CURVES USED IN ENGINEERING GRAPHICS

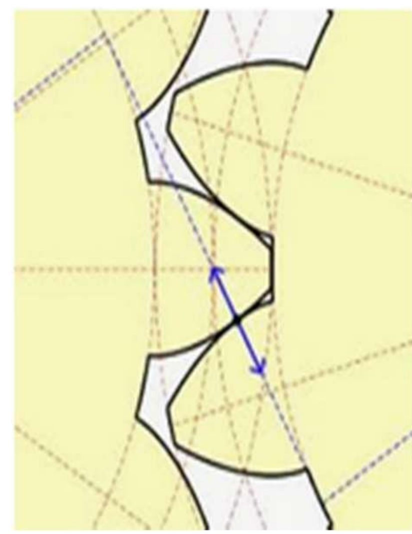
Introduction

- Where curves are used???

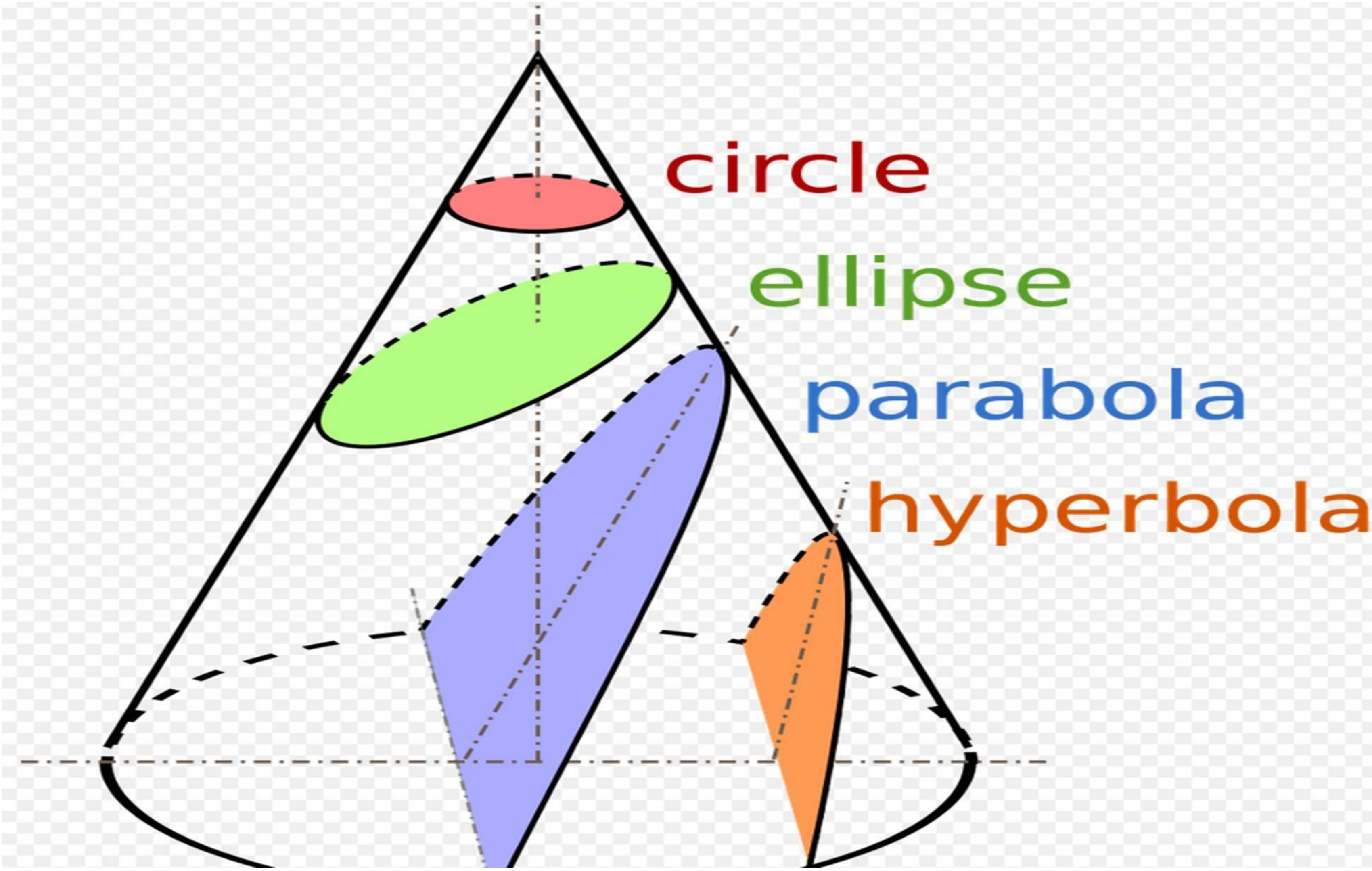






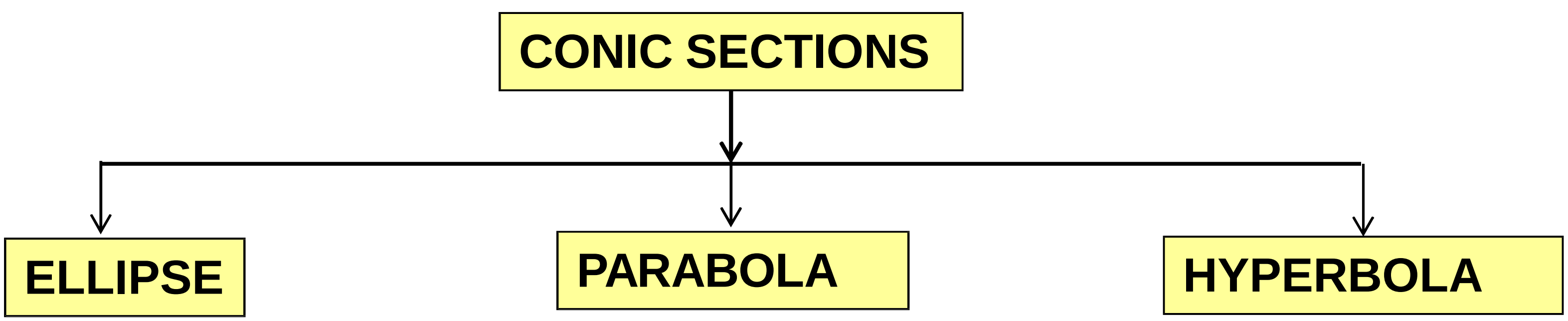



Conic sections

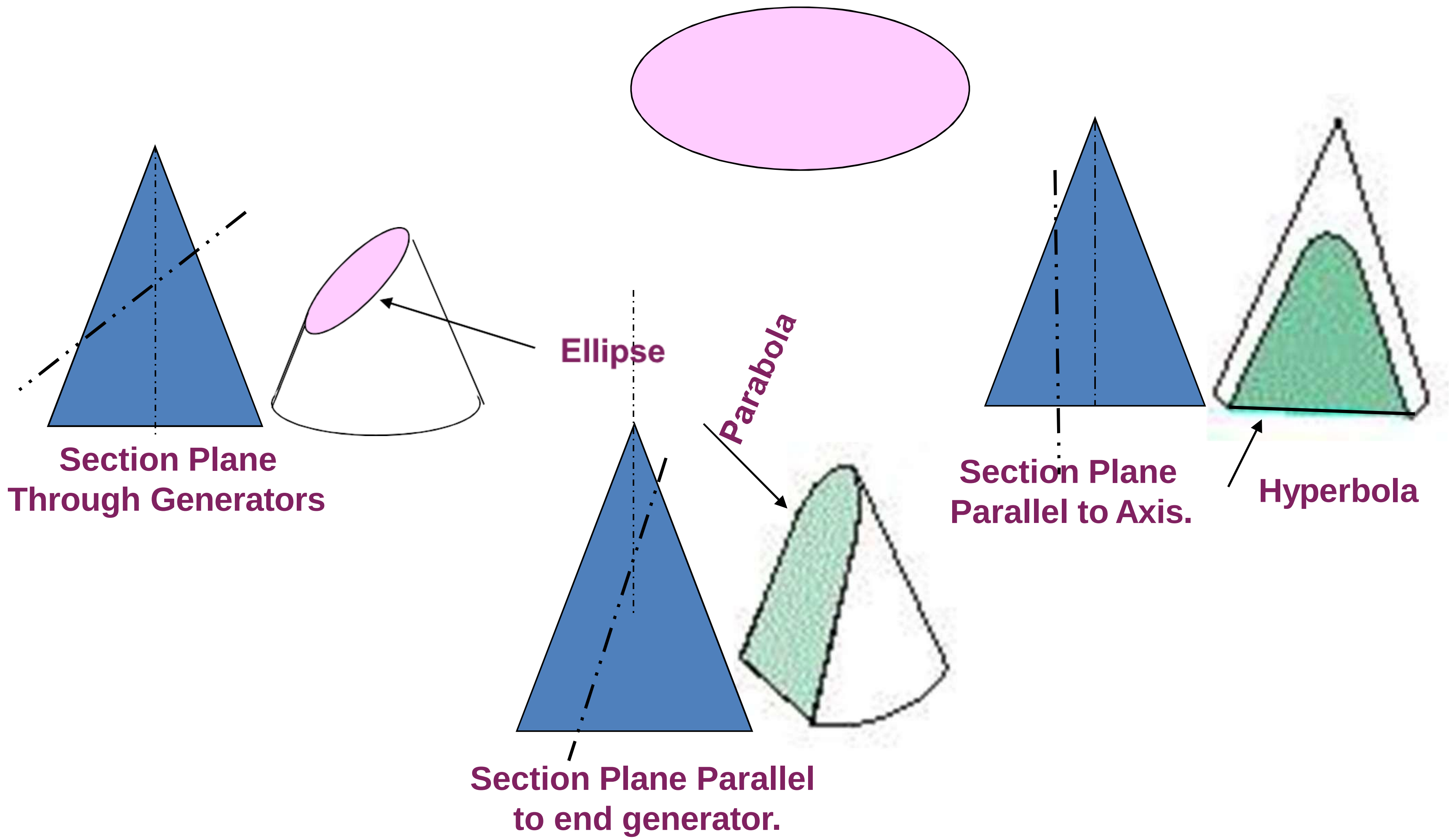


Conic sections

- **Conic section** (or simply **conic**) is a curve obtained as the intersection of the surface of a cone with a plane.



