ENGINEERING CURVES
Part- I {Conic Sections}

ELLIPSE

1. Concentric Circle Method

2. Rectangle Method

3. Oblong Method

4. Arcs of Circle Method

5. Rhombus Metho

6. Basic Locus Method
   (Directrix – focus)

PARABOLA

1. Rectangle Method

2 Method of Tangents
(Triangle Method)

3. Basic Locus Method
(Directrix – focus)

HYPERBOLA

1. Rectangular Hyperbola
   (coordinates given)

2 Rectangular Hyperbola
   (P-V diagram - Equation giv

3. Basic Locus Method
   (Directrix – focus)

Methods of Drawing
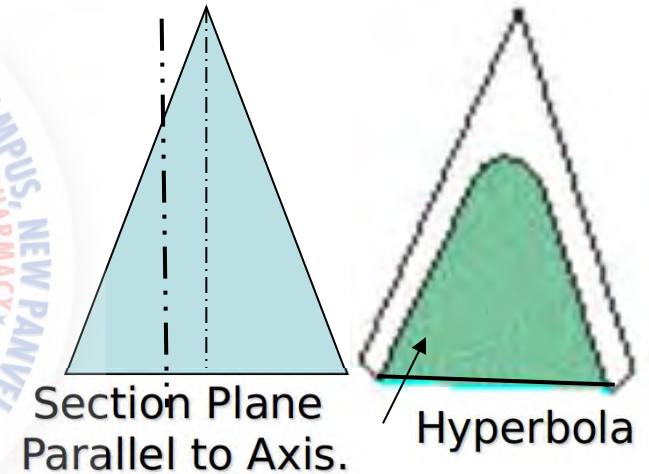**Tangents & Normals**
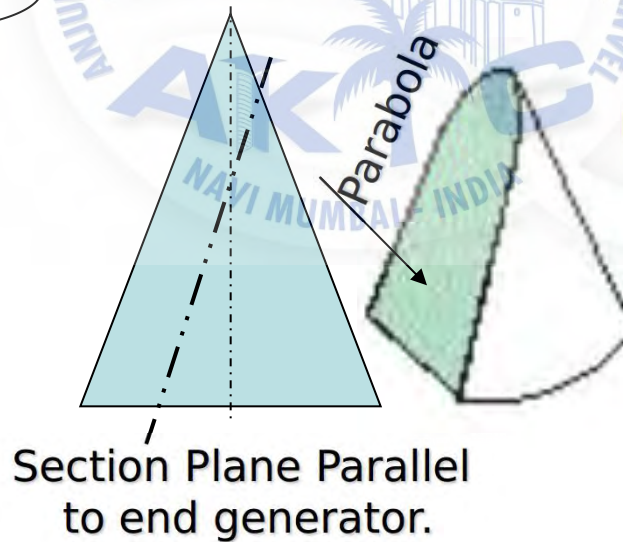 **To These Curves.**
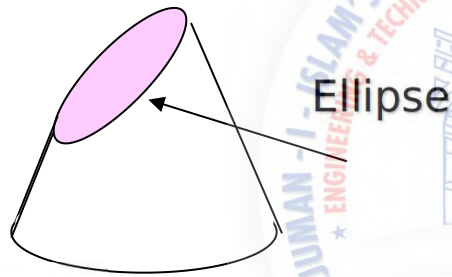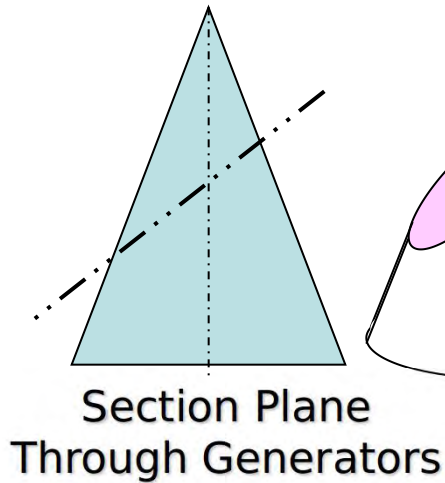
CONIC SECTIONS
ELLIPSE, PARABOLA AND HYPERBOLA ARE CALLED CONIC SECTIONS
BECAUSE
THESE CURVES APPEAR ON THE SURFACE OF A CONE
WHEN IT IS CUT BY SOME TYPICAL CUTTING PLANES.

OBSERVE
ILLUSTRATIONS
GIVEN BELOW..

Ellipse

Section Plane
Through Generators

Parabola

Section Plane
Parallel to Axis.

Hyperbola

Section Plane Parallel
to end generator.

COMMON DEFINATION OF ELLIPSE, PARABOLA & HYPERBOLA:

e are the loci of points moving in a plane such that the ratio of it's dista
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**

Refer Problem nos. 6. 9 & 12

SECOND DEFINATION OF AN 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*

**Refer Problem no.4**
Ellipse by Arcs of Circles Method.

These TWO   & FOCUS

ELLIPSE
BY CONCENTRIC CIRCLE METHOD

Problem 1 :-
Draw ellipse by **concentric circle method**.
Take major axis 100 mm and minor axis 70 mm long.

