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Internal Assesment Test – 1

Sub: Kinematics of Machines				Code: 18ME44
Date: 09/07/2022	Duration: 1.5 hrs	Max Marks: 100	Sem: 4	Branch (sections): ME (A)

Answer any three questions from part A and one question from part B. Good luck!

	PART A	Marks	OBE CO	OBE RBT
1	Define: a) Kinematic pairs b)Kinematic chain c)Mechanism d)Structure e) Degree of freedom	[10]	CO1	L2
2	Explain with neat sketch Ackerman steering mechanism. Mention condition for correct steering.	[10]	CO1	L2
3	Name an exact straight line motion mechanism having only turning pairs. Draw a neat proportionate sketch of the same. State geometric relationships among its links. Indicate the point tracing straight line and prove that the point can trace straight line.	[10]	CO1	L2
4	With neat sketch explain working principle of crank and slotted lever quick return motion mechanism	[10]	CO1	L2
	PART B			
5	A cam rotating clockwise at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5 cm diameter. The follower motion is defined as below. (i) Outward during 150° with UARM (ii) Dwell for next 30° (iii)Return during next 120° with SHM (iv)Dwell for the remaining period Stroke of the follower is 3 cm. Minimum radius of the cam is 3 cm. Draw the cam profile. Also find the maximum velocity and acceleration during the raise and return of the follower.	[20]	CO5	L3

6	A cam rotating clockwise at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5 cm diameter. The follower motion is defined as below. (i) Outward during 150° with UARM (ii) Dwell for next 30° (iii) Return during next 120° with SHM (iv) Dwell for the remaining period Stroke of the follower is 3 cm. Minimum radius of the cam is 3 cm. Draw the cam profile. Follower axis is offset to the right by 1 cm.	[20]	CO5	L3

CI **CCI** **HOD**

Scheme Of Evaluation
Internal Assessment Test 1 – March 2019

Sub:	Kinematics of Machines							Code:	17ME42
Date:	06/03/2019	Duration:	90mins	Max Marks:	50	Sem:	IV	Branch:	ME

Note: Answer Any THREE Questions from Part A and ONE question from Part B

Question #		Description PART A	Marks Distribution		Max Marks
1		**Define:** • Kinematic pairs • Kinematic chain • Mechanism • Structure • Degree of freedom	2 M 2M 2 M 2 M 2M	10 M	10 M
2		**Explain with neat sketch Ackerman steering mechanism. Mention condition for correct steering.** • Diagram • Explanation • Conditions for correct steering	3M 3M 4M	10 M	10 M
3	a)	**Name an exact straight line motion mechanism having only turning pairs. Draw a neat proportionate sketch of the same. State geometric relationships among its links. Indicate the point tracing straight line and prove that the point can trace straight line.** • Peaucellier mechanism • Diagram • Geometric relationships • To prove that the point traces the straight line	1M 3M 3M 3M	10 M	10 M
4		**With neat sketch explain working principle of crank and slotted lever quick return motion mechanism.** • Diagram • Explanation	5 M 5 M	10 M	10 M

		PART B			
5		**A cam rotating clockwise at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5 cm diameter. The follower motion is defined as below.** **(v) Outward during 150° with UARM** **(vi) Dwell for next 30°** **(vii) Return during next 120° with SHM** **(viii) Dwell for the remaining period** **Stroke of the follower is 3 cm. Minimum radius of the cam is 3 cm. Draw the cam profile. Also find the maximum velocity and acceleration during the raise and return of the follower.** • Displacement diagram • Cam profile • Velocity and Acceleration calculations	7M 9M 4M	20M	20M
6		**A cam rotating clockwise at uniform speed of 300rpm operates a reciprocating follower through a roller 1.5 cm diameter. The follower motion is defined as below.** **(v) Outward during 150° with UARM** **(vi) Dwell for next 30°** **(vii) Return during next 120° with SHM** **(viii) Dwell for the remaining period** **Stroke of the follower is 3 cm. Minimum radius of the cam is 3 cm. Draw the cam profile. Follower axis is offset to the right by 1 cm.** • Displacement diagram • Cam profile	8M 12M	20 M	20M

Internal Assesment Test – 1
Solutions

Sub: Kinematics of Machines				Code: 17ME42
Date: 06/03/2019	Duration: 90 mins	Max Marks: 50	Sem: 4	Branch (sections): ME (A,B)

1. Define:

a) **Kinematic pair:** 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***.

b) **Kinematic chain:** When the kinematic pairs are coupled in such a way that the last link is joined to the first link to transmit definite motion (*i.e. completely or* successfully constrained motion), it is called a ***kinematic chain*.** In other words, a kinematic chain may be defined as a combination of kinematic pairs, joined in such a way that each link forms a part of two pairs and the relative motion between the links or elements is completely or successfully constrained.

c) **Mechanism:** A mechanism is a combination of rigid or restraining bodies which are so shaped and connected that they move upon each other with definite relative motion. A mechanism may be obtained when one of the links of the kinematic chain is fixed.

