# UNIT – 1(a)

## CONIC SECTIONS

# ENGINEERING CURVES

## (Week -2)

- These are non-circular curves drawn by free hand.
- Sufficient number of points are first located and then a smooth curve passing through them are drawn by freehand or by using French Curve.

Examples

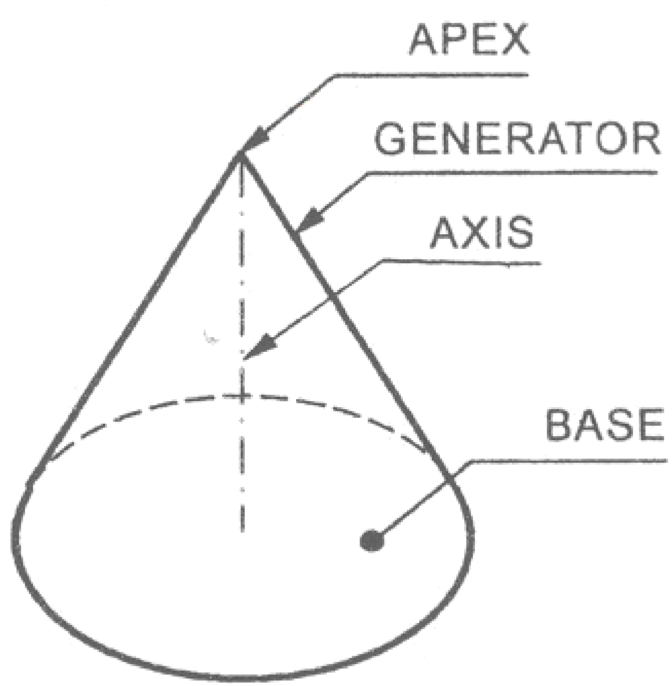
Conic Sections

Cycloids

Involutes, etc.,

# Definition of Cone

- A cone is a surface generated by the rotation of a straight line whose one end is in contact with a fixed point while the other end is in contact with a closed curve, not lying in the plane of the curve.



- Apex or Vertex is the top point of the cone
- Axis is imaginary line joining apex & centre of base
- Generator is the straight line which is generating the surface of the cone
- Base of the cone is the closed curve

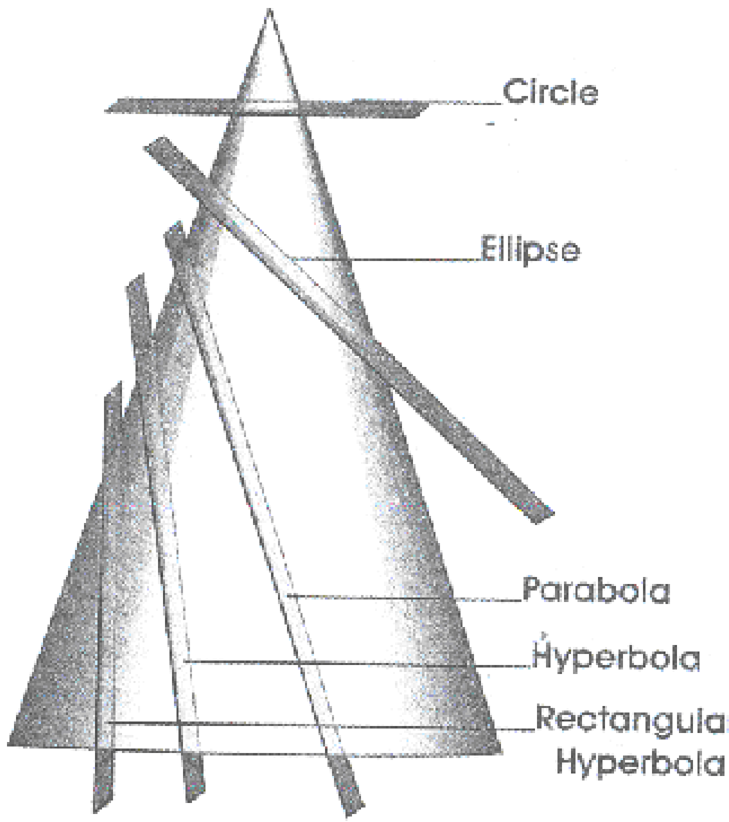
# CONIC SECTIONS

## Definition

Conic sections are the curves obtained by the intersection of a right circular cone by a plane at different angles.

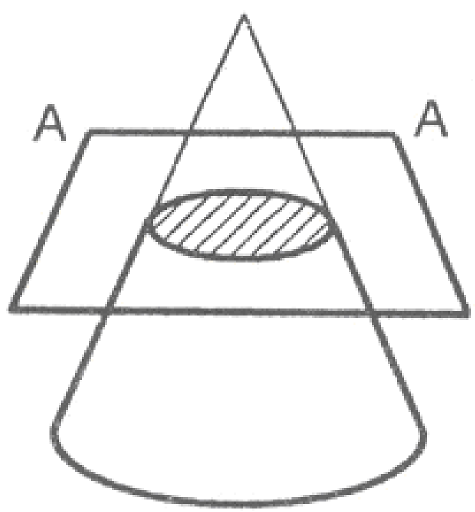
Circle, Ellipse, Parabola and Hyperbola are the curves thus obtained are called as conic sections or simply conics.

