**GOVERNMENT ENGINEERING COLLEGE, VALSAD**
*MECHANICAL ENGINEERING DEPARTMENT*

*KINEMATICS and THEORY OF MACHINES (3131906)*
*YEAR: 2019-20*

*w.e.f :17/06/2019*

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## ***CERTIFICATE***

This is to certify that Mr./Miss_____ of Branch _____ Semester-II, Enrollment No._____, has satisfactorily completed his/her term work for the subject Kinematics and Theory Machines (3131906 during even term-2019-20.)

Date:

Sign of Faculty Head of the Department

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# 01: Drawing work related to inversion of four bar mechanism and slider and crank mechanism.

1. Define the following terms.
   a. Kinematics
   b. Dynamics
   c. Kinetics
   d. Statics

2. Define the following terms
   a. Plane motion
   b. Rectilinear motion
   c. Curvilinear motion

3. Write a difference between following
   a. Linear displacement and angular displacement
   b. Linear velocity and angular velocity
   c. Linear acceleration and angular acceleration

4. Differentiate between Machine and Structure.

5. What are the various types of Links?

6. Define: Kinematic Pair. Give classification according to type of relative motion between the elements with sketch

7. Explain the following terms with neat sketch: -
   a) Lower Pair, b) Higher Pair, c) Kinematic chain, d) Inversion, e) Mechanism, f) Four bar chain, g) Degree of freedom
   b)
8. Write notes on complete and incomplete constraints motion in lower and higher pairs; illustrate your answer with neat sketch.

9. State and explain Grashof's criterion

10. What is meant by inversion of mechanism? Sketch all the four bar chain

inversion and explain it.

11. Sketch slider cranks chain mechanism and explains its inversion detail.

12. Sketch double slider cranks chain mechanism and explains all in detail.

13. Sketch and describe the working of crank and slotted lever quick return mechanism in detail.

14. Explain Degree of freedom with neat sketch. Also explain Gruebler's criterion method.

15. Explain: (1) Peaucellier mechanism, (2) Hart's mechanism, (3) Watt's Mechanism.

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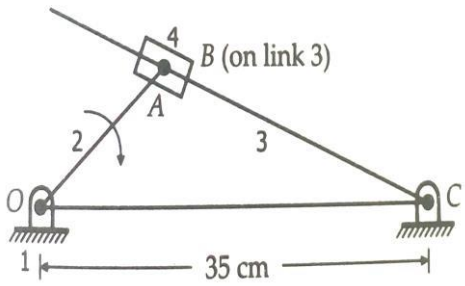
## 02: Drawing work related to velocity and acceleration diagram of various mechanisms.

1. The crank of a slider crank mechanism rotates clockwise at a constant speed of 300 rpm. The crank is 150 mm and connecting rod is 600 mm long. Determine 1. Linear velocity and acceleration of midpoint of connecting rod 2. Angular velocity and angular acceleration of the connecting rod, at a crank angle of 45o from inner dead centre position.

2 A Quick return mechanism is shown in fig. Link 2 rotates at 20 rad/sec. Draw the velocity and acceleration diagram. Given BC=25 cm, OA=15 cm

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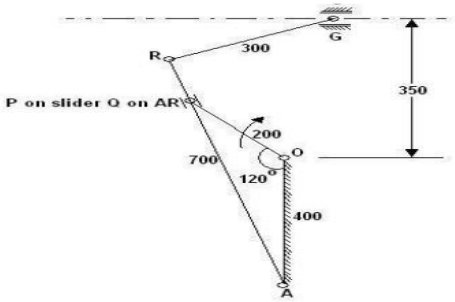
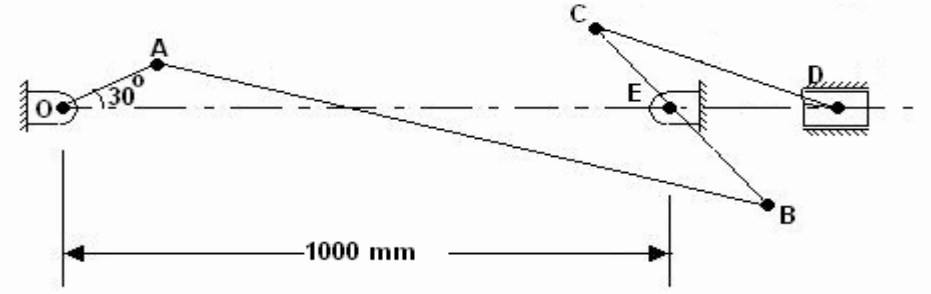
3 Fig. shows the link mechanism of a quick-return mechanism of a slotted lever type, the various dimensions of which are OA = 400mm, OP = 200mm, AR= 700 mm, RS=300 mm For the configuration shown, determine the acceleration of the cutting tool at S and the angular acceleration of the link RS. The crank OP rotates at 210 rpm.