Examples: Slider-crank, typewriter, clocks, watches, spring toys etc.

d) **Structure:** Structure is an assemblage of a number of resistant bodies (known as members) having no relative motion between them and meant for carrying loads having straining action.

Examples: A railway bridge, a roof truss, machine frames etc., are the examples of a structure.

e) **Degrees of freedom:** An unconstrained rigid body moving in space can have three translational and three rotational motions (that is six motions) about three mutually perpendicular axes. The number of degrees of freedom of a kinematic pair is defined as the number of independent relative motions, both translational and rotational that a kinematic pair can have.

Degrees of freedom = 6 – number of restraints

2. In Ackerman steering gear, the mechanism ABCD is a four bar crank chain. The shorter links BC and AD are of equal length and are connected by hinge joints with front wheel axles. The longer links AB and CD are of unequal length.

The following are the only three positions for correct steering:

1. When the vehicle moves along a straight path, the longer links AB and CD are parallel and the shorter links BC and AD are equally inclined to the longitudinal axis of the vehicle, as shown by firm lines in Fig.
2. When the vehicle is steering to the left, the position of the gear is shown by dotted lines in Fig. In this position, the lines of the front wheel axle intersect on the back wheel axle at I, for steering.
3. When the vehicle is steering to the right, the similar position may be obtained. In order to satisfy the fundamental equation for correct steering, links AD and DC are suitably proportioned. The value of θ and ϕ may be obtained either graphically or by calculations.

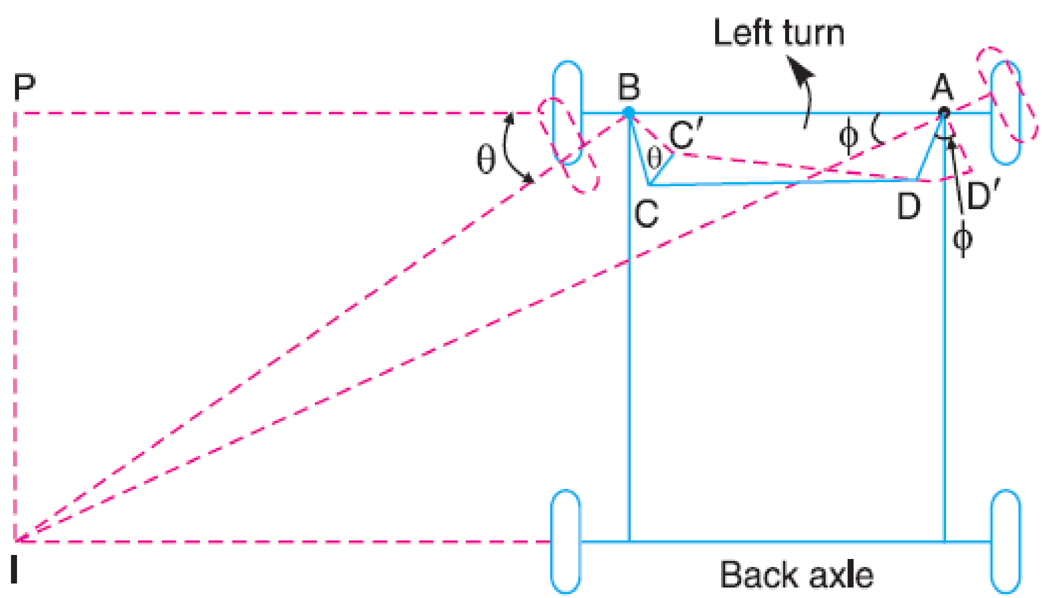


Fig. 1: Ackerman steering system

Conditions for correct steering:

Three correct steering positions will be:

1) When moving straight
2) When moving one correct angle to the right corresponding to the link ratio AK/AB and angle α.
3) Similar position when moving to the left.

3. **Peaucellier mechanism** is exact straight line motion mechanisms made up of turning pairs.

