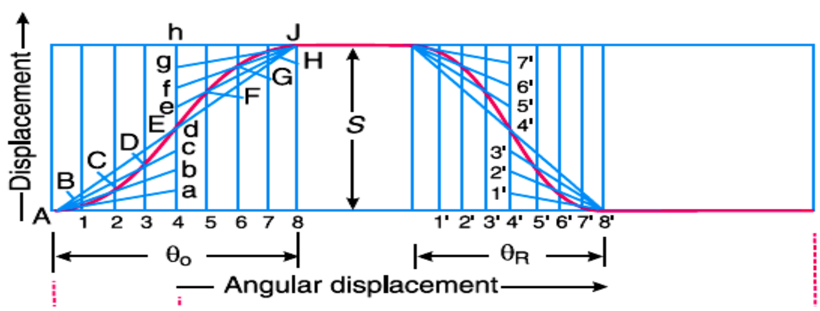
12 **Name the cam follower extensively used in air craft engines. Nov/Dec 2017**

The Roller Follower is a compact bearing with a high-rigidity shaft and a built-in needle bearing. Most suitable as a guide roller for cam mechanisms and linear motion in air craft engines.

13 **Classify and sketch the translating cam follower's base on their positions. May/Jun 2018**

14 **Sketch and name a specified contour cam, stating its advantage. May/Jun 2018**

15 **Draw the displacement diagram for a follower when it moves with uniform acceleration and retardation. May/Jun 2019**



16 Define prime circle and pitch curve of a cam. Nov/Dec 2018, Nov/Dec 2019

Prime Circle: It is the smallest circle that can be drawn from the centre of the cam and tangent to the pitch curve. For a knife edge and a flat face follower, the prime circle and the base circle are identical. For a roller follower, the prime circle is larger than the base circle by the radiusof the roller.

Pitch Curve: It is the curve generated by the trace point as the follower moves relative to the cam. For a knife edge follower, the pitch curve and the cam profile are same whereas for a roller follower, they are separated by the radius of the roller.

PART - B

1.(i) The following data relate to a cam profile in which the follower is a knife edge follower and moves with SHM during the ascent and decent. Minimum radius of cam = 25 mm, lift = 30 mm, angle of ascent = 120°, angle of descent 100°, angle of dwell between ascent and descent = 80°, speed of cam = 200 rpm. Draw profile of the cam and determine the maximum velocity and maximum acceleration during out stroke and the return stroke. **NOV/DEC 2019**
(ii) Why cycloidal cams are suitable for high speed applications? **NOV/DEC 2019**

2. i) A radial cam, operating roller follower, rotates at 200 rpm. The follower rises through 20 mm with SHM during 120° of cam rotation it dwells for 30° of cam rotation and returns to the initial position by SHM in next 150° of cam rotation. Assuming a minimum radius of cam to be 25 mm, and roller diameter as 10 mm draw the cam profile. (10)
ii) Determine V_{max} and A_{max} during outstroke. **NOV/DEC 2019**

3. 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 face:
(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 a initial position during 120° of cam rotation and
(iv) Follower to dwell for remaining 90 of cam rotation the minimum radius of the cam is 25 mm The motion of the follower is to take place with simple harmonic motion during out stroke and return stroke. **APR/MAY 2019**

4. A flat ended valve tappet is operated by symmetrical cam with circular arc for flank and nose. The straight line path of the tappet passes through the cam axis. Total angle of action 150°, lift 6mm base circle diameter 30mm, period of acceleration is the half the period of retardation during the lift. The cam rotates at 1250 rpm. Find (i) Flank and nose radius (ii) Maximum acceleration and retardation during the lift. **APR/MAY 2019**

5. (i) Draw the displacement, velocity and acceleration curves, when the follower with simple harmonic motion and derive the expression to maximum velocity and maximum acceleration. **APR/MAY 2019**
(ii) Depict the types of cams. **APR/MAY 2019**

6. Follower type = roller follower. lift 25 mm: base circle radius = 20 mm roller radius = 5 mm: outer stroke with UARM for 120° cam rotation; dwell for 60° cam rotation, return stroke with UARM, for 90° cam rotations dwell for the remaining period. Determine max velocity and acceleration during out stroke and return stroke if the cam rotates at 1200 rpm in counter clockwise direction. Draw the cam profile for conditions with follower offset to right of cam center by 5 mm **APR/MAY 2019**

7. Draw the profile of cam for operating the exhaust valve of an oil engine. It is required to give equal uniform acceleration and retardation during opening and closing of the valve each of which corresponds to 60° of cam rotation. The valve must remain the fully open position for 20° of cam rotation. The lift of the valve is 37.5 mm and the least radius of cam in 40 mm. The follower provided with a roller radius of 20 mm and its line of stroke passes through the axis of the cam. **NOV/DEC 2018**

8. In symmetrical tangent earn operating a roller follower, the least radius of the cam 30 mm and roller radius is 17.5 mm. The angle of ascent is 75° and the total lift is 17.5 mm. The speed of the cam shaft is 600 rpm. Calculate (i) The principal dimensions of the cam. (ii) The acceleration of the follower at the beginning of the lift, where straight flank merges into the circular nose and at the apex of the circular nose. Assume that there is no dwell between ascent and descent. **NOV/DEC 2018**

9. (i) Neatly sketch a cam mechanism with roller follower and indicate the following in the sketch and brief them: Cam profile, Bane circle, Prime circle and Pressure angle. **APR/MAY 2018**
(ii) In a cam follower mechanism, 40mm lift of the follower has to be made in the first 120° rotation of the cam. Draw the displacement diagram for the following types of motions, separately for each, taking at least 8 equal divisions of 120° (a) Simple harmonic motion b) Cycloidal motion. **APR/MAY 2018**

10. Draw the cam profile of an offset knife edge follower cam, which rotates in clockwise direction, with both rise and return have Uniform Acceleration and retardation motions, for the following data: Base circle Diameter of the cam = 50mm, Lift of the follower = 48 mm, Offset of follower =10 mm to the right of cam rotation centre Cam rotation angles for the follower motions are: Rise = 80°, First dwell = 100°, return = 120° and Second dwell = 60°. Assume the length of the displacement diagram as 180 mm (x axis) and divide the rise and return rectangles into at least 8 equal divisions each. **APR/MAY 2018**
11. A symmetrical com with convex flanks operates a flat-footed follower. The lift is 10 mm, base circle radius 20 mm. The total angle of the cam action is 162°. Find the radius of convex flanks and nose and determine the maximum acceleration and retardation during lift when the cam shaft rotates at 1200 rpm. Period of acceleration is half the period of retardation during the lift. **NOV/DEC 2017**

