CEE 111

Engineering Drawing

Lecture 5

ENGINEERING CURVES

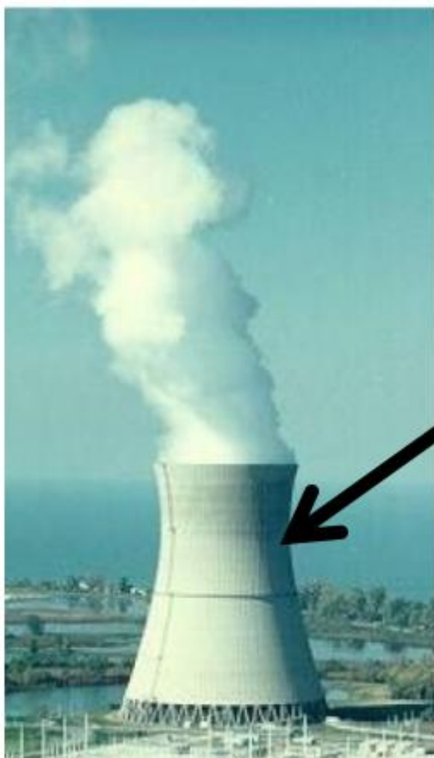
Part- I {Conic Sections}


BORDER ROADS ORGANISATION
BE GENTLE
ON
MY CURVES
753 TF
51 RCC

Common Engineering Curves

Parabolic shape

Elliptical shape



Hyperbola

spiral

ENGINEERING CURVES

Part- I {Conic Sections}

ELLIPSE

1. Concentric Circle Method
2. Rectangle Method
3. Arcs of Circle Method
4. Basic Locus Method (Directrix – focus)

PARABOLA

1. Rectangle Method
2. Method of Tangents (Triangle Method)
3. Basic Locus Method (Directrix – focus)

HYPERBOLA

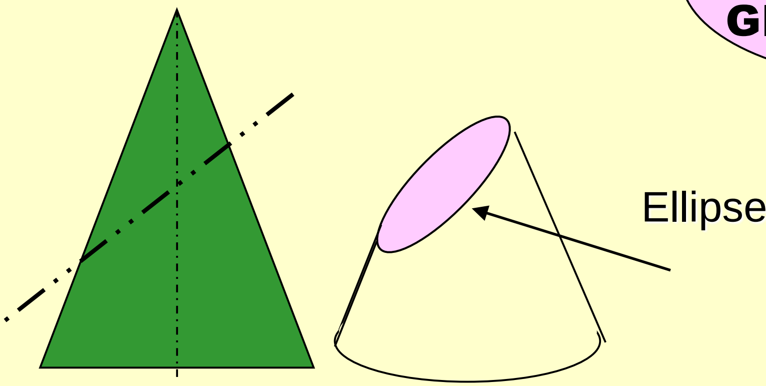
1. Rectangular Hyperbola (coordinates given)
2. Basic Locus Method (Directrix – focus)

Methods of Drawing Tangents & Normals To These Curves.

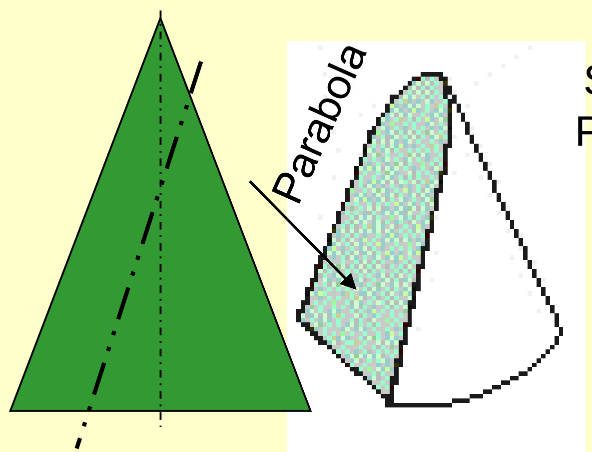
CONIC SECTIONS (Conic curves, conics)

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.

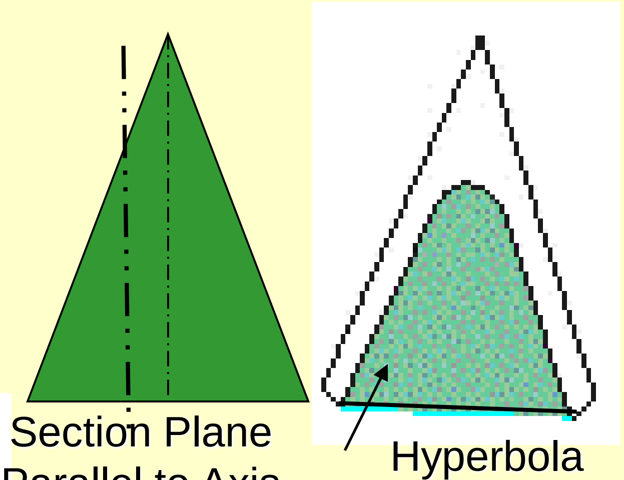
OBSERVE ILLUSTRATIONS GIVEN BELOW..



Section Plane
Through Generators



Section Plane Parallel
to end generator.



Section Plane
Parallel to Axis.

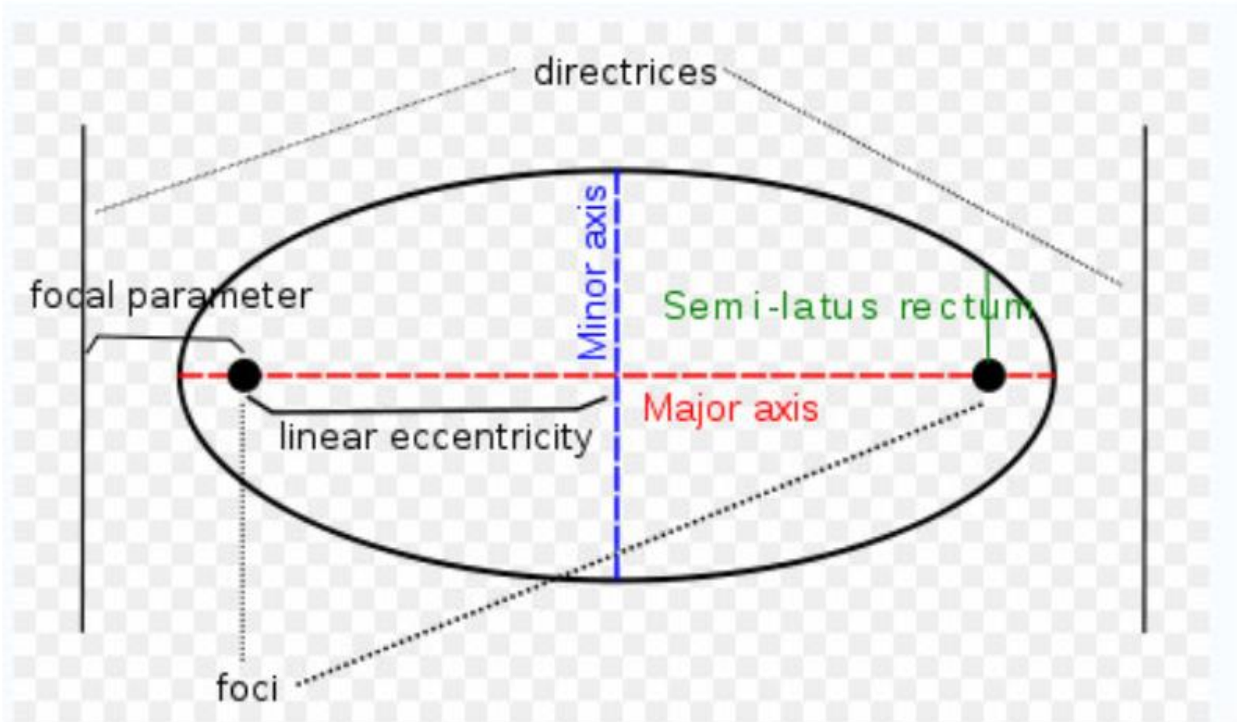
Conic sections are always "smooth". More precisely, they never contain any inflection points. This is important for many applications, such as Aerodynamics, Civil Engineering, Mechanical Engineering, etc.