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.
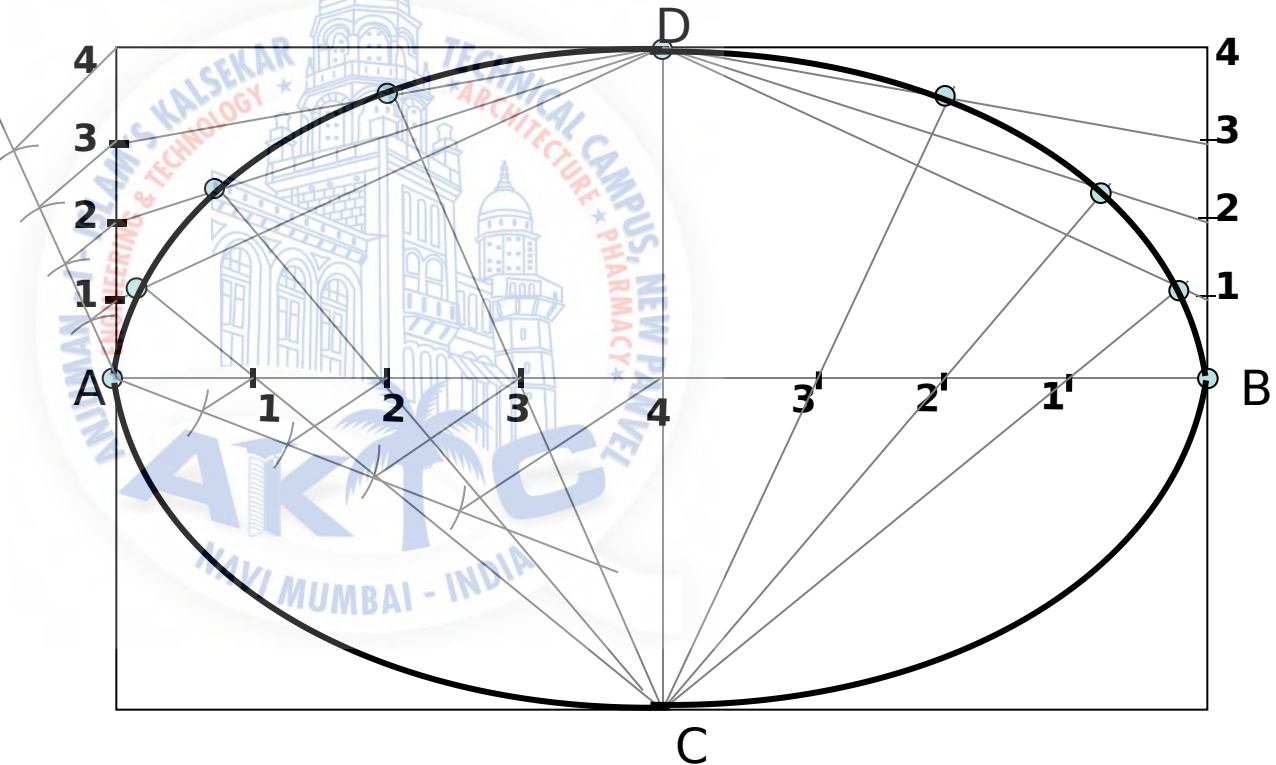
ELLIPSE
BY RECTANGLE METHOD
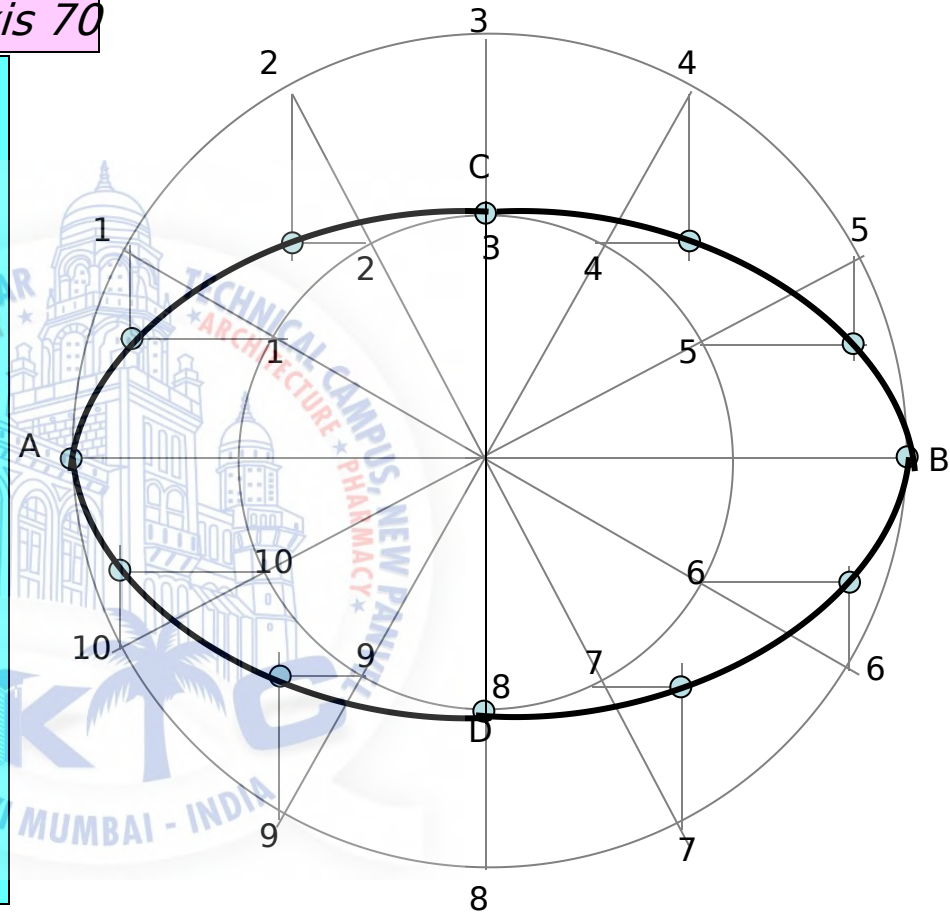
Steps:

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.

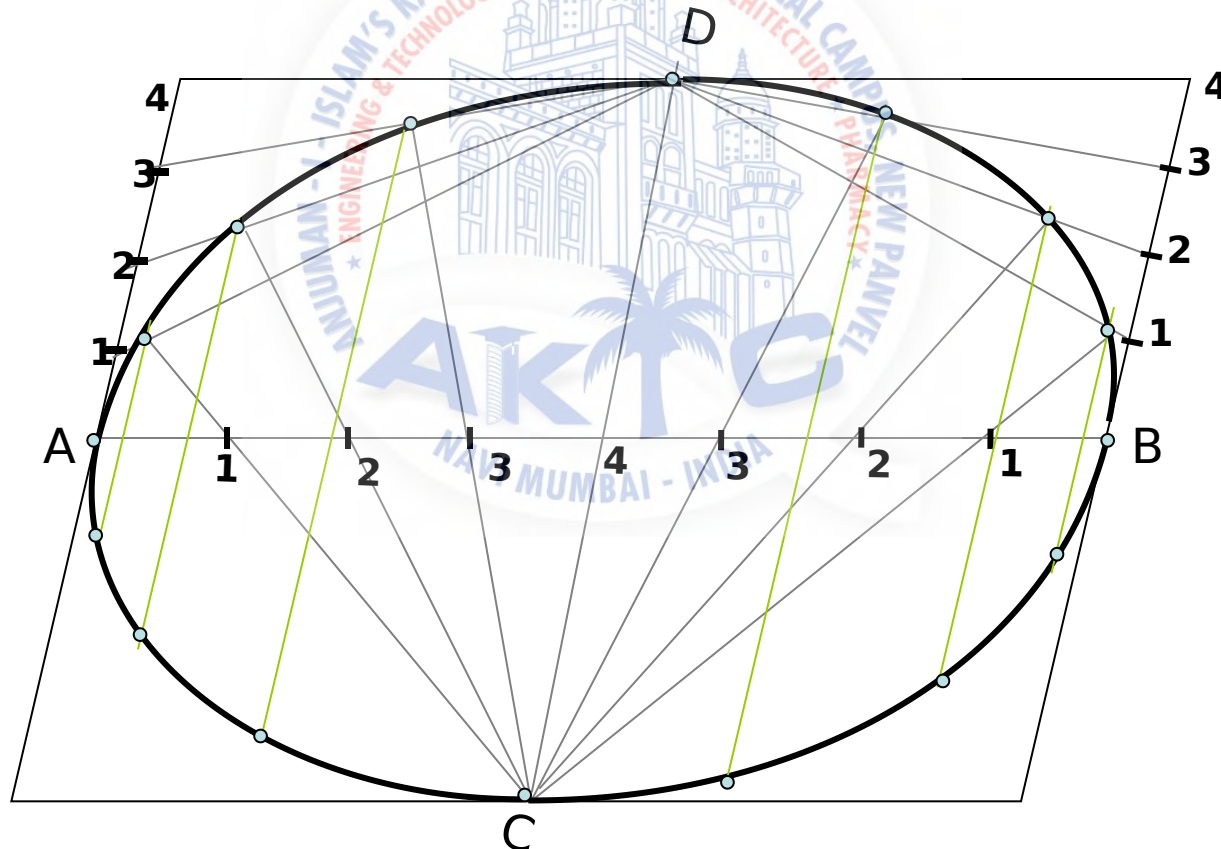**7.** Mark all these points properly and join all along with ends A and D in smooth possible curve. Do