# Conics defined by Section of a Cone



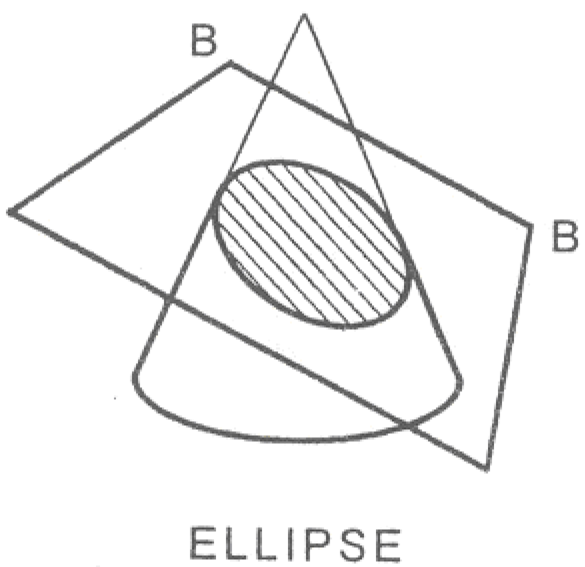
# CONIC SECTIONS

Circle: When the cutting plane AA is perpendicular to the axis and cuts all the generators, the section obtained is a circle.



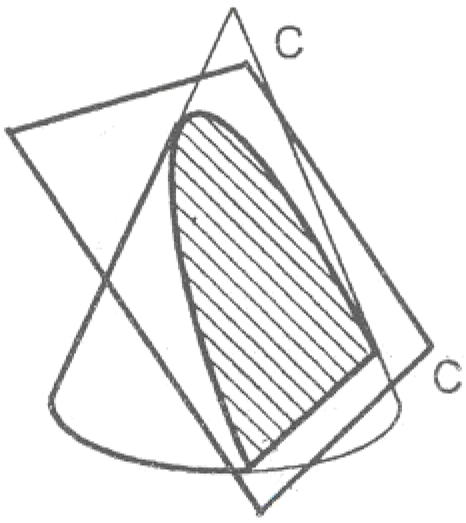
# Ellipse

- When the cutting plane BB is inclined to the axis of the cone and cuts all the generators on one side of the apex, the section obtained is an Ellipse.



# Parabola

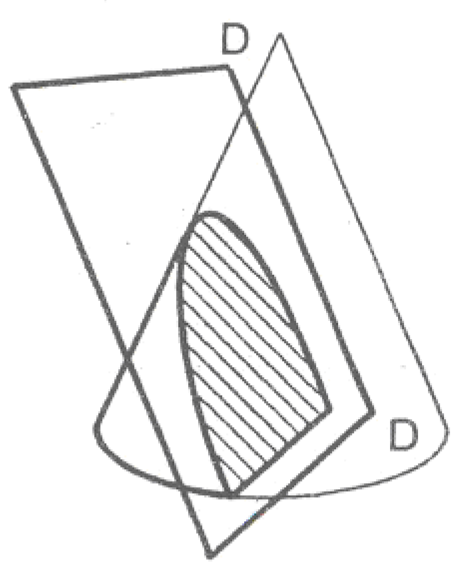
- When the cutting plane CC is inclined to the axis of the cone and parallel to one of the generators, the section obtained is a Parabola.




PARABOLA

# Hyperbola

- When the cutting plane DD makes a smaller angle with the axis than that of the angle made by the generator of the cone, the section obtained is a Hyperbola.




HYPERBOLA

# Eccentricity

$$e = \frac{\text{Distance of the moving point from the focus}}{\text{Distance of the moving point from the directrix}}$$