Conic

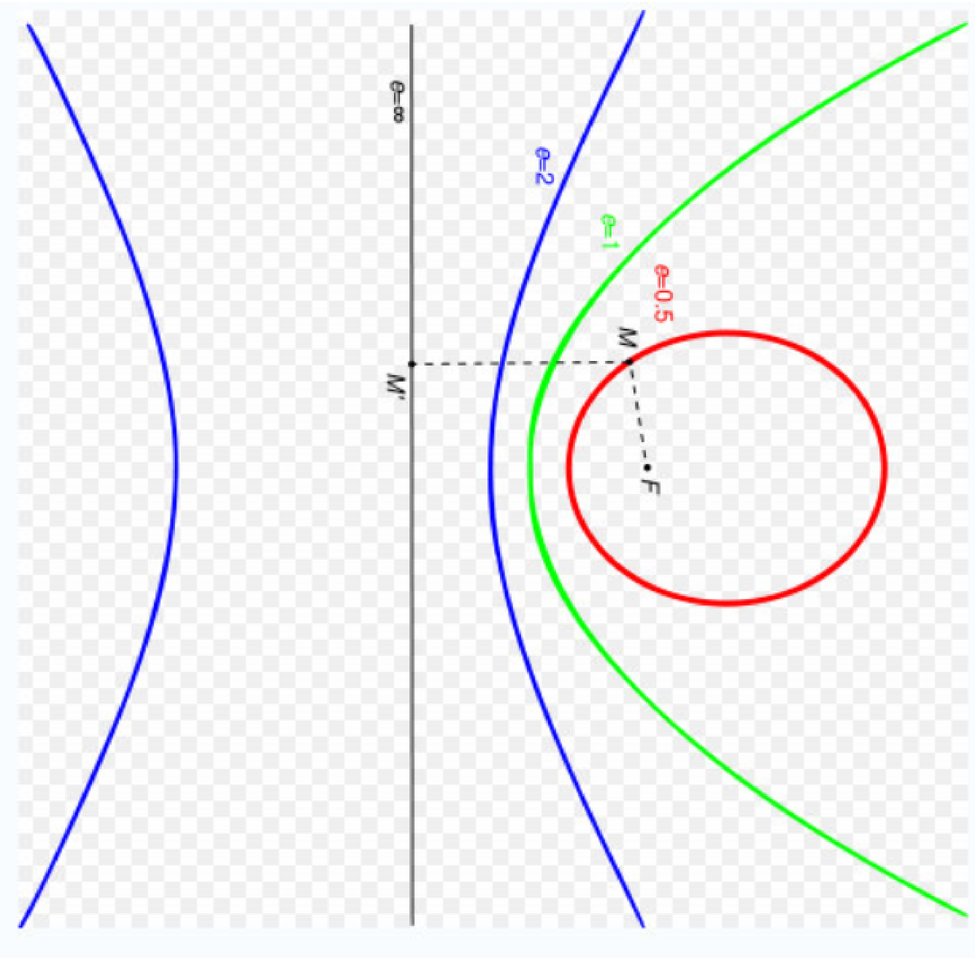
Conic is defined as the locus of a point moving in a plane such that the ratio of its distance from a fixed point and a fixed straight line is always constant.

Fixed point is called Focus

Fixed line is called Directrix



$$\text{Eccentrici ty} = \frac{\text{Distance of the point from the focus}}{\text{Distance of the point from the directric}}$$



When eccentricity

< 1 → Ellipse

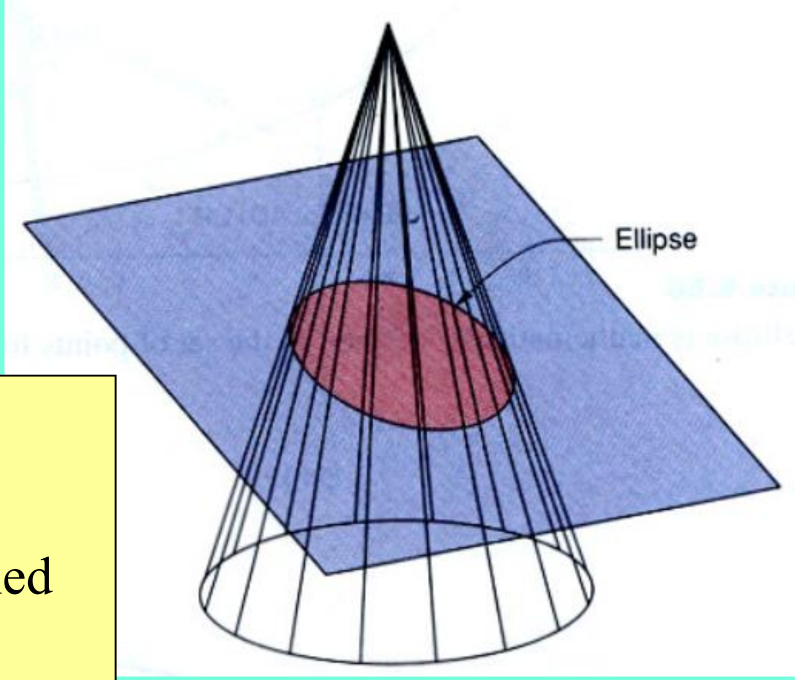
=1 → Parabola

> 1 → Hyperbola

eg. when *e*=1/2, the curve is an Ellipse, when *e*=1, it is a parabola and when e=2, it is a hyperbola.

Ellipse

An ellipse is obtained when a section plane, inclined to the axis, cuts all the generators of the cone.



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 axis***.}
These TWO fixed points are FOCUS 1 & FOCUS 2

Applications of Ellipse

Applications: Arches, Bridges, Bullet nose etc.

