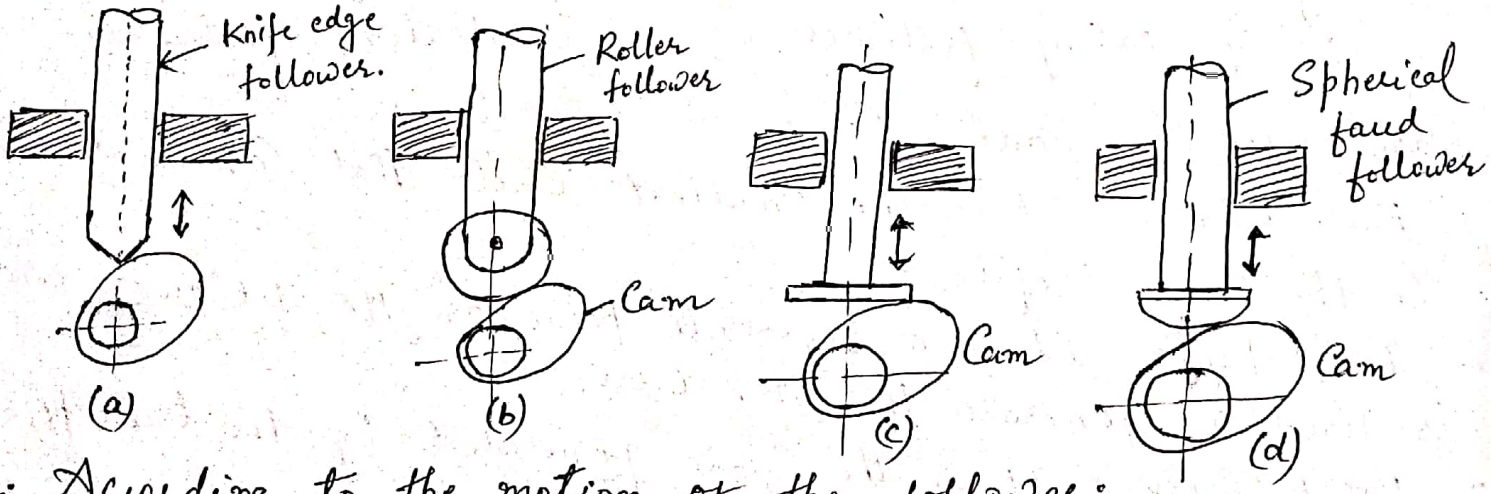
CAM: A Cam is a rotating machine element which gives reciprocating or oscillating motion to another element known as follower. The Cam and the follower have a line Contact and Constitute a higher pair. The Cams are usually rotated at Uniform Speed by a Shaft, but the follower motion is predetermined and will be according to the Shape of the Cam.

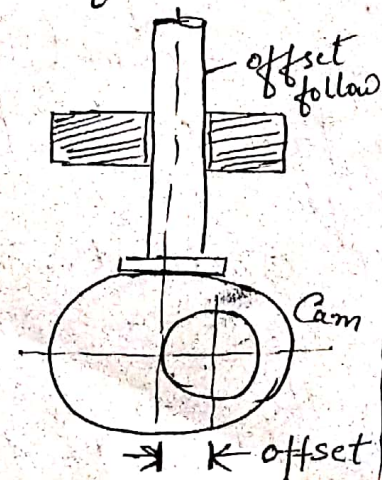
Classification of Followers:

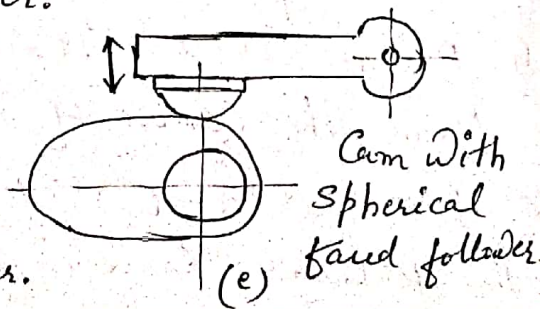
1. According to the Surface in Contact:-
(a) Knife edge follower (b) Roller follower.
(c) Flat faced or mushroom follower (d) Spherical faced follower



2. According to the motion of the follower:-
(a) Reciprocating or translating follower.
(b) Oscillating or rotating follower.