CONIC SECTIONS



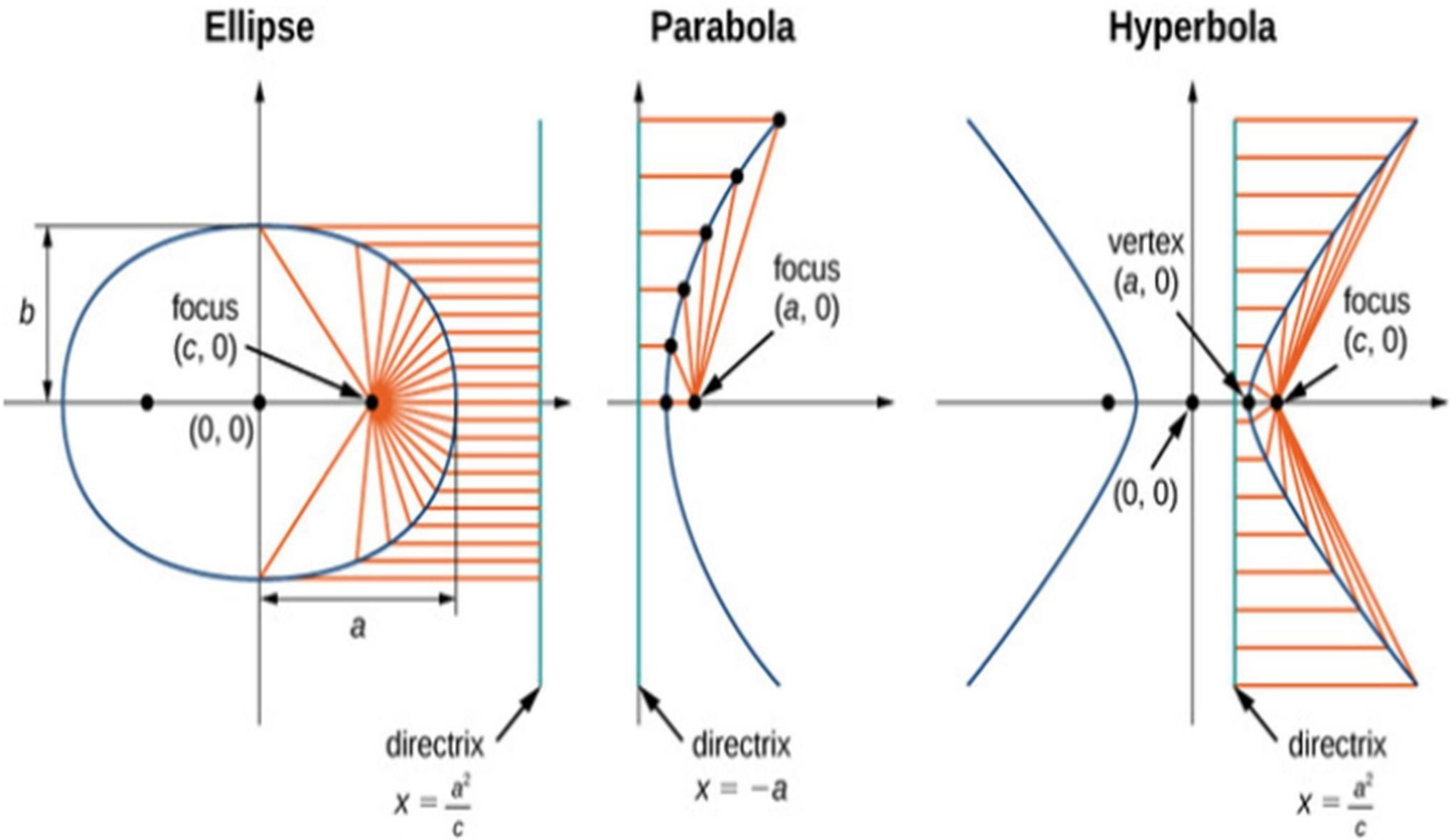
CONIC SECTIONS (CONTD.....)

These are the loci of points moving in a plane such that the ratio of it's distances from a ***fixed point*** And a ***fixed line*** always remains constant.
The Ratio is called **ECCENTRICITY. (E)**

A) For Ellipse E<1
B) For Parabola E=1
C) For Hyperbola E>1

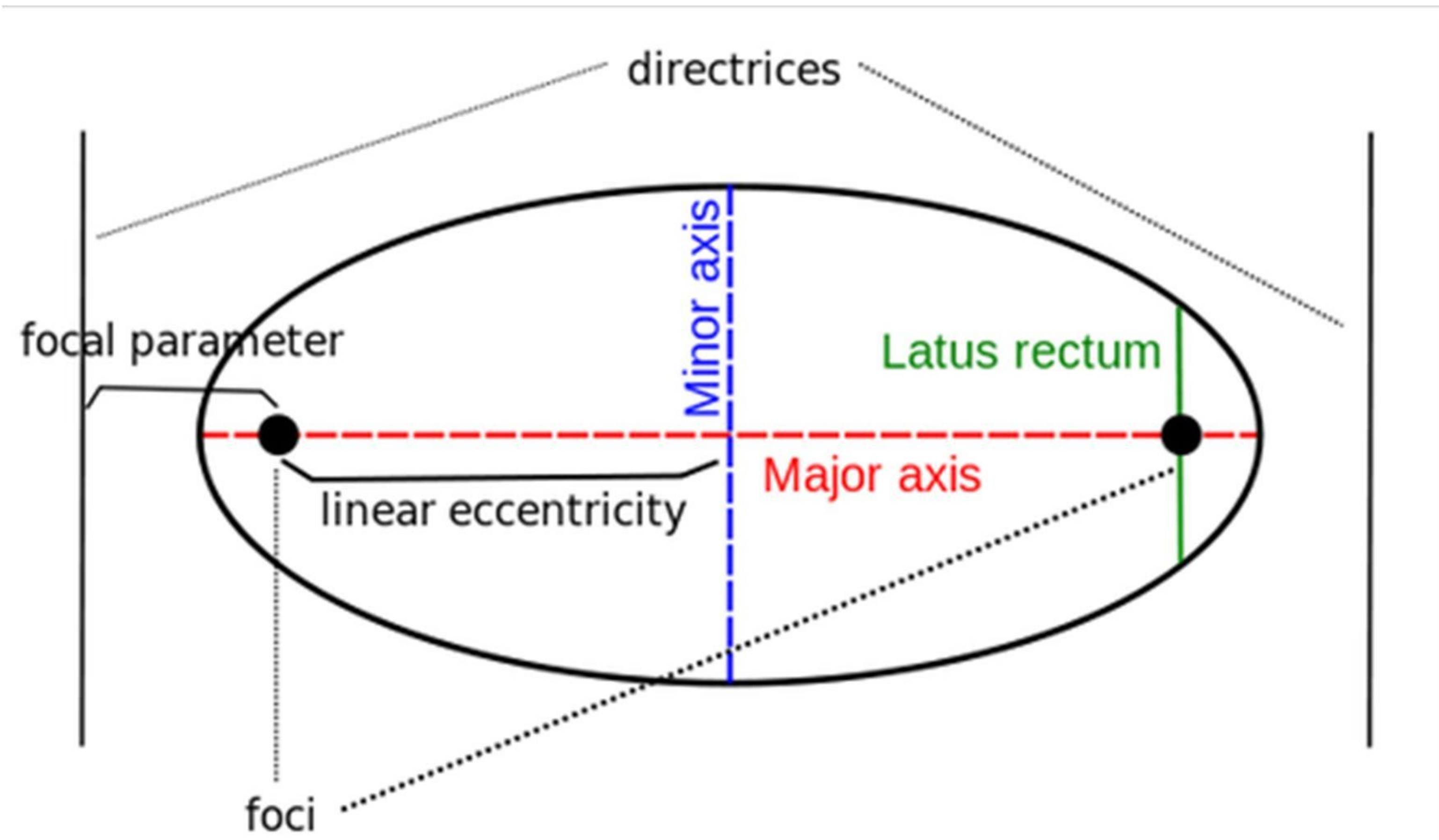
- **The fixed point is called *focus***
- **The fixed line is called *directrix***

Conic sections



ELLIPSE

It is a locus of a point moving in a plane such that the SUM of it's distances from TWO fixed points always remains constant. {And this sum equals to the length of major axis.}These TWO fixed points are FOCUS 1 & FOCUS 2



ELLIPSE (Contd…..)

