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

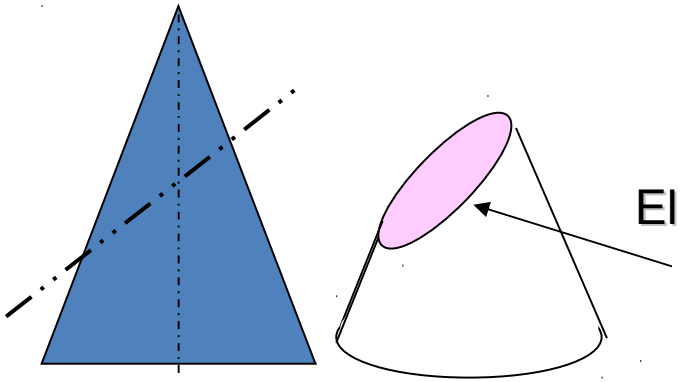
1. Rectangular Hyperbola (coordinates given)
2. Rectangular Hyperbola (P-V diagram - Equation given)
3. Basic Locus Method (Directrix – focus)

Methods of Drawing Tangents & Normals To These Curves.

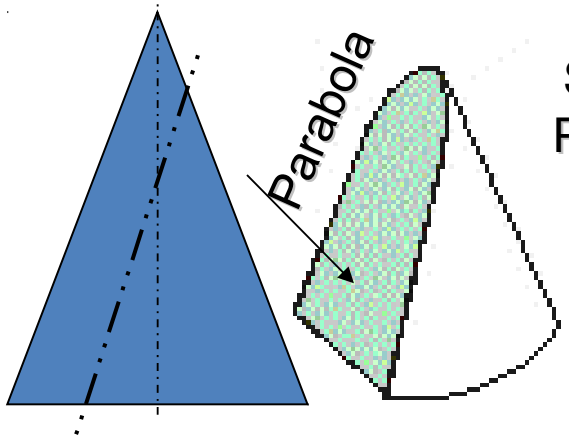
CONIC SECTIONS

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.

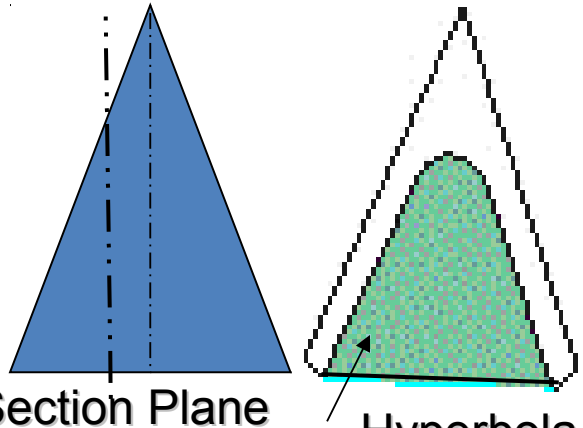
OBSERVE ILLUSTRATIONS GIVEN BELOW..



Section Plane
Through Generators



Section Plane Parallel
to end generator.



Section Plane
Parallel to Axis.

COMMON DEFINATION OF ELLIPSE, PARABOLA & HYPERBOLA:

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

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 axis*.}

These TWO fixed points are FOCUS 1 & FOCUS 2

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

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 }

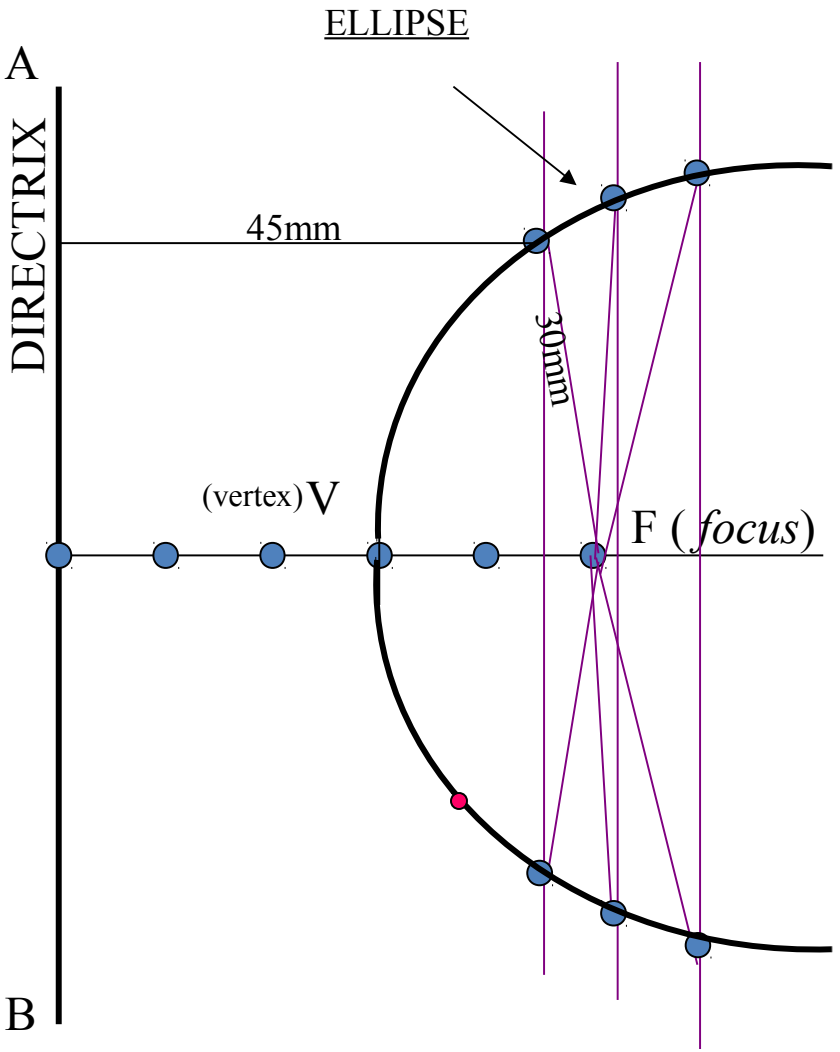
ELLIPSE

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.



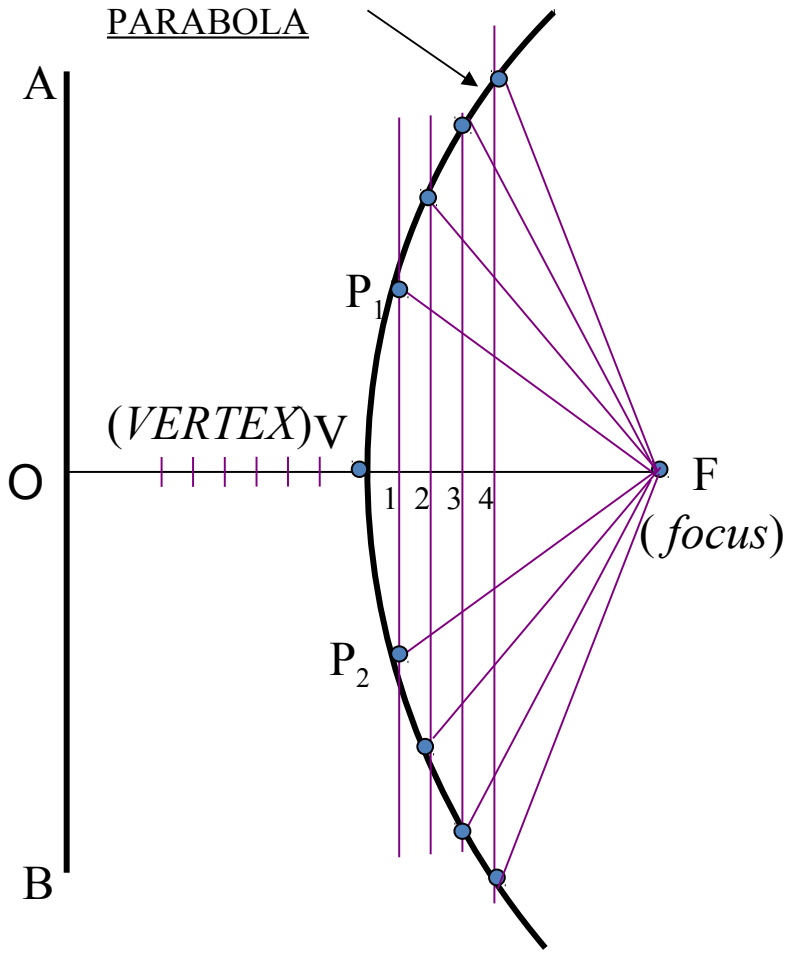
PARABOLA
DIRECTRIX-FOCUS METHOD

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 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.