3. According to the path of motion of the follower:-
(a) Radial follower
(b) Off-Set follower.





Note: In all Cases, the follower must be Constrained to follow the Cam. This may be done by springs, gravity or hydraulic means. In Some Cases, the follower may ride in groove.

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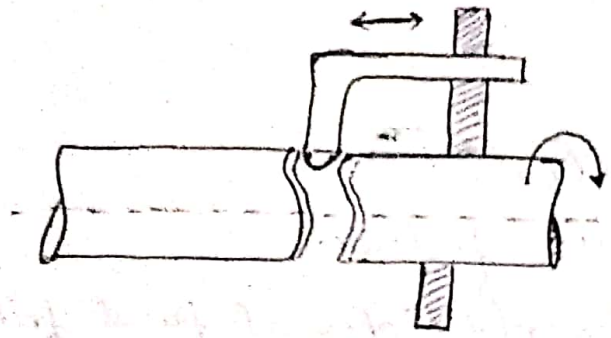
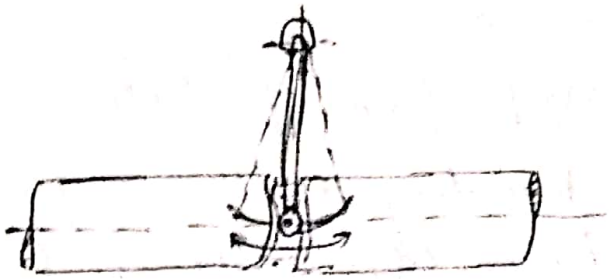
Classification of Cams:-

1. Radial or disc Cam: In radial Cams, the follower reciprocates or oscillates in a direction perpendicular to the Cam axis.
2. Cylindrical Cam: In Cylindrical Cams, the follower reciprocates or oscillates in a direction parallel to the Cam axis.



(a) Cylindrical Cam with reciprocating follower



(b) Cylindrical Cam with Oscillating follower.

Terms used in Radial Cams:-

1. Base Circle: It is the smallest circle that can be drawn to the Cam profile.
2. Trace point: It is a reference point on the follower and is used to generate the pitch curve.
3. Pitch Curve: It is the curve generated by the trace point as the follower moves relative to the Cam.
4. Prime Circle: It is the smallest circle that can be drawn from the centre of the Cam and tangent to the pitch curve.
5. Pressure angle: It is the angle between the direction of the follower motion and a normal to the pitch curve.
6. Pitch point: It is a point on the pitch curve having the maximum pressure angle.
7. Pitch Circle: It is the circle drawn from the centre of the Cam through the pitch points.
8. Lift or Stroke: It is the maximum travel of the follower from its lowest position of the topmost position.

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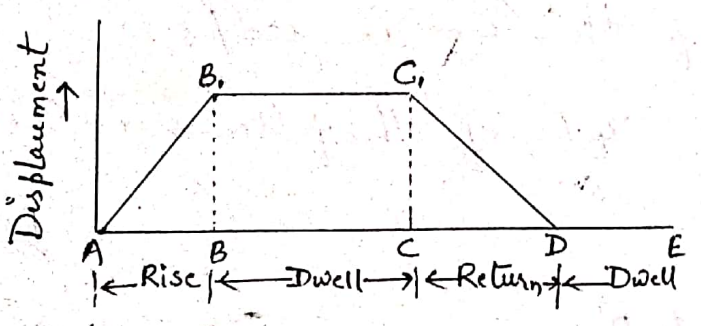
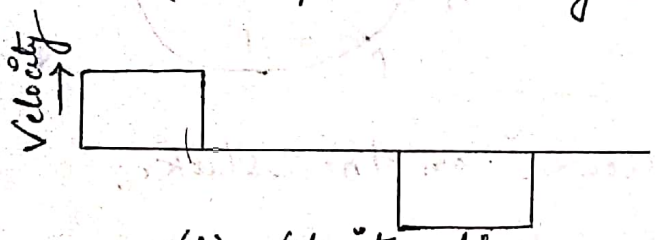
Motion of the follower :-