4 For the mechanism shown in Fig. crank OA rotates at 150 rpm clockwise. Using Instantaneous Center Method determine the linear velocity of the points B,C and D and angular velocities of links AB,BC and CD. OA = 100 mm, AB = 580 mm, BC= 300 mm, CD = 350 mm and BE= 200 mm



5. The crank of a reciprocating engine is 10 cm long and it rotates at a uniform speed of 20 rad/sec clockwise. The connecting rod length is 40 cm. Determine the velocity and acceleration of the piston and angular velocity and angular acceleration of the connecting rod when crank is at 0 degree and 135 degrees from IDC. Use Klein's construction method.

6. A crank and rocker mechanism ABCD has the following dimensions. AB = 0.75m, BC = 1.25m, CD = 1m, AD = 1.5m. E is the midpoint of the coupler link BC. AD is the fixed link. Crank AB has an angular velocity of 20 rad/sec counter clockwise and a deceleration of 280 rad/sec2 at the instant angle DAB = 600 Find: (1) Instantaneous linear velocity and acceleration of midpoint E of link BC, (2) Instantaneous angular velocity and acceleration of link CD.

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## 03. Drawing work related to cam profile.

1. Classify cam & followers and explain with neat sketch

2. Define the following terms related to cam.
   (i) Base circle (ii) Pitch circle (iii) Pressure angle (iv) Stroke of the follower

3. Draw the profile of a cam rotating in anti-clock wise direction and operating a knife edge follower when the axis of the follower passes through the axis of the cam shaft from following data:
   1. Follower moves outwards through 30 mm during 90° of cam rotation.
   2. Follower dwells for next 120°
   3. Follower returns to its original position during next 150°
   The displacement of the follower is to take place with SHM during outward stroke and with uniform velocity during inward stroke. The least radius of the cam is 50 mm.

4. A cam with a minimum radius of 25mm rotating clockwise at a uniform speed is to Be designed to give a roller follower, at the end of a valve rod, motion described below:
   (1) To raise the valve through 50mm during 120º rotation of the cam.
   (2) To keep the valve fully raised through next 30º;
   (3) To lower the valve during next 60º; and
   (4) To keep the valve closed during rest of the revolution i.e.150º;

5. Construct cam profile for a knife edge follower.
   Minimum radius of cam= 30mm,
   Stroke of follower = 24mm,
   Angle of rise = 900,
   Dwell after rise = 600,
   Angle of return = 1200,
   Dwell after return for rest of the period. Follower to move outwards with uniform velocity and return back with simple harmonic motion. The follower is offset to right by 15mm. The cam is to rotate in anticlockwise direction

6. Draw the profile of a cam operating a roller follower of 30 mm diameter from
the following data:
(i) It lifts the follower through 50 mm during 90o rotation with S.H.M.
(ii) The follower remains at rest for next 300 of cam rotation.
(iii) The follower is then descent to its original position during 600 of cam rotation with uniform acceleration and retardation.
(iv) It remains at rest for the rest of cam rotation.
Least radius of cam is 50 mm. If it rotates at 300 rpm, find maximum velocity and acceleration during ascent and descent.

7. In a tangent cam operating a roller follower the following data are given:
Base circle radius = 25 mm,
Roller radius = 10 mm,
Angle of ascent = 750,
Total lift = 20 mm,
Speed of the cam shaft = 600 rpm.
Calculate:
(1) The dimensions of the cam
(2) The acceleration of the follower
(a) at the beginning of the lift (b) when the roller is at beginning of nose radius (c) when the follower is at apex of the circular rose.