<u>Methods of Construction</u>

1. **Basic Locus method (Directrix- Focus method)**

2. **Concentric Circle Method**

3. **Rectangle Method**

4. **Oblong Method**

5. **Arcs of Circle Method**

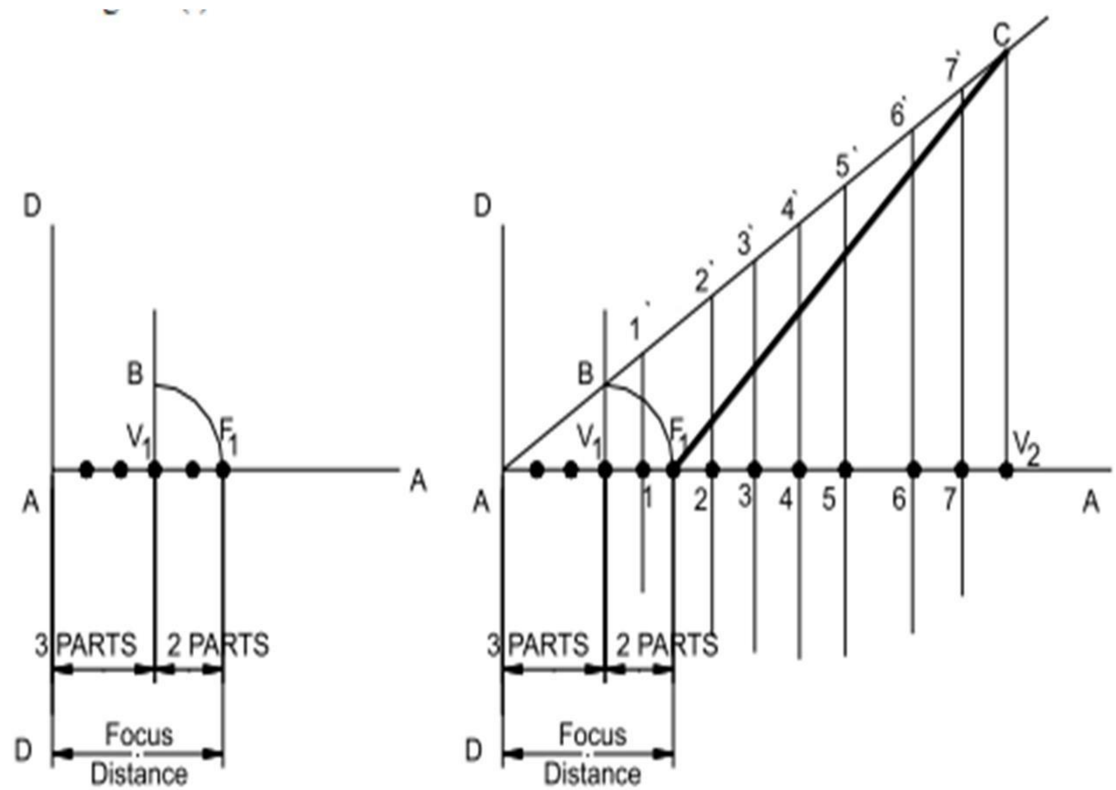
6. **Rhombus Method**

PROBLEM 6:- **POINT F IS 50 MM FROM A LINE AD. A POINT P IS MOVING IN A PLANE SUCH THAT THE *RATIO* OF IT'S DISTANCES FROM F AND LINE AD REMAINS CONSTANT AND EQUALS TO 2/3 DRAW LOCUS OF POINT P. { ECCENTRICITY = 2/3 }**

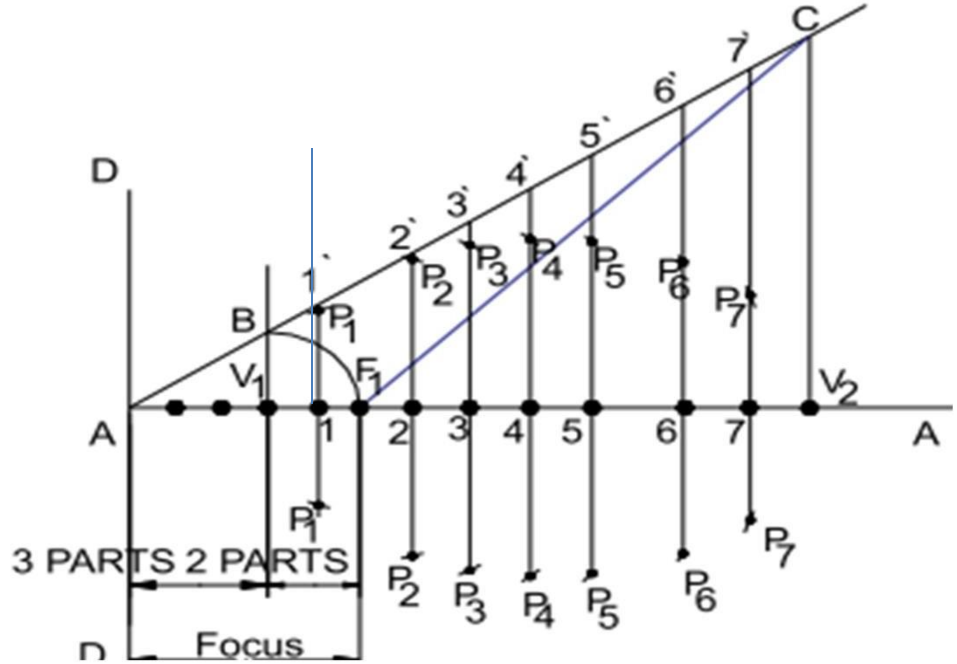
ELLIPSE

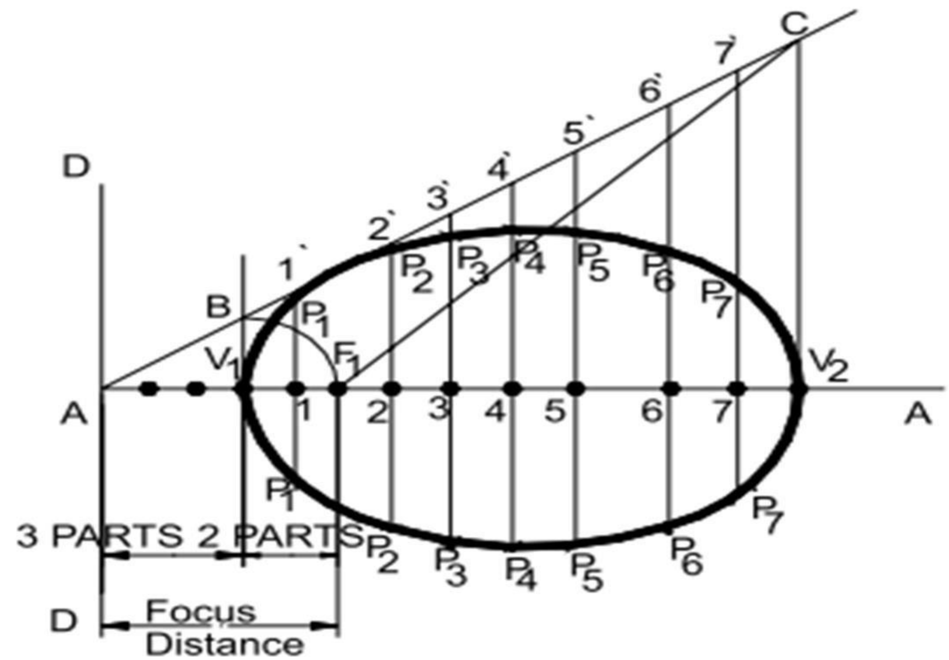
DIRECTRIX-FOCUS METHOD

- **STEPS:**
- **Draw a vertical line AD and point F1 50 mm from it.**
- **Divide 50 mm distance in 5 parts.**
- **Name 2nd part from F1 as V1. It is 20mm and 30mm from F1 and AD line resp. It is first point giving ratio of it's distances from F1 and AD 2/3**
- **Draw a perpendicular line (any convenient length) at point V1 and taking radius as V1 F1 and centre as V1, draw an arc which cuts the perpendicular line at a point B such that V1 B = V1 F1**
- **Join A, B and extend it conveniently.**
- **Draw a 45° line from the foci F1 such that it meets the extended AB line at a point C. Drop a vertical line from point \C onto the axis line AA, which gives the second vertex V2.**