ELLIPSE

BY CONCENTRIC CIRCLE METHOD

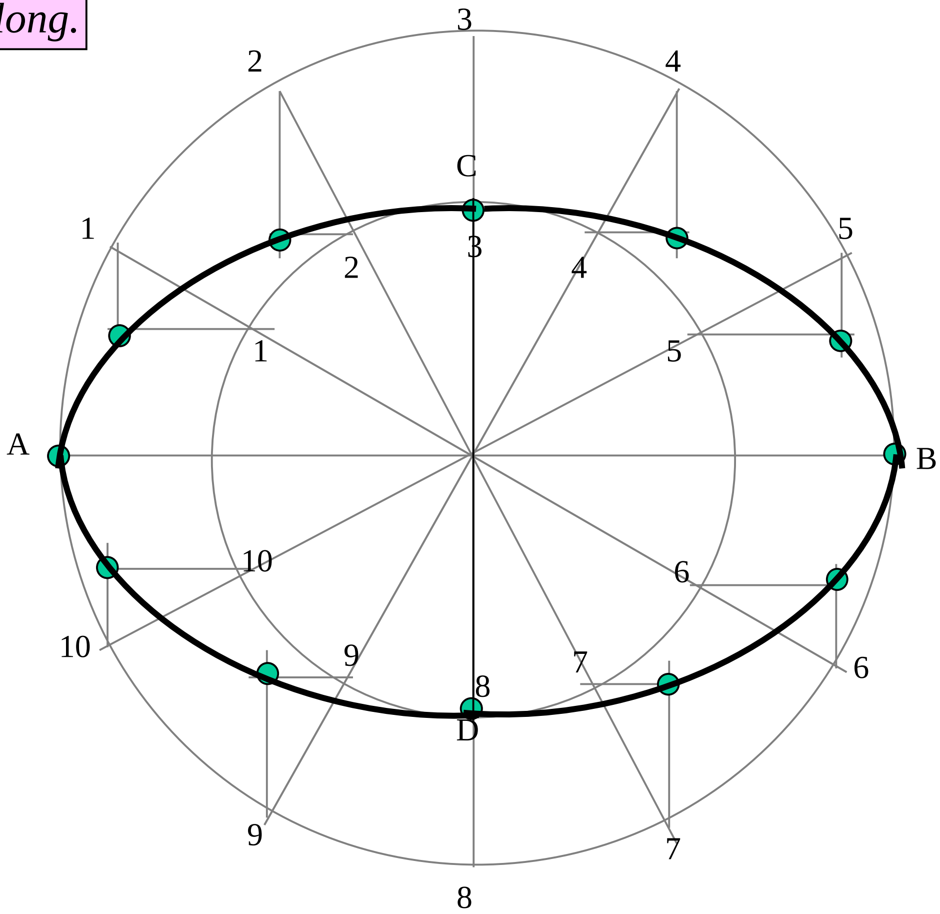
Problem 1 :-

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

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)

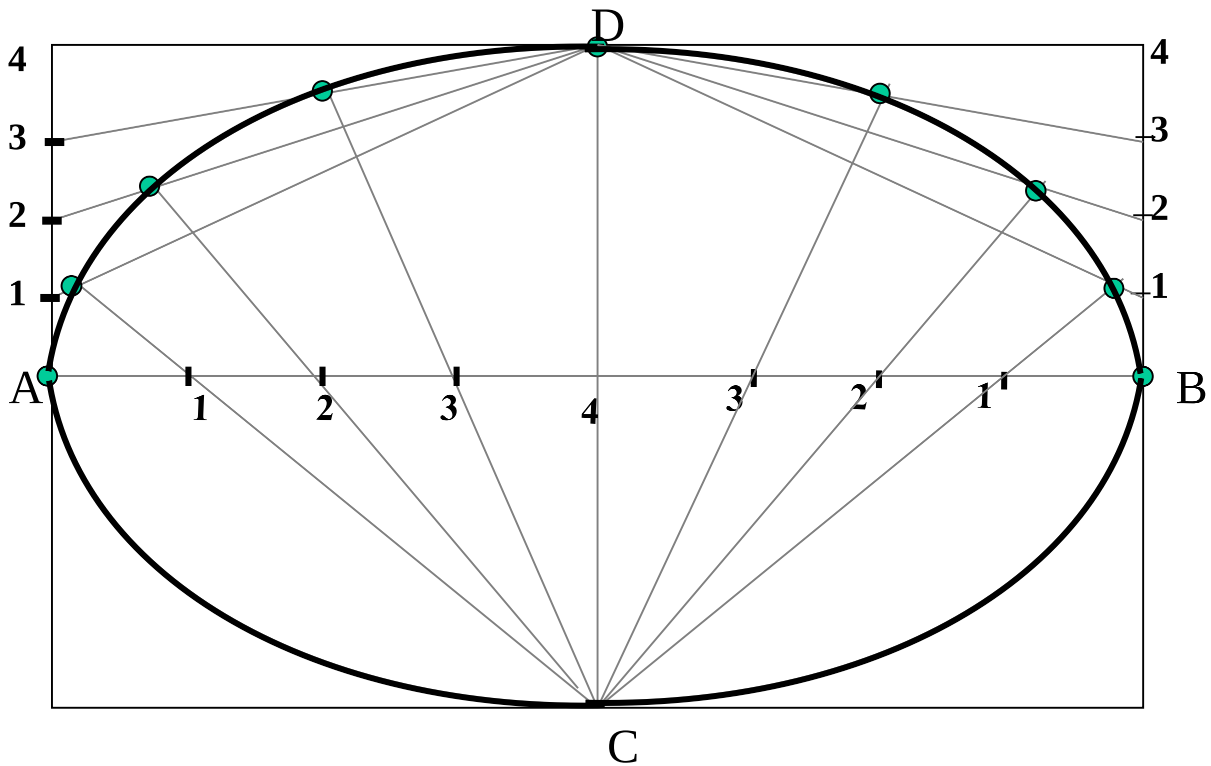
4. Name those as shown..

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 up to 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 the required ellipse.



PROBLEM 3.
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

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)

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.)

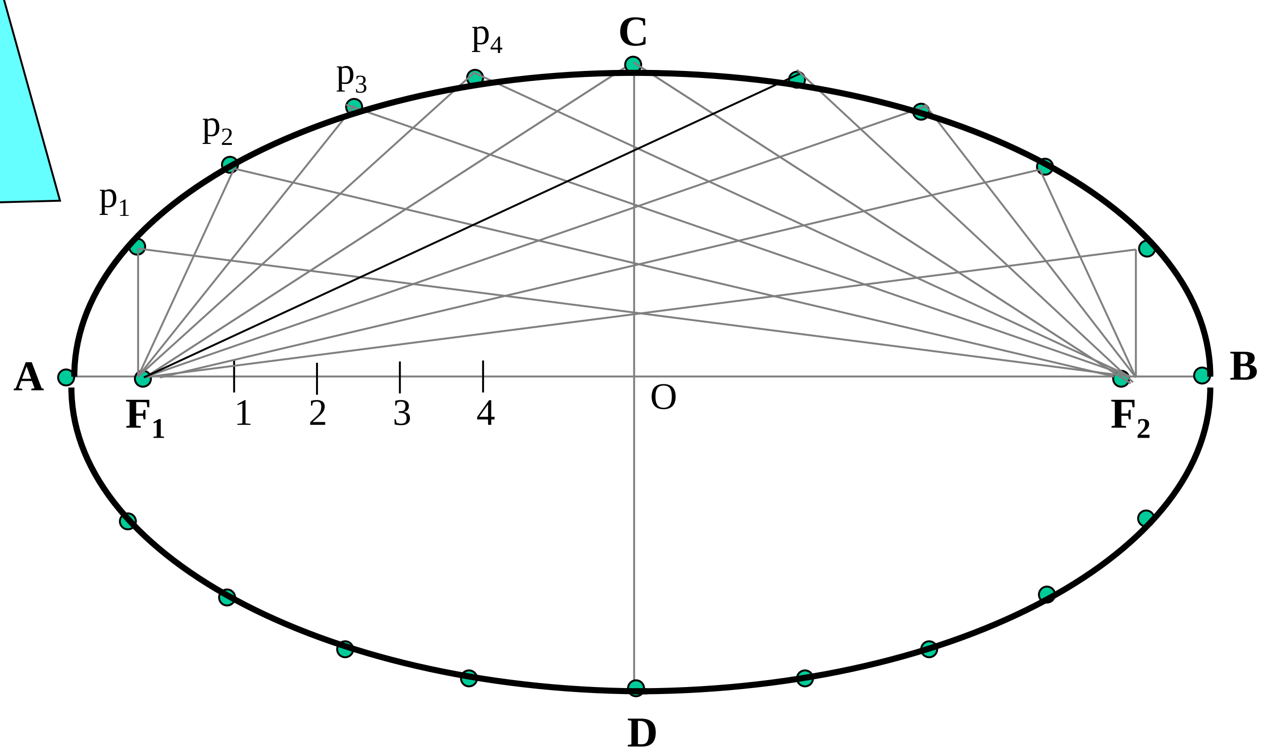
3.On line F_1- O taking any distance, mark points 1,2,3, & 4