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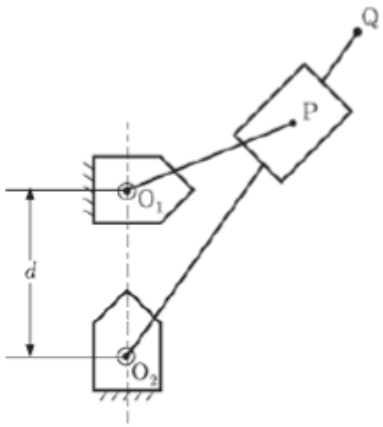
## 04: Drawing work and computation related to synthesis
## 05. Computerized Synthesis.

**1.** Design a four bar mechanism with input link a, output link c. Angle ɵ and φ for three successive positions are given in table. Use Freudenstein's method. Draw the mechanism in second position.

| Position | 1 | 2 | 3 |
|---|---|---|---|
| ɵ | 30 | 50 | 70 |
| φ | 40 | 75 | 100 |

**2.** A four bar chain mechanism is to be designed, by using three precision point to generate the function y = x1.5 for the range $1 \leq x \leq 4$ Assuming 300 starting position and 1200 finishing position for the input link and 900 starting position and 1800 finishing position for the output link, find the value of x , y , ɵ and φ corresponding to three precision point.

**3.** A simple quick return mechanism is shown in the figure. The forward to return ratio of the quick return mechanism is 2:1. If the radius of crank O1Pis 125 mm, then what will be the distance 'd ' (in mm) between the crank centre to lever pivot centre point ?




**4** Design a four bar mechanism with input link "a", coupler link "b" and output link "c". angles θ and Φ for three successive position are given in table below:

| | 1 | 2 | 3 |
|---|---|---|---|
| θ | 20° | 35° | 50° |
| Φ | 35° | 45° | 60° |

Using Freudenstein"s Equation find out other link lengths b, c and d. assume link length a = 1.

**5** ***Make computer program using "c" language for any two example of above***

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## 06.: Analysis related to belt, rope, and chain drive.

**1.** Explain with the figure the various types of belts and belts drive used for the transmission of power.

**2.** What are different types of chains? Explain with neat sketches, the power transmission chains.

**3.** Write the difference between Flat belt drive and V-belt drive.

**4.** Write the advantage and disadvantage of chain drive over belt or rope drive.

**5.** Derive the expression for the centrifugal tension for flat belt drive.

**6.** An engine, running at 150 r.p.m., drives a line shaft by means of a belt. The engine pulley is 750 mm diameter and the pulley on the line shaft being 450 mm. A 900 mm diameter pulley on the line shaft drives a 150 mm diameter pulley keyed to a dynamo shaft. Find the speed of the dynamo shaft, when 1. there is no slip, and 2. there is a slip of 2% at each drive.

**7.** The power is transmitted from a pulley 1 m diameter running at 200 r.p.m. to a pulley 2.25 m diameter by means of a belt. Find the speed lost by the driven pulley as a result of creep, if the stress on the tight and slack side of the belt is 1.4 MPa and 0.5 MPa respectively. The Young's modulus for the material of the belt is 100 MPa

**8.** A casting weighing 9 KN hangs freely from a rope which makes 2.5 turns round a drum of 300 mm diameter revolving at 20 r.p.m. The other end of the rope is pulled by a man. The coefficient of friction is 0.25. Determine 1. The force required by the man, and 2. The power to raise the casting

**9.** A chain drive is used for reduction of speed from 240 r.p.m. to 120 r.p.m. The number of teeth on the driving sprocket is 20. Find the number of teeth on the driven sprocket. If the pitch circle diameter of the driven sprocket is 600 mm and center to center distance between the two sprockets is 800 mm, determine the pitch and length of the chain.

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## 07.: Analysis related to brakes, and clutches.

1. Discussed the various types brakes with figure.

2. Describe the working of Internal expanding shoe brake with a neat sketch

3. What are the leading & trailing shoes of an internal expanding shoe brake?

4. What are the different types of clutch? Explain with figure.

5. Derive the expression for frictional torque transmitted by single plate clutch assuming i. Uniform pressure theory ii. Uniform wear theory.