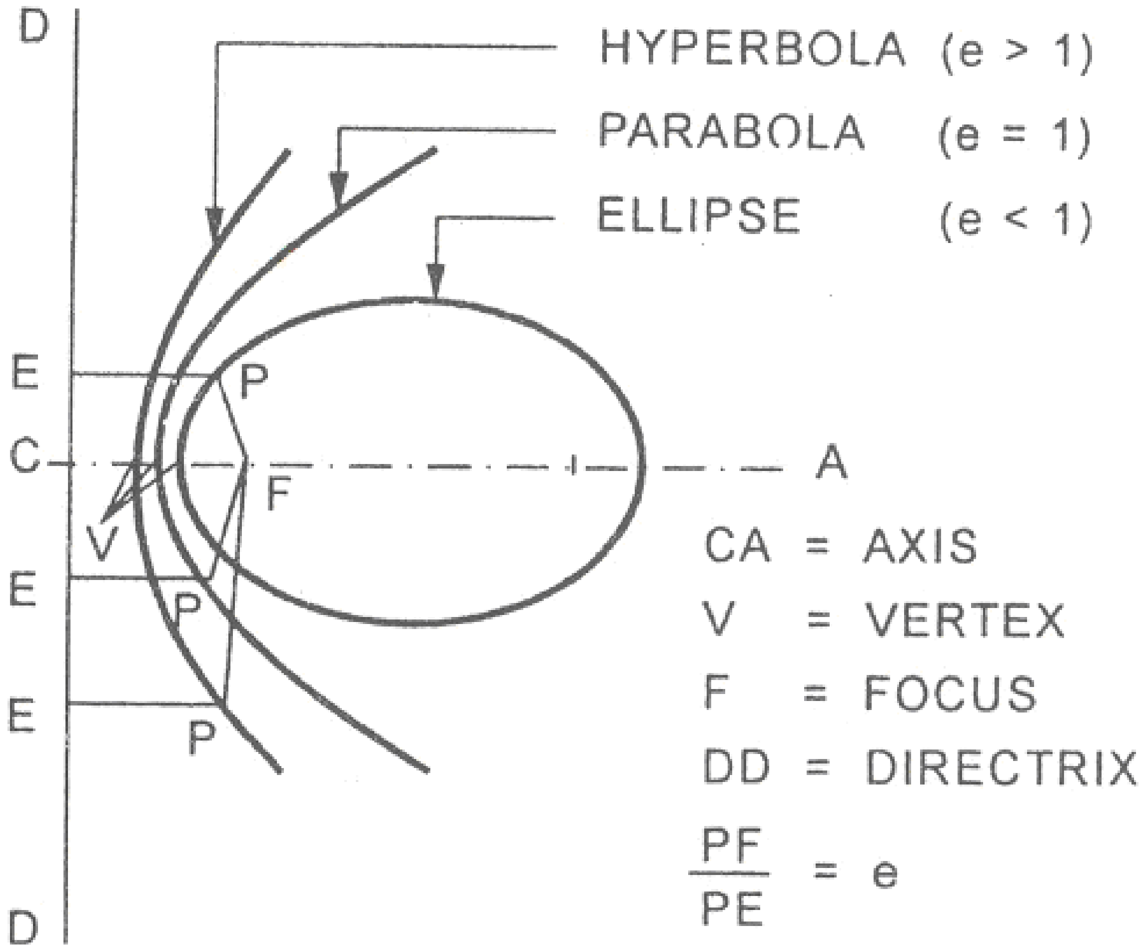
**Note**

If the $e < 1$, curve obtained is Ellipse

If the $e = 1$, curve obtained is Parabola

If the $e > 1$, curve obtained is Hyperbola

# Conic Sections



# Conics definition (By a locus of a Point)

- **Ellipse**: It is the locus of a point moving in a plane in such a way that the ratio of its distance from a fixed point (F) to the fixed straight line (DD) is a constant. i.e., $e < 1$.

- **Parabola**: It is the locus of a point moving in a plane in such a way that the ratio of its distance from a fixed point (F) to the fixed straight line (DD) is a constant. i.e., $e = 1$.

- **Hyperbola**: It is the locus of a point moving in a plane in such a way that the ratio of its distance from a fixed point (F) to the fixed straight line (DD) is a constant. i.e., $e > 1$.

# Engineering Applications

- Ellipse: Construction of arches, bridges, dams, elliptical gears of textile machines, etc.
- Parabola: Suspension bridges, reflectors for parallel beams such as head lights of automobiles, solar concentrators etc.
- Hyperbola: Design of cooling towers, hydraulic channels, electronic transmitters and receivers like radar antenna, etc.,

# Methods of Construction

- Eccentricity Method (Ellipse/Parabola/Hyperbola)
- Intersecting Arcs or Arc of circles or Foci method (Ellipse)
- Rectangle or Oblong method (Ellipse/Parabola)
- Parallelogram method/Tangent method (Parabola)
- Foci & Transverse Axis method (Hyperbola)

# ELLIPSE-ECCENTRICITY METHOD

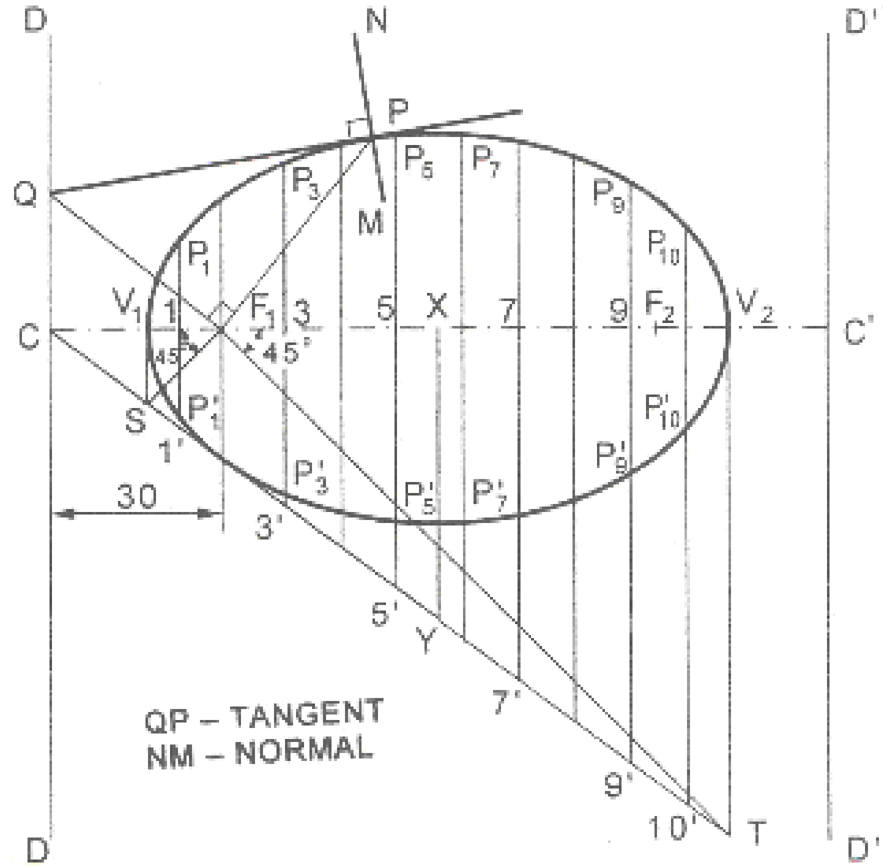
**PROBLEM 1**:

(a) Construct an ellipse when the distance between the focus and the directrix is 50mm and the eccentricity is 2/3.

(b) Draw the tangent and normal at any point P on the curve using directrix.

