

UNIT 3 – KINEMATICS OF CAMS

PART - A

1. What is cam?

A cam is a rotating machine element which gives reciprocating (or) oscillating motion to another element known as follower

2. Define tangent cam?

When the flanks of the cam are straight and tangential to the base circle and nose circle, the cam is known as tangent cam.

3. Distinguish radial and cylindrical cams.

Radial cam	Cylindrical cam
In this cam, the follower reciprocates (or) oscillates in a direction perpendicular to the axis.	In this the follower reciprocates (or) oscillates in a direction parallel to the cam axis.

4. What are the different motions of the follower?

- (i) Uniform motion,
- (iii) Simple harmonic motion,
- (iv) Uniform acceleration and retardation, and
- (iv) Cycloidal motion.

5. Compare Roller and mushroom follower of a cam.

S.No	Roller Follower	Mushroom Follower
1.	Roller followers are extensively used where more space is available.	The mushroom followers are generally used where space is limited.
2.	It is used in stationary gas engines, oil engines and aircraft valves in engines.	It is used in cams which operate the valves in automobile engines.

6. Explain offset follower.

When the motion of the follower is along an axis away from the axis of the cam centre, it is called offset follower.

7. Define trace point in the study of cams.

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.

8. Define pressure angle with respect to cams.

It is the angle between the direction of the follower motion and a normal to the pitch curve. This angle is very important in designing a cam profile. If the pressure angle is too large, a reciprocating follower will jam in its bearings.

9. Define Lift (or) Stroke in cam.

It is the maximum travel of the follower from its lowest position to the topmost position.

10. Define undercutting in cam. How is occurs?

The cam profile must be continuous curve without any loop. If the curvature of the pitch curve is too sharp, then the part of the cam shape would be lost and thereafter the intended cam motion would not be achieved. Such a cam is said to be undercut. Undercutting occurs in the cam because of attempting to achieve too great a follower lift with very small cam rotation with a smaller cam.

11. What do you know about Nomogram?

In Nomogram, by knowing the values of total lift of the follower (L) and the cam rotation angle (β) for each segment of the displacement diagram, we can read directly the maximum pressure angle occurring in the segment for a particular choice of prime circle radius (R_0).

12. What are the classifications of cam based on the follower movement?

- 1) Rise-Return-Rise (R-R-R) cams,
- 2) Dwell-Rise-Return-Dwell (D-R-R-D) cams,
- 3) Dwell-Rise-Dwell-Return-Dwell (D-R-D-R-D) cams,
- 4) Dwell-Rise-Dwell (D-R-D) cams.

13. What do you know about gravity cam?

In this type, the rise of the cam is achieved by the rising surface of the cam and the return by the force of gravity due to the weight of the cam

14. What are the different types of cams?

1. Wedge (or) flat cams
2. Radial (or) Disc cams

3. Spiral cams
4. Cylindrical (or) Barrel (or) Drum Cams
5. Conjugate cams
6. Globoidal cams
7. Spherical cams

15. Define Trace point.

It is a reference point on the follower to trace the cam profile. In case of a knife edge follower, the knife edge itself is a tracing point and in roller follower, the centre of the roller is the tracing point.

16. Define pressure angle.

It is the angle between the direction of the follower motion and a normal to the pitch curve. This is very important in cam design as it represents steepness of the cam profile. If the pressure angle is too large, a reciprocating follower will jam in its bearings.

17. Define Prime circle.

The smallest circle drawn tangent to the pitch curve is known as the prime circle.

18. Define Angle of Ascent.

The angle of rotation of cam from the position when the follower begins to rise till it reaches its highest position is known as angle of ascent. It is also known as out stroke and is denoted by θ_0 .

19. What is meant by Simple Harmonic Motion?

When a body rotates on a circular path with uniform angular velocity, its projection on the diameter will have simple harmonic motion. The velocity of the projection will be maximum at the centre of and zero at the ends of the diameter. In case of acceleration and retardation, the values will be zero at the centre and maximum at the ends of diameter.

20. What are the different shapes of high speed cams?

1. Circular Arc cam with flat faced follower
2. Tangent cam with reciprocating roller follower

21. Define cam angle.

It is the angle of rotation of the cam for a definite displacement of the follower.