12. Design a cam for operating the exhaust valve of an oil engine. It is required to give equal uniform acceleration and retardation during opening and closing of the valve each of which corresponds to 60° of cam rotation. The valve must remain in the fully open position for 20° of cam rotation. The lift of the valve in 37.5 mm and the least radius of the cam is 40 mm. The follower is provided with a roller of radius 20 mm and its line of stroke passes through the axis of the cam **NOV/DEC 2017**

13. Draw the profile of a cam operating knife edge follower having a lift of 30 mm. The cam raises the follower with SHM for 150° of the rotation followed by a period of dwell for 60°. The follower descends for the next 100° rotation of the cam with uniform velocity, again followed by a dwell period. The cam rotates at a uniform velocity of 120 rpm and has a least radius of 20 mm. What will be the maximum velocity and acceleration of the follower during the lift and the return? **APR/MAY 2017**

14. In a symmetrical tangent cam operating a roller follower, the least radius of the cam is 30 mm and roller radius is 17.5mm. The angle of ascent is 75° and the total lift is 17.5 mm. The speed of the camshaft is 600 rpm Calculate: (i) The principal dimensions of the cam: (ii) the acceleration of the follower at the beginning of the lift, where straight flank merges into the circular nose and at the apex of the circular nose; (iii) Draw the profile of the cam. Assume that there is no dwell between ascent and descent. **APR/MAY 2017**

15. 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. **NOV/DEC 2012, MAY/JUNE 2014, APRIL/MAY 2015**

16. 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 r.p.m., determine the maximum velocity and acceleration of the follower during the outward stroke and return stroke. **NOV/DEC 2013, NOV/DEC 2014**

17. A cam, with a minimum radius of 50 mm, rotating clockwise at a uniform speed, is required to given 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. **NOV/DEC 2013, APRIL/MAY 2015, NOV/DEC 2015**

18. 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. **NOV/DEC 2014, NOV/DEC 2015, NOV/DEC 2016**

19. 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.

20. 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.
21. 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. **MAY/JUNE 2016**

22. 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 =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. **NOV/DEC 2016**

23. Design a cam to raise a valve with simple harmonic motion through 15mm is 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. **NOV/DEC 2012**

24. 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? **MAY/JUNE 2016**

25. A cam is to be designed for, a knife-edge follower with the following data: Follower lift is 40 mm with SHM, during 90 °of cam rotation. Dwell for the next 30^0 Follower return to its original position with SHM, during the next 60° of cam rotation. Dwell for the remaining cam rotation. The line of stroke of the follower passes through the axis of the cam shaft. Radius of the base circle of the cam is 40 mm.
(i) Draw the displacement diagram. .
(ii) Draw the profile of the cam.
(iii) Determine the maximum velocity and acceleration of the follower during forward and return strokes, the cam rotates 200 rpm in clockwise direction. **(MAY 2014, MAY 2012)**

26. A cam is to be designed for a knife-edge follower with the following data:
(i) Cam lift = 40 mm during 90^0 of cam rotation with Simple harmonic motion. (ii) Dwell for next 30^0 (iii) During the next 60'0 of cam rotation, the follower returns to its original position with simple harmonic motion. (iv) Dwell for the remaining 180^0 Draw the profile of the cam when the line of stroke is offset 20 mm from the axis of the camshaft. The radius of the base circle of the cam is 40 mm. **(MAY 2009, NOV.2004)**

27. 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 face:
(i) Follower to have a stroke of 20 mm during 120^0 of cam rotation,
(ii) Follower to dwell for 30^0 of cam rotation,
(iii) Follower to return to its initial position during 120^0 of cam rotation, and
(iv) Follower to dwell for remaining 90^0 of cam rotation.

The minimum radius of the cam is 25 mm. The outstroke of the follower is performed with SHM and the return stroke with equal uniform acceleration and retardation. Draw the profile of the cam. **(MAY 2016, MAY 2010, NOV. 2008, NOV. 2006)**

28. Draw the displacement, velocity and acceleration curves, when the follower moves with SHM and derive the expression for maximum velocity and maximum acceleration. **(MAY/JUNE 2016)**

29. A cam drives a flat reciprocating follower in the following manner: During first 1200 rotation of the cam, follower moves outwards through a distance of 20mm with SHM. The follower dwells during next 300 of cam rotation. During next 1200 of cam rotation, the follower moves inwards with SHM. The follower dwells for the next 900 of cam rotation. The minimum radius of the cam is 25mm. draw the profile of the cam.

30. The following data are for a disc cam mechanism with roller follower: Minimum radius of the cam = 35 mm; Lift of the follower = 40 mm; Offset of the follower = 10 mm right; Roller diameter = 15 mm.
Cam rotation angles are as mentioned below:
During ascent = 120^0; Dwell = 800; During descent = 800; Dwell = 80^0. Cam rotates in clockwise direction and the follower motion is simple harmonic during both ascent and descent.

(i) Draw the displacement diagram of the follower and indicate the relevant data. (ii) Draw the cam profile and indicate the relevant data. **(NOV. 2003)**

31. In a cam with translating roller follower, the follower axis is offset to the right of the cam hinge by12 mm. The roller radius is 10 mm and the cam rotates in the clockwise direction. Layout the rise portion of the cam profile to meet the following specifications: Rise takes place during I800 of cam rotation of which for the first 900 the rise is with constant acceleration and the rest is with constant retardation. Take seven station points only. The lift of the cam is 30 mm and the least radius of the cam is 25 mm.

32. From the following data, draw the profile of the cam in which the follower moves with SHM during ascent while it moves with uniformly accelerated motion during descent: Least radius of cam = 50 mm; Angle of ascent = 48^0; Angle of dwell between ascent and descent = 42^0; Angle of descent = 60^0; Lift of follower = 40 mm; Diameter of follower 30 mm; Distance between the line of action of the follower and the axis of cam = 20 mm. If cam rotates at 360 rpm clockwise, find the maximum velocity and acceleration of the follower during descent. **(NOV.2013, MAY 2008)**

33. A cam rotating clockwise at a uniform speed of 100 rpm is required to give motion to knife- edge follower as below:

(i) Follower to move outwards through 25 mm during 120^0 of cam rotation.
(ii) Follower to dwell for the next 60^0 of cam rotation.
(iii) Follower to return to its starting position during next 900of cam rotation.
(iv) Follower to dwell for the remaining 90 °of cam rotation.

