ME 245 : Engineering Mechanics and Theory of Machines

Lecture-2: Study of cams

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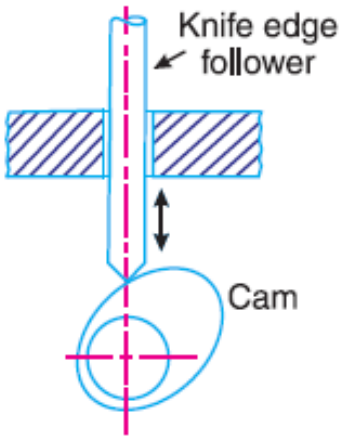
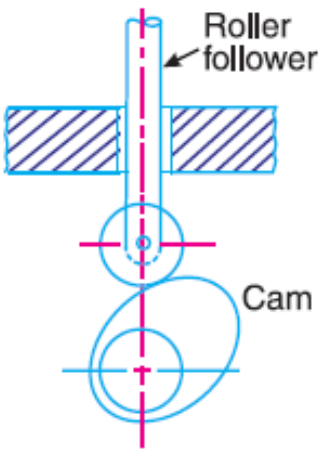
CAM

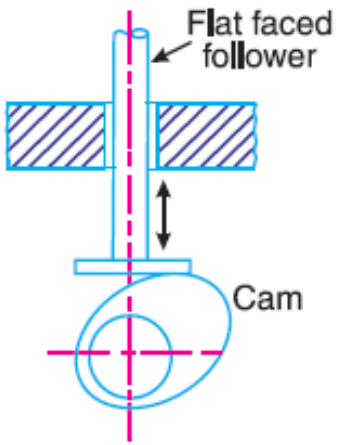
- A ***cam*** is a rotating machine element which gives reciprocating or oscillating motion to another element known as ***follower***
- The cam and the follower have a line contact and constitute a higher pair
- The cams are usually rotated at uniform speed by a shaft, but the follower motion is predetermined and will be according to the shape of the cam.



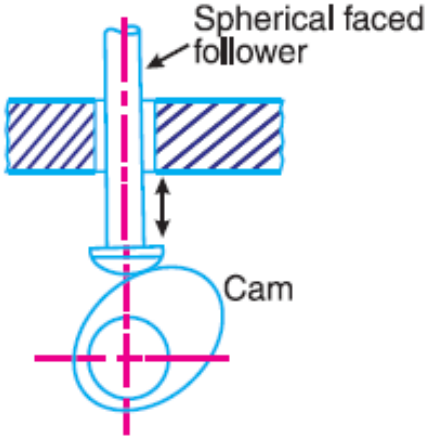
(*a*) Cam with knife edge follower.



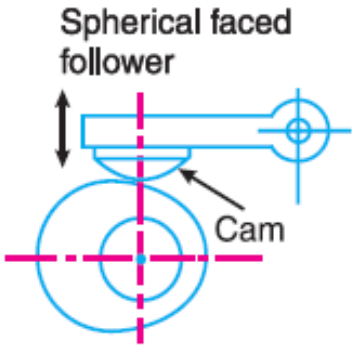
(*b*) Cam with roller follower.



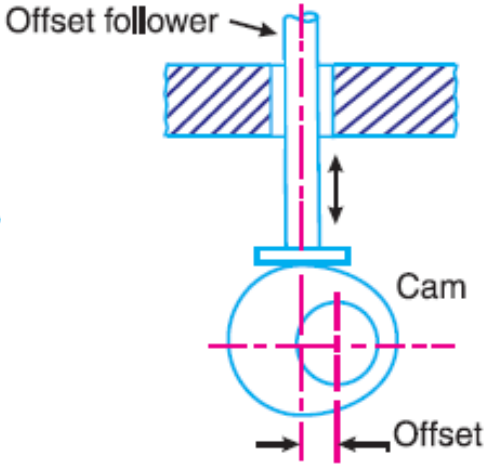
(*c*) Cam with flat faced follower.



(*d*) Cam with spherical faced follower.



(*e*) Cam with spherical faced follower.



(*f*) Cam with offset follower.

Fig. 20.1. Classification of followers.