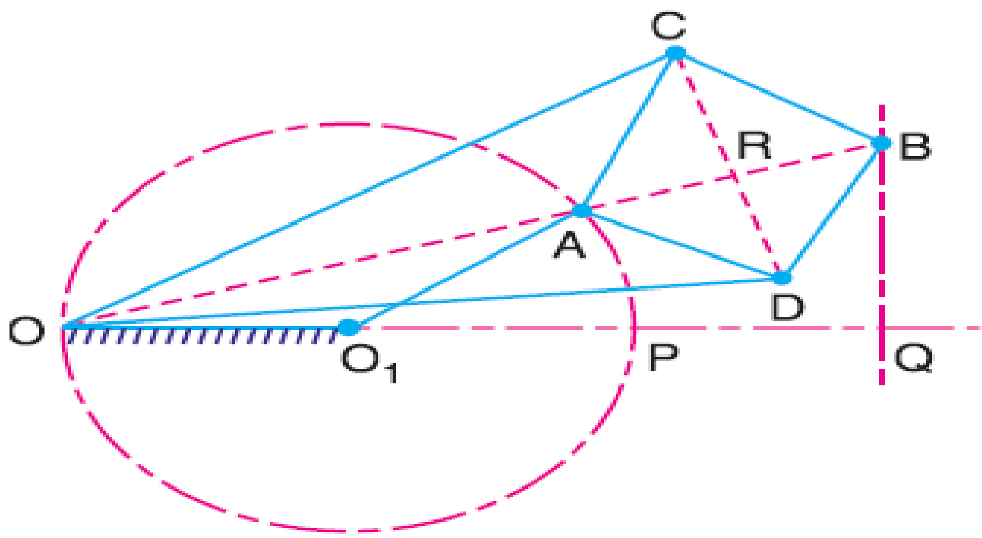


Fig. 2: Peaucellier mechanism

It consists of a fixed link OO1 and the other straight links O1A, OC, OD, AD, DB, BC and CA are connected by turning pairs at their intersections. The pin at A is constrained to move along the circumference of a circle with the fixed diameter OP, by means of the link O_1A.

AC = CB = BD = DA : OC =OD: and $OO_1 = O_1A$

It may be proved that the product OA × OB remains constant, when the link O_1A rotates. Join CD to bisect AB at R.

Now from right angled triangles ORC and BRC, We have

$$OC^2 = OR^2 + RC^2 \qquad ..(i)$$

and

$$BC^2 = RB^2 + RC^2 \qquad ..(ii)$$

subtratcing equation (ii) from (i), we have

$$OC^2 - BC^2 = OR^2 - RB^2$$

$$= (OR + RB)(OR-RB)$$

$$= OB \times OA$$

Since OC and BC are of constant length, therefore the product OB × OA remains constant.

Hence the point B traces a straight path perpendicular to the diameter OP.

4. **Crank and slotted lever quick return motion mechanism**

This mechanism is mostly used in shaping machines, slotting machines and in rotary internal combustion engines. In this mechanism, the link AC (i.e. link 3) forming the turning pair is fixed. The link 3 corresponds to the connecting rod of a reciprocating steam engine.

The driving crank CB revolves with uniform angular speed about the fixed centre C.

A sliding block attached to the crank pin at B slides along the slotted bar AP and thus causes AP to oscillate about the pivoted point A. A short link PR transmits the motion from AP to the ram which carries the tool and reciprocates along the line of stroke R1R2. The line of stroke of the ram (i.e. R1R2) is perpendicular to AC produced.

In the extreme positions, AP1 and AP2 are tangential to the circle and the cutting tool is at the end of the stroke. The forward or cutting stroke occurs when the crank rotates from the position CB1 to CB2 (or through an angle β) in the clockwise direction. The return stroke occurs when the crank rotates from the position CB2 to CB1 (or through angle α) in the clockwise direction. Since the crank has uniform angular speed,

Therefore,

$$\frac{\textit{Time of cutting stroke}}{\textit{Time of return stroke}} = \frac{\beta}{\alpha} = \frac{\beta}{360^\circ - \beta} \; or \; \frac{360^\circ - \alpha}{\alpha}$$