---

Problem 2
Draw ellipse by **Rectangle** *method.*
Take major axis 100 mm and minor axis 70 mm long.
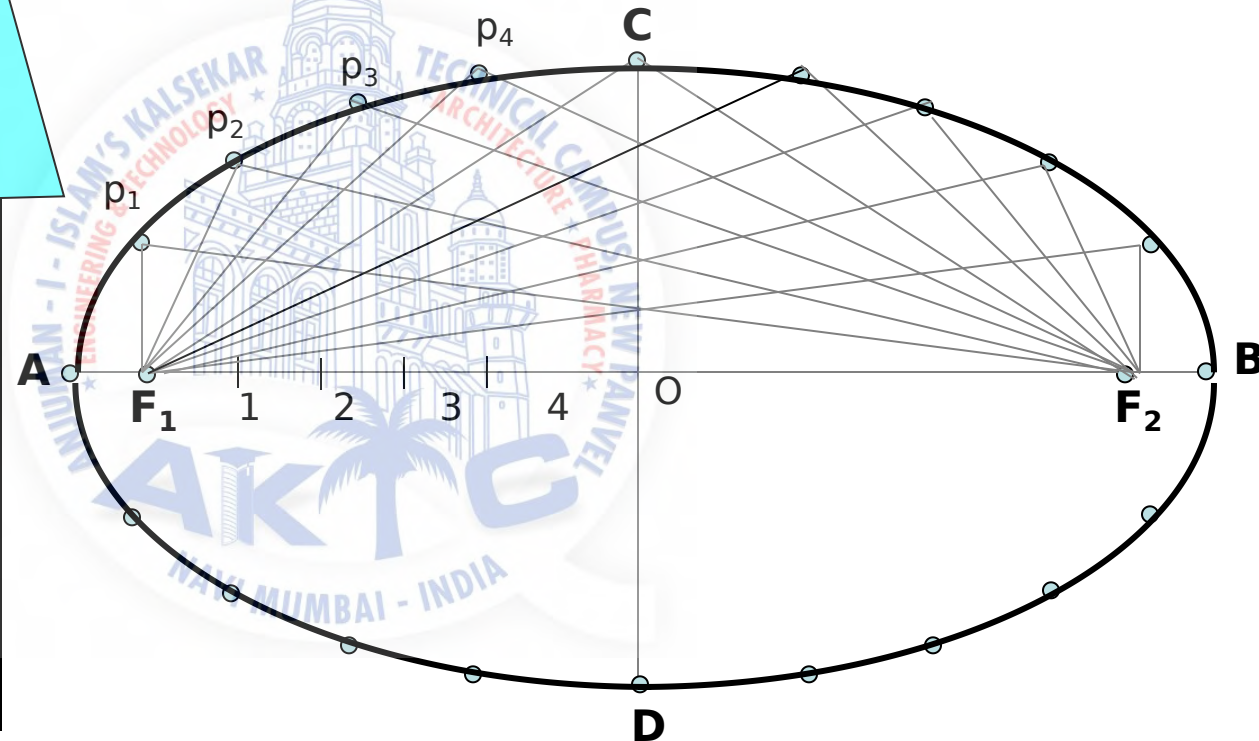
BY OBLONG METHOD

Problem 3:-
Draw ellipse by **Oblong method.**
Draw a parallelogram of 100 mm and 70 mm long sides with included angle of 75⁰ Inscribe Ellipse in it.

**STEPS ARE SIMILAR TO
THE PREVIOUS CASE
(RECTANGLE METHOD)
ONLY IN PLACE OF RECTANGLE,
HERE IS A PARALLELOGRAM.**

BY ARCS OF CIRCLE METHOD

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

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

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
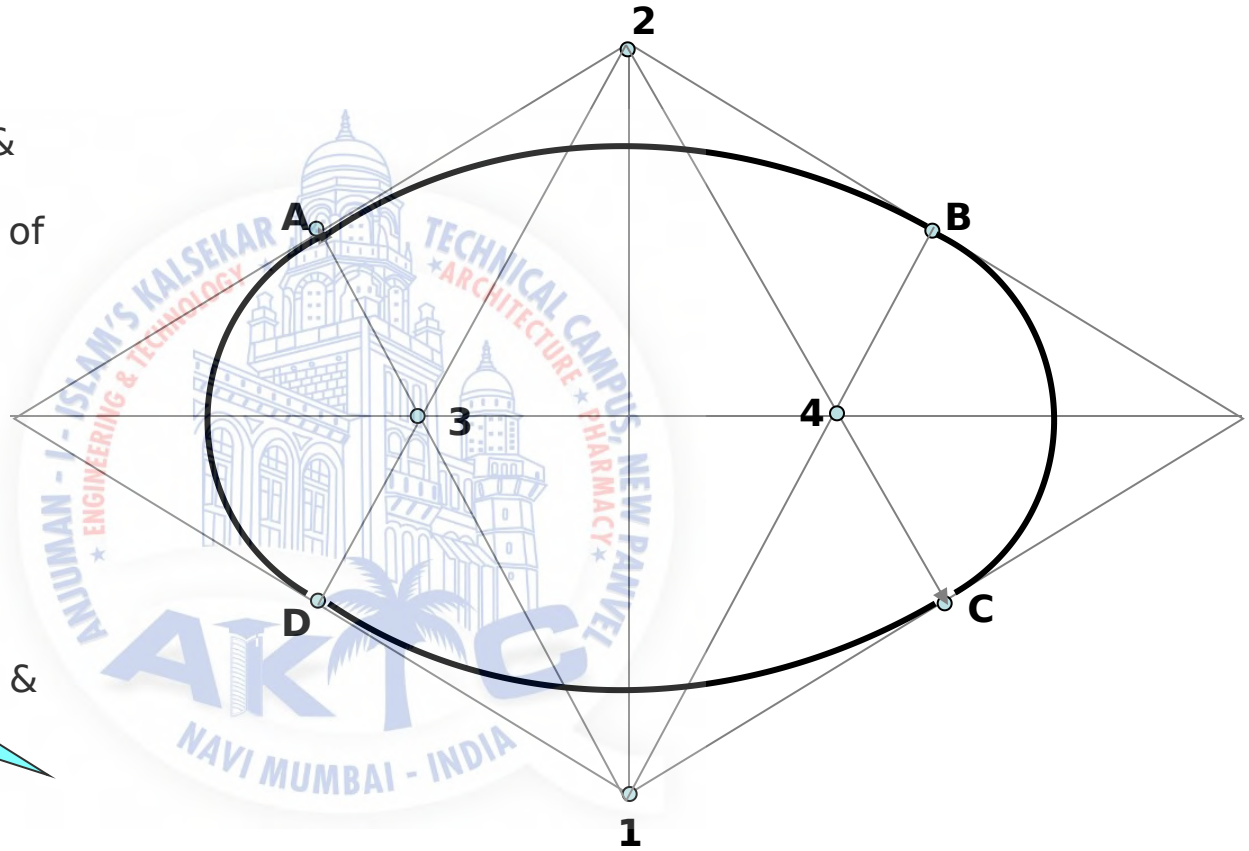 drawing arcs. Name the point p_2
6.Similarly get all other P points.
   With same steps positions of

p_4

p_3

p_2

C

p_1

A

F_1 1   2   3   4   O   B

F_2

D

PROBLEM 5 MR 5-AIKTC-KRRC
DRAW RHOMBUS OF 100 MM & 70 MM LONG
DIAGONALS AND INSCRIBE AN ELLIPSE IN IT.