CAM Terminology

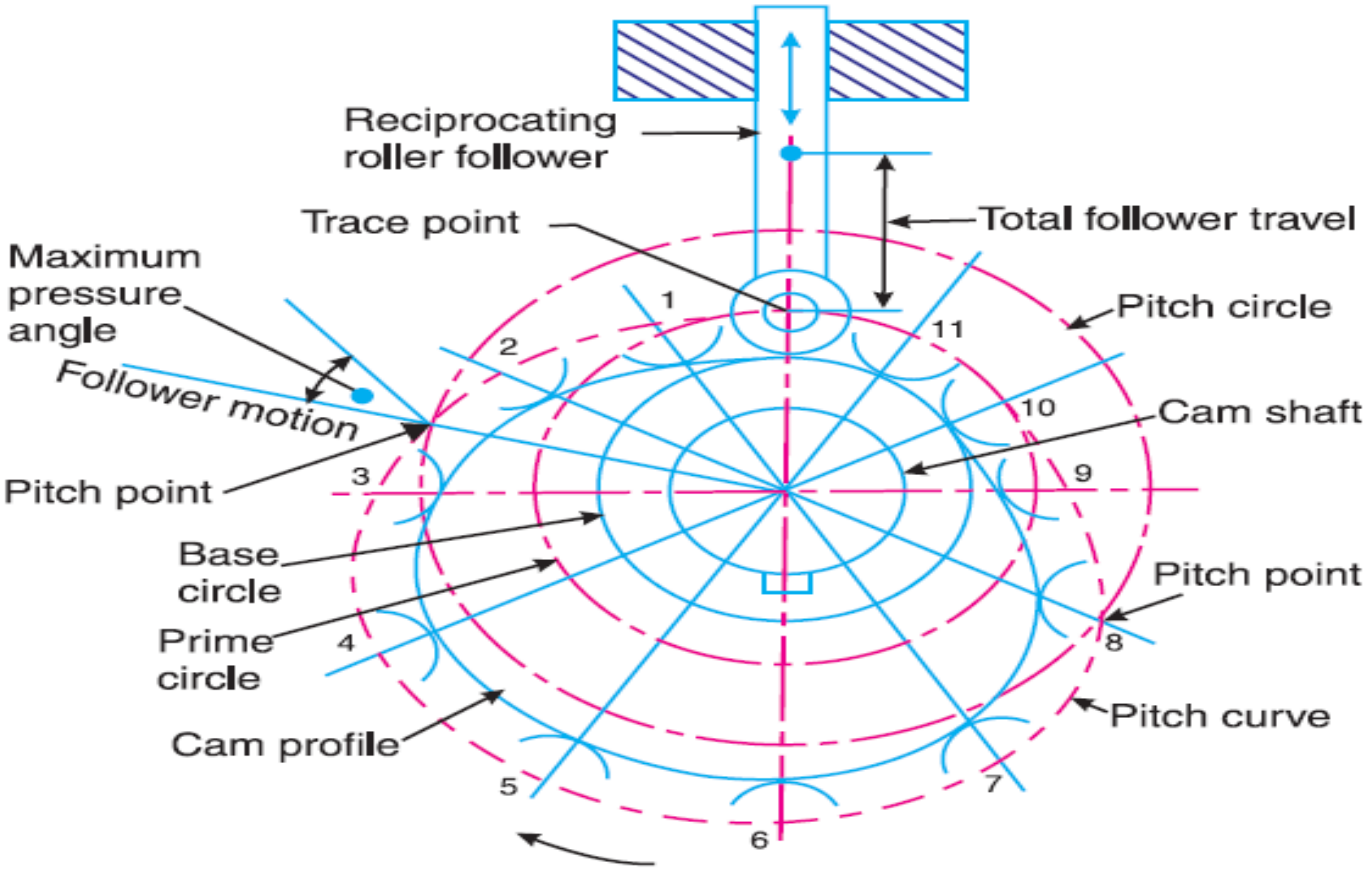


Fig. 20.3. Terms used in radial cams.

CAM Terminology

- Base circle: It is the smallest circle that can be drawn to the cam profile.

- Trace point: 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.

- Pressure angle: It is the angle between the direction of the follower motion and a normal to the pitch curve.

- Pitch point: It is a point on the pitch curve having the maximum pressure angle.

- Pitch circle: It is a circle drawn from the centre of the cam through the pitch points.

- 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.

- 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 radius of the roller.