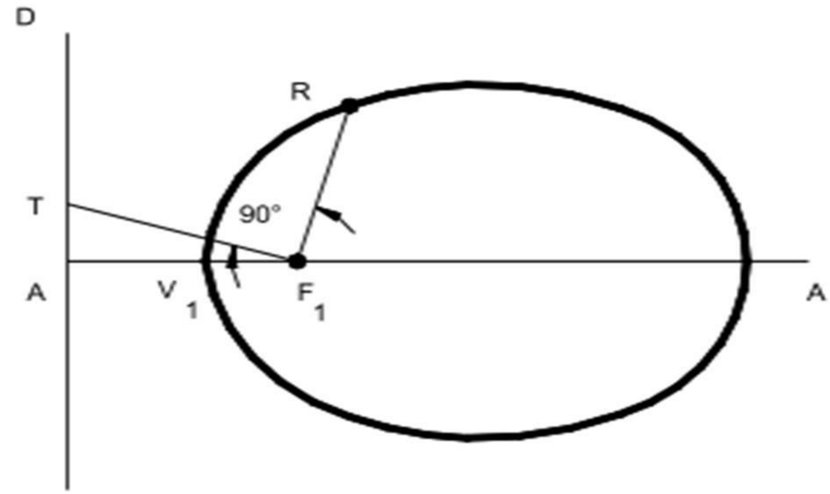
- Mark any number of points (which may or may not be equidistant) in between vertices V1 & V2 and name them 1, 2, 3,….
- Draw perpendicular lines at these divided points 1, 2, 3,…. such that they meet extends AB line at points 1’, 2’, 3’,…. ,.
- step 8: Take 1 – 1’ as radius and centre as F1, cut the perpendicular line 1 – 1’ on either side of the axis, to generate two points named P1 and P’1 on either side of the axis line.
- Step 9: Repeat step 8 taking (2 – 2’),(3 – 3’),(4 – 4’)… as radius and centre as F1 only, cut the respective perpendicular lines (2 – 2’),(3 – 3’),(4 – 4’)…, which generates points P2, P3, P4,… on either side of the axis line.
- Join all the points P1, P2, P3, P4,… including vertices V1 & V2 by smooth curves, which will give the required ellipse,

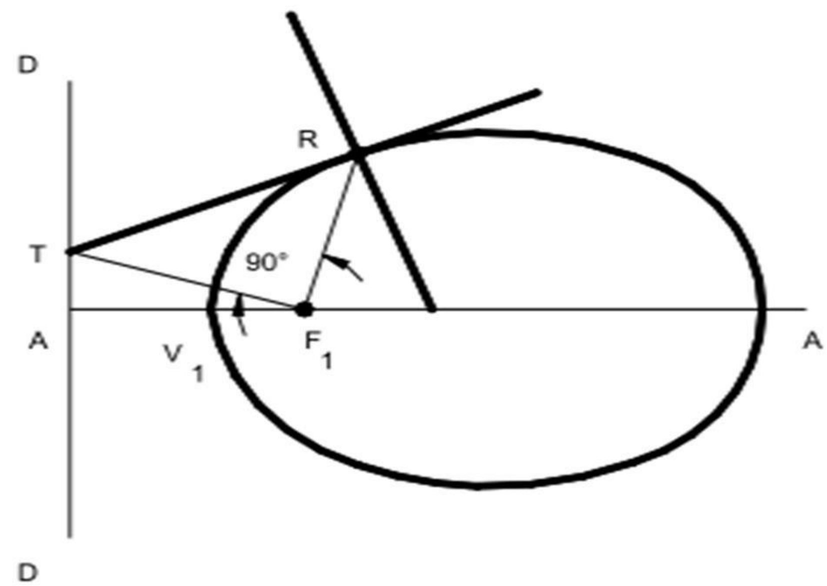




NORMAL AND TANGENT OF ELLIPSE

- Construct the conic section using the eccentricity method.
- Mark a point on the conic section with the given distance, where the normal and the tangent are required and name that point R. Join R to the focus point F1.
- Draw a perpendicular line to RF1 , so that it touches the directrix at the point T
- Join points T, and R and extend it to get a tangent line.
- Draw a perpendicular line to the tangent TR to get the normal line, to the given conic section.

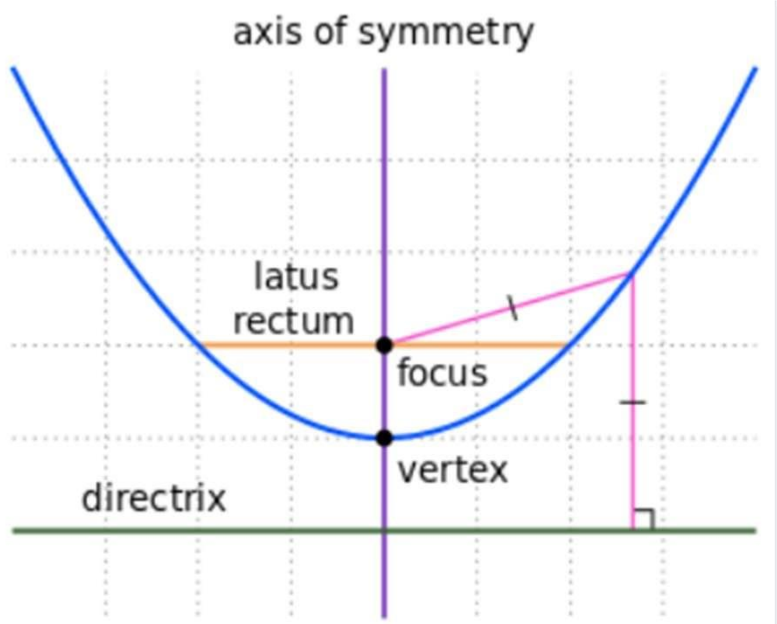




PARABOLA

- Parabola is as a conic section, created from the intersection of a right circular conical surface and a plane parallel to another plane that is tangential to the conical surface

- Parabola is the locus of points in that plane that are equidistant from both the directrix and the focus



Construction method

1. Basic Locus Method (Directrix – focus)

2. Rectangle Method

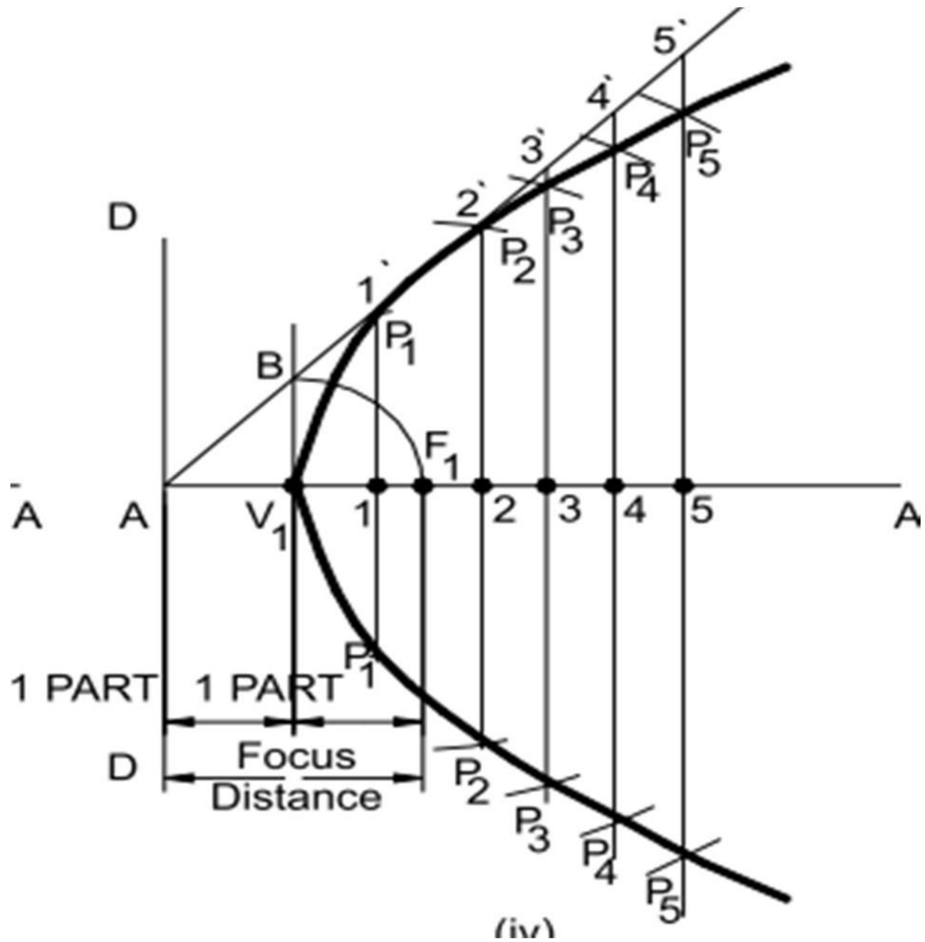
2 Method of Tangents (Triangle Method)

PROBLEM 9: Point F is 50 mm from a vertical straight line AD. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AD.