# ELLIPSE BY ECCENTRICITY METHOD

- Problem




F, & F, - FOCI

V, & V, - VERTICES

DD & D'D' - DIRECTRICES

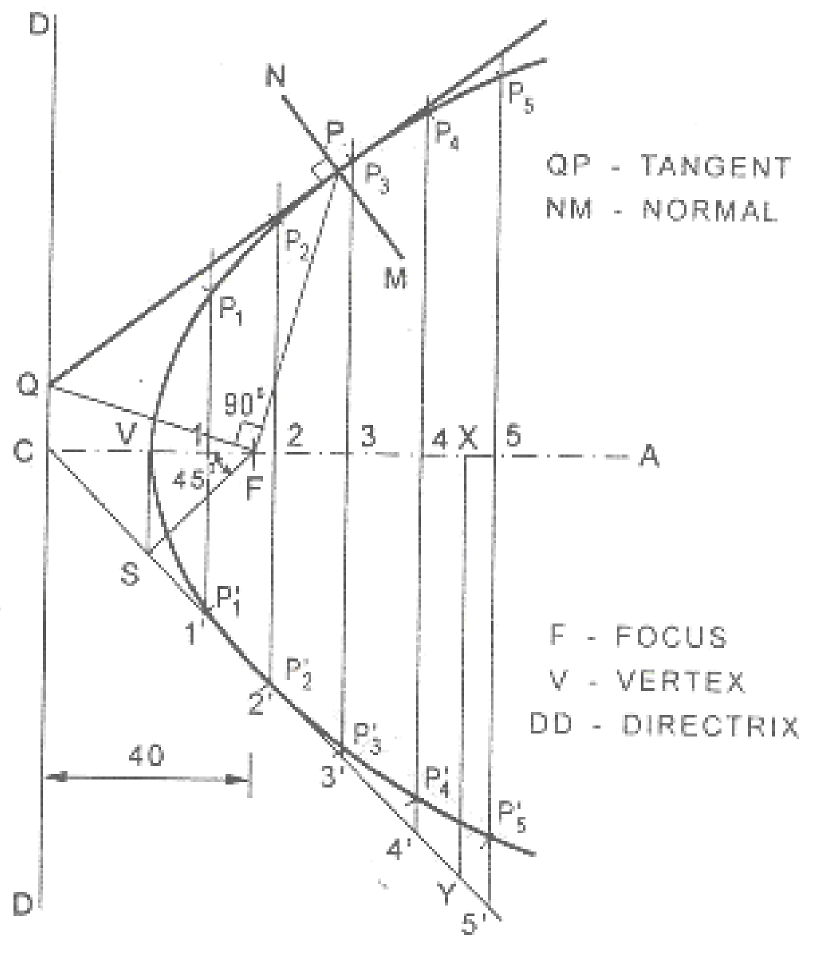
# PARABOLA-
# ECCENTRICITY METHOD

**PROBLEM 2:**

Construct a parabola when the distance between focus and the directrix is 40mm. Draw tangent and normal at any point P on your curve.

# Parabola construction by Eccentricity method (Week -3)

- Problem




PARABOLA - ECCENTRICITY METHOD

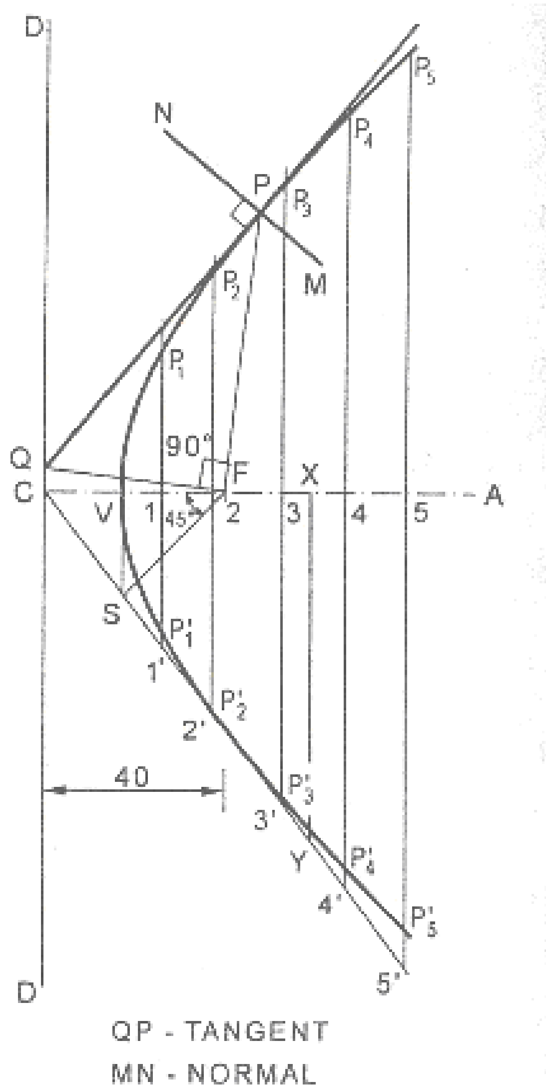
# HYPERBOLA-ECCENTRICITY MECHOD

**PROBLEM 3:**

Construct a hyperbola when the distance between the focus and directrix is 70mm. The eccentricity is 4/3. Draw a tangent and normal at any point on the hyperbola.

# Hyperbola by Eccentricity method

- <u>Problem</u>



# CYCLOIDS AND INVOLUTES (Week -4)

## CYCLOID

It is a curve traced by a point on the circumference of a circle which rolls along a straight line without slipping.

**Engineering Applications**:

Used in small gears in instruments like dial gauges and watches.