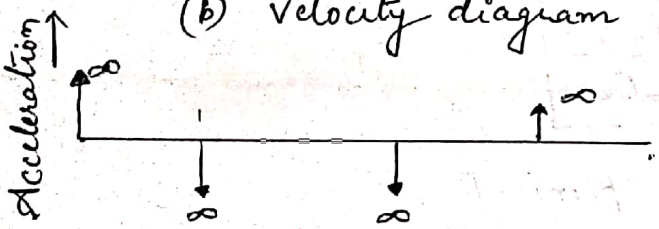
1. Displacement, Velocity and Acceleration Diagrams When the follower moves with Uniform Velocity



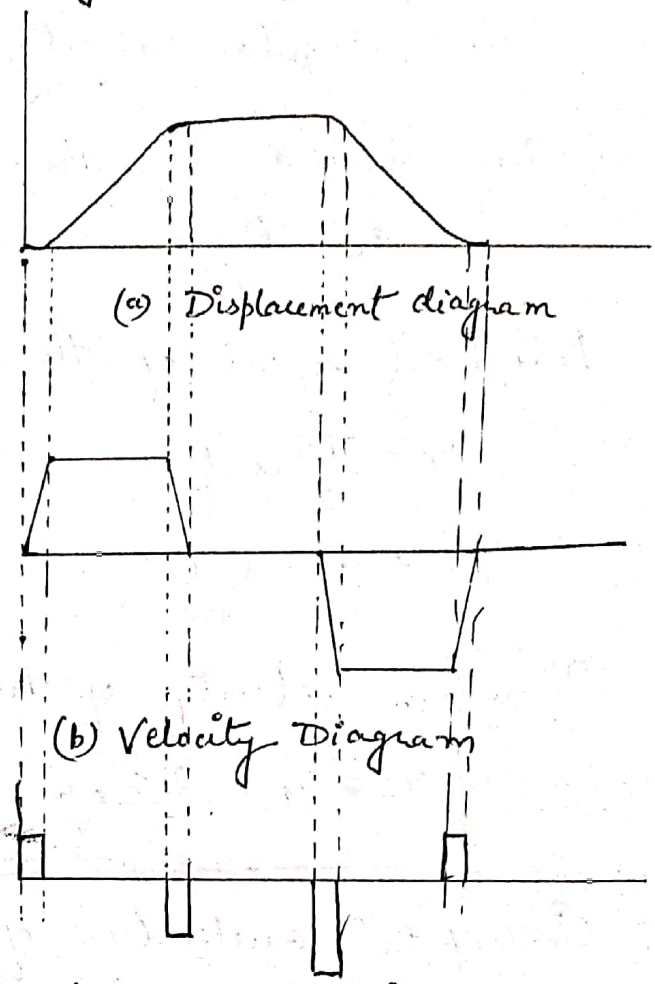
(a) Displacement diagram



(b) Velocity diagram



(c) Acceleration diagram.