PARABOLA

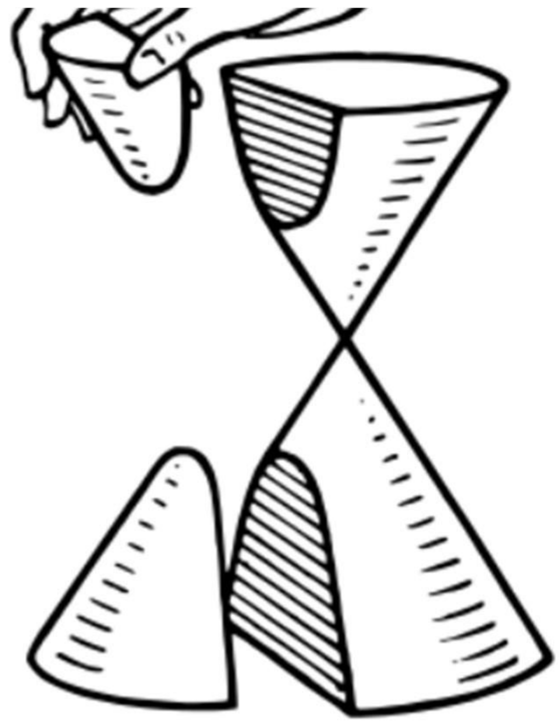
DIRECTRIX-FOCUS METHOD

- **STEPS:**
- Draw a vertical line AD and point F1 50 mm from it.
- Divide AF1. Mark V1 at the center of AF1
- ☐ Mark any number of points (which may or may not be equidistant) and name them 1, 2, 3,….
- ☐ Draw perpendicular lines at these divided points 1, 2, 3,…. such that they meet extends AB line at points 1', 2', 3',…. ,.
- ☐ Take 1 – 1' as radius and centre as F1, cut the perpendicular line 1 on either side of the axis, to generate two points named P1 and P'1 on either side of the axis line.
- ☐ Repeat step taking (2 – 2'),(3 – 3'),(4 – 4')… as radius and centre as F1 only, cut the respective perpendicular lines (2 2'),(3 – 3'),(4 – 4')…, which generates points P2, P3, P4,… on either side of the axis line
- ☐ Join all the points v1, P1, P2, P3, P4,… by smooth curves, which will give the required parabola.



HYPERBOLA

The hyperbola is one of the three kinds of [conic section](), formed by the intersection of a [plane]() and a double [cone]().

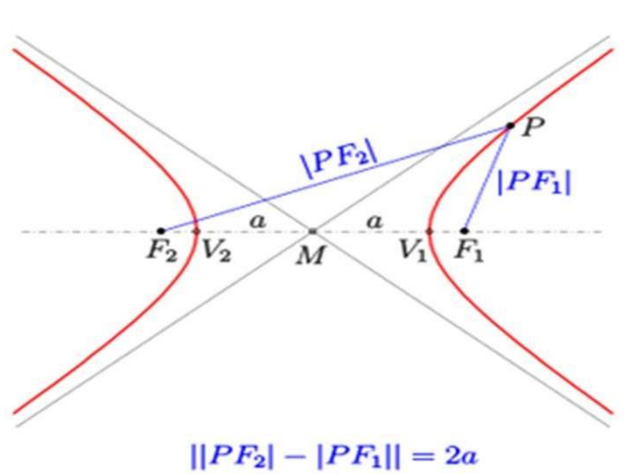


HYPERBOLA

1.Rectangular Hyperbola (coordinates given)

2 Rectangular Hyperbola (P-V diagram - Equation given)

3.Basic Locus Method (Directrix – focus)

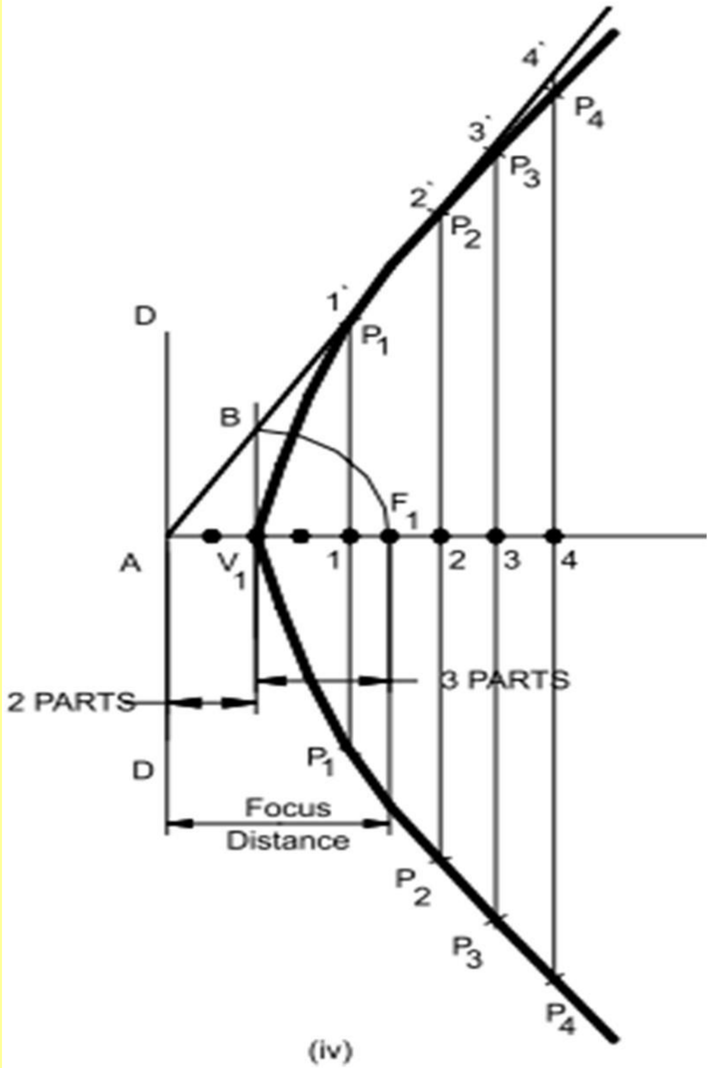


A **hyperbola** is a set of points, such that for any point P of the set, the absolute difference of the distances | P F 1 | , | P F 2 | ,|PF1|-|PF2| to two fixed points F 1 , F 2, (the *foci*), is constant, usually denoted by 2 a ,

PROBLEM 12:- POINT F IS 50 MM FROM A LINE AB. A POINT P IS MOVING IN A PLANE SUCH THAT THE RATIO OF IT'S DISTANCES FROM F AND LINE AB REMAINS CONSTANT AND EQUALS TO 3/2 DRAW LOCUS OF POINT P. { ECCENTRICITY = 3/2 }

HYPERBOLA
DIRECTRIX -FOCUS METHOD

- Draw a vertical directrix line DD and an axis line AA perpendicular to it, of convenient length. Mark the focus distance from the directrix on the axis line and name the point F1.
- Divide the line segment AF1 into equal number of parts, such that the number of parts is equal to the sum of the numerator and the denominator of the eccentricity ratio, e.g., say, if the eccentricity ratio is 3/2 then divide the line segment AF1 into (3 + 2 = 5) 5 parts.
- Use the eccentricity formula to locate the vertex V1 on the axis line such that V1 F1 is equal to 3 parts (numerator) and AV1 is equal to 2 parts (denominator), among the five parts divided.
- Draw a perpendicular line at point V1 of convenient length and taking radius as V1 F1 and centre as V1, draw an arc which cuts the perpendicular line at a point named B, such that V1 B = V1 F1.
- Join A, B and extend it conveniently
- Mark any number of points (which may or may not be equidistant) to the right side of vertex V1 and name them 1, 2, 3,…
- Draw perpendicular lines at these divided points 1, 2, 3,…. such that they meet, AB extend line at points 1',2', 3',….,
- Take 1 – 1' as radius and centre as F1, cut the perpendicular line 1 – 1' on either side of the axis, to get 2 points named P1 on either side of the axis line AA.