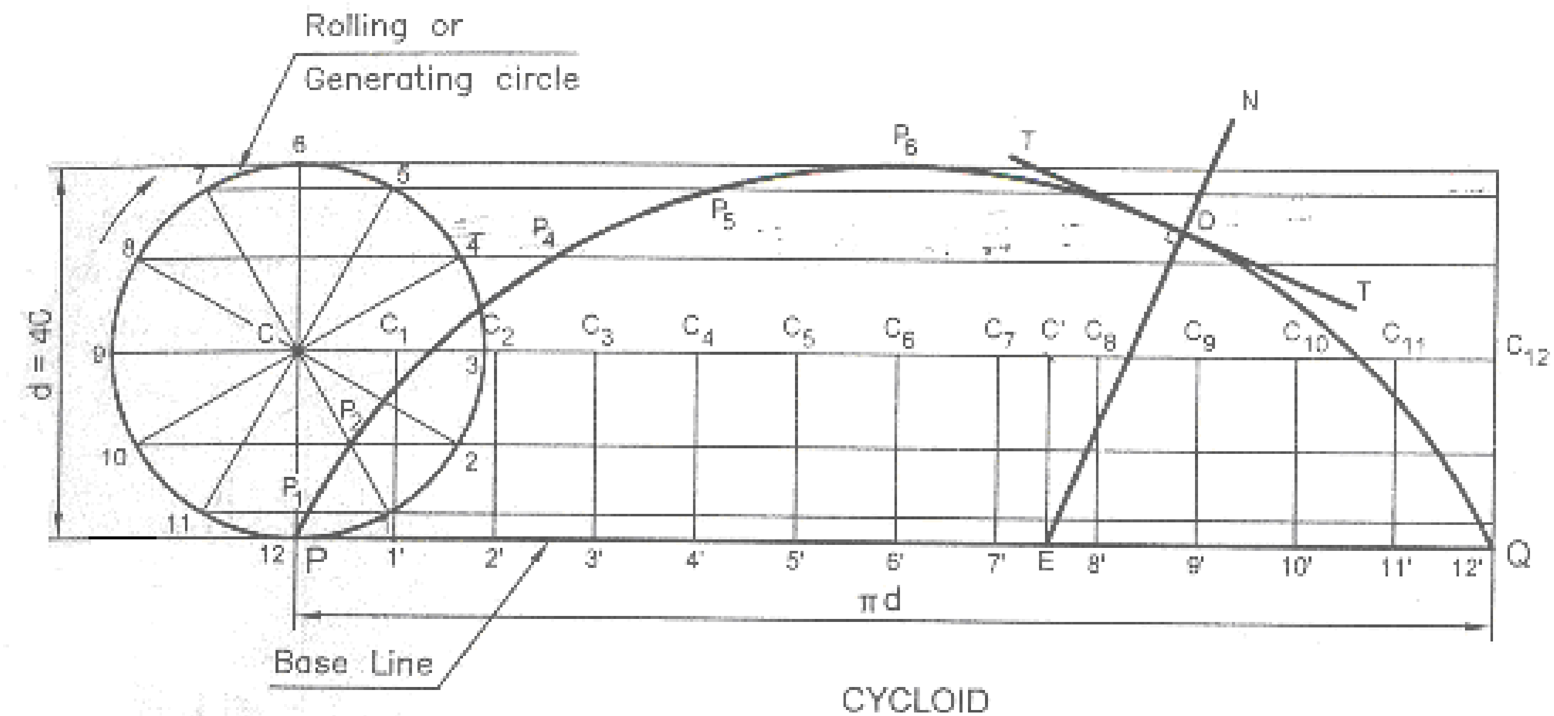
# CYCLOID

**PROBLEM 4:**

A coin of 40mm diameter rolls over a horizontal table without slipping. A point on the circumference of the coin is in contact with the table surface in the beginning and after one complete revolution. Draw the path traced by the point.

# Cycloid Construction

- Problem



# Epicycloid

- Epicycloid is a curve generated by a point on the circumference of a circle which rolls without slipping on the outside of another circle.
- The fixed circle on the outside of which the generating circle rolls is called the Base circle or Directing circle.
- Engineering Applications: In cycloidal teeth gears, the faces are of Epicyloidal profile and the flanks are of Hypocycloidal profile to ensure correct meshing.