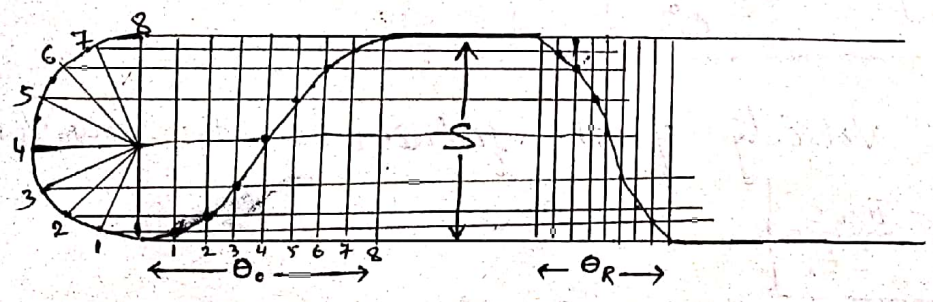


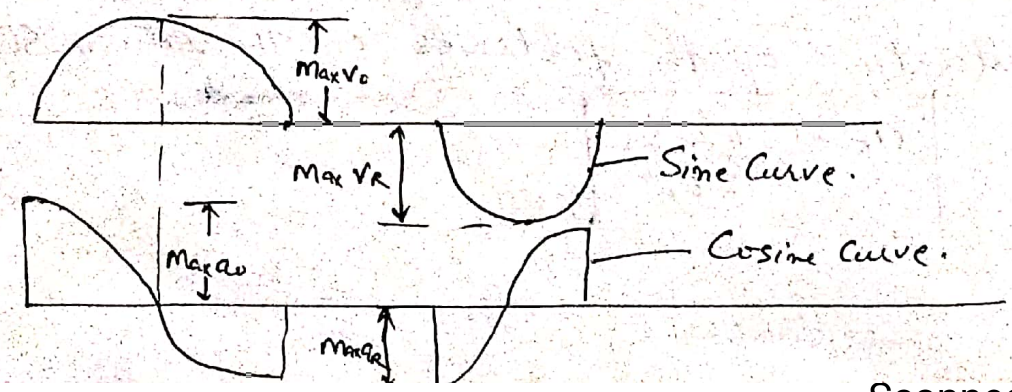
(a) Displacement diagram

(b) Velocity Diagram

(c) Acceleration Diagram.

2. Displacement, Velocity and Acceleration Diagrams When the follower moves with Simple Harmonic motion.





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Let, S = Stroke of the follower.

θ_o & θ_R = Angular displacement of the Cam during Out stroke & return stroke of the follower resp. in radians.

ω = Angular Velocity of the Cam in rad/s

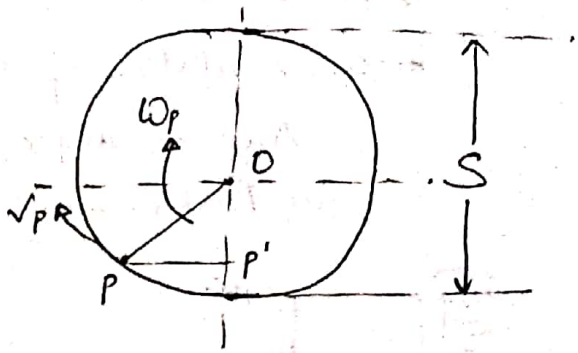
∴ Time required for the Out Stroke of the follower in Seconds

$$t_o = \theta_o / \omega$$

Peripheral speed of the point P'

$$V_p = \frac{\pi S}{2} \times \frac{1}{t_o}$$

$$= \frac{\pi S}{2} \times \frac{\omega}{\theta_o}$$



Maximum Velocity of the follower on the stroke,

$$V_o = V_p = \frac{\pi S}{2} \times \frac{\omega}{\theta_o} = \frac{\pi \omega S}{2\theta_o}$$

Centripetal acceleration of the point P

$$a_p = \frac{(V_p)^2}{OP} = \left(\frac{\pi \omega S}{2\theta_o}\right)^2 \times \frac{2}{S} = \frac{\pi^2 \omega^2 S}{2\theta_o^2}$$