34. The minimum radius of cam is 50 mm; Draw the profile of the cam when the line of stroke of the follower passes through the axis of the camshaft. IF the displacement of the follower takes place with uniform and equal acceleration and retardation on both the outstroke and return strokes, find the maximum velocity and acceleration during its outstroke and return strokes. Also draw the displacement, velocity and acceleration diagrams for one complete revolutions of the cam. **(MAY 2006, MAY 2005)**

35. The following particulars refers to a symmetrical circular cam operating a flat faced follower: Lease radius of cam = 16 mm; Nose radius = 3.2 mm; Distance between cam shaft centre and nose centre = 25 mm, Angie of action of cam = 150^0; Cam shaft speed = 600 rpm, Assuming that there is a no dwell between ascent or descent, determine: (i) the lift of the valve, (ii) the flank radius, and (iii) the acceleration and retardation of the follower at a point where circular nose merges into circular flank. **(NOV. 2006, MAY 2006, NOV.2005, NOV.2004)**

PART C

1. In a symmetrical tangent cam operating a roller follower, the least radius of the cam is 30 mm and roller radius is 17.5 mm. The angle of ascent is 75° and the total lift is 17.5 mm. The speed of the cam shaft is 600 rpm. Calculate (i) the principal dimensions of the cam (ii) the acceleration of the follower at the beginning of the lift, where straight flank merges into the circular nose and at the apex of the circular nose. Assume that there is no dwell between ascent and descent. **NOV/DEC 2019**

2. A tangent cam with straight working faces tangential to a base circle of 120 mm diameter has a roller follower of 48mm diameter. The line of stroke of the roller follower passes through axis of the cam. The nose circle radius of the cam is 12 mm and the angle between the tangential faces of the cam 90°. If the speed of the cam is 180 rpm, determine the acceleration of the follower, when

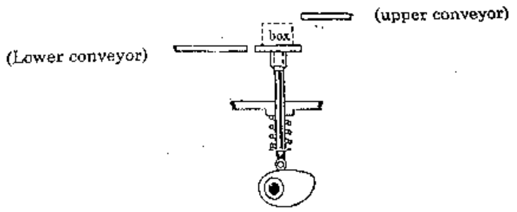
(i) During the lift the roller just leaves the straight flank

(ii) The roller is at the outer end of its lift, ie., at the top of the nose. **APR/MAY 2019**

3. For a high speed application using cam mechanism, the motion of the follower should be with gradually changing smooth acceleration and with constant pressure angle for whole cycle of rotation of the cam. Suggest a suitable type of motion and a suitable follower, for this application stating the reasons **APR/MAY 2018**

4. Design a cam for operating exhaust valve of an oil engine. It is required to give simple harmonic motion during opening of valve with 120° of cam rotation and simple harmonic motion during closing of the valve with 60° of cam rotation. The valve must remain in the fully open position for 30° of cam rotation. The lift of the valve is 50 mm and the least radius of the cam is 25 mm. The follower in provided with a roller of radius 10 mm and its line of stroke passes through the axis of the cam. **NOV/DEC 2017**

5. A cam is to be used for a platform that will repeatedly lift boxes from a lower conveyor to an upper conveyor. This machine is shown in Figure Plot a displacement diagram and determine the required speed of the cam when the follower motion sequence is as follows: (i) Rise 40mm in 1.2 s. (ii) Dwell for 0.3 s. (iii) Fall 20 mm in 0.9 s (iv) Dwell 0.6 s. (v) Fall 20 mm in 0.9 s. **APR/MAY 2017**



UNIT – IV – PART A

1 **What do you understand by the term 'Interference' as applied to gears? Apr/May 2015, Nov/Dec 2016, May/Jun 2019**

The top surface of teeth is made flat the tip of the teeth of one gear tends to dig into the bottom flank of mating gears. This action is called interference.

2 **What are the special advantages of epicyclic gear trains? Apr/May 2015, May/Jun 2019**

To achieve high speed reduction with in very limited space.

- Back gear of lathe
- Differential gear of the automobiles
- Hoists
- Pulley blocks
- Wrist watches

3 **State the law of gearing. Nov/Dec 2015, May/Jun 2017**

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

4 **How is the epicyclic gear train works? Nov/Dec 2015**

An epicylic gear is a planetary gear arrangement consisting of one or more planet (epicyclic) gears (P) meshed and rotating round a central sun gear (S).

It's application can be in a automatic transmission in an automobile gear box. Epicyclic gears consist of several components: sun, carrier, planets, and rings. The sun is the center gear, meshing with the planets, while the carrier houses the planet gear shaft. As the carrier rotates, planets rotate on planet gear shafts while orbiting the sun. Finally, the ring is the internal gear that meshes with the planets.

5 **Define normal and axial pitch in helical gears. May/June 2016**

1. Normal pitch. It is the distance between similar faces of adjacent teeth, along a helix on the pitch cylinder normal to the teeth. It is denoted by p_N.
2. Axial pitch. It is the distance measured parallel to the axis, between similar faces of adjacent teeth. It is the same as circular pitch and is therefore denoted by p_c.

6 **What is the advantage when arc of recess is equal to arc of approach in meshing gears? May/June 2016**

Since arc of recess is equal to arc of approach in meshing gears then the interference is just avoided.

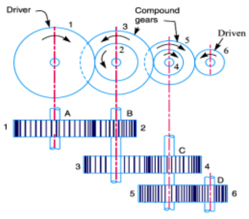
7 **What type of gear arrangement is used to traverse the carriage in lathe machine? May/Jun 2017**

The reverted gear trains and epicyclic gear trains are used in back gear of lathe

8 **Give the classification of gears based on position of teeth on the wheel. Nov/Dec 2017**

(a) Straight, (b) Inclined, and (c) Curved

9 **Draw the compound gear train and write its speed ratio. Nov/Dec 2017**

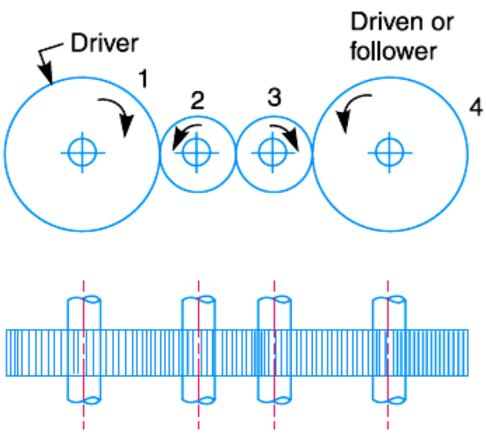


$$\frac{N_1}{N_6} = \frac{T_2 \times T_4 \times T_6}{T_1 \times T_3 \times T_5}$$