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/



PROBLEM 4:- 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

DIRECTRIX-FOCUS METHOD

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

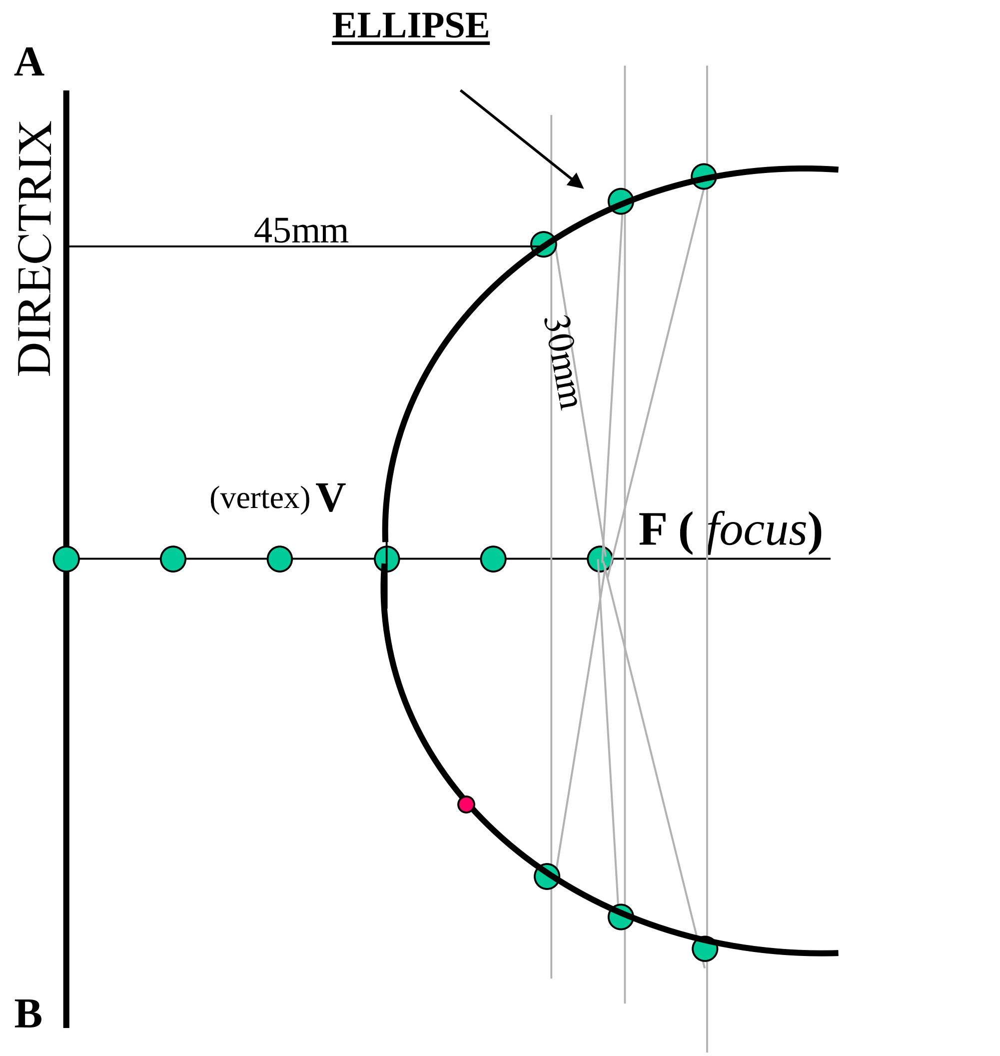
4 Form more points giving same ratio such as 30/45, 40/60, 50/75 etc.

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.

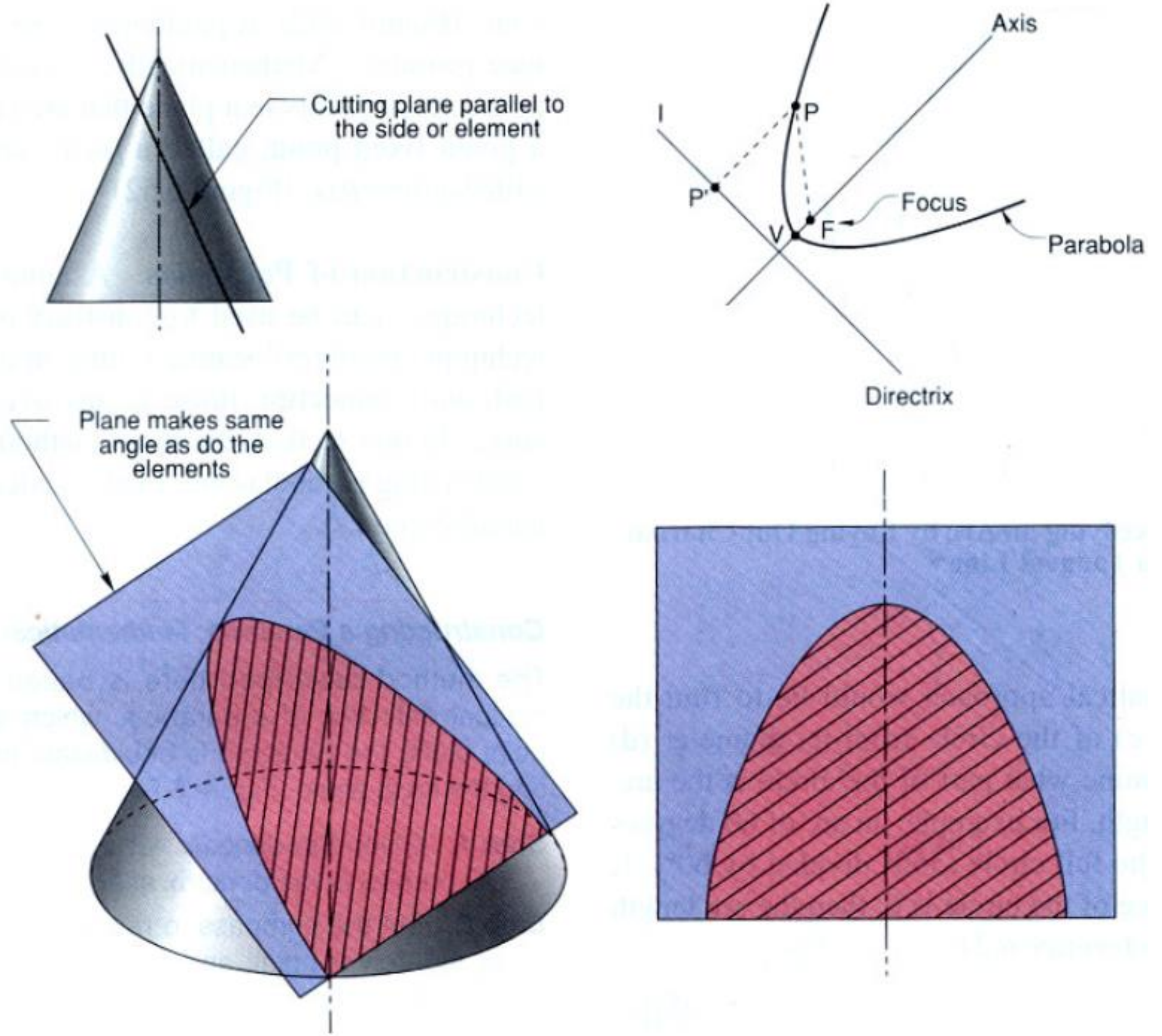
7. Join these points through V in smooth curve.