# EPICYCLOID

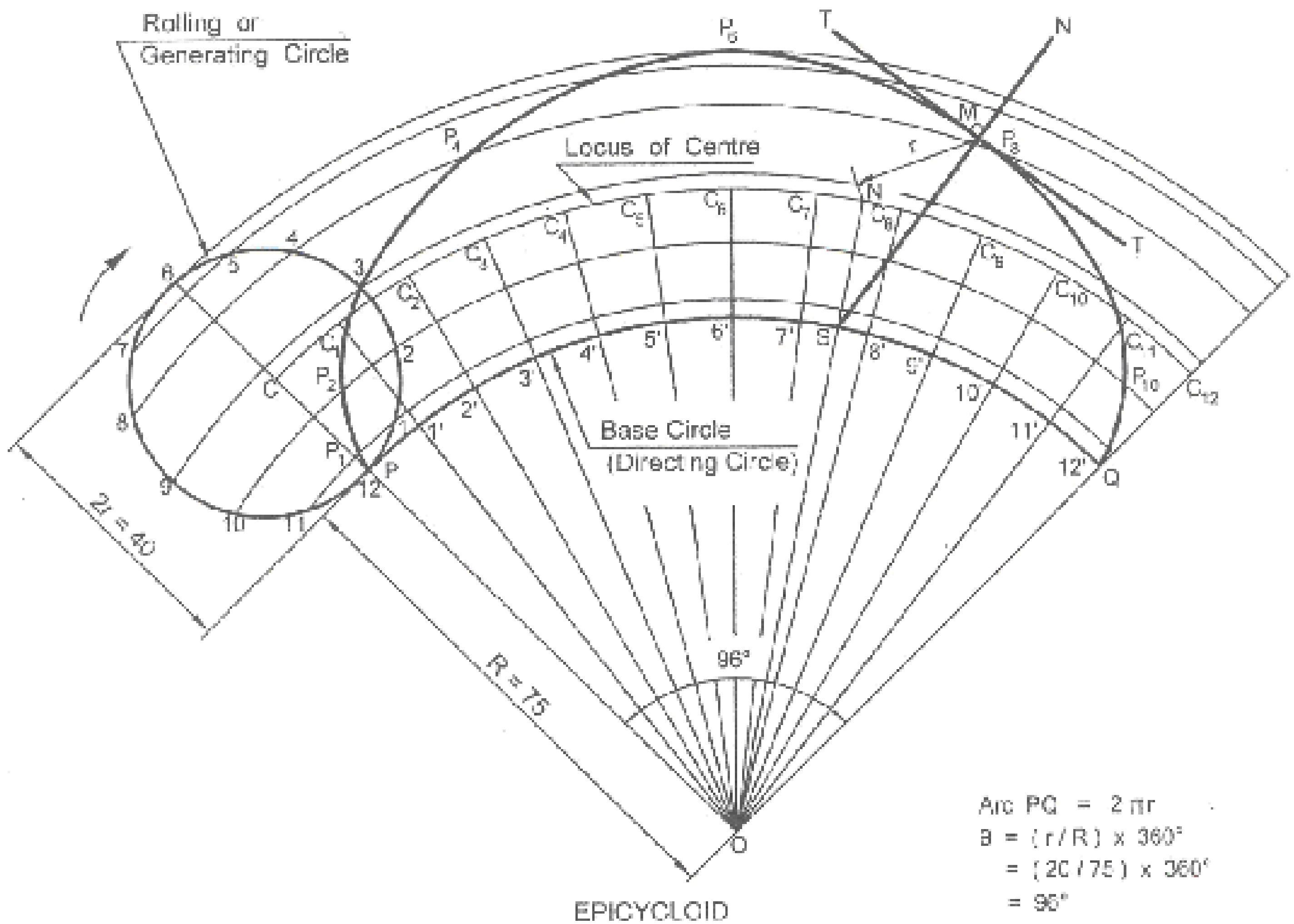
**PROBLEM 5:**

Draw an epicycloid of rolling circle 40mm (2r), which rolls outside another circle (base circle) of 150mm diameter (2R) for one revolution.

Draw a tangent and normal at any point on the curve.

# Construction of Epicycloid

- Problem



# Hypocycloid

- Hypocycloid is a curve traced by a point on the circumference of a circle which rolls without slipping on the inside of another circle.

**Note:** i) The method for constructing Hypocycloid is the same as for Epicycloid.

ii) The center C of the generating circle is inside the directing circle.