STEPS:
1. Draw rhombus of given
   dimensions.
2. Mark mid points of all sides &
   name Those A,B,C,& D
3. Join these points to the ends of
   smaller diagonals.
4. Mark points 1,2,3,4 as four
   centers.
5. Taking 1 as center and 1-A
   radius draw an arc AB.
6. Take 2 as center draw an arc
       CD.
7. Similarly taking 3 & 4 as
       centers
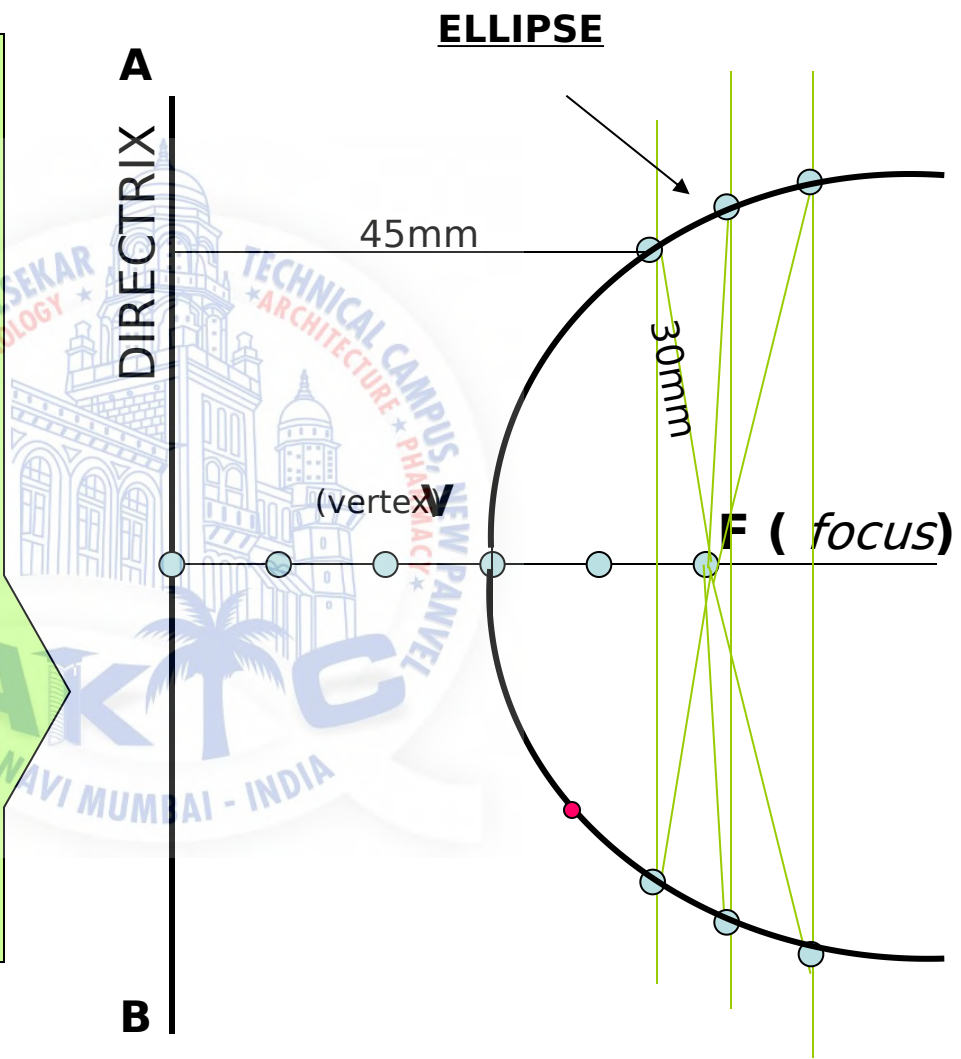   and 3-D radius draw arcs DA &
       BC.

PROBLEM 6:- 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 **2/3** DRAW LOCUS OF POINT **P. { ECCENTRICITY = 2/3 }**

ELLIPSE

STEPS:
1 .Draw a vertical line AB and point F
   50 mm from it.
2 .Divide 50 mm distance in 5 parts.
3 .Name 2nd part from F as V. It is 20mm
   and 30mm from F and AB line resp.
   It is first point giving ratio of it's
   distances from F and AB 2/3 i.e 20/30
4 Form more points giving same ratio such
   as 30/45, 40/60, 50/75 etc.
5.Taking 45,60 and 75mm distances from
   line AB, draw three vertical lines to the
   right side of it.
6. Now with 30, 40 and 50mm distances in
   compass cut these lines above and below,
   with F as center.
7. Join these points through V in

DIRECTRIX

45mm

30mm

(vertex V

F (focus)

A

B

PARABOLA
RECTANGLE METHOD

PROBLEM 7: A BALL THROWN IN AIR ATTAINS 100 M HIEGHT AND COVERS HORIZONTAL DISTANCE 150 M ON GROUND. Draw the path of the ball (projectile)-
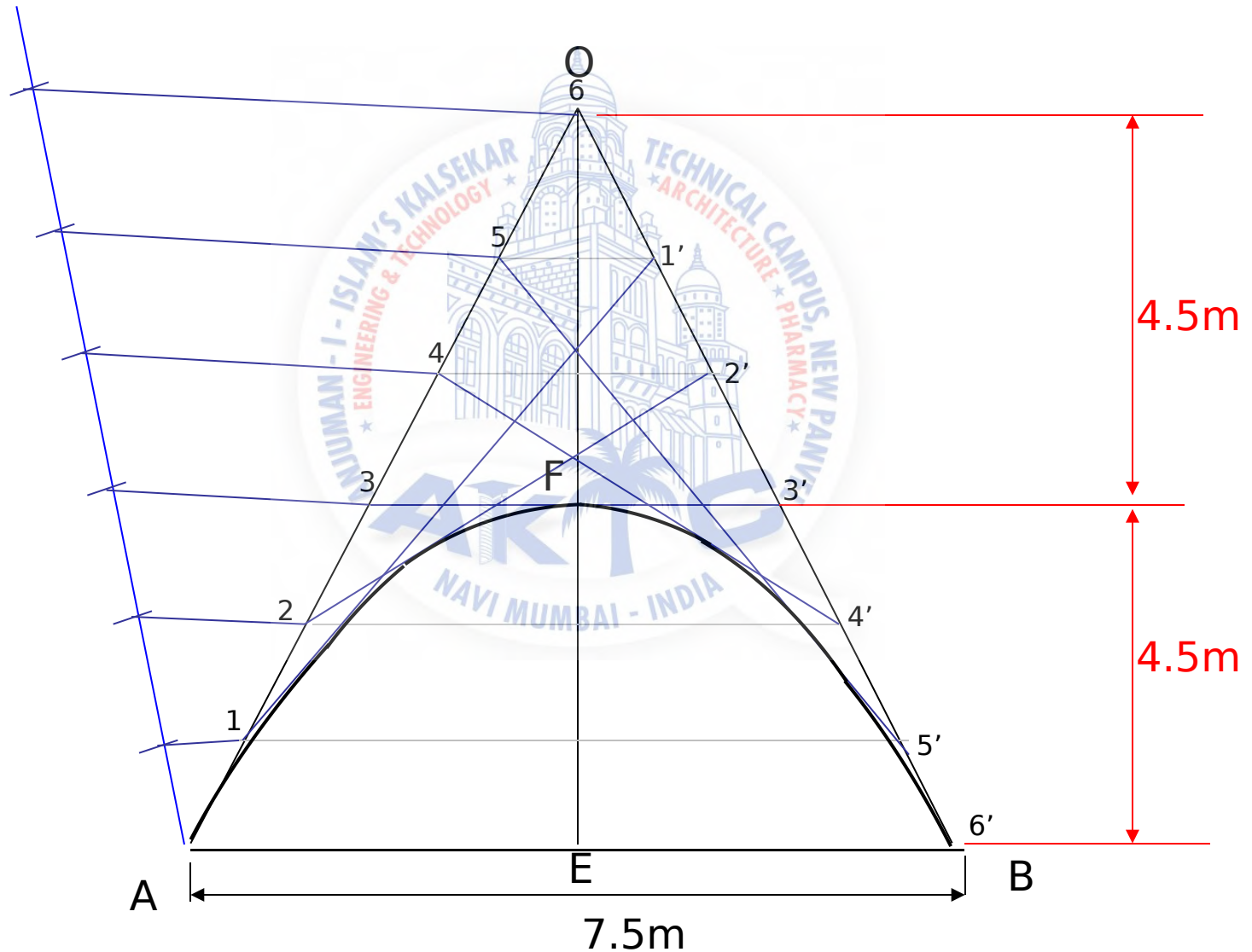
STEPS:
1. Draw rectangle of above size and divide it in two equal vertical parts
2. Consider left part for construction. Divide height and length in equal number of parts and name those 1,2,3,4,5& 6
3. Join vertical 1,2,3,4,5 & 6 to the top center of rectangle
4. Similarly draw upward vertical lines from horizontal1,2,3,4,5 And wherever these lines intersect previously drawn inclined lines in sequence Mark those points and further join in smooth possible curve.
5. Repeat the construction on right side rectangle also.Join all in sequence
This locus is Parabola.
.
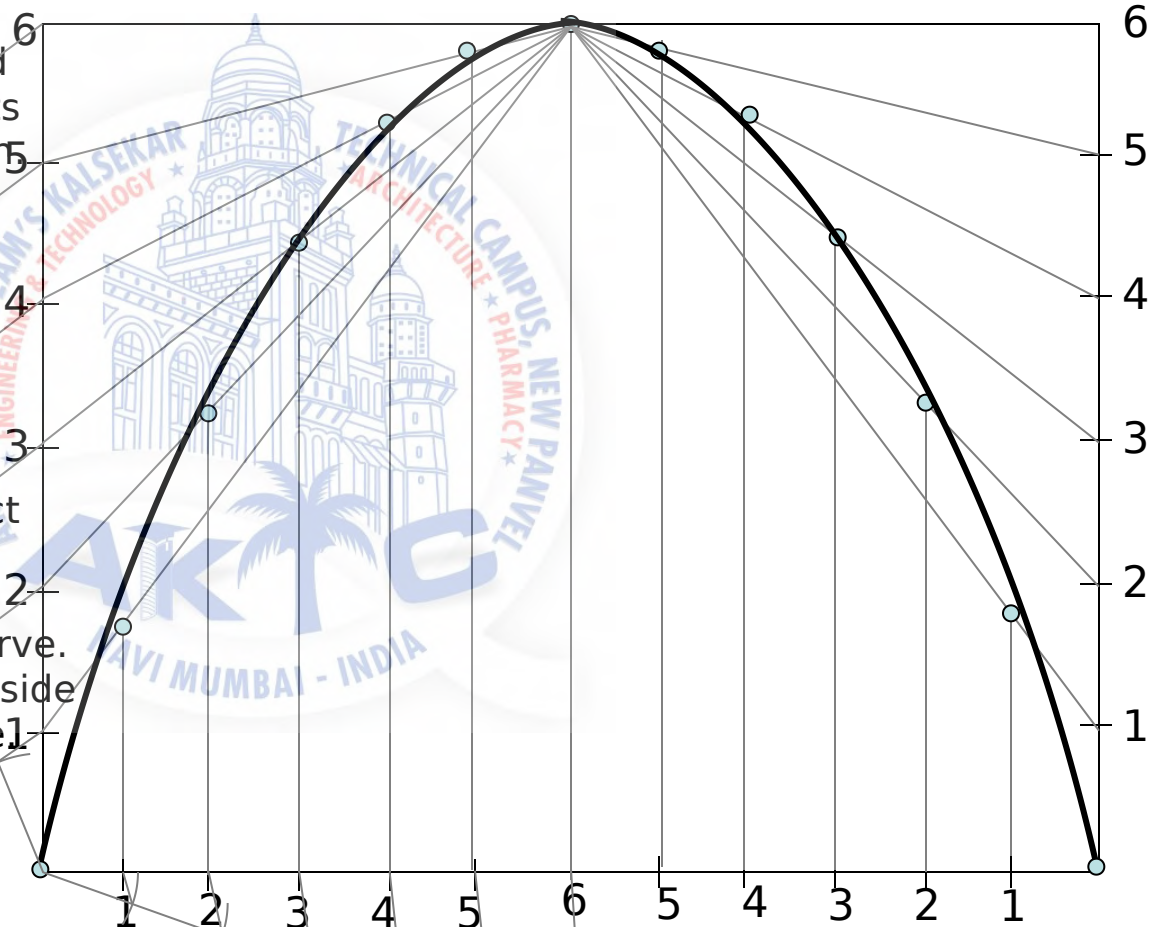
Draw a parabola by tangent method given base 7.5m and axis 4.5m