6. A single block brake is shown in figure. The diameter of the drum is 300 mm and the angle of contact is 900. If the operating force of 600N is applied at the end of a lever and the coefficient of friction between the drum and lining is 0.3 determine the torque that may be transmitted by the block brake.

7. A single plate clutch with both sides effective; is required to transmit 25 kw at 900 rpm. the outer diameter of the plate is 350 mm. the maximum intensity of pressure over the friction surface is not to exceed 0.1 N/mm2. considering uniform wear criteria and assuming coefficient of friction as 0.25; determine (i) the inner diameter of the plate (ii) axial force required to engage the clutch.

8. A multiple – disc clutch transmits 50 kw of power at 1400 rom. Axial intensity of pressure not to exceed 0.12 1 N/mm2, and the coefficient of friction of the friction surfaces is 0.12. the inner radius of the discs is 80 mm, and is .7 times the outer radius. Determine number of disc required to transmit the given power. Assume uniform wear condition

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## 08.: Analysis related to gears and gear train.

**1.** Explain gear terminology with sketch.

**2.** Define pressure angle and draw neat sketch showing pressure angle in two meshing gears.

**3.** What is velocity of sliding for two meshing gears on what parameters do it depends?

**4.** What is the difference between following gear tooth profile?

14 1/2$^o$ composite system
14 1/2$^o$ full depth involutes system
20$^o$ full depth involute system
20$^o$ stub involute system

**5.** Explain “interference” and “undercutting”.

**6.** Derive an expression for minimum number of teeth required on the pinion in order to avoid interference In involute gear teeth when it meshes with wheel.

**7.** Suggest different methods to eliminate interference.

**8.** What is gear train? Enlist different type of gear train & explain all with neat sketch. Also derive the equation of the velocity ratio.

**9.** Two gears of module 4 mm have 24 and 33 teeth. The pressure angle is 200 and each gear has a standard addendum of one module. Find the length of arc of contact and the maximum velocity of sliding if the pinion rotates at 120 r.p.m.

**10.** A pinion having 18 teeth engages with an internal gear having 72 teeth. If the gears have involutes profiled teeth with 20o pressure angle, module of 4 mm, and the addendum on pinion and gear are 8.5 mm and 3.5 mm respectively. Find the length of path of contact.

**11.** Two spur gears of 24 teeth and 36 teeth of 8 mm module and 200 pressure angles are in mesh. Addendum of each gear is 7.5 mm. the teeth are of involute form. determine: 1. the angle through which the pinion turns while any pair of teeth are in contact, and 2.the velocity of sliding between the teeth when the contact on the pinion is at a radius of 102 mm. the speed of the pinion is 450 r.p.m.

**12.** A 200 involute pinion with 20 teeth drives a gear having 60 teeth, Module is 8 mm and addendum of each gear is 10 mm.
State whether interference occur or not. Give reasons.
Find the length of path of approach and arc of approach if pinion is the driver.

**13.** Two gear wheels mesh externally and are to give a velocity ratio of 3. The teeth are involute from of module 6. The standard addendum is 1 module. If the pressure angle is 180 and pinion rotates at 90 r.p.m find 1. The number of teeth on each wheel, so that the interference is just avoided, 2. The length of path of contact, and 3. The maximum velocity of sliding between the teeth.

**14.** An epicyclic gear train is composed of fixed annular gear A having 300 teeth. Meshing with A is wheel X which drives wheel Z through an idle wheel Y. wheel Z being concentric with A. wheels X and Y are carried on an arm E which revolves clockwise at 120 r.p.m about the axis of A and Z. if the wheel X and Z have 50 and 80 teeth respectively, determine the number of teeth on Y and r.p.m of Y. Does the direction of rotation of arm E and gear Y are same?

**15.** An epicyclic train is composed of a fixed annular gear A having 150 teeth. Meshing with A is a gear B, which driver gear D through an idle gear C, D being concentric with A. gear B and C are carried on an arm which revolves clockwise at 100 rpm about the axis of A and. If the gear B and have 25 and 40 teeth respectively, find
The number of teeth on gear C
Speed and sense of rotation of gear C