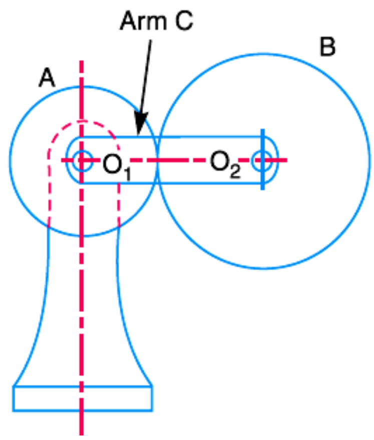
10 **State the two important similarities of a spur gear pair and helical gear pair. May/Jun 2018**

- Both the gears are suitable for transmission of power and motion between parallel driver and driven shafts only.
- They cannot be used for non-parallel shafts.
- Both can provide positive drive (no slippage and thus constant velocity ratio
- Both are suitable for small distance power transmission.
- No flexible element exists between two gears

11 **Sketch an ordinary gear train and an epicyclic gear train stating their important difference. May/Jun 2018**



Simple Gear Train



Epicyclic Gear Train

12 **Define train value of a gear train. Nov/Dec 2018**

The ratio of the speed of the driven or follower to the speed of the driver is known as train value of the gear train. It is the reciprocal of speed ratio

$$\textit{Train value} = \frac{N_2}{N_1} = \frac{T_1}{T_2}$$

13 **Define module of gears and its relation to circular pitch. Nov/Dec 2016, May/Jun 2019**

Module is the ratio of the pitch circle diameter to the number of teeth

Pitch circle, Pc = π x Module

14 **Write the advantages of cycloidal gears. Nov/Dec 2018, May/Jun 2019**

- Since the cycloidal teeth have wider flanks, therefore the cycloidal gears are stronger than the involute gears, for the same pitch, Due to this reason, the cycloidal teeth are preferred specially for cast teeth.
- In cycloidal gears, the contact takes place between a convex flank and concave surfaces, where as in involute gears, the convex surfaces are in contact this condition results in less wear in cycloidal gears as compared to involute gears. However the difference in wear is negligible.
- In cycloidal gears the interference does not occur at all. Though the are advantages of cycloidal gears but they are outweighed by the greater simplicity and flexibility of the involute gears.

15 **What do you mean by spiral gears and hypoid gears? Nov/Dec 2019**

Spiral gears - The spiral gears (also known as skew gears or screw gears) are used to connect and transmit motion between two non-parallel and non-intersecting shafts. The pitch surfaces of the spiral gears are cylindrical and the teeth have point contact. These gears are only suitable for transmitting small power.
Hypoid gears - A bevel wheel with teeth engaging with a spiral pinion mounted at right angles to the wheel's axis, used to connect non-intersecting shafts in vehicle transmissions and other mechanisms

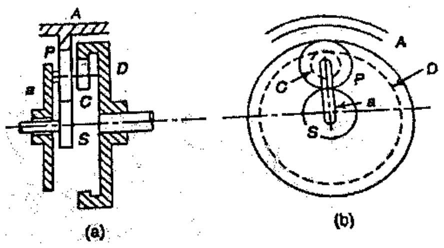
16 **Distinguish cycloid and involute profiles of gear tooth. Nov/Dec 2019**

Involute Gear	Cycloidal Gear
The centre distance for a pair of involute gears can be varied within limits without changing the velocity ratio	Cycloidal gears requires exact centre distance to be maintained
The pressure angle, from the start of the engagement of teeth to the end of the engagement, remains constant.	The pressure angle is maximum at the beginning of engagement, reduces to zero at pitch point, starts decreasing and again becomes maximum at the end of engagement
The face and flank of involute teeth are generated by a single curve	Cycloidal gears, double curves (ie. epi-cycloid and hypo-cycloid) are required for the face and flank respectively

PART - B

1. (i) Calculate length of path of contact (ii) arc of contact (iii) the contact ratio, when a pinion having 23 teeth drives a gear having 57 teeth. The profile of the gears is involute with pressure angle 20°, module 8 mm and addendum equal to one module **NOV/DEC 2019**

2. In a reduction gear shown in Fig. the input S has 24 teeth. P and C constitute a compound planet having 30 and 18 teeth respectively. If all the gears are of same pitch, find the ratio of the reduction gear ie., ratio of speed of gear S to speed of gear D. Assume A to be fixed. **NOV/DEC 2019**



3. A pair of 20° full depth involute spur gears having 30 and 50 teeth respectively of module 4 mm are in mesh. The smaller gear rotates at 1000 rpm. Determine:
(i) Sliding velocities at engagement and at disengagement of pair of a teeth, and
(ii) Contact ratio **APR/MAY 2019**

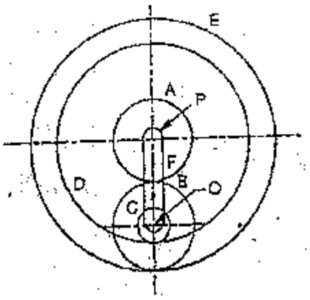
4. In an epicyclic gear train, an arm carried to gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 rpm in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B, If the gear A instead of being fixed, makes 300 rpm in the clockwise direction, what will be the speed of gear B? **APR/MAY 2019**

5. Prove that the max length of arc of contact between a pair of gear tooth to avoid interference is (r + R) tanϕ. **APR/MAY 2019**

6. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20 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 bas half the maximum possible length. Determine the addendum height for each gear wheel, length of the path of contact. **APR/MAY 2019**

7. A compound epicyclic gear is shown in Fig. The gears A D and E are free to rotate on axis P. The compound gear B & C rotate together on the axis Q at the end of arm F. All gears have equal pitch. The number of external teeth on gears A, B and C are 18. 45 and 21 respectively. The gear D & E are annular gears. The gear A rotates at 100 rpm in

anticlockwise direction and gear D rotates at 450 rpm clockwise. Find the speed and direction of the arm F and the gear E. **APR/MAY 2019**



8. Derive an expression to find the minimum number of teeth on the pinion to avoid interference of gears. **NOV/DEC 2018**

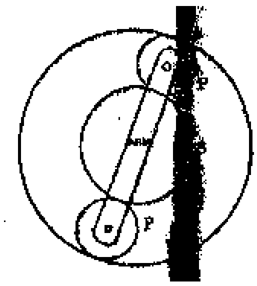
9. An internal wheel B with 80 teeth is keyed to a shaft F. A fixed internal wheel C with 82 teeth is concentric with B. A compound wheel D-E gears with the two internal wheels. D has 28 teeth and gears with C while E gears with B. The compound wheels revolve freely on a pin which project from a disc keyed to shaft A co axial with F. if the wheels have the same pitch and the shaft A makes 800 rpm. What is the speed of the shaft F? **NOV/DEC 2018**

10. (i) State the fundamental law of gearing. Prove this law, by considering and neatly sketch to moving curved surfaces in contact. **APR/MAY 2018**
(ii) Name the two types of tooth profiles satisfying the law of gearing and brief any one of them. **APR/MAY 2018**