22. What are the classifications of follower based on the follower movement?

- i) Reciprocating (or) translating follower.
- ii) Oscillating (or) rotating follower.

23. Define Pitch curve.

The locus of the tracing point is known as the pitch curve. For the purpose of laying out the cam profiles, it is assumed that the cam is fixed and the follower rotates around it.

24. What are the classifications of the follower based on the path of motion of the follower?

- a) Radial follower.
- b) Offset follower.

25. What are the classifications of cam base on the constraint of the follower?

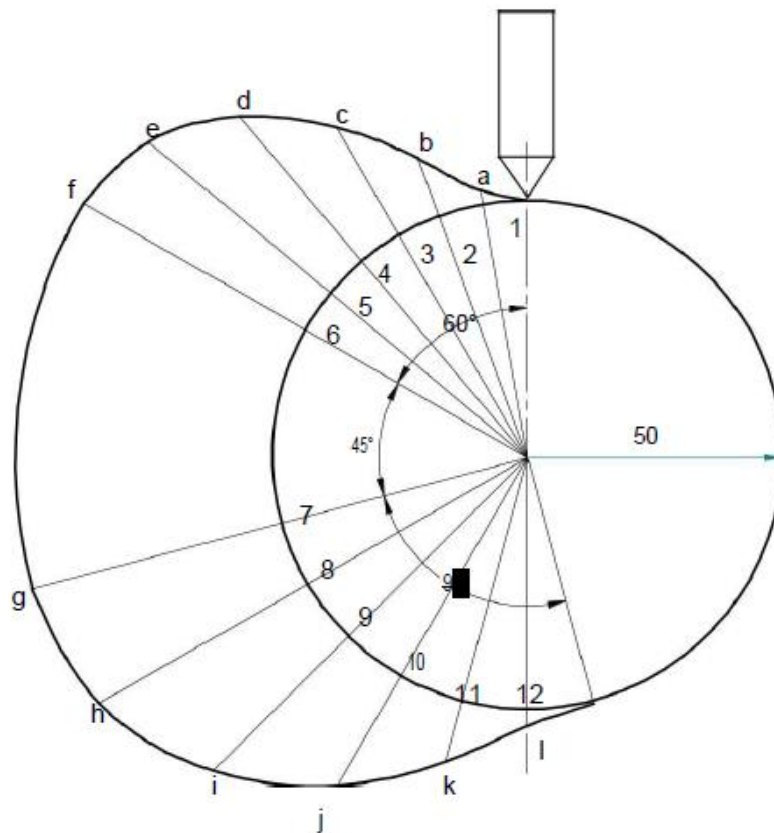
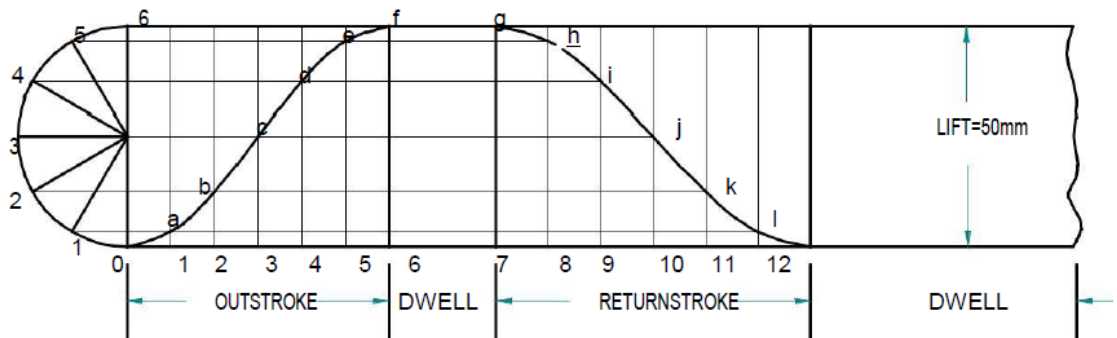
- a) Pre-loaded spring cams.
- b) Positive drive cams.
- c) Gravity cams.