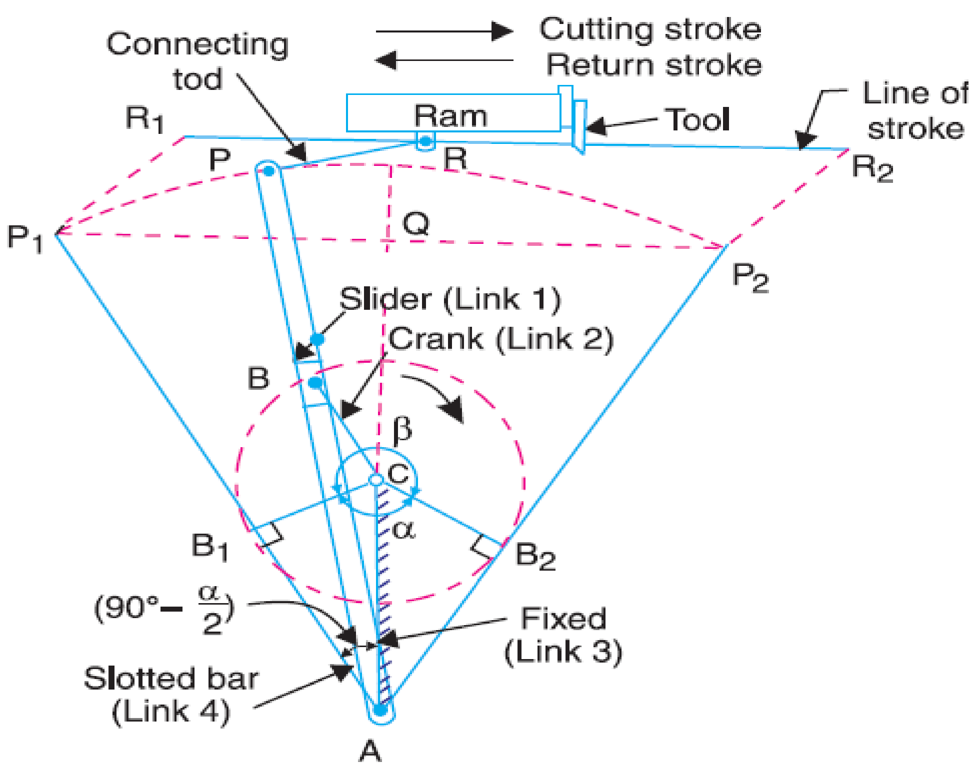
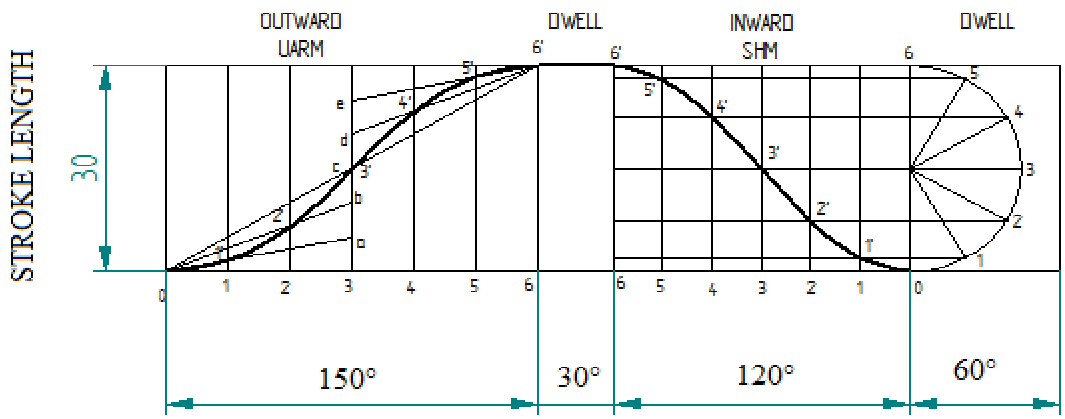


Fig.3: Crank and Slotted lever quick return motion mechanism

5.

DISPLACEMENT DIAGRAM



ANGULAR DISPLACEMENT

Velocity and Acceleration calculations:

Raise or outward (UARM)

$$\omega = \frac{2\pi N}{60} = \frac{2\pi \times 300}{60} = 31.416 \text{ rad/sec} \; ; \; S = 3\text{ cm} = 30\text{ mm}.$$

$$\text{Max. velocity}, V_a = \frac{2\omega S}{\theta_a} = \frac{2 \times 31.416 \times 30}{150 \times \frac{\pi}{180}} = 720 \text{ cm/sec}$$

$$= \underline{0.72 \text{ m/sec}}$$

$$\text{Max. acceleration}, a_a = \frac{4\omega^2 S}{\theta_a^2} = \frac{4 \times 31.416^2 \times 30}{\left(150 \times \frac{\pi}{180}\right)^2}$$

$$= 17.28 \times 10^3 \text{ mm/sec}^2$$

$$= \underline{17.28 \text{ m/sec}^2}$$

Return or Inward (SHM)

$$\text{Max. velocity}, V_d = \frac{\pi \omega S}{2\theta_d} = \frac{\pi \times 31.416 \times 30}{2 \times \left(120 \times \frac{\pi}{180}\right)} = 706.86 \text{ mm/sec}$$

$$= \underline{0.707 \text{ m/sec}}$$

$$\text{Max. acceleration}, a_d = \frac{\pi^2 \omega^2 S}{2\theta_d^2} = \frac{\pi^2 \times 31.416^2 \times 30}{2 \times \left(120 \times \frac{\pi}{180}\right)^2}$$

$$= 33.31 \times 10^3 \text{ mm/sec}^2$$

$$= \underline{33.31 \text{ m/s}^2}$$

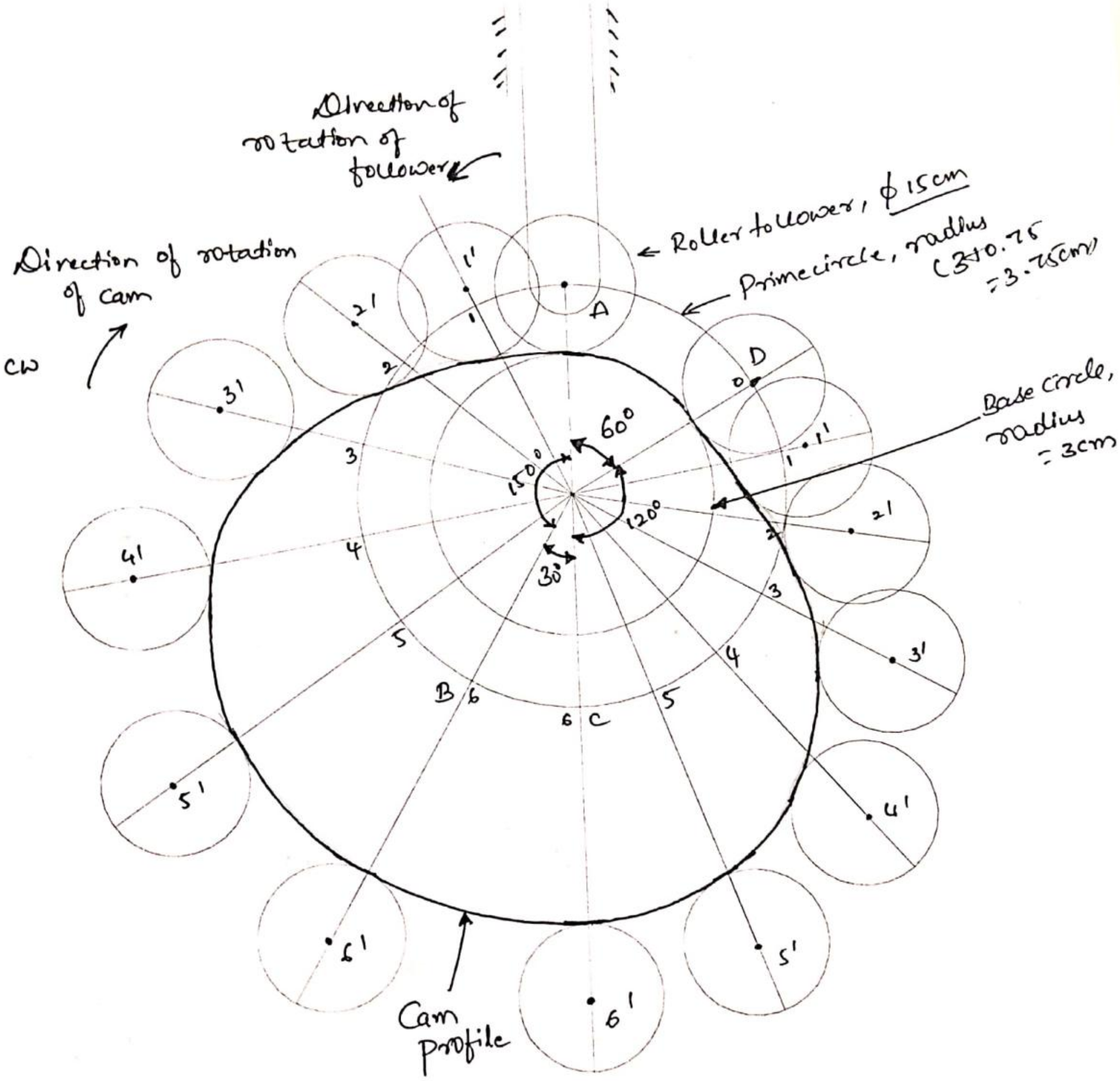
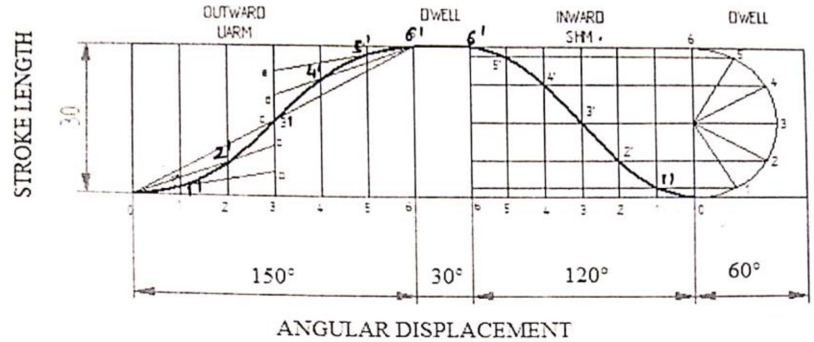