Take scale 1cm = 0.5m

O

6

5

1'

4

2'

F

3

3'

4.5m

2

4'

1

5'

6'

A

E

B

7.5m

4.5m

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

SOLUTION STEPS:
1. Locate center of line, perpendicular to
   AB from point F. This will be initial
   point P and also the vertex.
2. Mark 5 mm distance to its right side,
   name those points 1,2,3,4 and from those
   draw lines parallel to AB.
3. Mark 5 mm distance to its left of P and
   name it 1.
4. Take O-1 distance as radius and F as
   center draw an arc
   cutting first parallel line to AB. Name
   upper point P_1 and lower point P_2. (FP$_1$=O1)

5. Similarly repeat this process by taking
   again 5mm to right and left and locate

PARABOLA

A

P_1

(VERTEX)N

O   1 2 3 4   F
        (focus)

P_2

B
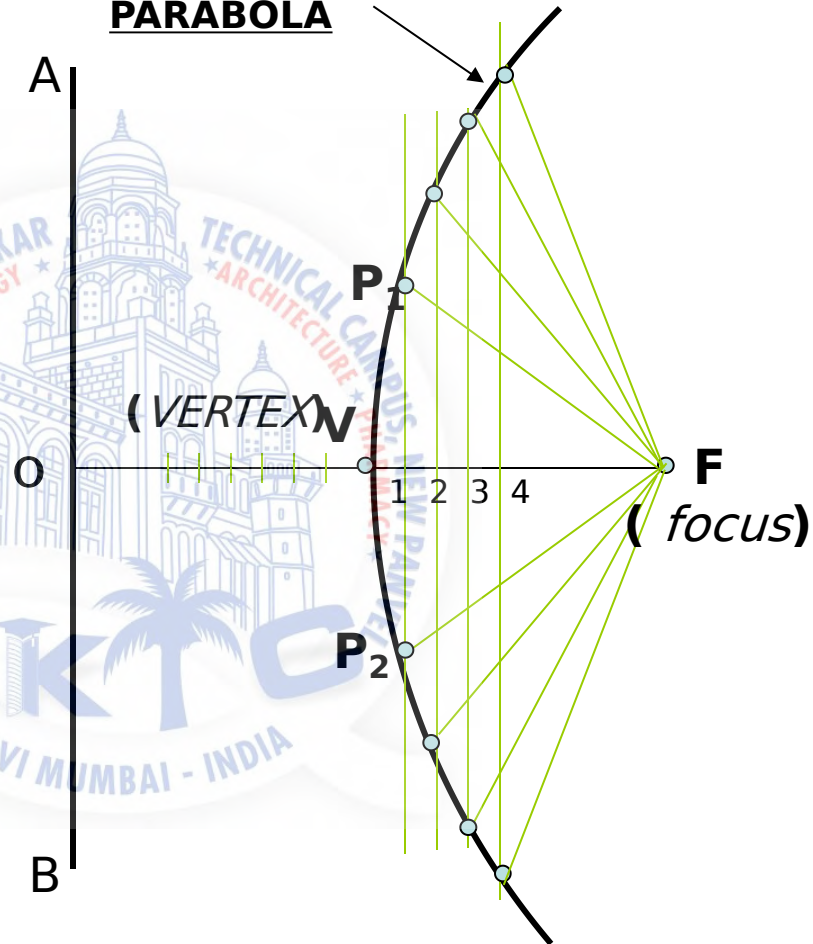
Problem No.10: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively.Draw Hyperbola through it.

Solution Steps:

1) Extend horizontal line from P to right side.

2) Extend vertical line from P upward.