UNIT 3 – KINEMATICS OF CAMS

PART - B

1. Draw the cam profile for following conditions: Follower type = Knife edged, in-line; lift = 50mm; base circle radius = 50mm; out stroke with SHM, for 60° cam rotation; dwell for 45° cam rotation; return stroke with SHM, for 90° cam rotation; dwell for the remaining period. Determine max. velocity and acceleration during out stroke and return stroke if the cam rotates at 1000 rpm in clockwise direction.

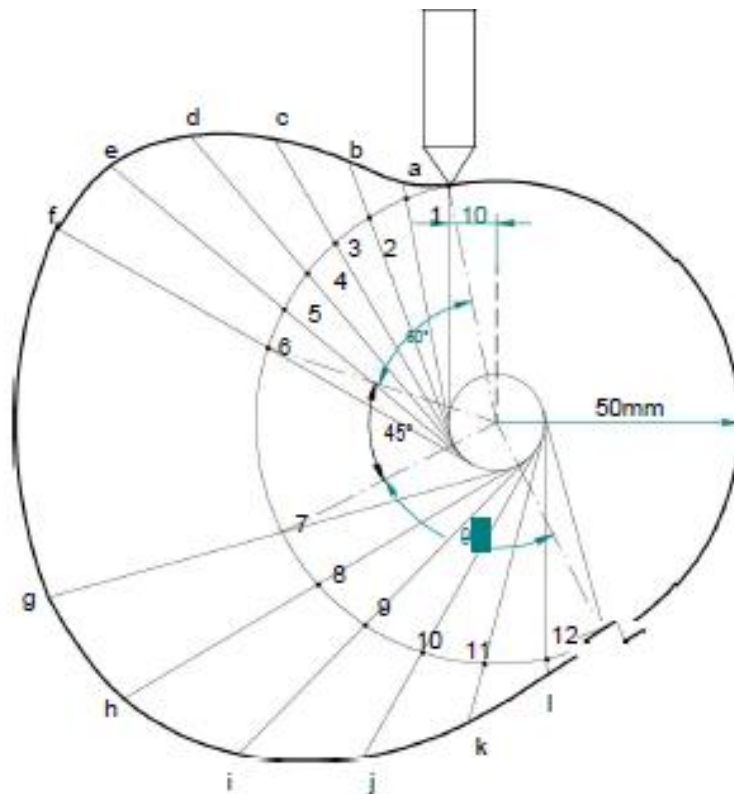
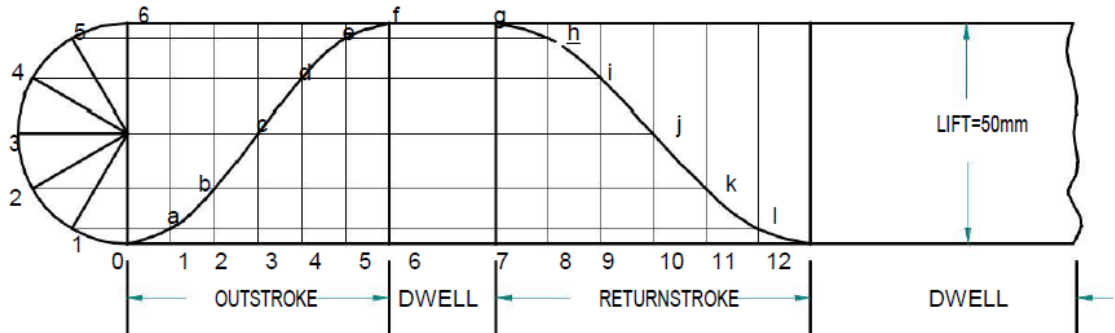
Displacement diagram:



Cam profile

2. Draw the cam profile for the same operating conditions of problem (1), with the follower off set by 10 mm to the left of cam center