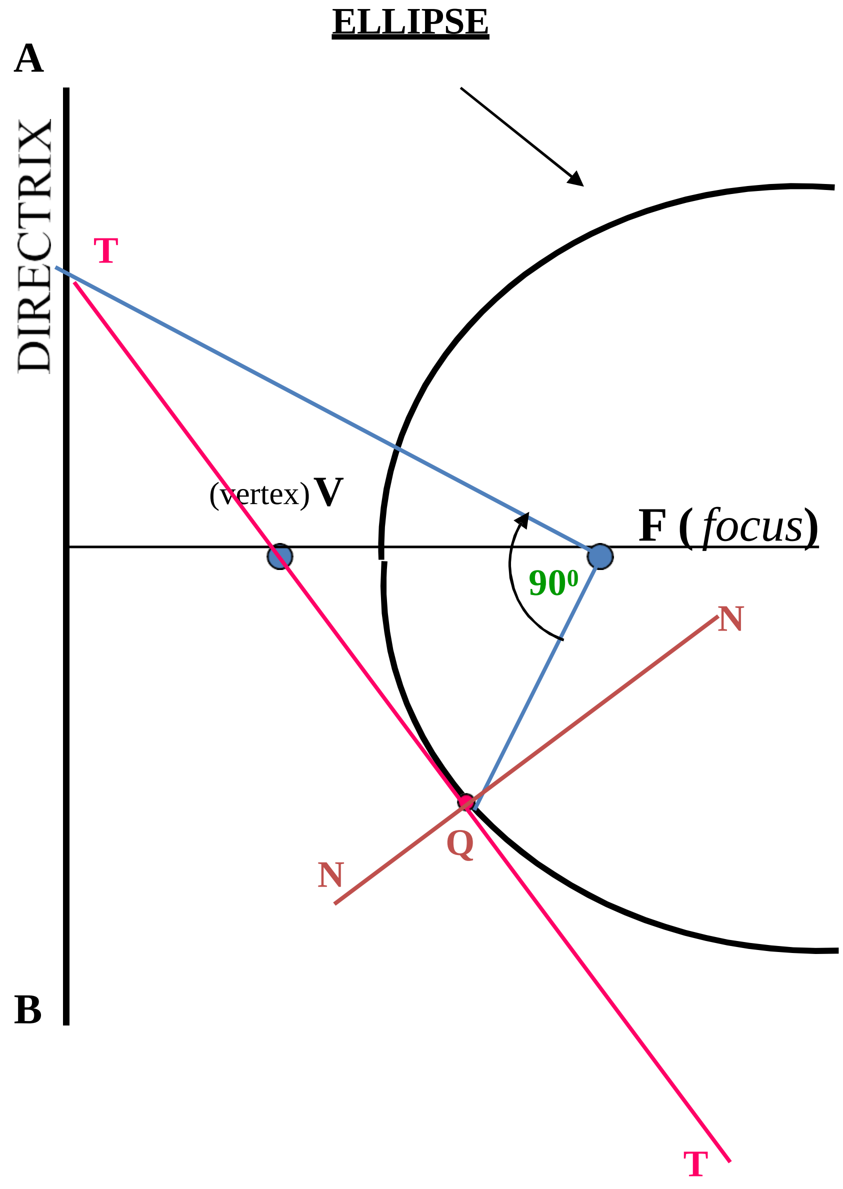


ELLIPSE
TANGENT & NORMAL

Problem 14:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT **Q** TO **F.**
2. CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.

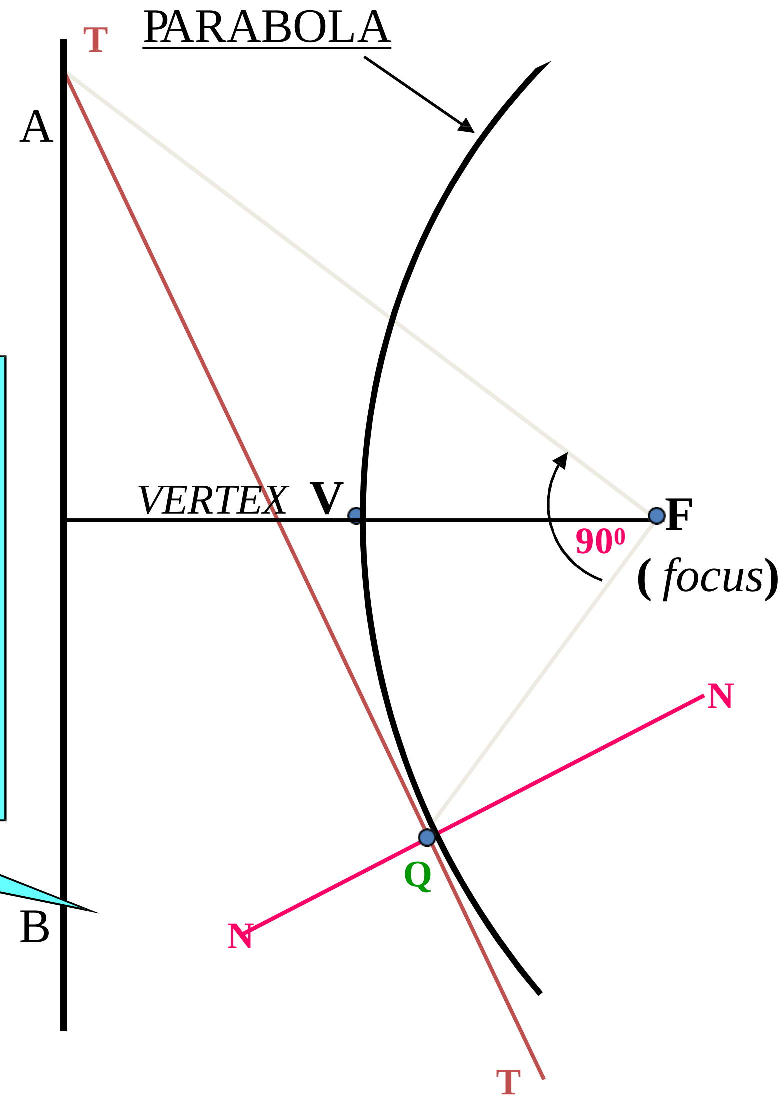


PARABOLA
TANGENT & NORMAL

Problem 15:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT **90^0** ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4.JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO THE CURVE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.

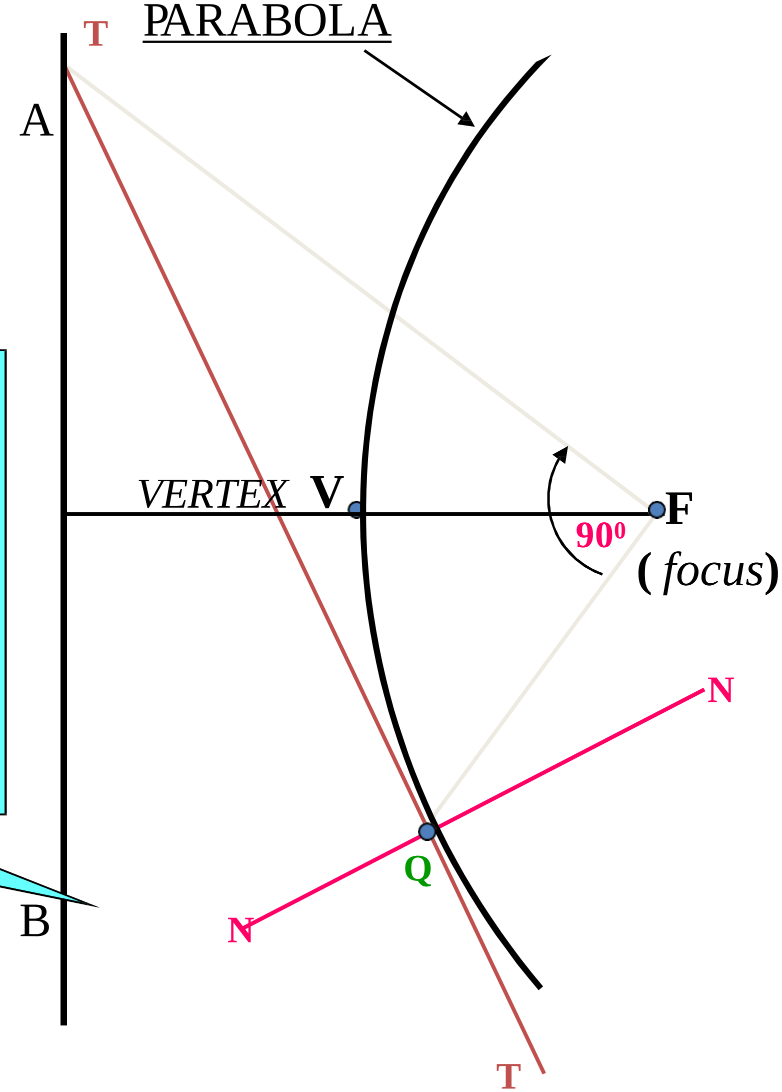


PARABOLA
TANGENT & NORMAL

Problem 15:

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT **Q** TO **F.**
2. CONSTRUCT **90^0** ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO THE CURVE FROM Q
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.