3) On horizontal line from P, mark some points taking any distance and name them after P-1, 2,3,4 etc.
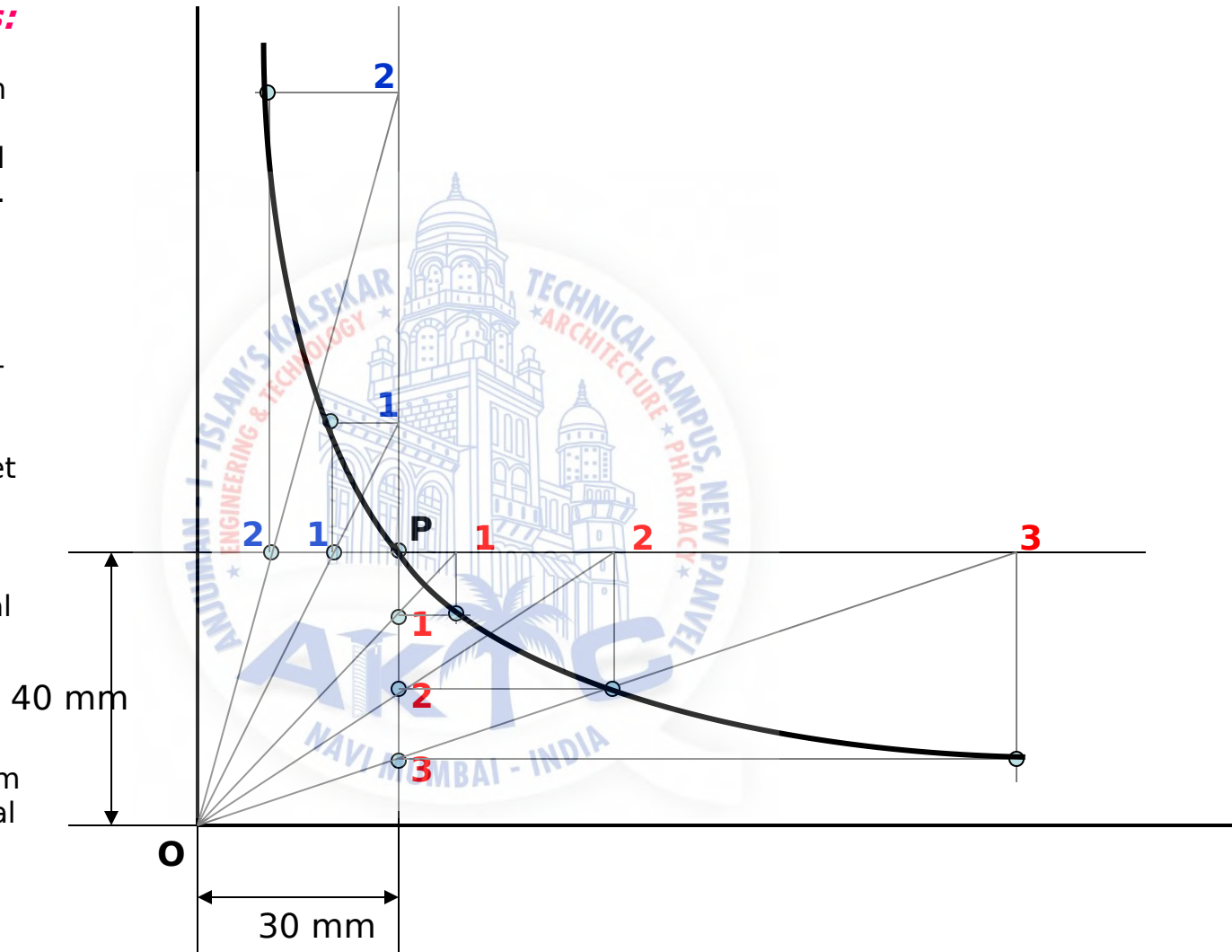
4) Join 1-2-3-4 points to pole O. Let them cut part [P-B] also at 1,2,3,4 points.

5) From horizontal 1,2,3,4 draw vertical lines downwards and

6) From vertical 1,2,3,4 points [from P-B] draw horizontal lines.

7) Line from 1 horizontal and line from 1 vertical will meet at P_1.Similarly mark P_2, P_3, P_4 points.
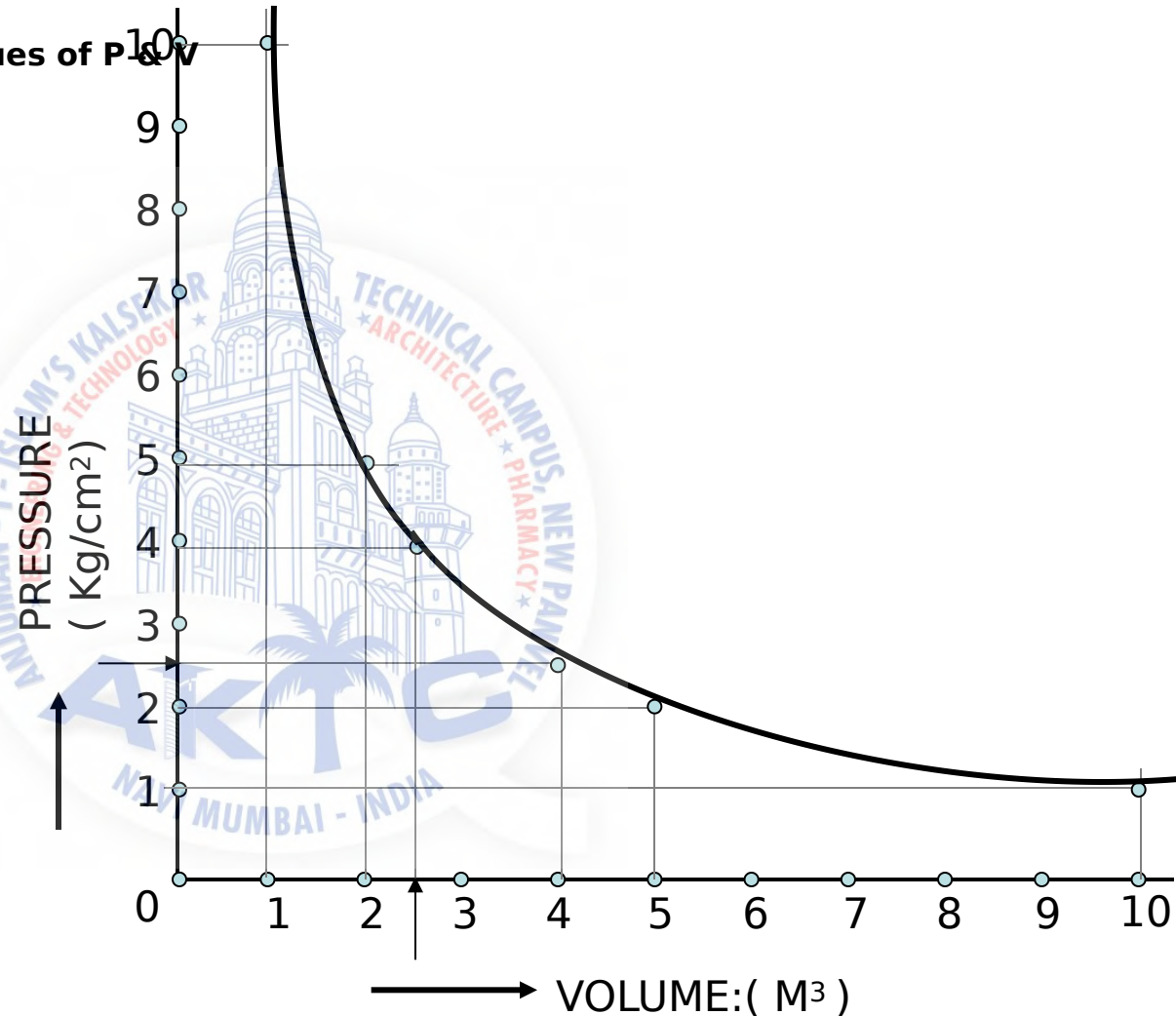
8) Repeat the procedure by

40 mm

30 mm

Problem no.11: A sample of gas is expanded in a cylinder from 10 unit pressure to 1 unit pressure.Expansion follows law PV=Constant.If initial volume being 1 unit, draw the curve of expansion. Also Name the curve.