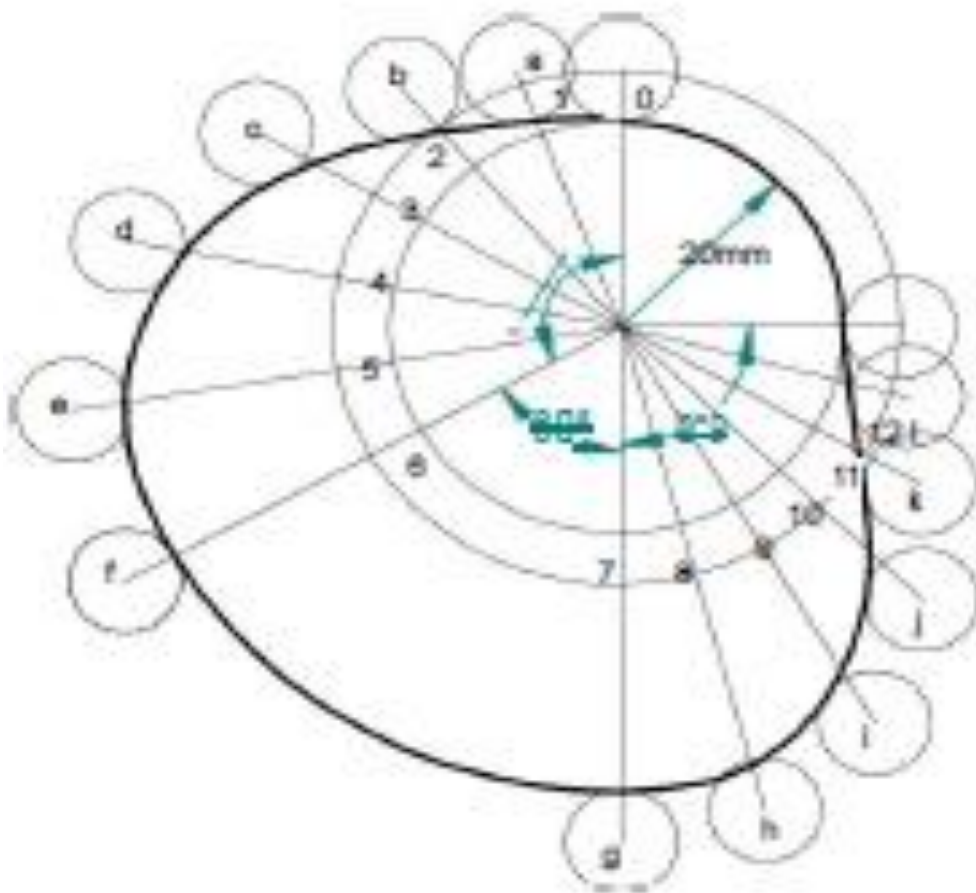
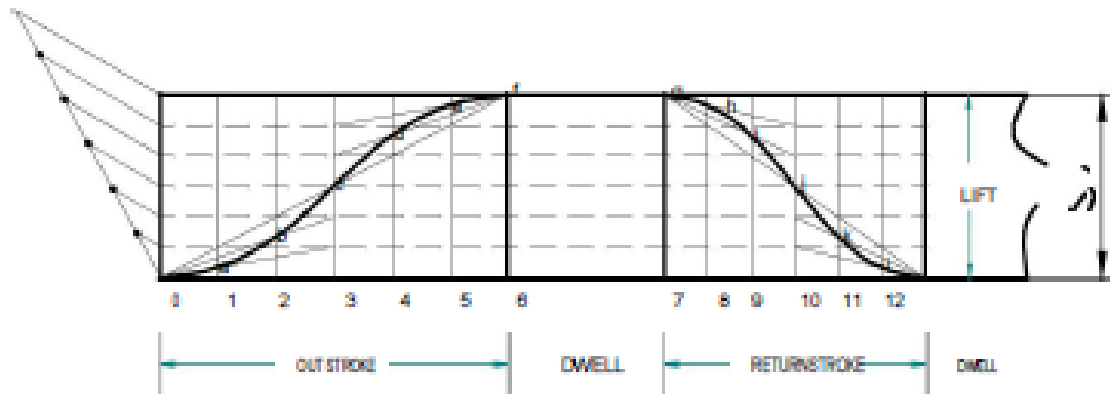
Displacement diagram:



Cam profile

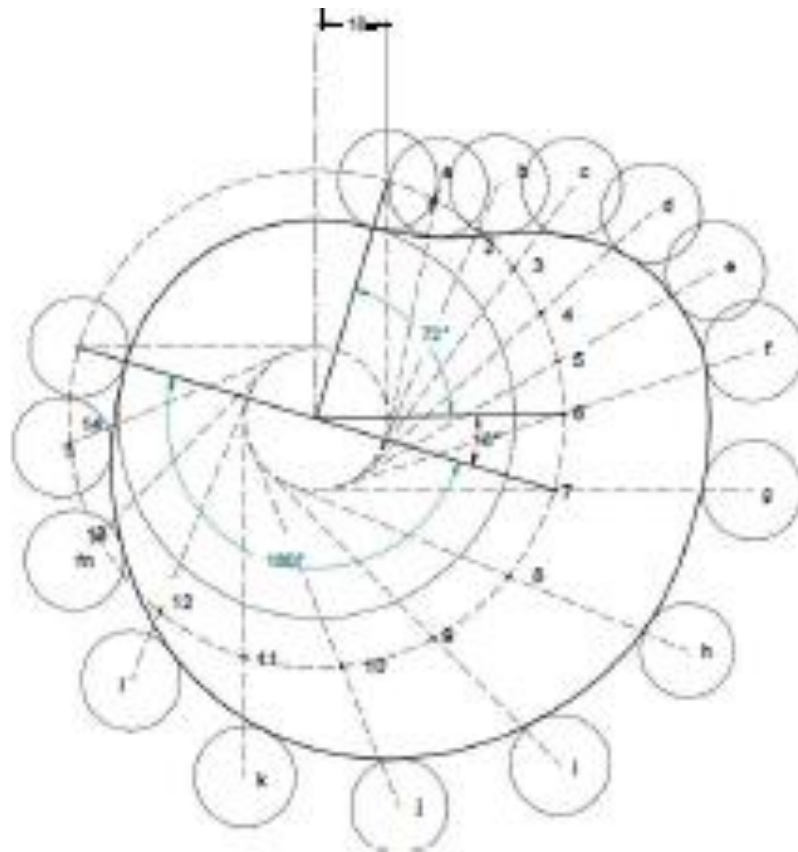
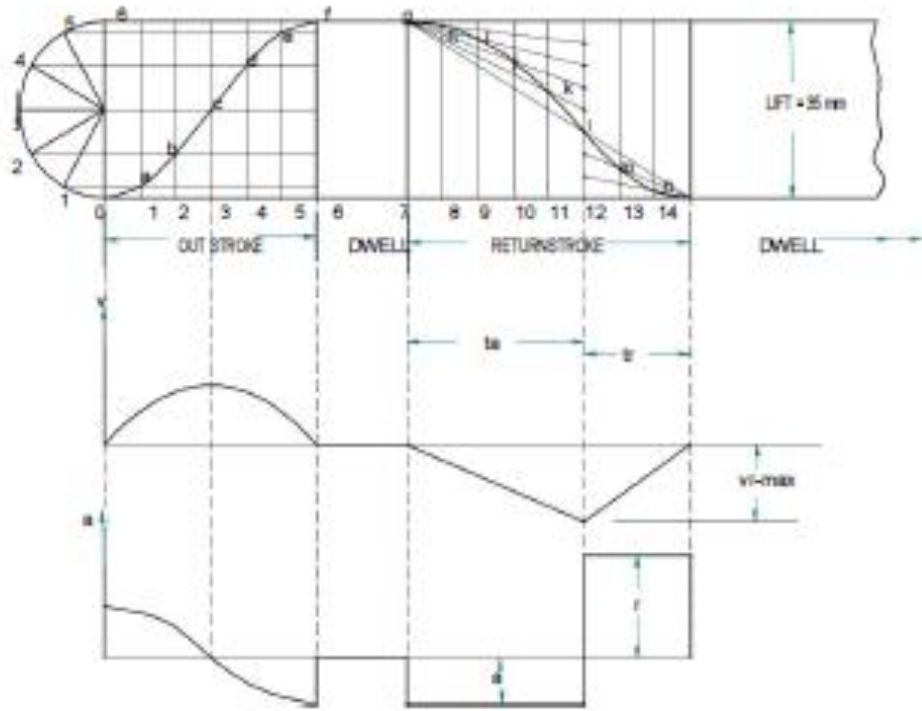
3. Draw the cam profile for following conditions:
 Follower type = roller follower, in-line; lift = 25mm; base circle radius = 20mm; roller radius = 5mm; out stroke with UARM, for 120° cam rotation; dwell for 60° cam rotation; return stroke with UARM, for 90° cam rotation; dwell for the remaining period. Determine max. velocity and acceleration during out stroke and return stroke if the cam rotates at 1200 rpm in clockwise direction.