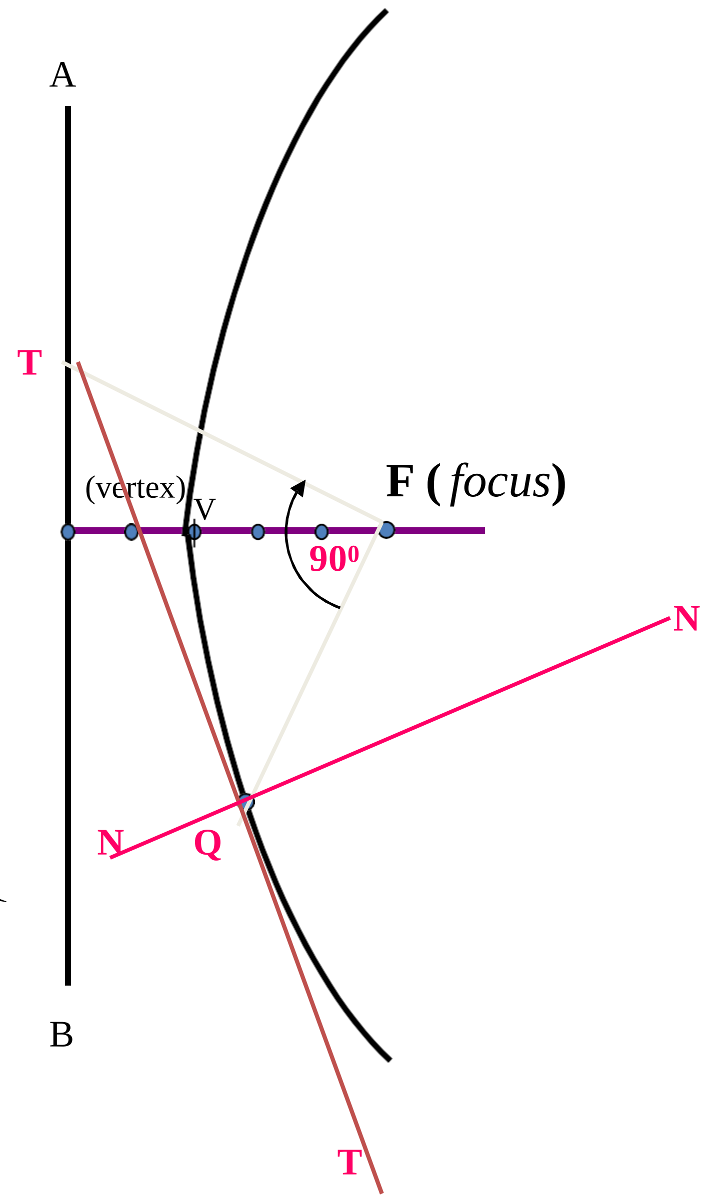


HYPERBOLA
TANGENT & NORMAL

Problem 16

TO DRAW TANGENT & NORMAL TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT **Q** TO **F.**
2. CONSTRUCT 90^0 ANGLE WITH THIS LINE AT POINT **F**
3. EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO **Q** AND EXTEND. THIS IS TANGENT TO CURVE FROM **Q**
5. TO THIS TANGENT DRAW PERPENDICULAR LINE FROM **Q**. IT IS NORMAL TO CURVE.

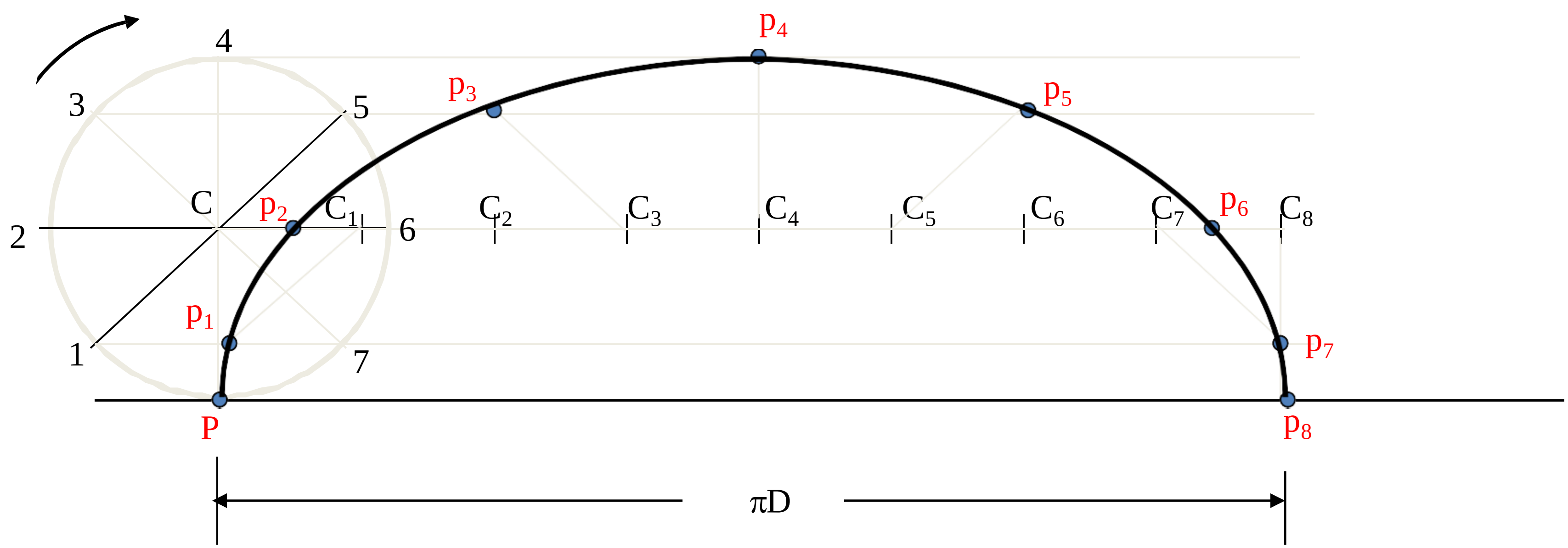


CYCLOID

A **cycloid** is the curve traced by a point on the rim of a circular wheel as the wheel rolls along a straight line without slipping.

PROBLEM 22: DRAW LOCUS OF A POINT ON THE PERIPHERY OF A CIRCLE WHICH ROLLS ON STRAIGHT LINE PATH. Take Circle diameter as 50 mm

CYCLOID



Steps

1) From center C draw a horizontal line equal to πD distance.
2) Divide πD distance into 8 number of equal parts and name them C1, C2, C3 etc.
3) Divide the circle also into 8 number of equal parts and in clock wise direction, after P name 1, 2, 3 up to 8.
4) From all these points on circle draw horizontal lines. (parallel to locus of C)
5) With a fixed distance C-P in compass, C1 as center, mark a point on horizontal line from 1. Name it P1.
6) Repeat this procedure from C2, C3, C4 upto C8 as centers. Mark points P2, P3, P4, P5 up to P8 on the horizontal lines drawn from 2, 3, 4, 5, 6, 7 respectively.
7) Join all these points by curve. **It is Cycloid**.

Reference Youtube Videos

- ELLIPSE DRAWING

https://www.youtube.com/watch?v=qkPZgVbtiHE

- PARABOLA DRAWING
- https://www.youtube.com/watch?v=ZlekZGPfbo8
- Hyperbola Drawing:
- https://www.youtube.com/watch?v=dcaGNfplUbU

Reference Youtube Videos

- Cycloid drawing

https://www.youtube.com/watch?v=UiNKuPztBfg

- Involute Drawing

https://www.youtube.com/watch?v=WmhOVyQVveQ

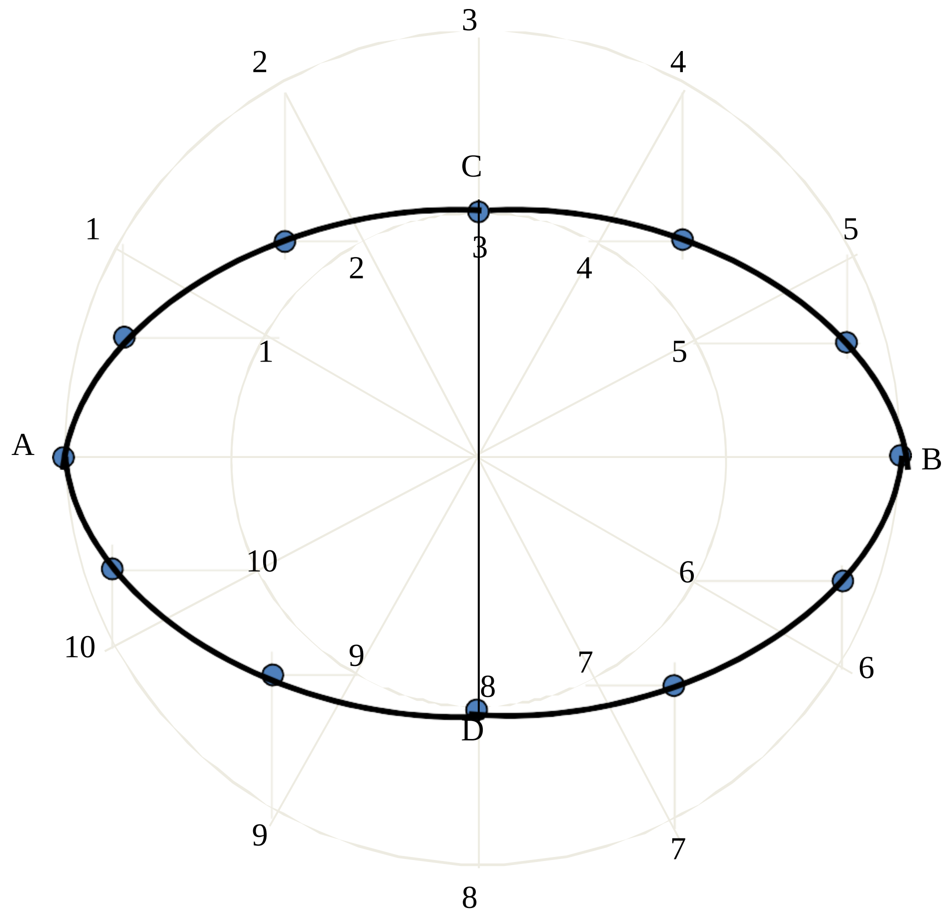
OTHER METHODS FOR CONSTRUCTING ELLIPSE

Problem 1 :-

Draw ellipse by **concentric circle method**.
Take major axis 100 mm and minor axis 70 mm long.