HYPERBOLA

P-V DIAGRAM

Form a table giving few more values of P & V

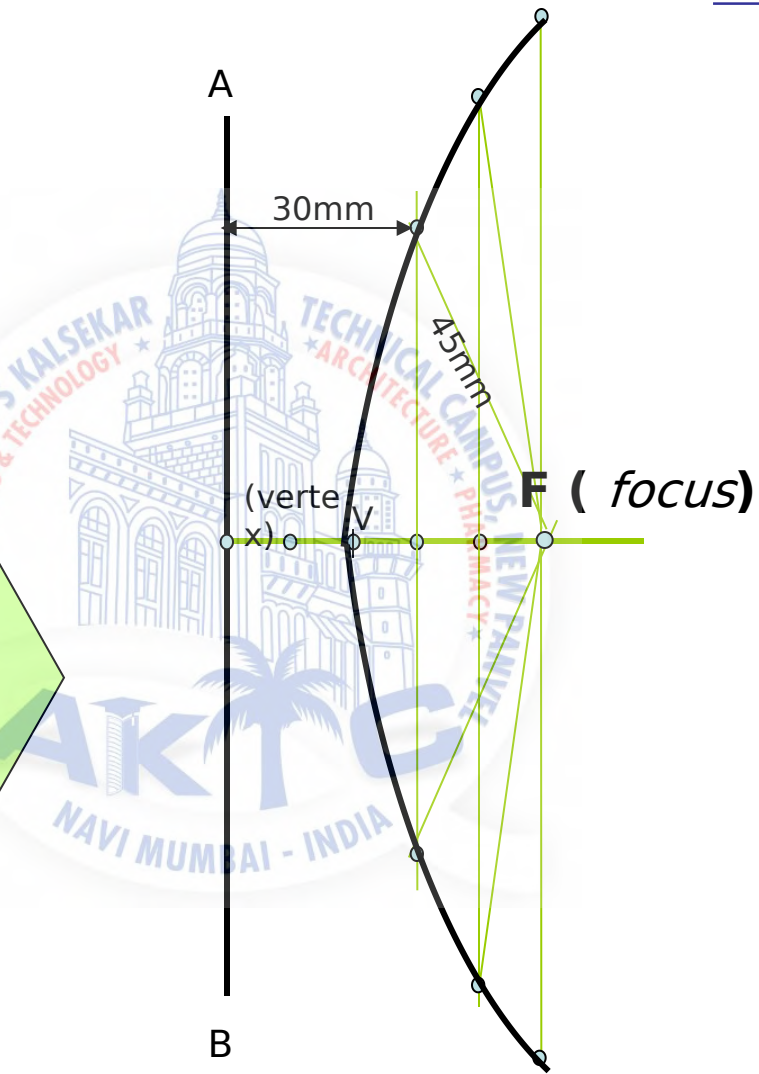| P	✗	V	=	C
10	✗	1	=	10
5	✗	2	=	10
4	✗	2.5	=	10
2.5	✗	4	=	10
2	✗	5	=	10
1	✗	10	=	10

Now draw a Graph of
Pressure against Volume.
It is a PV Diagram and it is Hyperbola.
Take pressure on vertical axis and
Volume on horizontal axis.

PRESSURE
(Kg/cm^2)

0   1   2   3   4   5   6   7   8   9   10

VOLUME:(M^3)

HYPERBOLA
DIRECTRIX
FOCUS METHOD

PROBLEM 11:- A 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 **2/3** DRAW LOCUS OF POINT **P.** **{ ECCENTRICITY = 2/3 }**

STEPS:
1 .Draw a vertical line AB and point F
   50 mm from it.
2 .Divide 50 mm distance in 5 parts.
3 .Name 2nd part from F as V. It is 20mm
   and 30mm from F and AB line resp.
   It is first point giving ratio of it's
   distances from F and AB 2/3 i.e 20/30
4 Form more points giving same ratio such
   as 30/45, 40/60, 50/75 etc.
5.Taking 45,60 and 75mm distances from
   line AB, draw three vertical lines to the
   right side of it.
6. Now with 30, 40 and 50mm distances in
   compass cut these lines above and below,
   with F as center.
7. Join these points through V in smooth

A

30mm

45mm

(vertex)

V

F (*focus***)**

B

Problem 13:

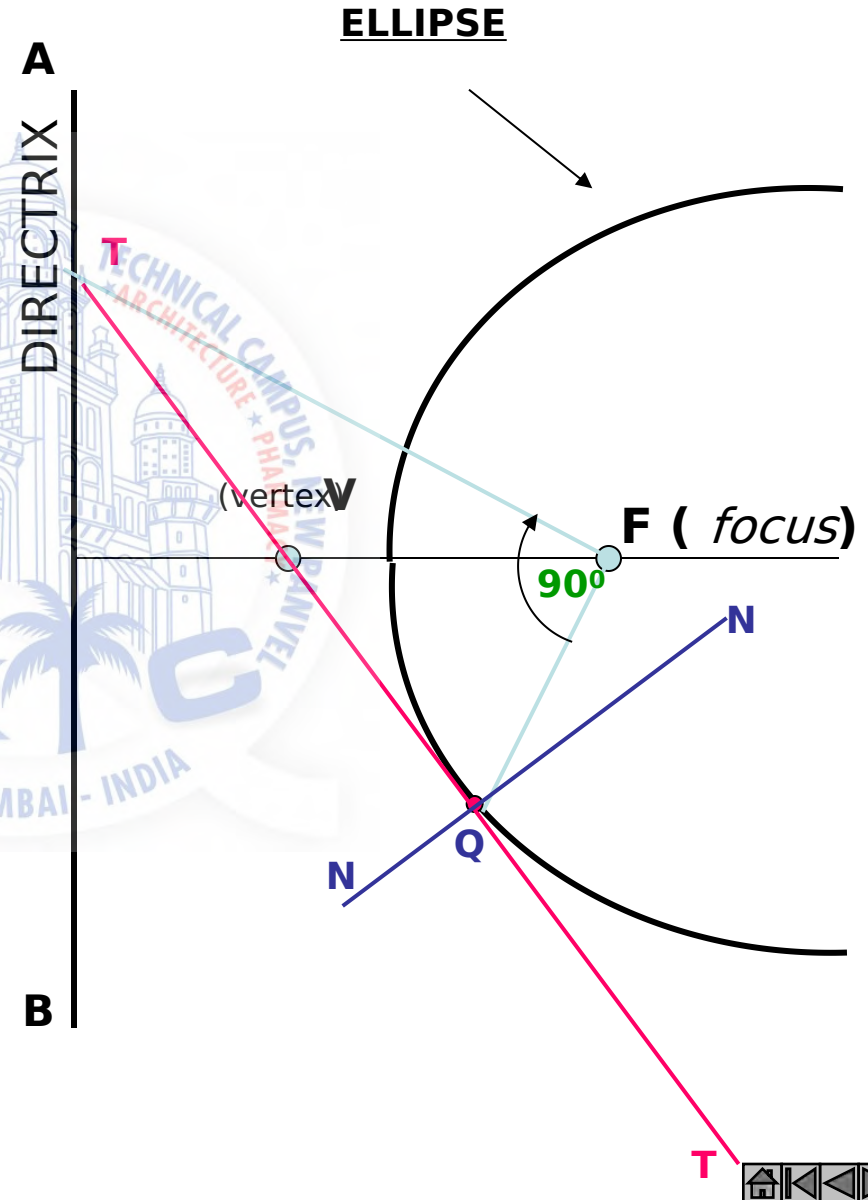# TO DRAW TANGENT & NORMAL
TO THE CURVE FROM A GIVEN POINT (Q)