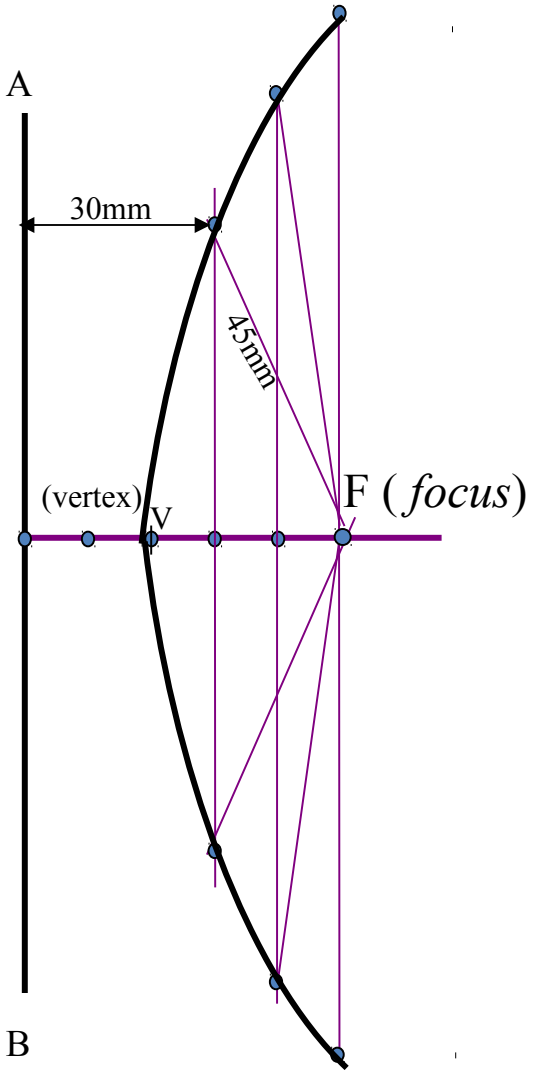
PROBLEM 12:- POINT F IS 50 MM FROM A LINE AB.A POINT P IS MOVING IN A PLANE SUCH THAT THE *RATIO* OF IT'S DISTANCES FROM F AND LINE AB REMAINS CONSTANT AND EQUALS TO 2/3 DRAW LOCUS OF POINT P. { ECCENTRICITY = 2/3 }

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 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.