Fig.4 : Cam profile

Q. NO. 6

DISPLACEMENT DIAGRAM



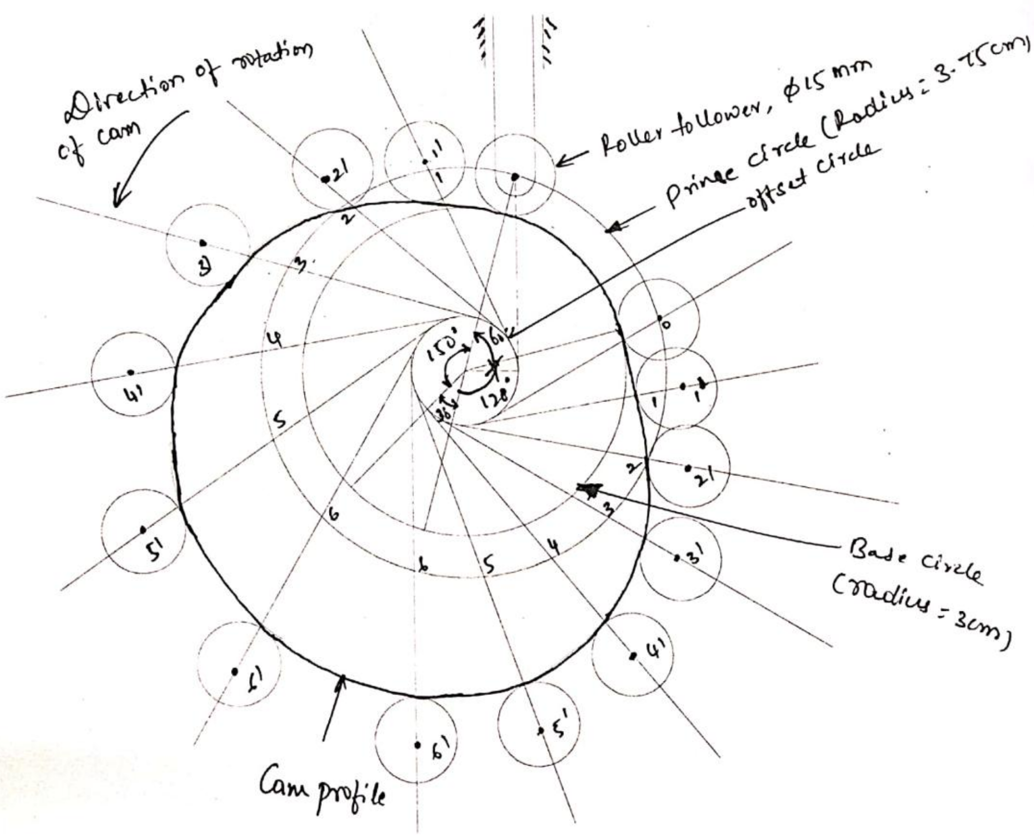


Fig. 5 : Cam profile