This is required locus of P.It is an ELLIPSE.



Parabola

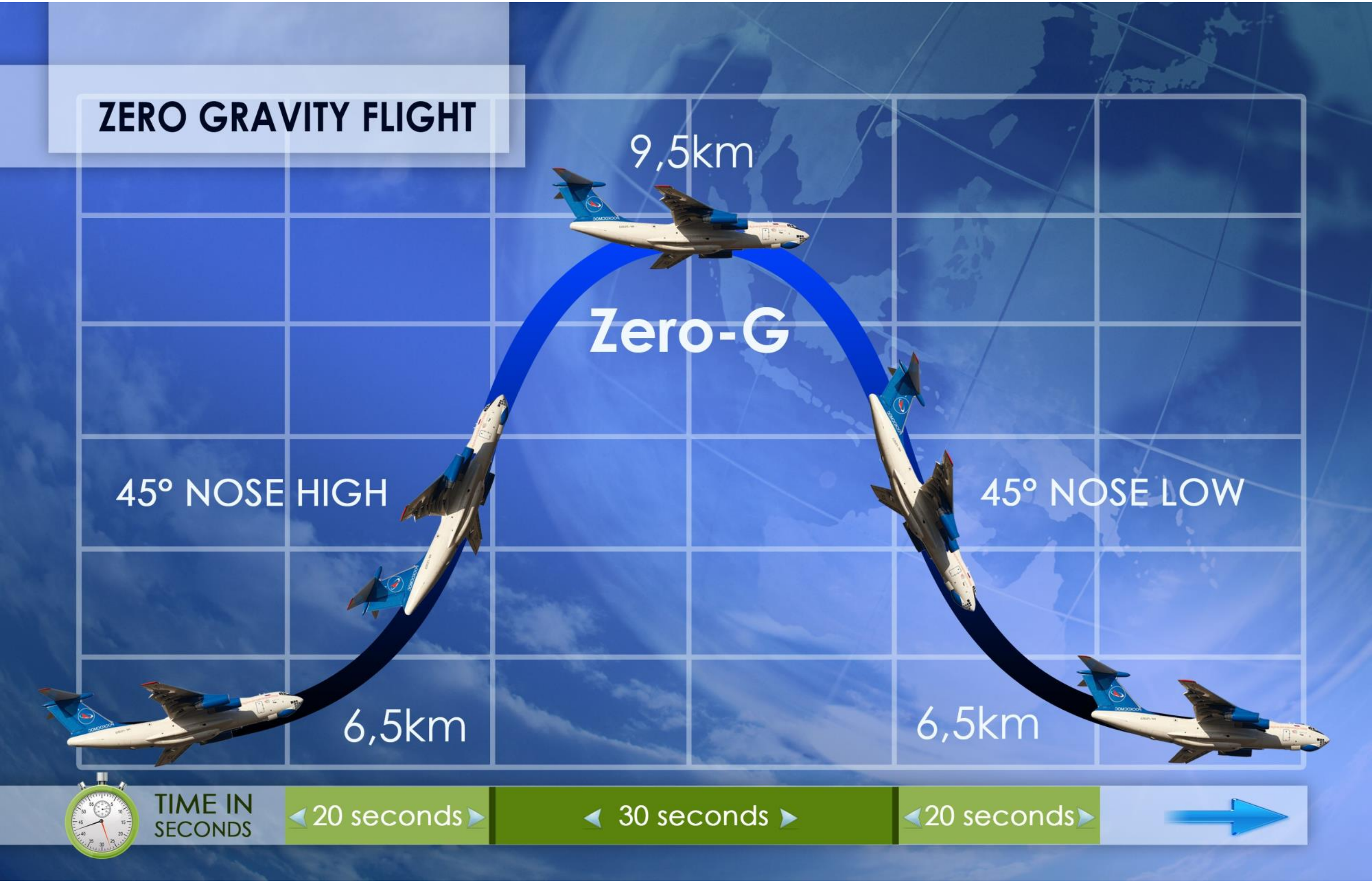
A parabola is obtained when a section plane, parallel to one of the generators cuts the cone.



Golden Gate Bridge in San Francisco

Radio telescopes use a parabolic dish to focus radio signals

Parabola (Applications)



Zero Gravity Adventure on a IL-76 in Russia

PROBLEM 5: A BALL THROWN IN AIR ATTAINS 100 M HIEGHT AND COVERS HORIZONTAL DISTANCE 150 M ON GROUND. Draw the path of the ball (projectile)-

PARABOLA
RECTANGLE METHOD

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.