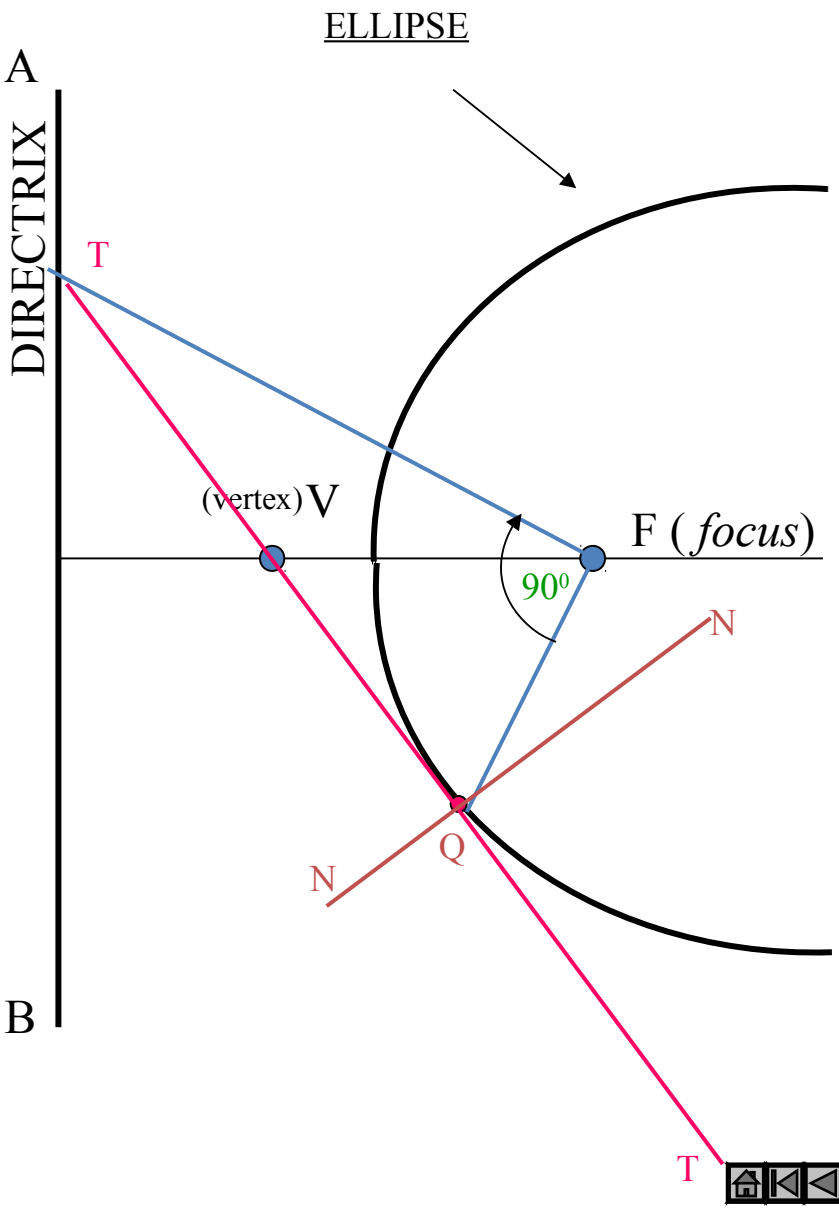


ELLIPSE
TANGENT & NORMAL

Problem 14:

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

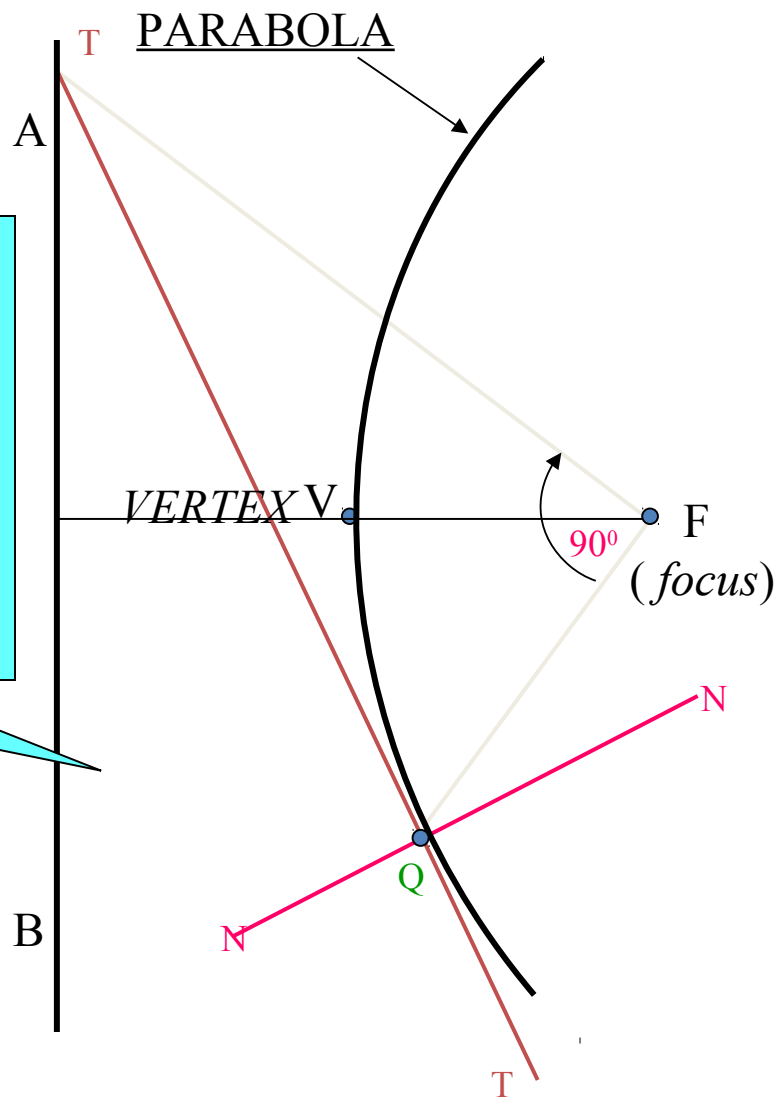
1.JOIN POINT Q TO F.
2.CONSTRUCT 900 ANGLE WITH THIS LINE AT POINT F
3.EXTEND THE LINE TO MEET DIRECTRIX AT T
4. JOIN THIS POINT TO Q AND EXTEND. THIS IS TANGENT TO ELLIPSE FROM Q
5.TO THIS TANGENT DRAW PERPENDICULAR LINE FROM Q. IT IS NORMAL TO CURVE.