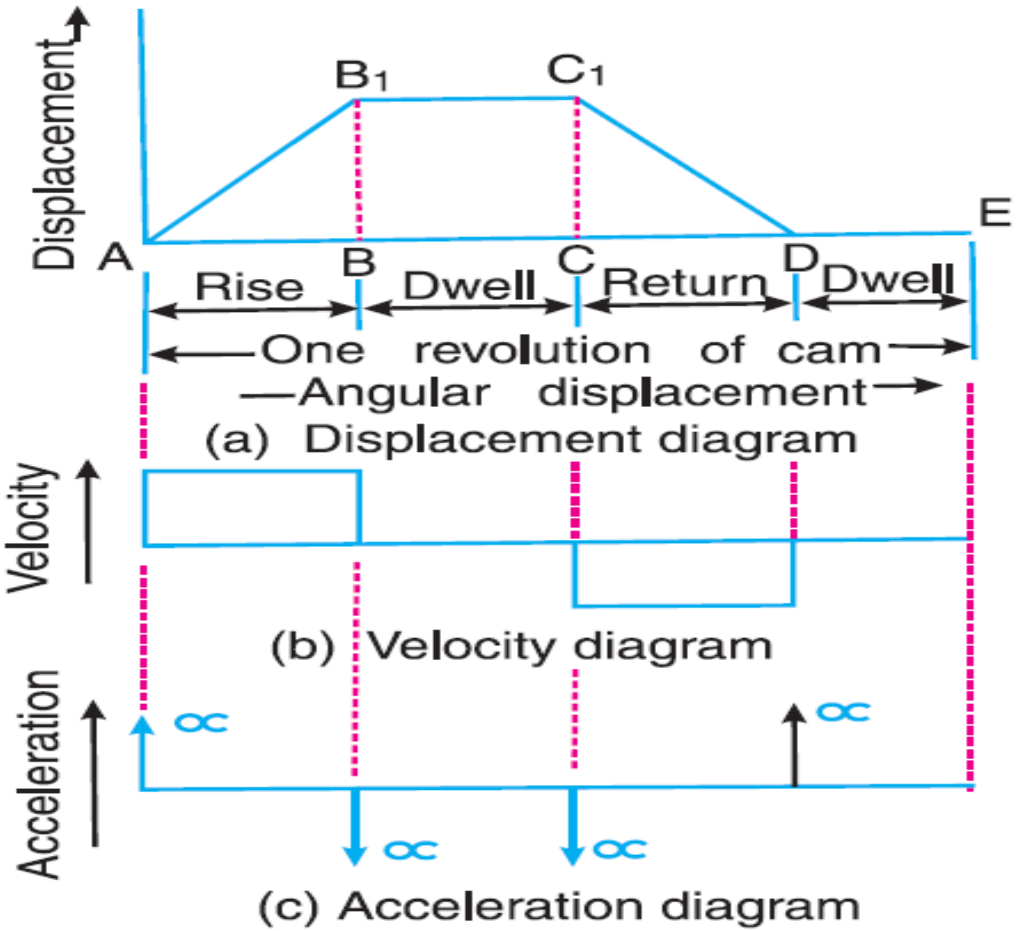
- Lift or stroke: It is the maximum travel of the follower from its lowest position to the topmost position.

- Motion of the Follower

The follower, during its travel, may have one of the following motions.

1. Uniform velocity, **2.** Simple harmonic motion, **3.** Uniform acceleration and retardation, and **4.** Cycloidal motion.

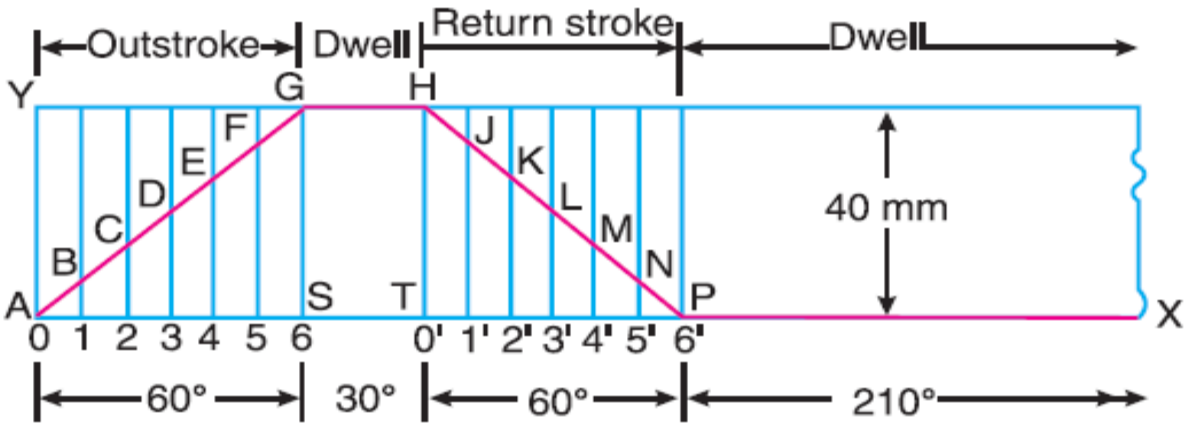
Displacement, Velocity and Acceleration Diagrams when the Follower Moves with Uniform Velocity