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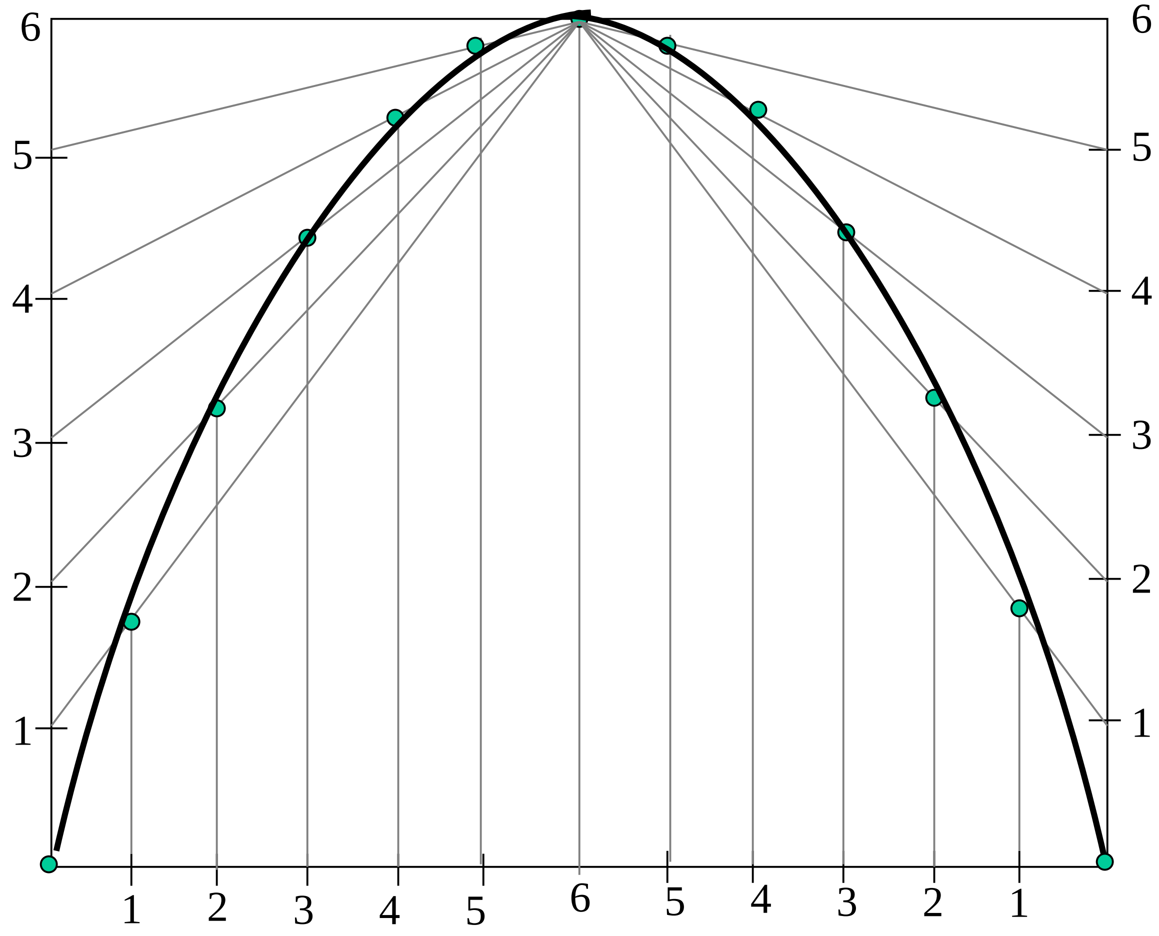
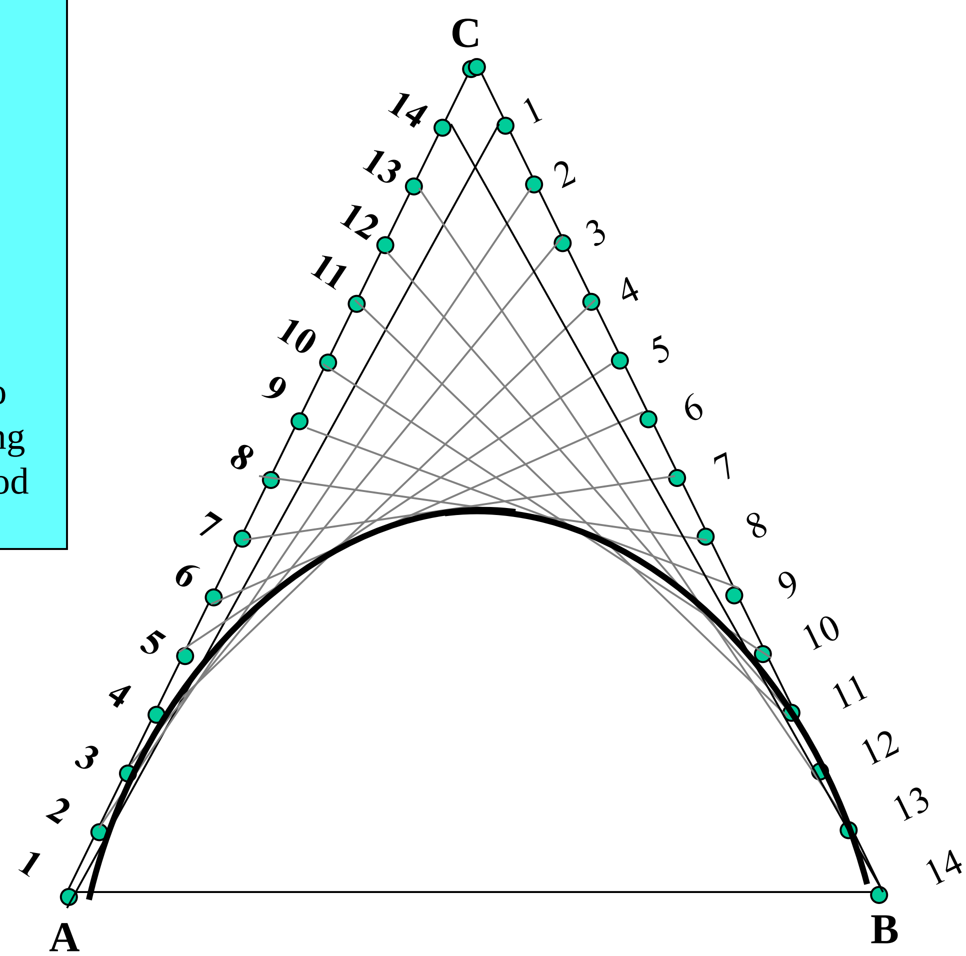


Problem no.6: Draw an isosceles triangle of 100 mm long base and 110 mm long altitude.Inscribe a parabola in it by method of tangents.

PARABOLA
METHOD OF TANGENTS

Solution Steps:

1. Construct triangle as per the given dimensions.
2. Divide it's both sides in to same no.of equal parts.
3. Name the parts in ascending and descending manner, as shown.
4. Join 1-1, 2-2,3-3 and so on.
5. Draw the curve as shown i.e.tangent to all these lines. The above all lines being tangents to the curve, it is called method of tangents.



PROBLEM 7: 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.

PARABOLA

DIRECTRIX-FOCUS METHOD

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.

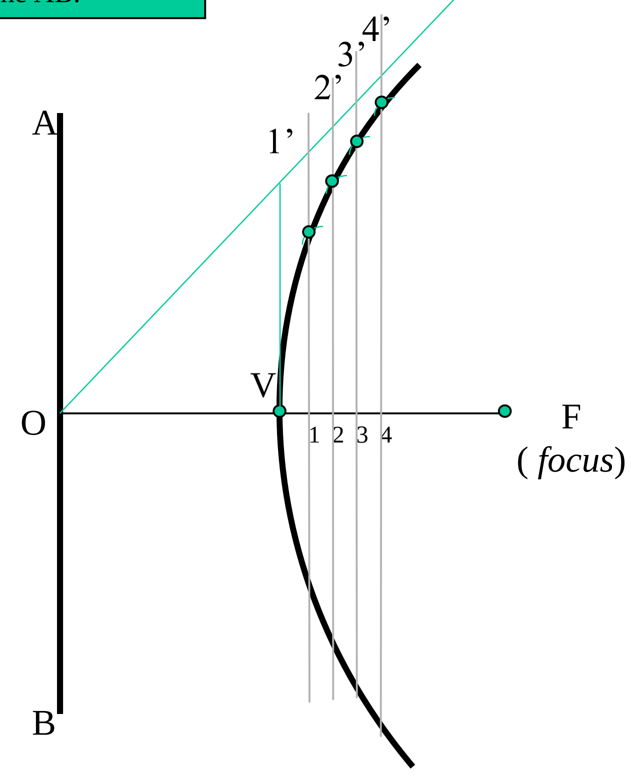
3.Mark 5 mm distance to its left of P and name it 1.

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 P_3P_4.

6.Join all these points in smooth curve.

It will be the locus of P equidistance from line AB and fixed point F.