11. (i) Explain with neat sketches various classifications of gear trains. **APR/MAY 2018**
(ii) Neatly sketch the gear train called as Fergusson's Paradox. Explain and prove why is it called Paradox, by assuming suitable number of teeth for the gears of this train **APR/MAY 2018**

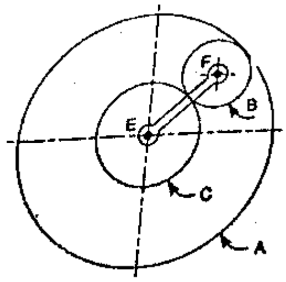
12. A pinion having 24 teeth drives a gear having 60 teeth. The profile of the gears is involute with 20° pressure angle, 10 mm module and 10 mm addendum Find the length of path of contact, arc of contact and the contact ratio. **NOV/DEC 2017**

13. An epicyclic train of gears is arranged as shown in Fig. How many revaluation does the arm, to which the pinion are attached, when S makes 300 rpm counter clockwise and A is stationary. The number of teeth on the gears S and A are 30 and 130 respectively **NOV/DEC 2017**



14. The following data relate to a pair of 20 involute gear 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: (i) The number of pairs of teeth in contact (ii) The angle turned through by the pinion and the gear wheel when one pair of teeth is in contact, and (iii) The ratio of aiding to rolling motion when the tip of a tooth on the larger wheel (1) is just making contact, (2) is just leaving contact with its mating tooth, and (3) is at the pitch point. **APR/MAY 2017**

15. An epicyclic gear consists of three gears A, B and C as shown in Fig. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 rpm. If the gear A is fixed, determine the speed of gears B and C. **APR/MAY 2017**



16. 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. **APRIL/MAY 2015, MAY/JUNE 2016**

17. 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.

18. 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? **NOV/DEC 2013**

19. 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**. NOV/DEC 2014**

20. 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? **NOV/DEC 2015**

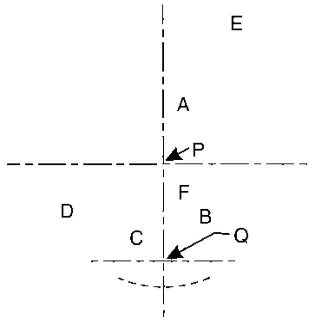
21. A pair 20° full depth involute spur gear having 30 and 50 teeth respectively module 4 mm arc in mesh, the smaller gear rotates at 1000 rpm. Determine (a) Sliding velocities at engagement and disengagement of a pair of teeth and (b) Contact ratio.

22. 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 number of teeth are: TC = 28 TD = 26; TE = TF = 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**. NOV/DEC 2016**

23. 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. **MAY/JUNE 2014, NOV/DEC 2016**

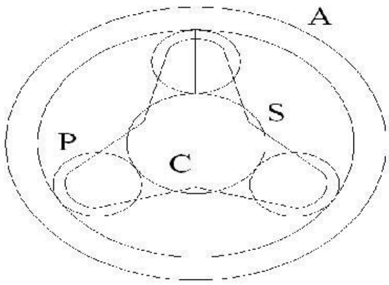
24. In a reverted epicyclic train, the arm F carries two wheels A and D and a compound wheel B-C. Wheel A meshes with wheel B and Wheel D meshes with wheel C. The number of teeth on wheel A, D and C are 80, 48, and 72. Find the speed and direction of wheel D, when wheel A is fixed and arm F makes 200 rpm clockwise. **MAY/JUNE 2016**

25. 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. **NOV/DEC 2012, NOV/DEC 2014**

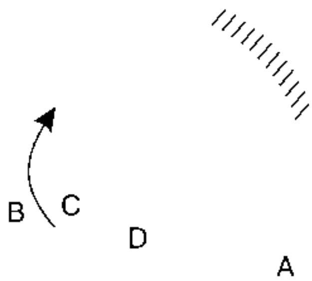


26. The sun planet gear of an epicyclic gear train, the annular D has 100 internal teeth, the sun gear A has 50 external teeth and planet gear B has 25 external teeth. The gear B meshes with gear D and gear A. The gear B is carried on arm E, which rotates about the centre of annular gear D. If the gear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

27. 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. **NOV/DEC 2012, NOV/DEC 2015**



28. 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. **NOV/DEC 2013, APRIL/MAY 2015, NOV/DEC 2016**



29. A pinion having 20 teeth engages with an internal gear having 80 teeth. If the gears have involute profiled teeth with 20^0 pressure angle, module of 10 mm and addendum of 10 mm, find the path of contact, arc of contact and the contact ratio. **(NOV.2017)**

30. An epicyclic gear consists of three gears A, B and C as shown in Fig. The gear A has 72 internal teeth and gear C has 32 external teeth. The gear B meshes with both A and C and is carried on an arm EF which rotates about the centre of A at 18 r.p.m.. If the gear A is fixed, determine the speed of gears B and C. **(MAY 2017)**

31. A compound epicyclic gear is shown diagrammatically in Fig. The gears A, D and E are free to rotate on the axis P. The compound gear 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 the gears A, B and C are 18, 45 and 21 respectively. The gears D and E are annular gears.

The gear A rotates at 100 r.p.m. in the anticlockwise direction and the gear D rotates at 450 r.p.m. clockwise. Find the speed and direction of the arm and the gear E. **(NOV.2016)**

32. Fig. shows a differential gear used in a motor car. The pinion A on the propeller shaft has 12 teeth and gears with the crown gear B which has 60 teeth. The shafts P and Q form the rear axles to which the road wheels are attached. If the propeller shaft rotates at 1000 r.p.m. and the road wheel attached to axle Q has a speed of 210 r.p.m. while taking a turn, find the speed of road wheel attached to axle P. **(MAY 2016)**

33. In an epicyclic gear train, an arm carries two gears A and B having 36 and 45 teeth respectively. If the arm rotates at 150 r.p.m. in the anticlockwise direction about the centre of the gear A which is fixed, determine the speed of gear B. If the gear A instead of being fixed, makes 300 r.p.m. in the clockwise direction, what will be the speed of gear B? **(NOV. 2015)**

34. Two gear wheels mesh externally and are to give a velocity ratio of 3 to 1. The teeth are of involute form; module = 6 mm, addendum = one module, pressure angle = 20°. The pinion rotates at 90 r.p.m. 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, and 4. the maximum velocity of sliding. **(MAY 2014)**

35. The following data relate to a pair of 20° involute gears in mesh: Module = 6 mm, Number of teeth on pinion = 17, Number of teeth on gear = 49; Addenda on pinion and gear wheel = 1 module.
Find: 1. The number of pairs of teeth in contact; 2. 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 (iii) is at the pitch point. **(MAY 2017)** BTL4