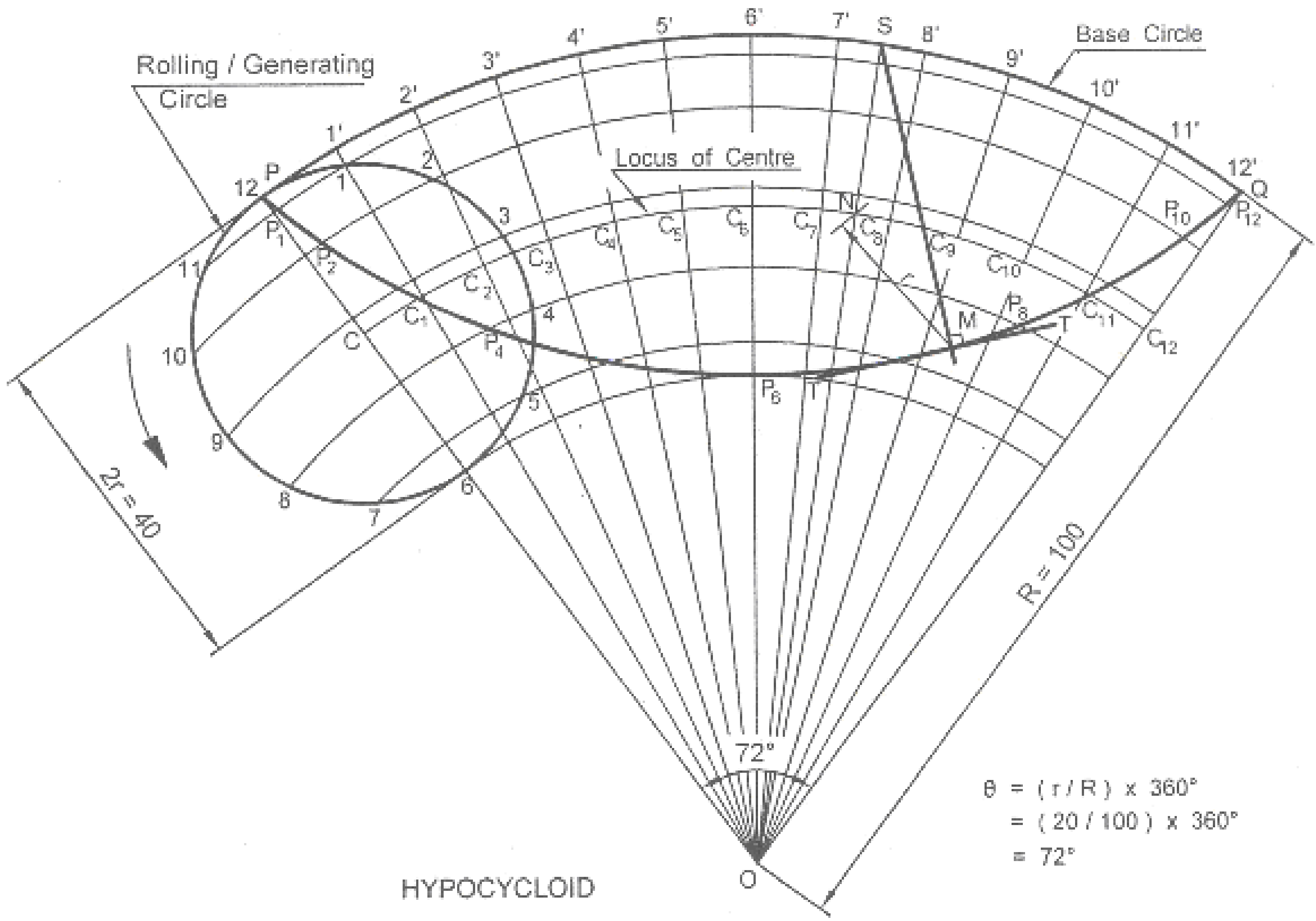
# HYPOCYLOID

**PROBLEM 6:**

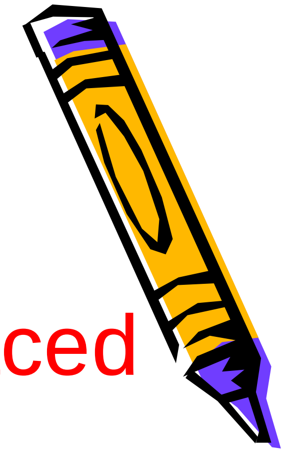
Draw a hypocycloid of a circle of 40mm diameter which rolls inside another circle of 200mm diameter for one revolution.

# Construction of Hypocycloid

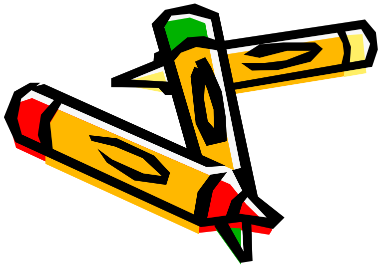
- <u>Problem</u>



# INVOLUTES (Week -5)



- Involute is a single-curved line traced out by an end of a string when unwound itself from straight line or a circle or a polygon, the string being always kept taut.
- Engineering Applications: Casings of centrifugal pumps and Cams are of involute shape.



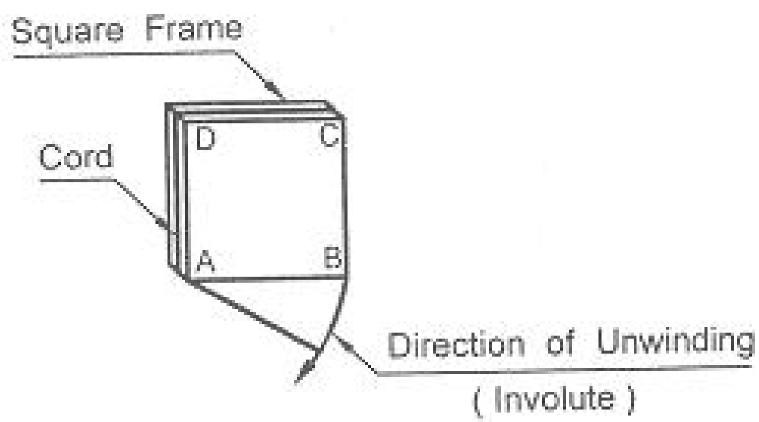
# INVOLUTE OF A SQUARE

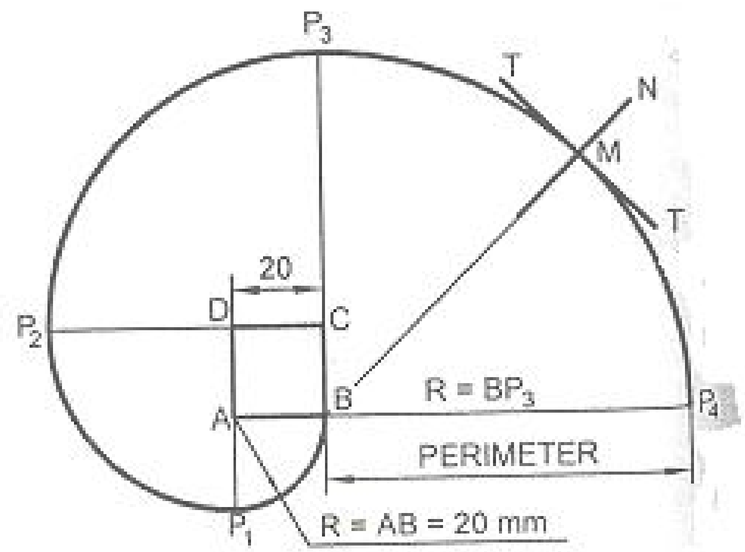
**PROBLEM 7:**

Draw the involute of a square of side 20mm. Draw a tangent and normal at any point M