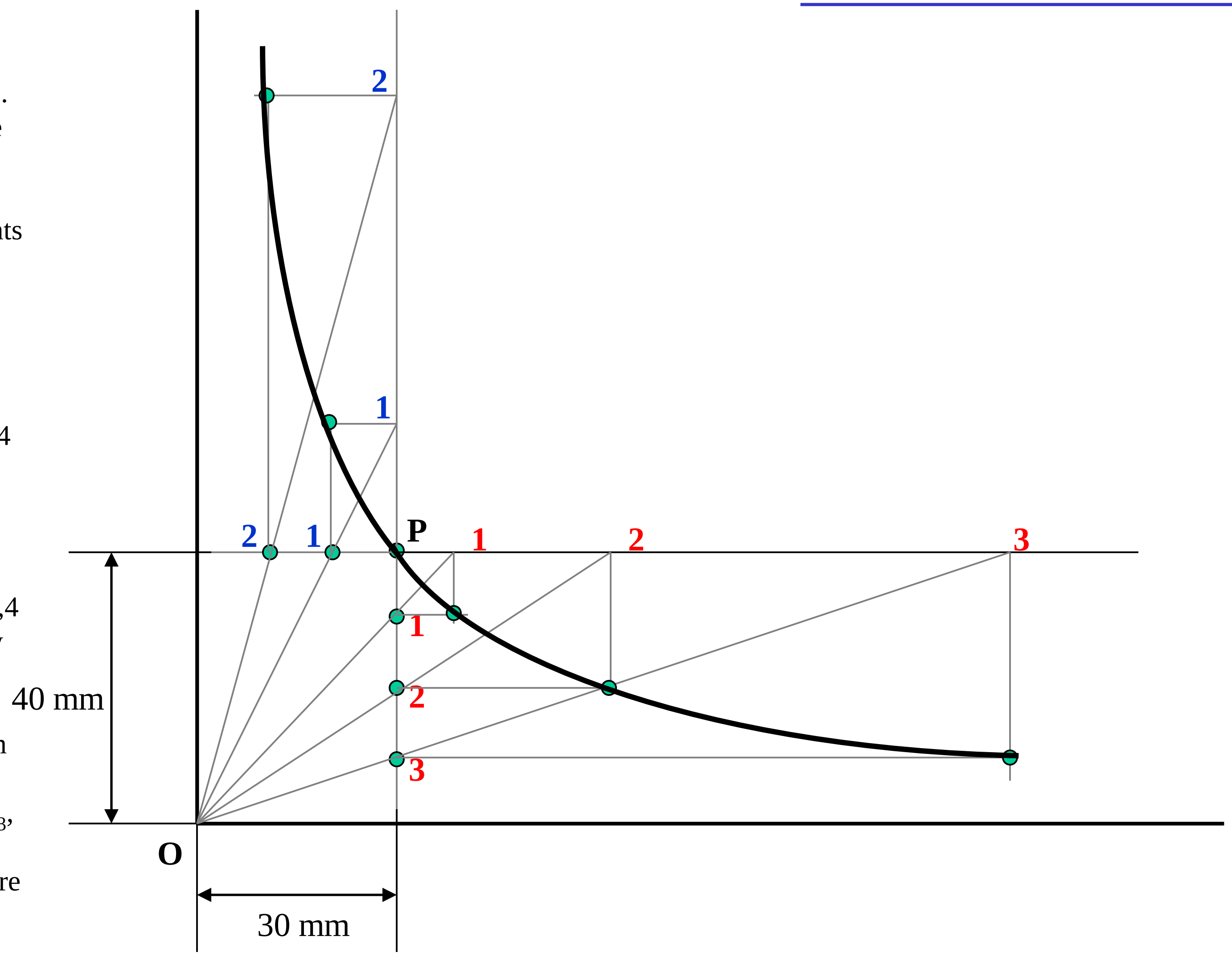
Hyperbola

Problem No.7: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively.Draw Hyperbola through it.

HYPERBOLA
THROUGH A POINT OF KNOWN CO-ORDINATES

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 marking four points on upward vertical line from P and joining all those to pole O. Name this points P_6, P_7, P_8 etc. and join them by smooth curve.



PROBLEM 8:- 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

STEPS:

1 .Draw a vertical line AB and point F 50 mm from it.

2 .Divide 50 mm distance in 5 parts.

3 .Name 3rd part from F as V. It is 30 mm and 20 mm from F and AB line resp. It is first point giving ratio of it's distances from F and AB 3/2 i.e 30/20

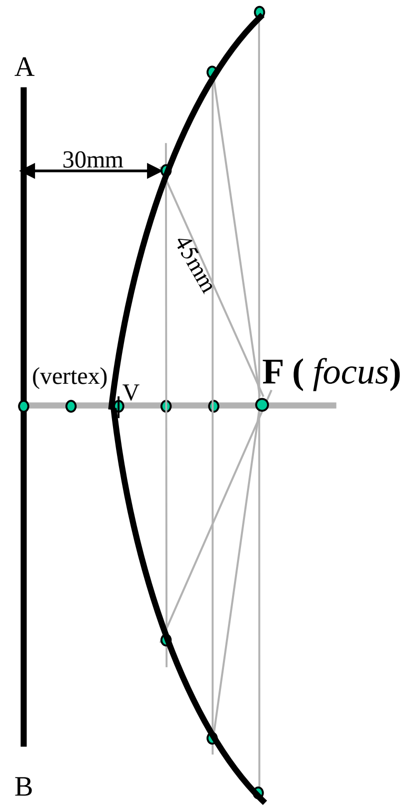
4 Form more points giving same ratio such as 45/30, 60/40, 75/50 etc.

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 curve.

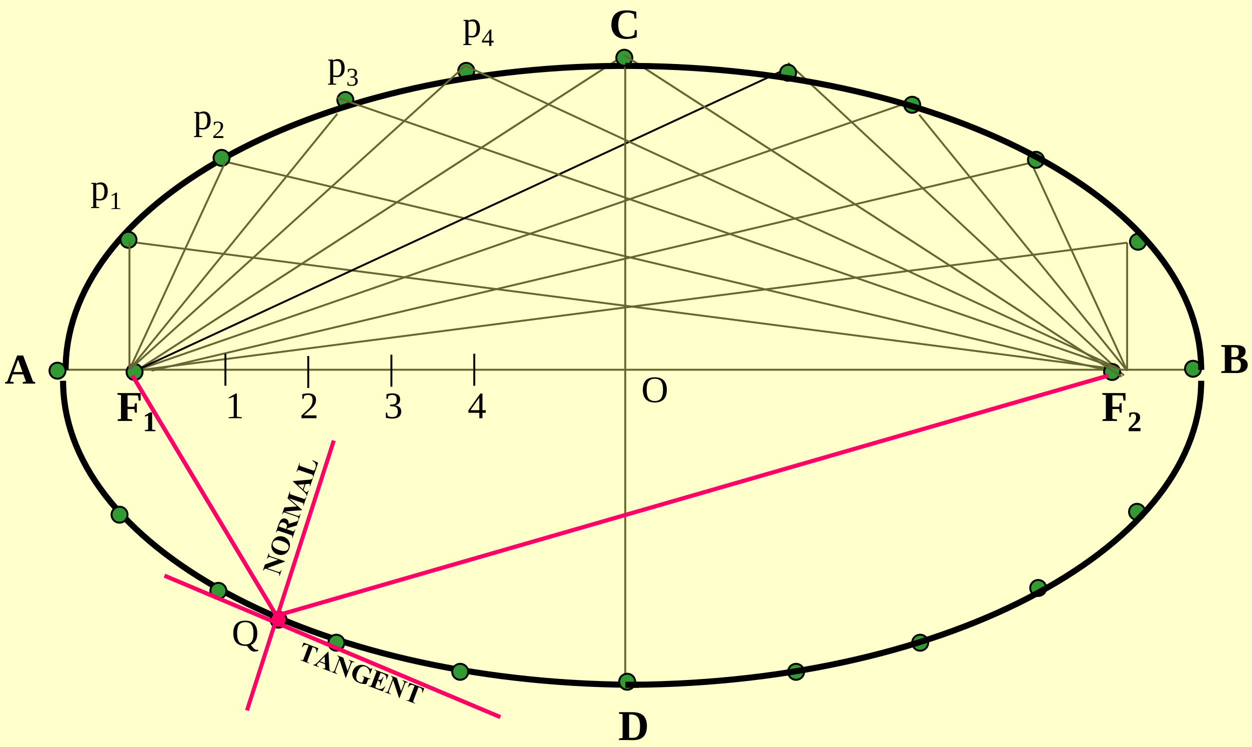
This is required locus of P. It is a Hyperbola.