36. Two mating gears have 20 and 40 involute teeth of module 10 mm and 20° 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. **(NOV. 2016)**

37. Two involute gears of 20° 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: 1. the angle turned through by pinion when one pair of teeth is in mesh; and 2. The maximum velocity of sliding. **(NOV.2014)**

PART C

1. Derive expression for minimum number of teeth on the wheel in order to avoid interference. **APR/MAY 2019**

2. Number of teeth on spur gears A,B,C,D and E are 30,15,45,20 and 75 respectively. The shaft with Gear A is input and the shaft with gear E is output and the gears have to mesh with the same order as mentioned above. Neatly sketch them as (a) Simple Gear Train and (b) a Non reverted Gear Train with gears C and D on a single shaft and find the output speeds of each gear train with sense of rotation when the input shaft rotates 100 rpm in counter clockwise direction. **APR/MAY 2018**

UNIT – V – PART A

1 **Distinguish between brakes and dynamometers. Apr/May 2015**
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.
Dynamometer is a brake but in addition it has a device to measure the frictional resistance. Knowing the frictional resistance, we may obtain the torque transmitted and hence the power of the engine

2 **Write the mathematical expression for the maximum efficiency of a screw jack. Nov/Dec 2015, May/Jun 2019**

Maximum efficiency of the screw jack is $\eta_{max} = \frac{1-\sin\varphi}{1+\sin\varphi}$

3 **Write mathematical expression for the length of the belt required for two pulleys of diameters d1 and d2 and at distance x apart are connected by means of an open belt drive. Nov/Dec 2015, May/Jun 2019**

Length of the belt $L = \frac{\pi}{2}(d_1 + d_2) + 2x + \frac{(d_1-d_2)^2}{4x}$

4 **What is self-energizing brake? May/June 2016**
When moments of efforts applied on the break drum and frictional force are in the same direction, the breaking torque becomes maximum (frictional force aids the braking action). In such a case the brake is said to be partially self-actuating or self-energising

5 **Why self-locking screws have lesser efficiency? May/June 2016**
Self locking needs some friction on the thread surface of the screw and hence it needs higher effort to lift a body and hence automatically the efficiency decreases.

6 **Differentiate self-energising and self-locking brakes? Nov/Dec 2016**

Self-energising brakes - When moments of efforts applied on the break drum and frictional force are in the same direction, the breaking torque becomes maximum (frictional force aids the braking action). In such a case the brake is said to be partially self-actuating or self-energising.
Self-locking brakes - When the frictional force is great enough to apply the brake with no external force, then the brake is said to be self-locking brake.

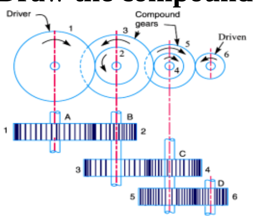
7 **What are the disadvantages of V-belt drive over flat belt? Nov/Dec 2016**
1. V- belt cannot be used in large distance. .
2. It is not as durable as flat belt.
3. Since the V belt subjected to certain amount of creep therefore it is not suitable for constant speed applications such as synchronous machines, and timing devices.
4. It is a costlier system.

8 **What kind of friction acts between the tyre and road in an automobile? May/Jun 2017**

9 **State the functional difference between a clutch and a brake. May/Jun 2017**
Clutch is a transmission and control device that provides for energy transfer from the driver to the driven shaft.
Brake is a transmission and control device that stops a moving load, regulates movement, or holds a load at rest by transforming kinetic energy into heat.

10 **Give the classification of gears based on position of teeth on the wheel. Nov/Dec 2017**
(a) Straight, (b) Inclined, and (c) Curved

11 **Draw the compound gear train and write its speed ratio. Nov/Dec 2017**



$$\frac{N_1}{N_6} = \frac{T_2 \times T_4 \times T_6}{T_1 \times T_3 \times T_5}$$

12 **In an open belt drive of horizontal type, the slack side of belt should be kept on the top side of pulleys. Why? May/Jun 2018**

13 **What are the advantages of using friction clutches? May/Jun 2018**
- To engage or disengage the rest of transmission as required.
- To transmit the engine power to rear wheels when the rear wheels without shock.
- To enable the gear to get engaged when the vehicle is in motion.

14 **What are the characteristics of Brake lining material? Nov/Dec 2018**
1. It should have high coefficient of friction with minimum fading. In other words, the coefficient of friction should remain constant with change in temperature.
2. It should have low wear rate.
3. It should have high heat resistance.
4. It should have high heat dissipation capacity.
5. It should have adequate mechanical strength.
6. It should not be affected by moisture and oil.

15 **Define slip and creep in a belt drive. Nov/Dec 2018**
Slip – Sometimes the frictional grip between the belts and the shafts becomes insufficient. This may cause some forward motion of the driver without carrying the belt with it. This may also cause some forward motion of the belt without carrying the driven pulley with it. This is called slip of the belt.
Creep - When the belt passes from the slack side to the tight side, a certain portion of the belt extends and it contracts again and vice versa. Due to these changes of length, there is a relative motion between the belt and the pulley surfaces. This relative motion is termed as creep.

16 **What is the effect of centrifugal tension in belt drives. Apr/May 2015, May/Jun 2019**
A belt running over a pulley experience a centrifugal force similar to body experience while moving in a circular path. This centrifugal force is due to mass of the belt of the position of the belt over the pulleys, speed

of the belt and radius of curvature of pulley. The effect of centrifugal force is to induce additional tension on tight and slack side.

17 **What are the advantages of hydraulic brake over other brakes? May/Jun 2019**
High mechanical advantage system provides equal braking effect on all wheels, wearing of parts are negligible, system is self-compensating.

18 **Define lead and pitch of a screw thread. Nov/Dec 2019**
Lead. It is the distance, a screw thread advances axially in one turn.
Pitch. It is the distance from a point of a screw to a corresponding point on the next thread, measured parallel to the axis of the screw.

19 **State the two assumptions based on which the bearings are designed. Nov/Dec 2019**
1. The pressure is uniformly distributed throughout the bearing surface, and
2. The wear is uniform throughout the bearing surface.