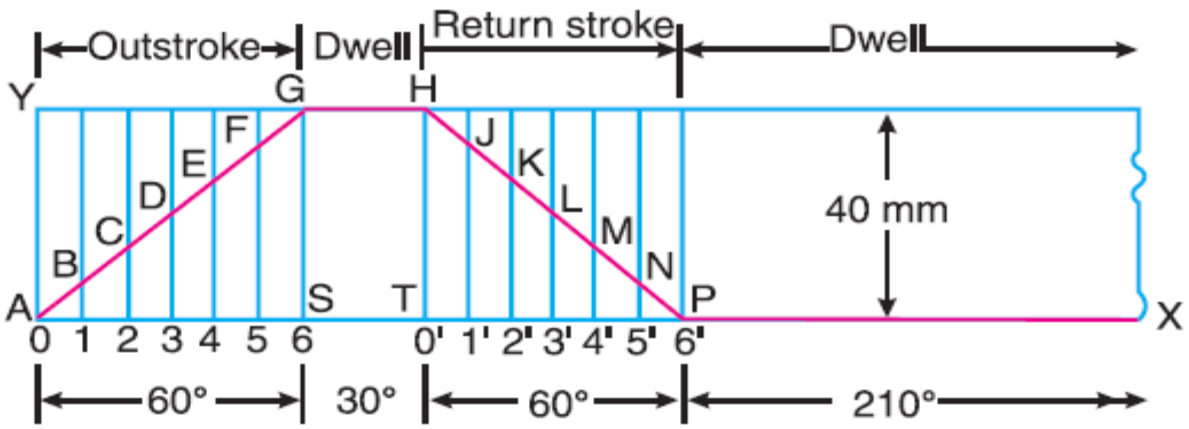
- A cam is to give the following motion to a knife-edged follower : 1. Outstroke during 60° of cam rotation ; 2. Dwell for the next 30° of cam rotation ; 3. Return stroke during next 60° of cam rotation, and 4. Dwell for the remaining 210° of cam rotation.