1. JOIN POINT Q TO F_1 & F_2
2. BISECT ANGLE $F_1 Q F_2$ THE ANGLE BISECTOR IS NORMAL
3. A PERPENDICULAR LINE DRAWN TO IT IS TANGENT TO THE CURVE.
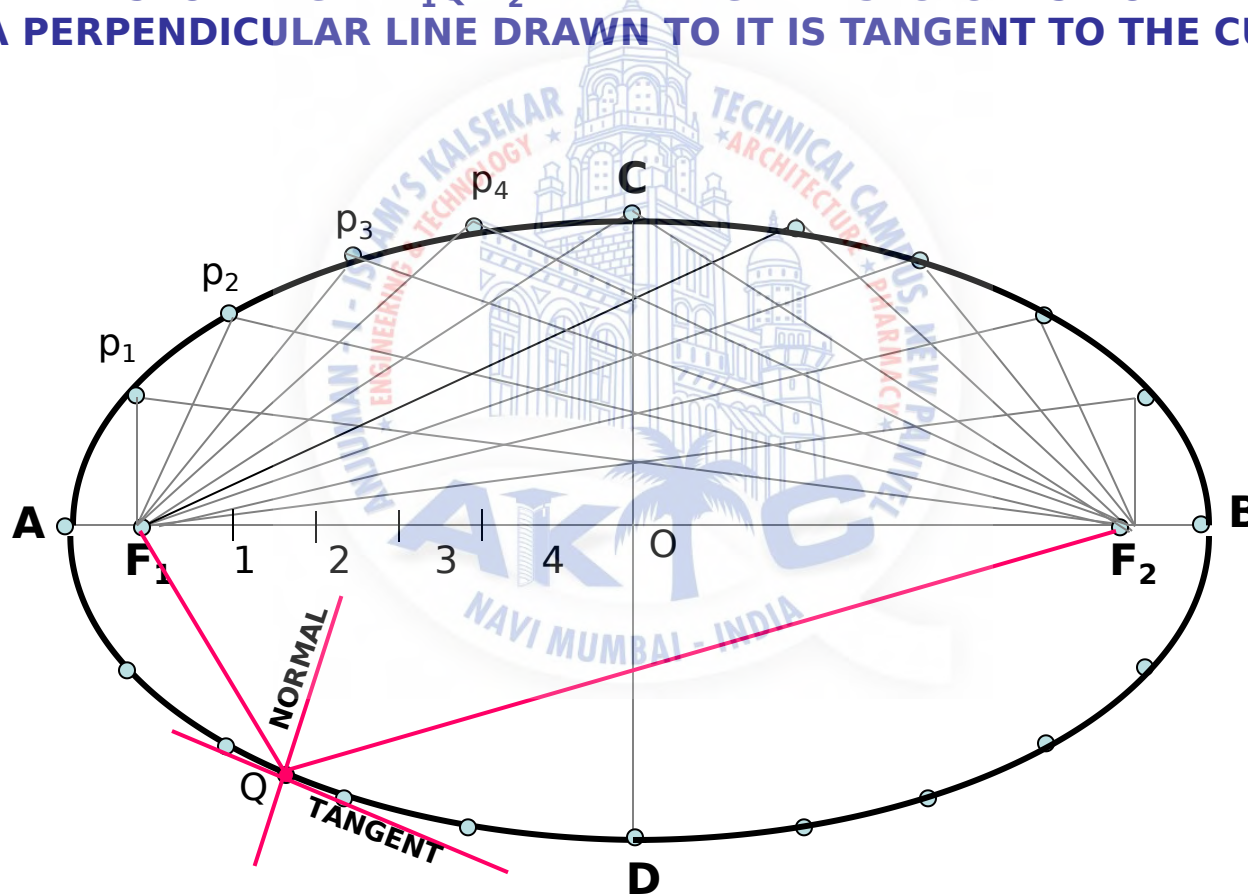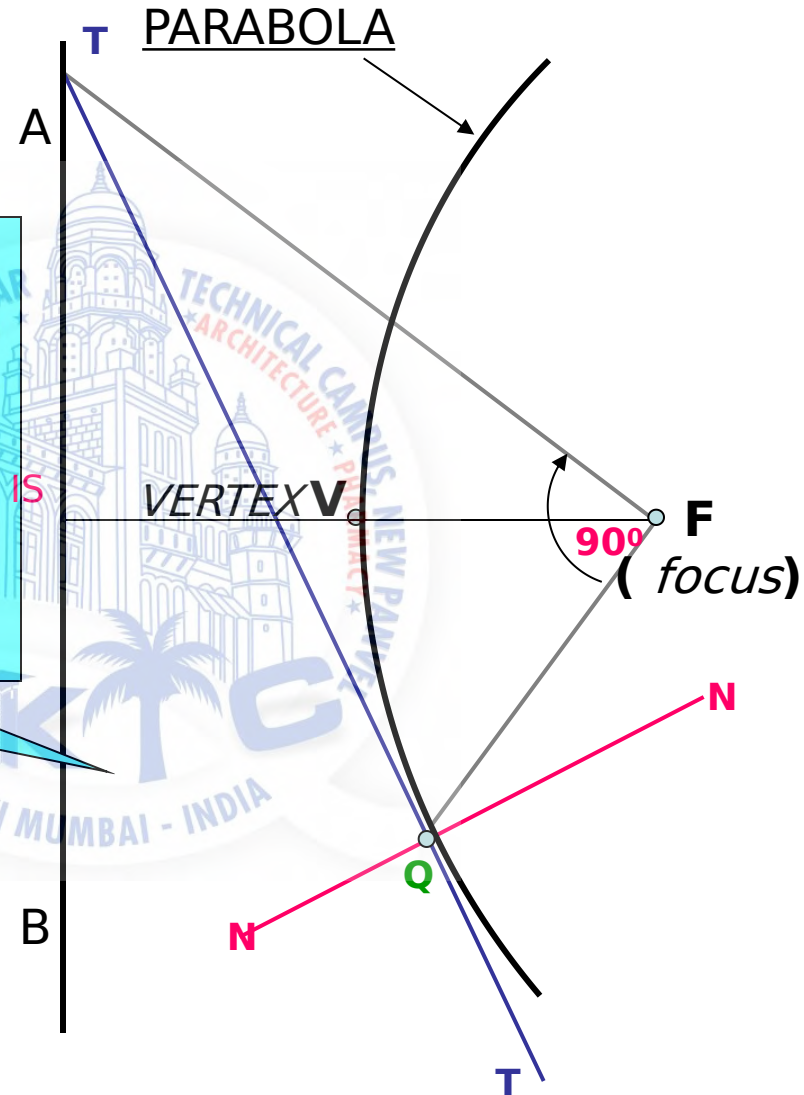
Problem 14:

ELLIPSE
TANGENT & NORMAL

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

ELLIPSE

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.

A

DIRECTRIX

T

(vertex **V**

F (*focus***)**

90⁰

N

N

Q

B

T

Problem 15:

**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 THE CURVE FROM Q
5. TO THIS TANGENT DRAW PERPENDICULAR
   LINE FROM Q. IT IS NORMAL TO CURVE.

T

PARABOLA

A

VERTEX **V**

F
(*focus***)**

90⁰

N

N

Q

B

T

Problem 16

HYPERBOLA
TANGENT & NORMAL

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.

A

T

(vertex)

V

F (*focus***)**

90^0

N

N

Q

B

T