PART - B

1. A screw jack is used to raise 50 kN of load. The spindle of the screw jack moves in a fixed nut and has a single start square thread of 60 mm mean diameter having a pitch of 20 mm. The coefficient of friction between the screw and nut is 0.12. Effort is applied at the end of a single lever having an effective length of 0.75m. The land is prevented from revolving and it is carried on a swivel seat, the bearing surface of which has mean radius of 4/3 times that of threads. The coefficient of friction between the seat and spindle is 0.10. Find the force applied at the end of the lever when the land in raised. Also, find the mechanical efficiency of the screw jack. Check whether the screw jack is sell locking or not? **NOV/DEC 2019**

2. A Pulley used to transmit power with rope drive has diameter 3 m and has 15 grooves of 45°. The angle of contact is 160° and the coefficient of friction between ropes and the groove sides is 0.3. The maximum possible tension in the ropes is 1000 N and the mass of the rope is1.5 kg per meter length. What is the speed of the pulley in rpm and the power transmitted if the condition of maximum power exists? **NOV/DEC 2019**

3. An open belt running over two pulleys 240 mm and 600 mm diameter connects two parallel shafts 3 m apart and transmit 4 kW from the smaller pulley that rotates at 300 rpm. Coefficient friction between the belt and the pulley is 0.3 and the safe working tension 10N per mm width. Determine:
(i) Minimum width of the belt
(ii) Initial belt tension and
(iii) Length of the belt required. **APR/MAY 2019**

4. A dry single plate clutch is to be designed for an automotive vehicle whose engine is rated to give 100 kW at 2400 rpm. and maximum torque 500 N-m. The outer radius of friction plate is 25% more than the inner radius. The intensity of pressure between the plate not to exceed 0.07N/mm2. The coefficient of friction may be assumed equal to 0.3. The helical springs required by this clutch to provide axial force necessary to engage the clutch are eight. If each spring has stiffness = 40N/mm, determine the initial compression in the springs and dimensions the friction plate. **APR/MAY 2019**

5. A flat belt, 8 mm thick and 100 mm wide transmit power between two pulley, running at 1600 m/min. The mass of the belt is 0.9 kg/m length. The angle of lap in the smaller pulley is 165° and the coefficient of friction between the belt and pulley is 0.3 If the maximum permissible stress in the belt is 2 MN/m^2
Find (i) Maximum power transmitted and (ii) The Initial tension in the belt **APR/MAY 2019**

6. The spindle of a screw jack has single start square threads with an outside diameter of 45 mm and a pitch of 10 mm. The spindle moves in a fixed nut The load is carried on swivel head but is not free to rotate. The bearing surface of the swivel head has a mean diameter of 60 mm. The coefficient of friction between the nut and screw is 0.12 and that between the swivel head and the spindle is 0.10. Calculate the load which can be raised by efforts of 100 N each applied at the end of two levers each of effective length of 350 mm. Also determine the velocity ratio and the efficiency of the lifting arrangement. **APR/MAY 2019**

7. A multi disc clutch has three discs on the driving shaft and two on the driven shaft. The outside diameter of the contact surface is 240 mm and the inside diameter is 120 mm. Assuming uniform wear and coefficient of friction as 0.3. Find the maximum axial intensity of pressure between discs for transmitting 25 KW at 1575 rpm. **NOV/DEC 2018**

8. Derive an expression to find the length of a belt in an open belt drive **NOV/DEC 2018**

9. (i) State and prove the relationship between angle of friction and coefficient of friction with suitable sketches. **APR/MAY 2018**
(ii) An open belt running over two pulleys of diameters 600 mm and 200 mm connects two parallel shafts which are 2.5m apart. The smaller pulley transmits 7.5 kW at 300 rpm. The coefficient of friction between the pulley and the belt is 0.3. Determine the ratio of tension on tight side, T1 with tension on slack side, T2 and the initial tension on the belt. **APR/MAY 2018**

10. (i) Neatly sketch a Simple Band Brake and derive the equations for braking torque for both directions of rotation separately and compare them. **APR/MAY 2018**
ii) The outer and inner radii of a flat collar thrust bearing are 120 mm and 72 mm respectively. The total axial thrust is 60 kN and the intensity of uniform pressure is 0.25 MPa. If the coefficient of friction is 0.05 and the shaft rotates at 600 rpm, determine the power lost in overcoming the friction and the number of colors required to withstand the axial thrust. **APR/MAY 2018**

11. A Cross belt running over two pulley 600 mm and 300 mm diameter connects two parallel shaft 4 meters apart and transmit 7.5kW from the larger pulley that rotates at 225 rpm. Coefficient of friction between the belt and the pulley is 0.35 and the safe working tension in 25 N per mm width. Determine (i) Minimum width of the belt (ii) Initial belt tension and (iii) Length of the belt required. **NOV/DEC 2017**

12. An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a angle square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at the screw threads is 0.1. Estimate power of the motor. **NOV/DEC 2017**

13. The following data relate to a screw jack: Pitch of the threaded screw = 8mm, Diameter of the threaded screw = 40 mm, Coefficient of friction between screw and nut 0.1, Load = 20kN assuming that the load rotates with the screw, determine the (i) Ratio of torques required to raise and lower the load (ii) Efficiency of the machine. **APR/MAY 2017**

14. A single plate clutch transmits 25 kW at 900 rpm. The maximum pressure intensity between the plates is 85 kN/m^2. The outer diameter of the plate is 360 mm. Both the sides of the plate are effective and the coefficient of friction is 0.25. Determine the (i) Inner radius of the plate (ii) Axial force to engage the clutch. **APR/MAY 2017**

15. For a flat belt, prove that $T1/T2 = e^{\mu\theta}$ Where Tl and T2 = 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. **NOV/DEC 2012**

16. An open belt running over two pulleys 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.

17. A multiplate 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. **NOV/DEC 2013, APRIL/MAY 201S**

18. 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.

19. 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 on 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. **NOV/DEC 2012, NOV/DEC 2016**

20. 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 belt6 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.

21. Two pulley one 450 mm diameter and other 200mm dia 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. **NOV/DEC 2012, MAY/JUNE 2014, NOV/DEC 2014**

22. 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 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. **NOV/DEC 2014**

23. 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. **MAY/JUNE 2014**

24. A conical pivot bearing supports a vertical shaft of 200mm diameter. It is subjected to a load of 30kN. The angle of cone is 1200 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.

25. A single plate clutch is required to transmit 8 KW at 1000 rpm. The axis pressure is limited to 70 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.