Displacement diagram:



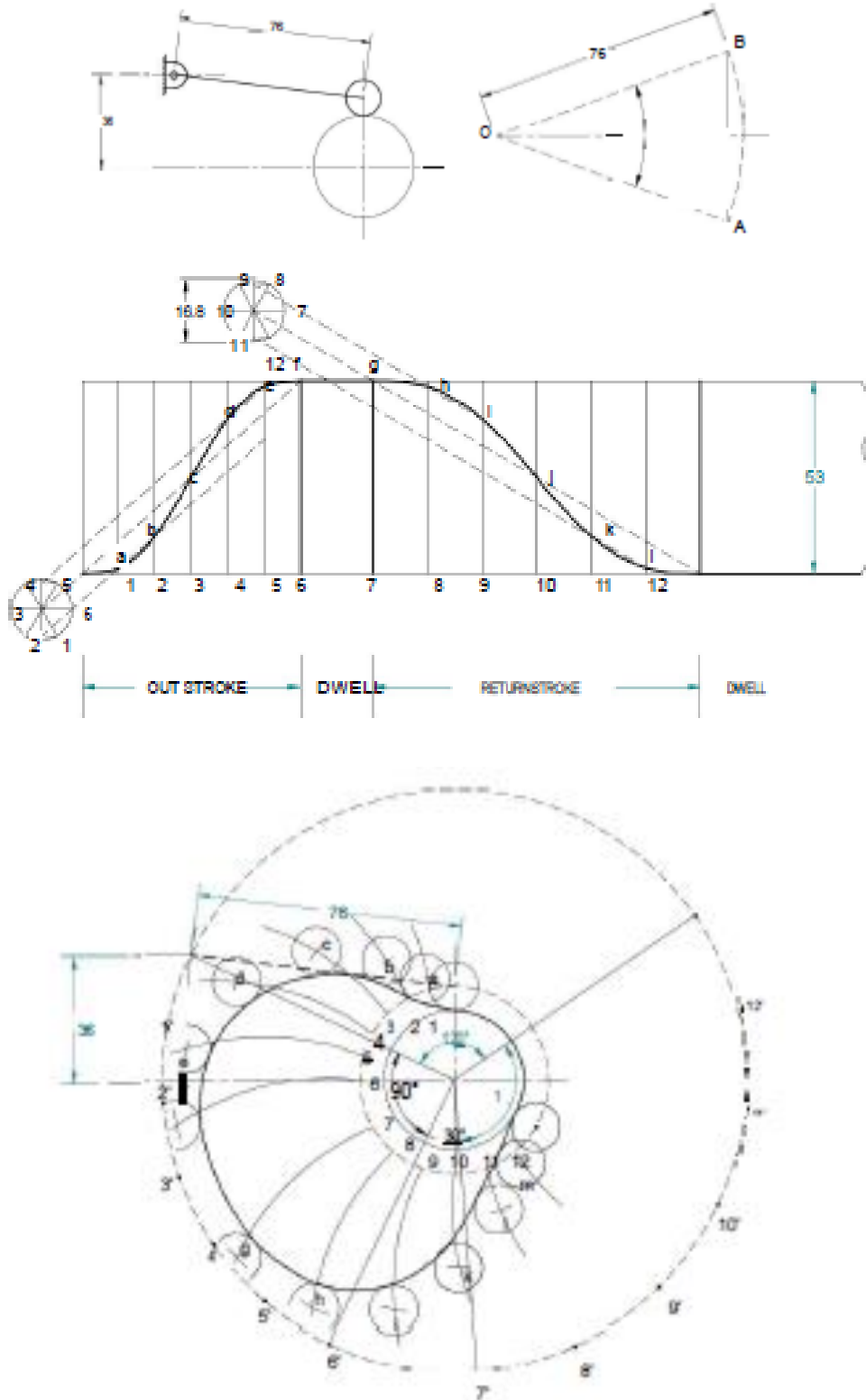
Cam profile

4. Draw the cam profile for following conditions: Follower type = roller follower, off set to the right of cam axis by 18mm; lift = 35mm; base circle radius = 50mm; roller radius = 14mm; out stroke with SHM in 0.05sec; dwell for 0.0125sec; return stroke with UARM, during 0.125sec; dwell for the remaining period. During return stroke, acceleration is $\frac{3}{5}$ times retardation. Determine max. velocity and acceleration during out stroke and return stroke if the cam rotates at 240 rpm.