Problem 9:

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

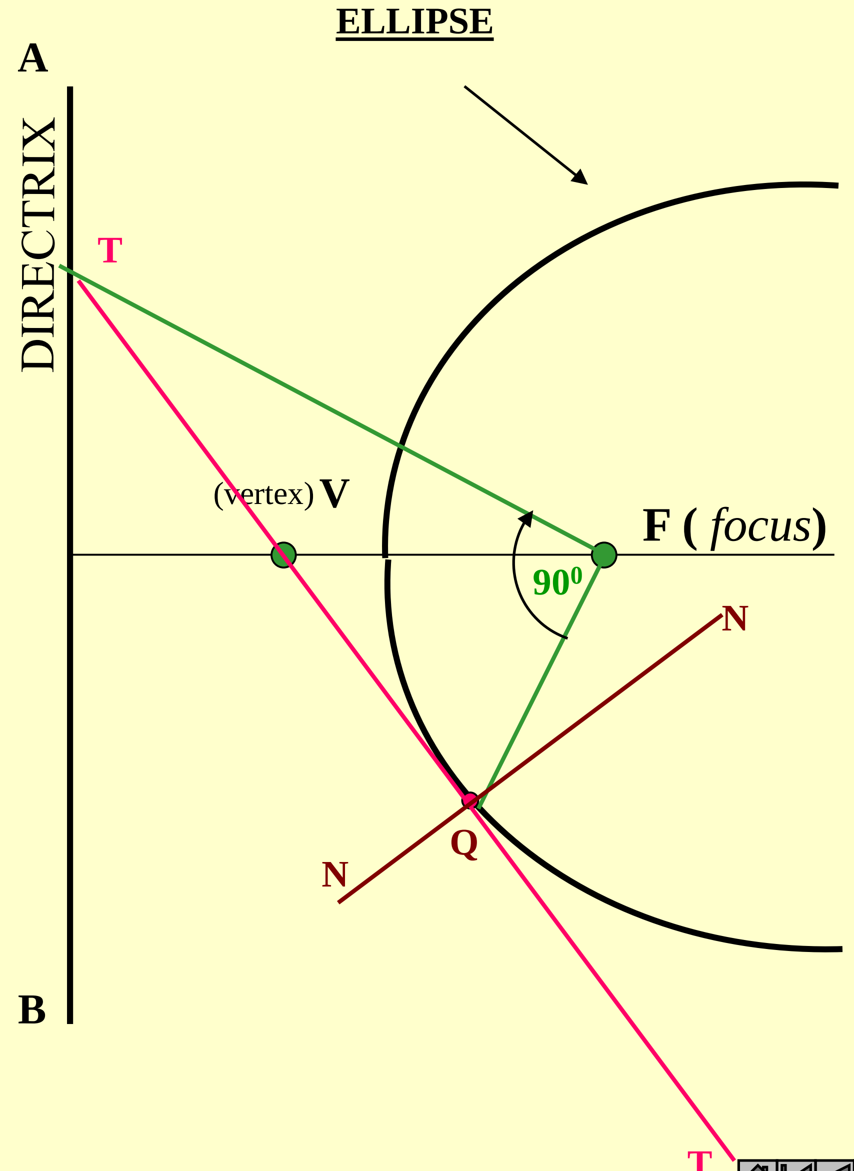
1. JOIN POINT Q TO F_1 & F_2
2. BISECT ANGLE $F_1Q\ F_2$ THE ANGLE BISECTOR IS NORMAL
3. A PERPENDICULAR LINE DRAWN TO IT IS TANGENT TO THE CURVE.



Problem 10:

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

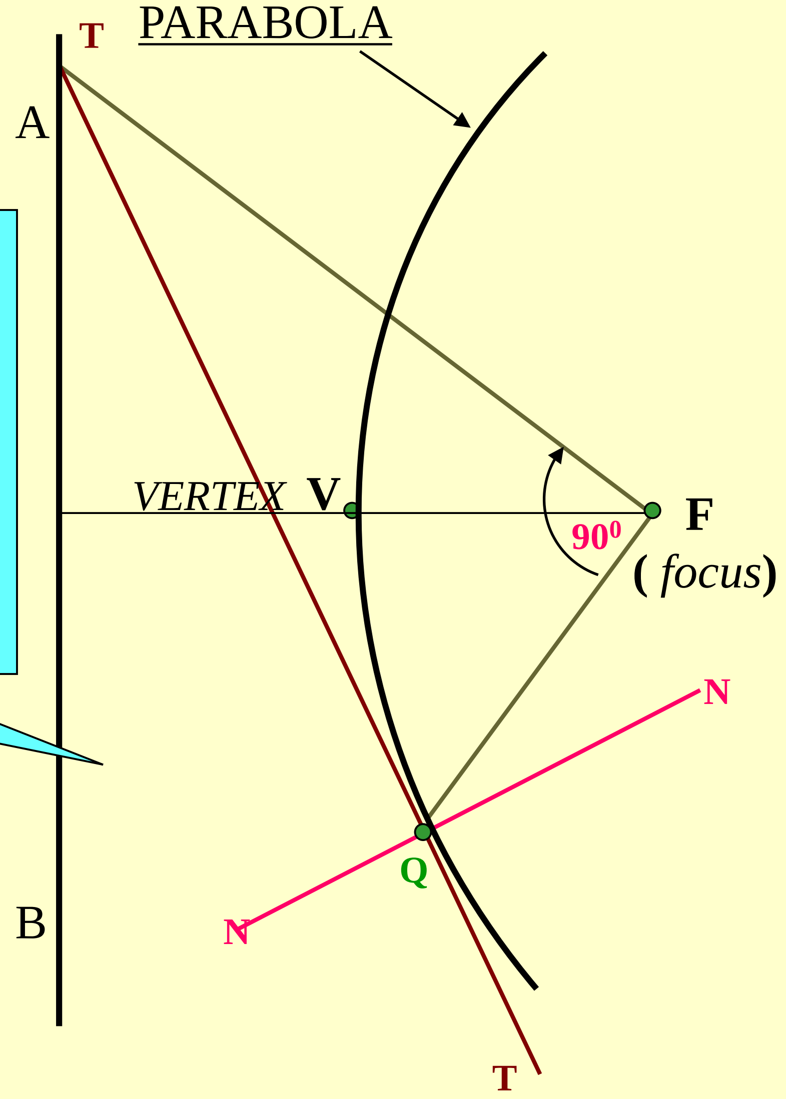
1.JOIN POINT **Q** TO **F.**
2.CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT **F**
3.EXTEND THE LINE TO MEET DIRECTRIX AT **T**
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



Problem 11:

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.



Problem 12

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.