26. 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. **NOV/DEC 2015**

27. 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.
NOV/DEC 2013, NOV/DEC 2016

28. An electric motor driven power screw moves a nut in a horizontal plane against a force of 75 kN at a speed of 300 mm/min. The screw has a single square thread of 6 mm pitch on a major diameter of 40 mm. The coefficient of friction at the screw threads is 0.1. Estimate power of the motor. (**NOV.2017)**

29. The following data relate to a screw jack:

Pitch of the threaded screw = 8 mm; Diameter of the threaded screw = 40 mm; Coefficient of friction between screw and nut = 0.1; Load = 20 KN.
Assuming that the load rotates with the screw, determine:
(i) The ratio of torques required to raise and lower the load, and
(ii) The efficiency of the machine. **(MAY 2017, MAY2012)**

30. A single plate clutch transmits 25 kW at 900 rpm. The maximum pressure intensity between the plates is 85 kN/m^2. The ratio of radii is 1.25. Both the sides of the plate are effective and the coefficient of friction is 0.25. Determine (i) the inner diameter of the plate and (ii) the axial force to engage the clutch. Assume theory of uniform wear.
(MAY 2017)

31. 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 1. The load rotates with the screw, and 2. The load rests on the loose head which does not rotate with the screw. The external and internal diameter of the bearing surface of the loose head are 60 mm and 10 mm respectively. The coefficient of friction for the screw as well as the bearing surface may be taken as 0.08. **(NOV.2016)**

32. A leather faced conical clutch has a cone angle of 30°. If the intensity of pressure between the contact surfaces is limited to 0.35 N/mm^2 and the breadth of the conical surface is not to exceed one-third of the mean radius, find the

dimensions of the contact surfaces to transmit 22.5 kW at 2000 r.p.m. Assume uniform rate of wear and take coefficient of friction as 0.15. (13) **(NOV.2016)**

33. Following data is given for a rope pulley transmitting 23.628 kW :
Diameter of pulley = 40 cm; Speed = 110 r.p.m.; angle of groove = 45°; Angle of lap = 60°; Coefficient of friction = 0.28; Number of ropes = 10; Mass in kg/m length of ropes = 0.0053 x C^2 ; and working tension is limited to 12.2 C^2 kN, where C is girth of rope in cm. Find initial tension and diameter of each rope. **(MAY 2016)**

34. The cutter of a broaching machine is pulled by square threaded screw of 55mm external diameter and 10 mm pitch. The operating nut takes the axial load of 400 N on a flat surface of 60 mm internal diameter and 90 mm external diameter. If the coefficient of friction is 0.15 for all contact surfaces on the nut, determine the power required to rotate the operating nut, when the cutting speed is 6 m/min. **(MAY 2016)**

35. A compressor, requiring 90 kW is to run at about 250 r.p.m. The drive is by V-belts from an electric motor running at 750 r.p.m. The diameter of the pulley on the compressor shaft must not be greater than 1 meter while the centre distance between the pulleys is limited to 1.75 meter. The belt speed should not exceed 1600 m/min. Determine the number of V-belts required to transmit the power if each belt has a cross sectional area of 375 mm^2, density 1000 kg/m^3 and an allowable tensile stress of 2.5 MPa. The groove angle of the pulley is 35°. The coefficient of friction between the belt and the pulley is 0.25. Calculate also the length required of each belt. **(NOV 2016)**

36. 2.5 kW of power is transmitted by an open belt drive. The linear velocity of the belt is 2.5 m/s. The angle of lap on the smaller pulley is $165^{0.}$ The coefficient of friction is 0.3. Determine the effect on power transmission in the following cases:
(i) Initial tension in the belt is increased by 8%, (ii) Initial tension in the belt is decreased by 8%, (iii) Angle of lap is increased by 8% by the use of an idler pulley, for the same speed and the tension on the tight side, and (iv) Coefficient of friction is increased by 8% by suitable dressing to the friction surface of the belt. Also state which of the above methods suggested could be more effective? **(NOV. 2015)**

37. The following data relate to a screw jack: Pitch of the threaded screw = 8 mm; Diameter of the threaded screw = 40 mm; Coefficient of friction between screw and nut = 0.1; Load = 20 KN. Assuming that the load rotates with the screw, determine: (a) the ratio of torques required to raise and lower the load, and (b) the efficiency of the machine. **(NOV. 2015)**

38. A friction clutch is used to rotate a machine from a shaft rotating at a uniform speed of 250 rpm. The disc type clutch has both of its sides effective, the coefficient of friction being 0.3. The outer and inner diameters of the friction plate are 200 mm and 120 mm respectively. Assuming uniform wear of the clutch, the intensity of pressure is not to exceed 100 kN/m^2. If the moment of inertia of the rotating parts of the machine is 6.5 $kg\text{-}m^2$, determine the time to attain the full speed by the machine and the energy lost in slipping of the clutch. What will be the intensity of pressure, if the condition of uniform pressure of the clutch is considered? Also determine the ratio of power transmitted with uniform wear to that with uniform pressure. **(NOV. 2015)**

PART - C

1. A double start square threaded screw with 50 mm major diameter has 8 mm. The coefficient friction between screw and nut is 0.1 If the nut is held fixed, determine the torque required on the screw to raise and to lower a load of 40kN assuming the load to rotate with the screw State giving reasons whether the screw is self-locking or overhauling. **APR/MAY 2019**

2. A compressor, requiring 90 KW to open to 250 rpm. The Drive-is by V-belts from an electric motor running at 750 rpm. The diameter of the pulley on the compressor shaft must not be greater than 1 meter while the center distance between the pulleys is limited to 1.75 m The belt speed should not exceed 1600 m/min Determine the number of V belt required to transmit the power if each belt has a cross sectional roof 375 mm^2 density 1000 kg/m^3 and an allowable tensile stress of 2.5 Mpa. The groove angle of the pulley is 35°. The coefficient of friction between the belt and the pulley is 0.25. Also calculate the length of each belt. **APR/MAY 2019**

3. A simple band brake operates on a drum of 600 mm in diameter that is running at 200 rpm. The coefficient of friction is 0.25. The brake band has a contact of 270°, one end is fastened to a fixed pin and the other end to the brake arm 125 mm from the fixed pin. The straight brake arm is 750 mm long and placed perpendicular to the diameter that

bisects the angle of contact (i) What is the pull necessary on the end of the broken arm to stop the wheel if 35 KW is being absorbed? What is the direction for minimum pull? (ii) What width of steel band of 2.5 mm thick in required for this brake, if the maximum tensile stress is not to exceed 50 N/mm^2 **NOV/DEC 2018**

4. 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 screw jack when (i) the load rotates with the screw and (ii) the load rests on the loose head which does not rotate with the screw the external and internal diameters of the bearing surface of the loose head are 60 mm and 10 mm respectively. The coefficient of friction for the screw as well as the bearing surface may be taken as 0.08. **NOV/DEC 2018**

5. Data related to a square threaded Screw Jack are: Pitch diameter = 60 mm, Pitch of the thread = 16mm, Load = 30kN, Coefficient of friction between Screw and nut is 0.2. Determine the ratio of torque required to lower and to raise the load. Also, find the efficiency of the screw jack when the load is raised. **APR/MAY 2018**