Cam profile

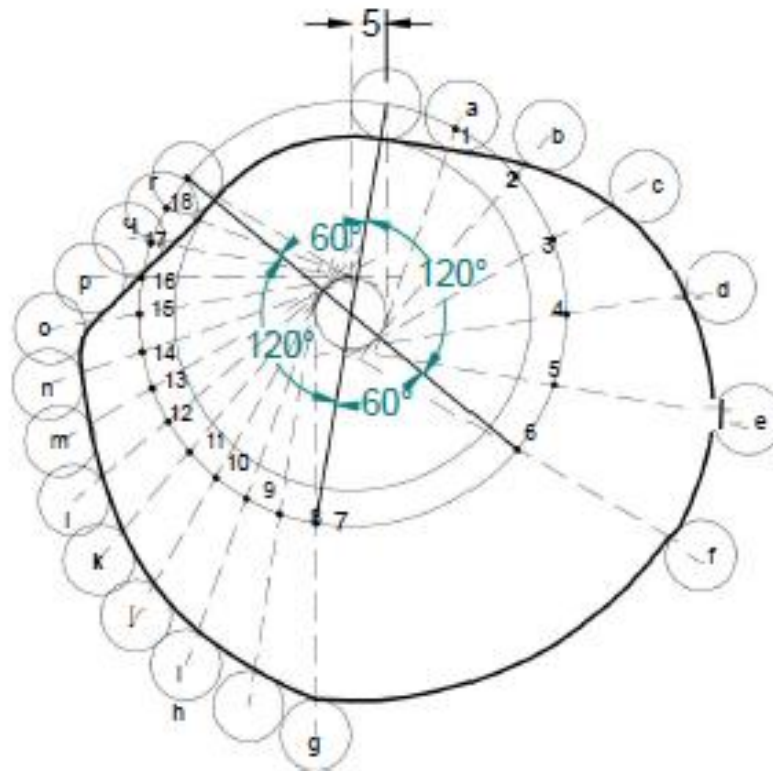
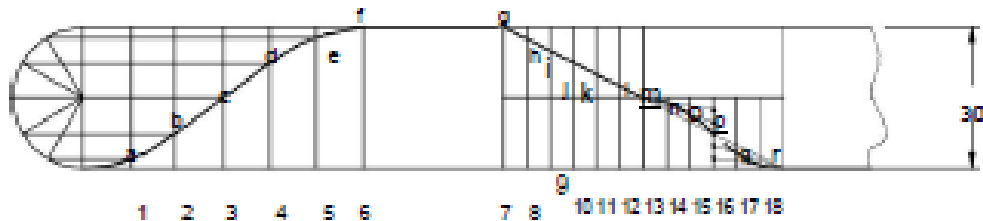
5. Draw the cam profile for following conditions: Follower type = oscillating follower with roller as shown in fig.; base circle radius = 20mm; roller radius = 7mm; follower to rise through 40° during 90° of cam rotation with cycloidal motion; dwell for 30° ; return stroke with cycloidal motion during 120° of cam rotation; dwell for the remaining period. Also determine the max. velocity and acceleration during outstroke and return stroke, if the cam rotates at 600 rpm.



Cam profile

6. Draw the cam profile for following conditions: Follower type = roller follower, offset to the right by 5mm; lift = 30mm; base circle radius = 25mm; roller radius = 5mm; out stroke with SHM, for 120° cam rotation; dwell for 60° cam rotation; return stroke during 120° cam rotation; first half of return stroke with Uniform velocity and second half with UARM; dwell for the remaining period.