# Involute of a Square

- <u>Problem</u>




INVOLUTE OF A SQUARE

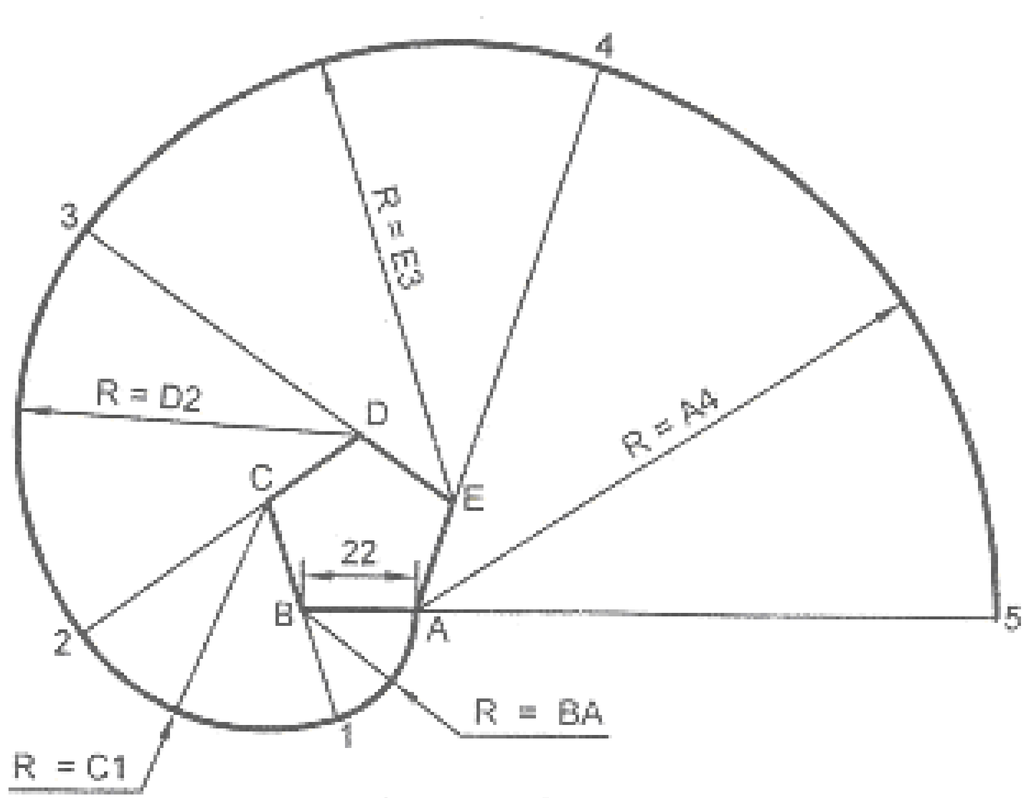
# Involute of a Pentagon

**PROBLEM 8:**

Construct the involute of a pentagon of 22mm side.

# Involute of a Pentagon

- <u>Problem</u>




INVOLUTE OF A PENTAGON

# INVOLUTE OF CIRCLE- UNWOUND PROBLEM

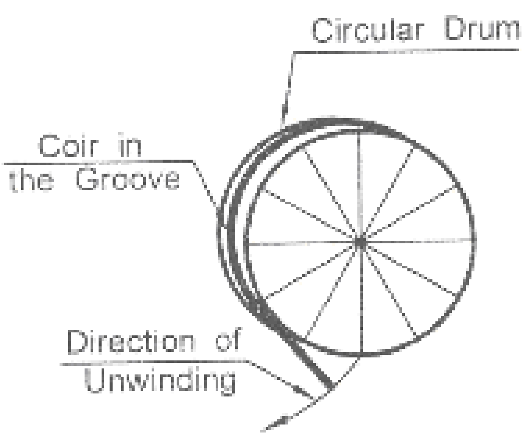
**PROBLEM 9:**

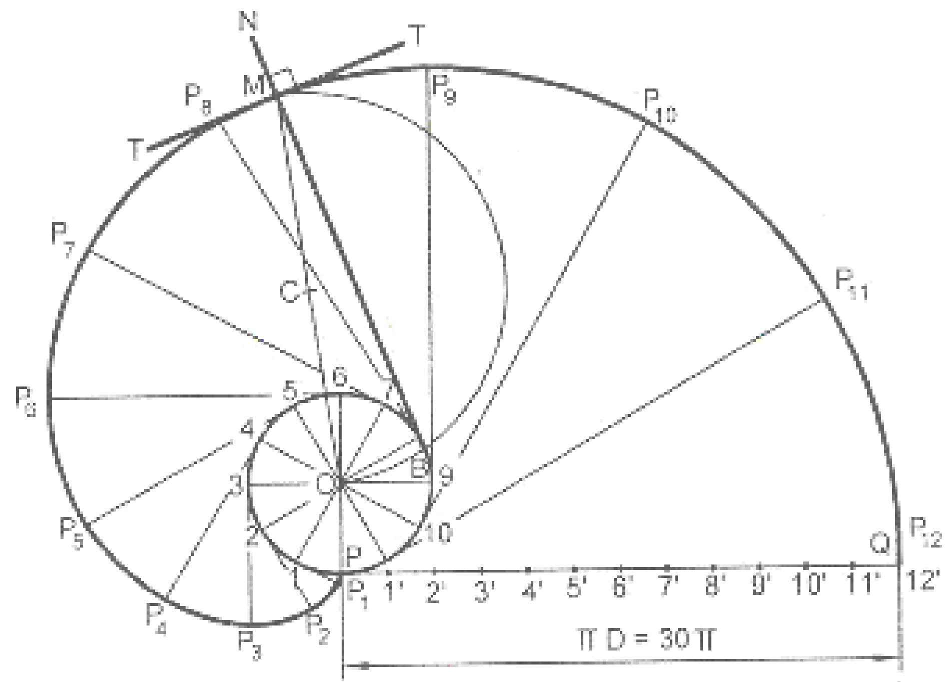
A coir is unwound from a drum of 30mm diameter. Draw the locus of the free end of the coir for unwinding through an angle of 360°.

Draw also a normal and tangent at any point on the curve. (UQ)

# Involute of a Circle

- <u>Problem</u>




INVOLUTE OF A CIRCLE

# INVOLUTE OF A CIRCLE- WOUND PROBLEM

**PROBLEM 10:**

An inelastic string of length 100mm is wound round a circle of 26mm diameter. Draw the path traced by the end of the spring. (UQ)

# END