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,

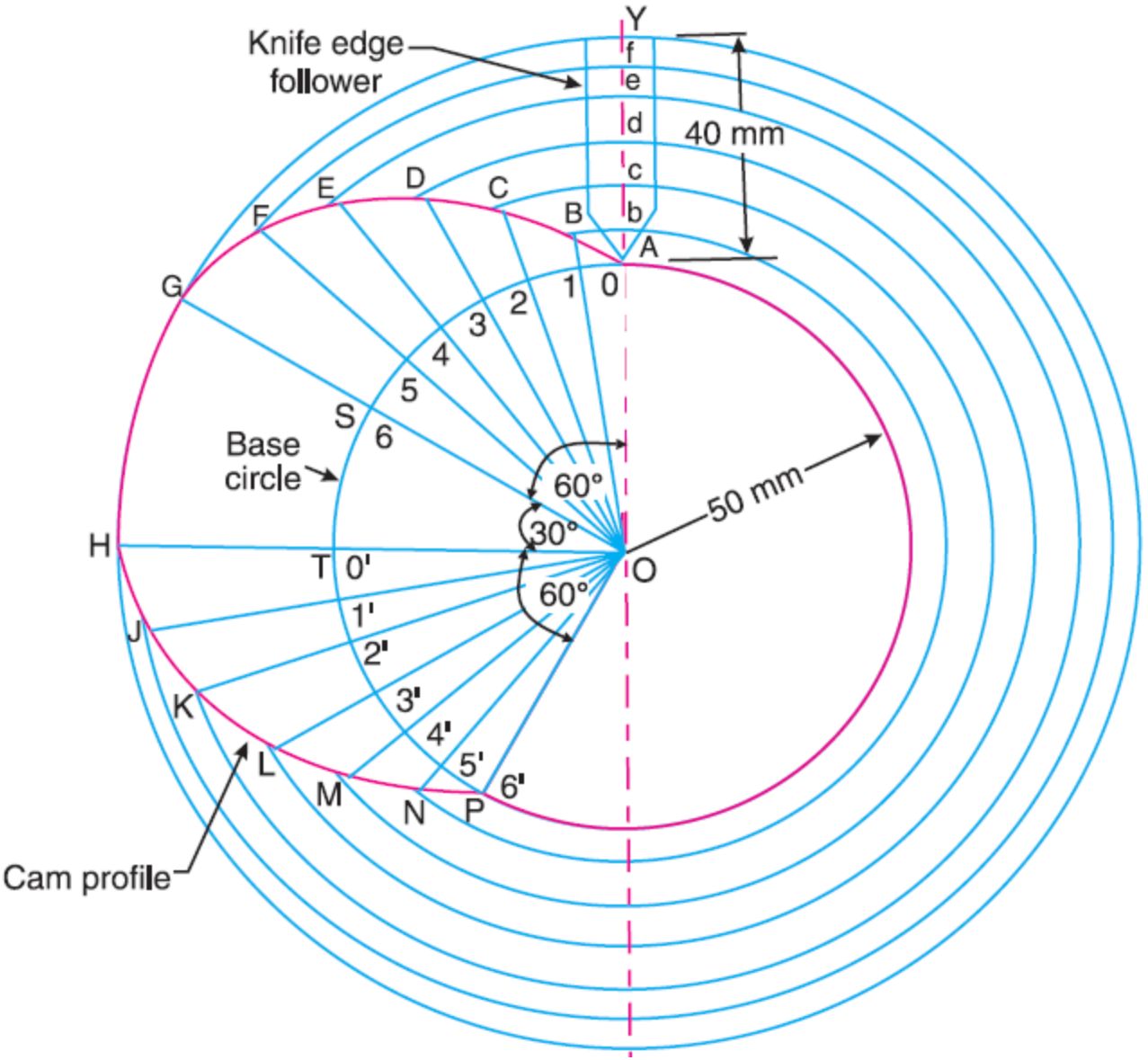
Construction



Construction



1. Draw a horizontal line $AX = 360°$ to some suitable scale. On this line, mark $AS = 60°$ to represent outstroke of the follower, $ST = 30°$ to represent dwell, $TP = 60°$ to represent return stroke and $PX = 210°$ to represent dwell.
2. Draw vertical line AY equal to the stroke of the follower (*i.e.* 40 mm) and complete the rectangle as shown in Fig. 20.10.
3. Divide the angular displacement during outstroke and return stroke into any equal number of even parts (say six) and draw vertical lines through each point.
4. Since the follower moves with uniform velocity during outstroke and return stroke, therefore the displacement diagram consists of straight lines. Join AG and HP.
5. The complete displacement diagram is shown by $AGHPX$ in Fig. 20.10.


Knife edge follower
Y
f
e
d
c
b
A
40 mm
B
C
D
E
F
G
1
0
2
3
4
5
S
6
Base circle
60°
30°
50 mm
H
T
0'
O
60°
1'
J
2'
3'
K
4'
5'
L
6'
M
N
P
Cam profile

1. Draw a base circle with radius equal to the minimum radius of the cam (*i.e.* 50 mm) with *O* as centre.
2. Since the axis of the follower passes through the axis of the cam shaft, therefore mark trace point *A*, as shown in Fig. 20.11.
3. From *OA*, mark angle *AOS* = 60° to represent outstroke, angle *SOT* = 30° to represent dwell and angle *TOP* = 60° to represent return stroke.
4. Divide the angular displacements during outstroke and return stroke (*i.e.* angle *AOS* and angle *TOP*) into the same number of equal even parts as in displacement diagram.
5. Join the points 1, 2, 3 ...etc. and $0', 1', 2', 3'$, ... etc. with centre *O* and produce beyond the base circle as shown in Fig. 20.11.
6. Now set off $1B, 2C, 3D$ ... etc. and $0'H, 1'J$ ... etc. from the displacement diagram.
7. Join the points *A*, *B*, *C*,... *M*, *N*, *P* with a smooth curve. The curve *AGHPA* is the complete profile of the cam.