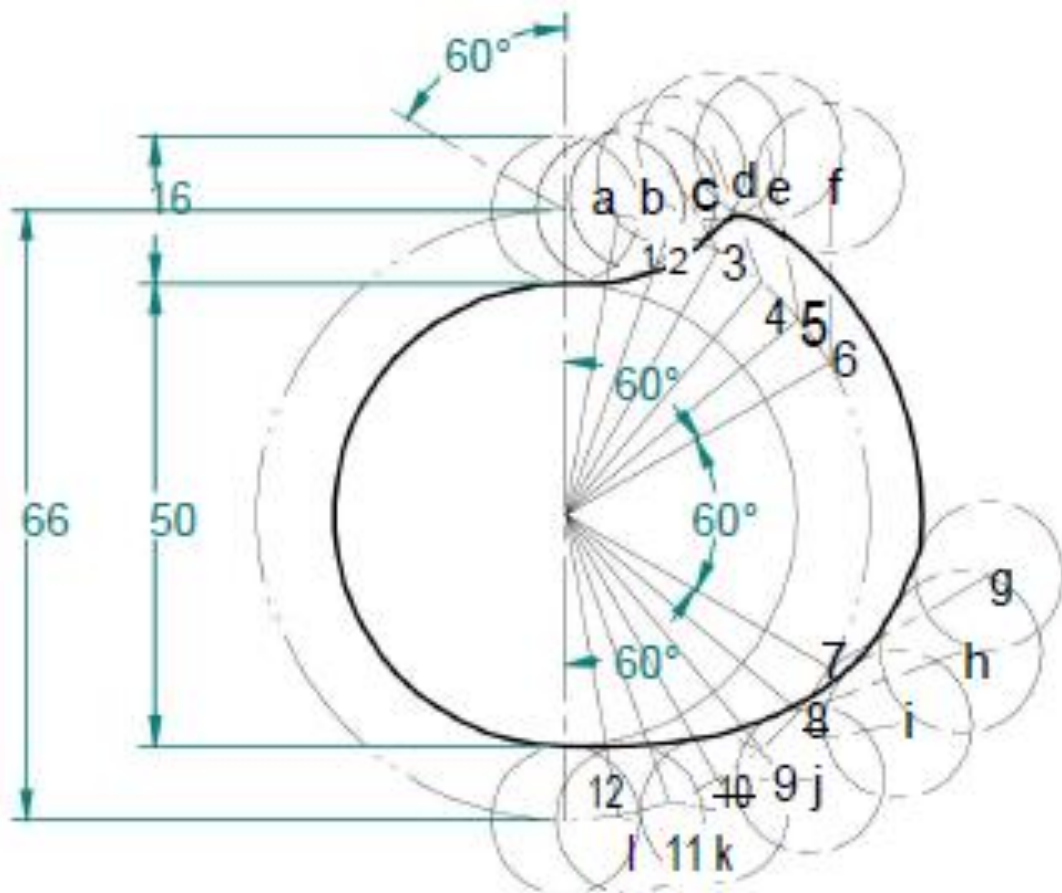
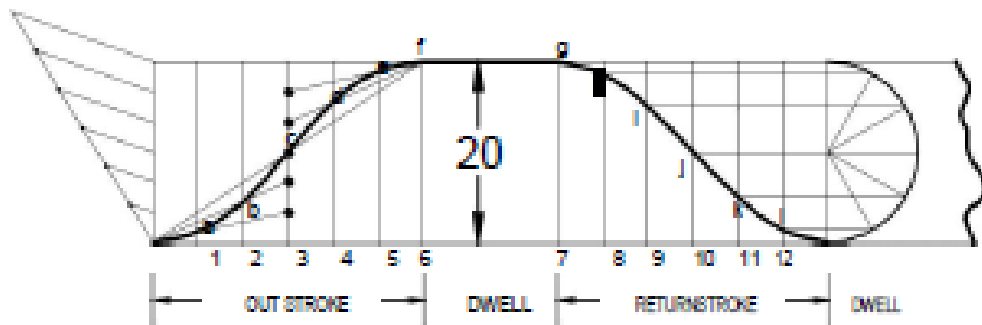
Displacement diagram:



Cam profile

7. A push rod of valve of an IC engine ascends with UARM, along a path inclined to the vertical at 60° . The same descends with SHM. The base circle diameter of the cam is 50mm and the push rod has a roller of 60mm diameter, fitted to its end. The axis of the roller and the cam fall on the same vertical line. The stroke of the follower is 20mm. The angle of action for the outstroke and the return stroke is 60° each, interposed by a dwell period of 60° . Draw the profile of the cam.

Displacement diagram:



Cam profile