ELLIPSE
BY CONCENTRIC CIRCLE METHOD

Steps:
1.Draw both axes as perpendicular bisectors of each other & name their ends as shown.
2.Taking their intersecting point as a center, draw two concentric circles considering both as respective diameters.
3.Divide both circles in 12 equal parts & name as shown.
4.From all points of outer circle draw vertical lines downwards and upwards respectively.
5.From all points of inner circle draw horizontal lines to intersect those vertical lines.
6.Mark all intersecting points properly as those are the points on ellipse.
7.Join all these points along with the ends of both axes in smooth possible curve. It is required ellipse.



ELLIPSE

BY RECTANGLE METHOD

Problem 2

Draw ellipse by **Rectangle** *method.*

Take major axis 100 mm and minor axis 70 mm long.

Steps:

1 Draw a rectangle taking major and minor axes as sides.

2. In this rectangle draw both axes as perpendicular bisectors of each other..

3.For construction, select upper left part of rectangle. Divide vertical small side and horizontal long side into same number of equal parts.(here divided in four parts)

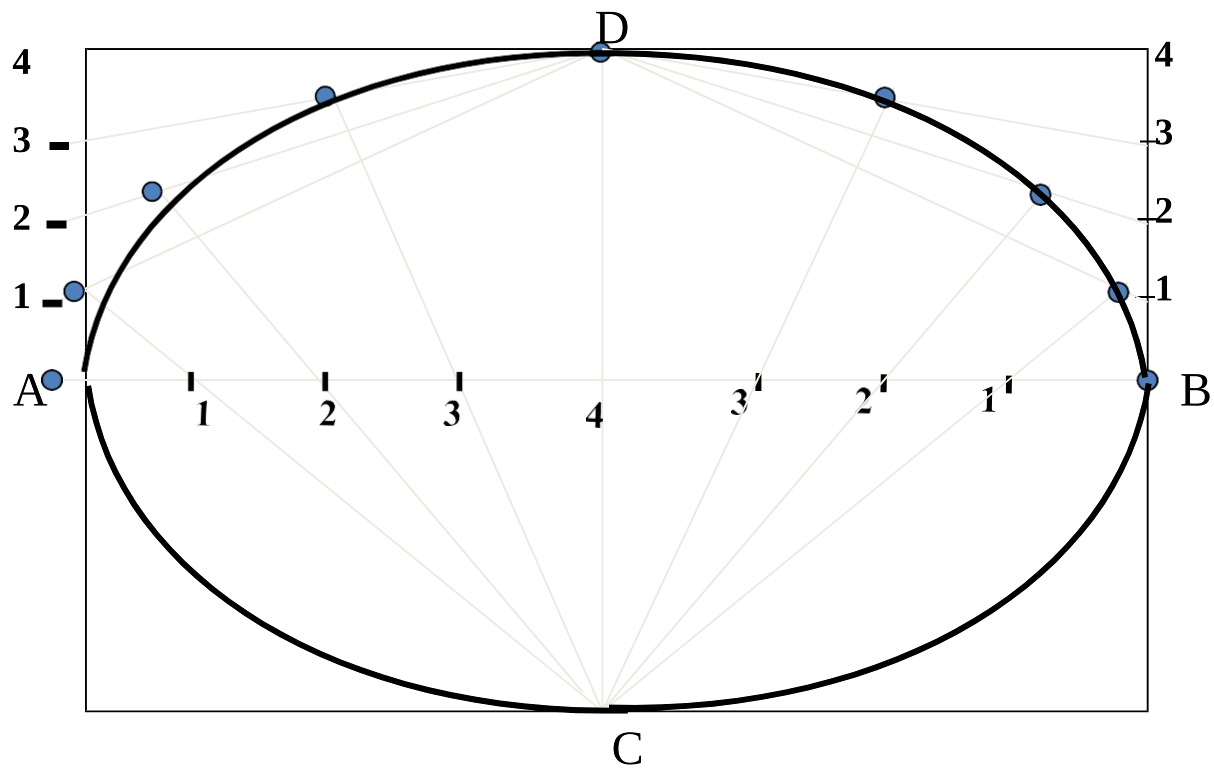
4. Name those as shown..

5.Now join all vertical points 1,2,3,4, to the upper end of minor axis. And all horizontal points i.e.1,2,3,4 to the lower end of minor axis.

6.Then extend C-1 line upto D-1 and mark that point. Similarly extend C-2, C-3, C-4 lines up to D-2, D-3, & D-4 lines.

7.Mark all these points properly and join all along with ends A and D in smooth possible curve. Do similar construction in right side part.along with lower half of the rectangle.Join all points in smooth curve.

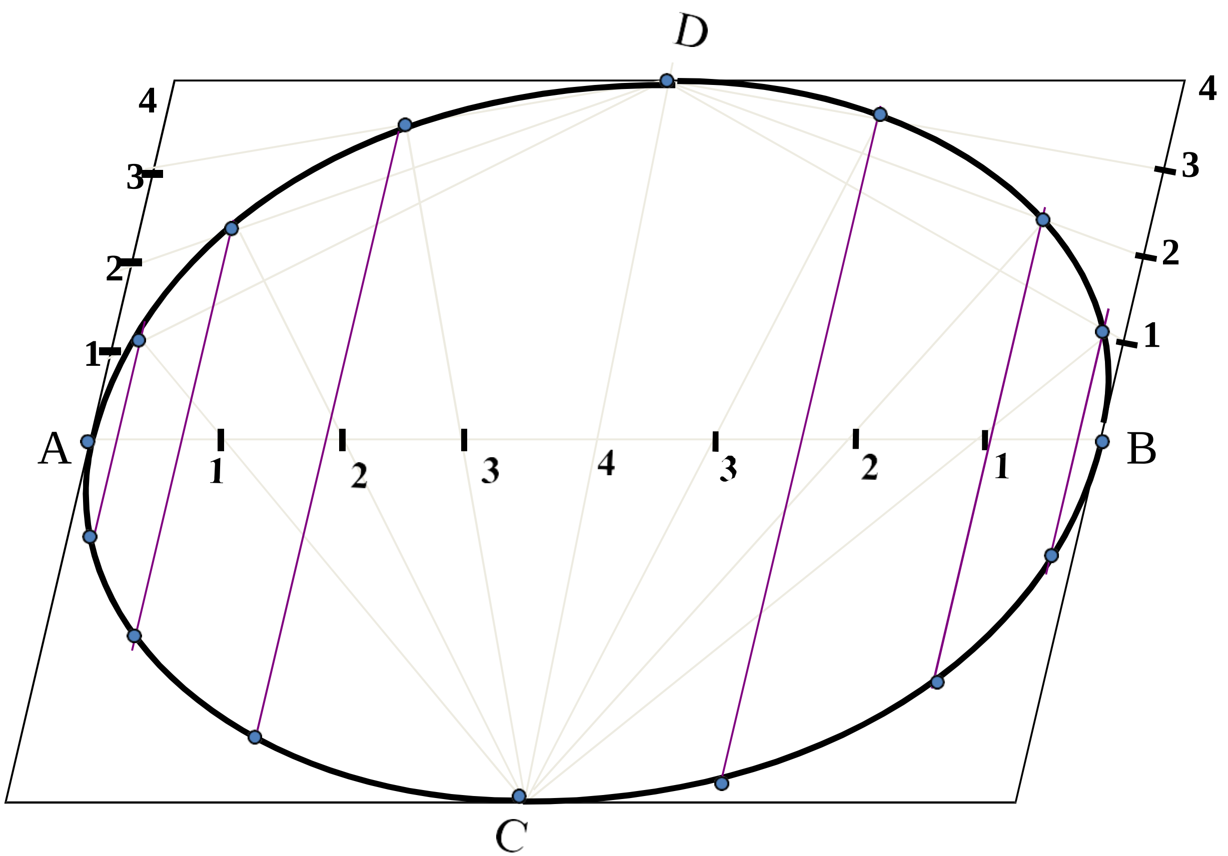
It is required ellipse.



Problem 3:- *Draw ellipse by* **Oblong method.**
Draw a parallelogram of 100 mm and 70 mm long sides with included angle of 75^0*.Inscribe Ellipse in it.*

ELLIPSE

BY OBLONG METHOD



PROBLEM 4.
MAJOR AXIS AB & MINOR AXIS CD ARE 100 AMD 70MM LONG RESPECTIVELY .DRAW ELLIPSE BY ARCS OF CIRLES METHOD.

ELLIPSE

BY ARCS OF CIRCLE METHOD

STEPS:

1.Draw both axes as usual.Name the ends & intersecting point
2.Taking AO distance I.e.half major axis, from C, mark F_1 & F_2 On AB . (focus 1 and 2.)
3.On line F_1- O taking any distance, mark points 1,2,3, & 4
4.Taking F_1 center, with distance A-1 draw an arc above AB and taking F_2 center, with B-1 distance cut this arc.
Name the point p_1
5.Repeat this step with same centers but taking now A-2 & B-2 distances for drawing arcs. Name the point p_2
6.Similarly get all other P points. With same steps positions of P can be located below AB.
7.Join all points by smooth curve to get an ellipse/

As per the definition Ellipse is locus of point P moving in a plane such that the SUM of it's distances from two fixed points (F_1 & F_2) remains constant and equals to the length of major axis AB.(Note A .1+ B .1=A . 2 + B. 2 = AB)