Maximum acceleration of the follower on the Outstroke

$$a_o = a_p = \frac{\pi^2 \omega^2 S}{2\theta_o^2}$$ ∴

Similarly, maximum Velocity of the follower on the return stroke,

$$V_R = \frac{\pi \omega S}{2\theta_R}$$

Maximum acceleration of the follower on the return Stroke

$$a_R = \frac{\pi^2 \omega^2 S}{2\theta_R^2}$$

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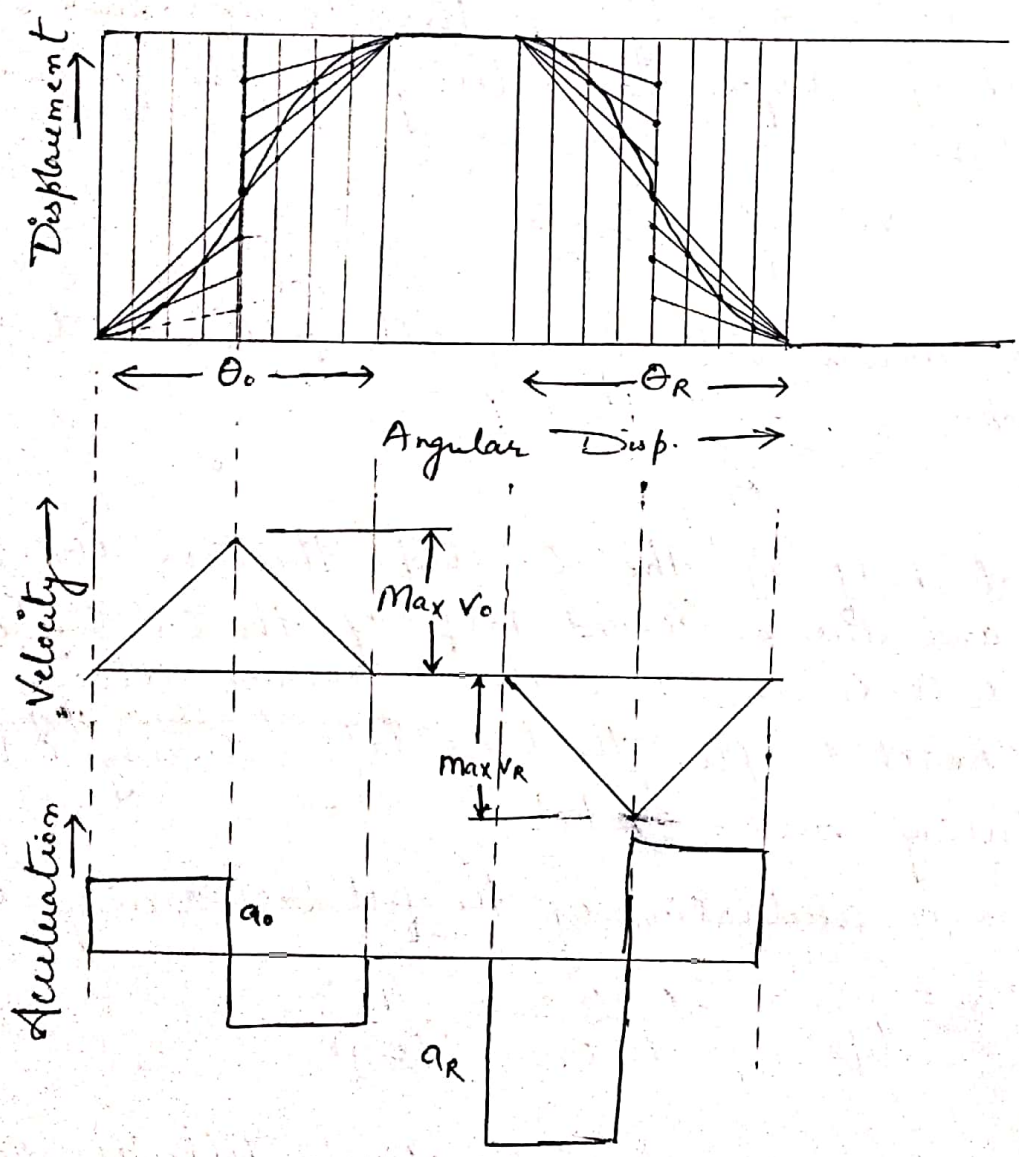
3. Displacement, Velocity and Acceleration Diagrams when the follower moves with Uniform Acceleration & retardation.

Since the acceleration and retardation are uniform, therefore the velocity varies directly with the time.



Let S = Stroke of the follower

θ_o & θ_R = Angular displacement of the cam during out stroke and return stroke of the follower resp.

ω = Angular velocity of the cam

Time reqd. for the follower during outstoke,

$t_o = \theta_o/\omega$

Time reqd. for the follower during return stroke,

$t_R = \theta_R/\omega$.

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Mean velocity of the follower during Outstroke

$$= S/t_o$$

Mean velocity of the follower during return stroke

$$= S/t_R$$

Since the maximum velocity of follower is equal to twice the mean velocity, therefore max. velocity of the follower during Outstroke,

$$V_o = \frac{2S}{t_o} = \frac{2\omega \cdot S}{\theta_o}$$

Similarly, maximum velocity of the follower during return stroke,

$$V_R = \frac{2\omega S}{\theta_R}$$

During first half of the outstroke there is Uniform acceleration and during second half of the Outstroke there is Uniform retardation. Thus the maximum velocity of the follower is reached after the time $t_o/2$ (during outstroke) and $t_R/2$ (during return stroke).

∴ Maximum acceleration of the follower during Outstroke,

$$a_o = \frac{V_o}{t_o/2} = \frac{2 \times 2\omega \cdot S}{t_o \cdot \theta_o} = \frac{4\omega^2 S}{(\theta_o)^2}$$

Similarly, maximum acceleration of the follower during return Stroke,

$$\boxed{a_R = \frac{4\omega^2 S}{(\theta_R)^2}}$$

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