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.

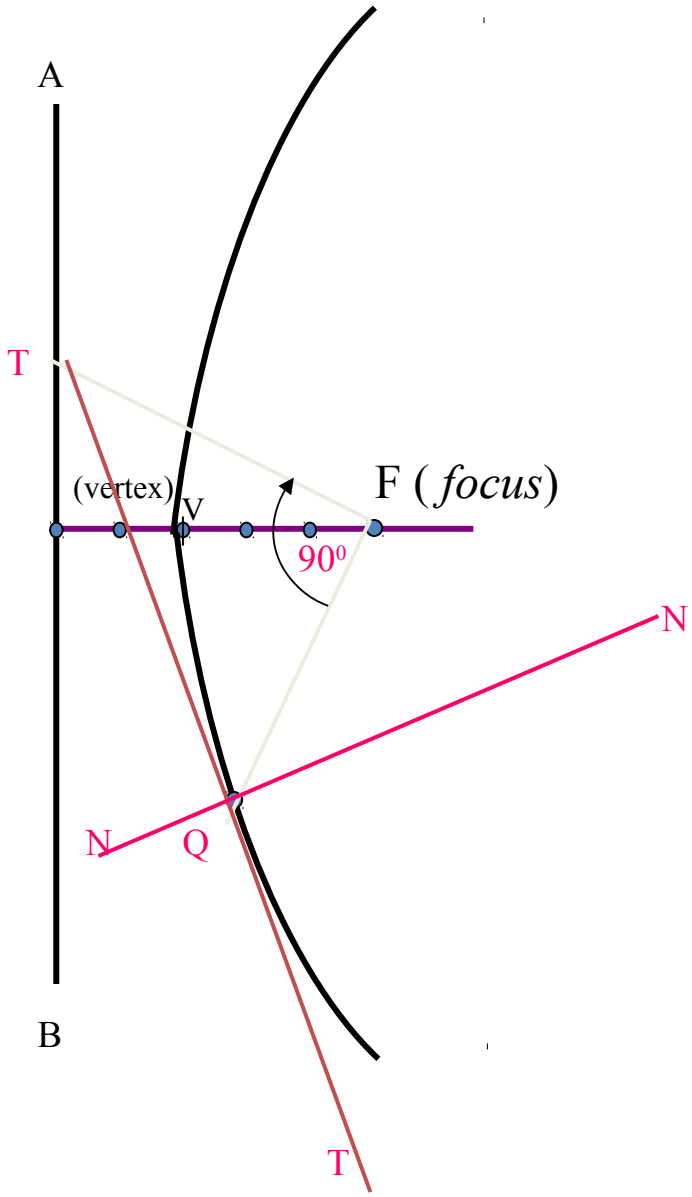


Problem 16

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.



ENGINEERING CURVES

Part-II

(Point undergoing two types of displacements)

INVOLUTE	CYCLOID	SPIRAL	HELIX
1. Involute of a circle a)String Length = πD b)String Length > πD c)String Length < πD	1. General Cycloid 2. Trochoid (superior) 3. Trochoid (Inferior) 4. Epi-Cycloid 5. Hypo-Cycloid	1. Spiral of One Convolution. 2. Spiral of Two Convolutions.	1. On Cylinder 2. On a Cone
2. Pole having Composite shape.			
3. Rod Rolling over a Semicircular Pole.			

AND

Methods of Drawing Tangents & Normals To These Curves.

DEFINITIONS

CYCLOID:

T IS A LOCUS OF A POINT ON THE
PERIPHERY OF A CIRCLE WHICH
ROLLS ON A STRAIGHT LINE PATH.

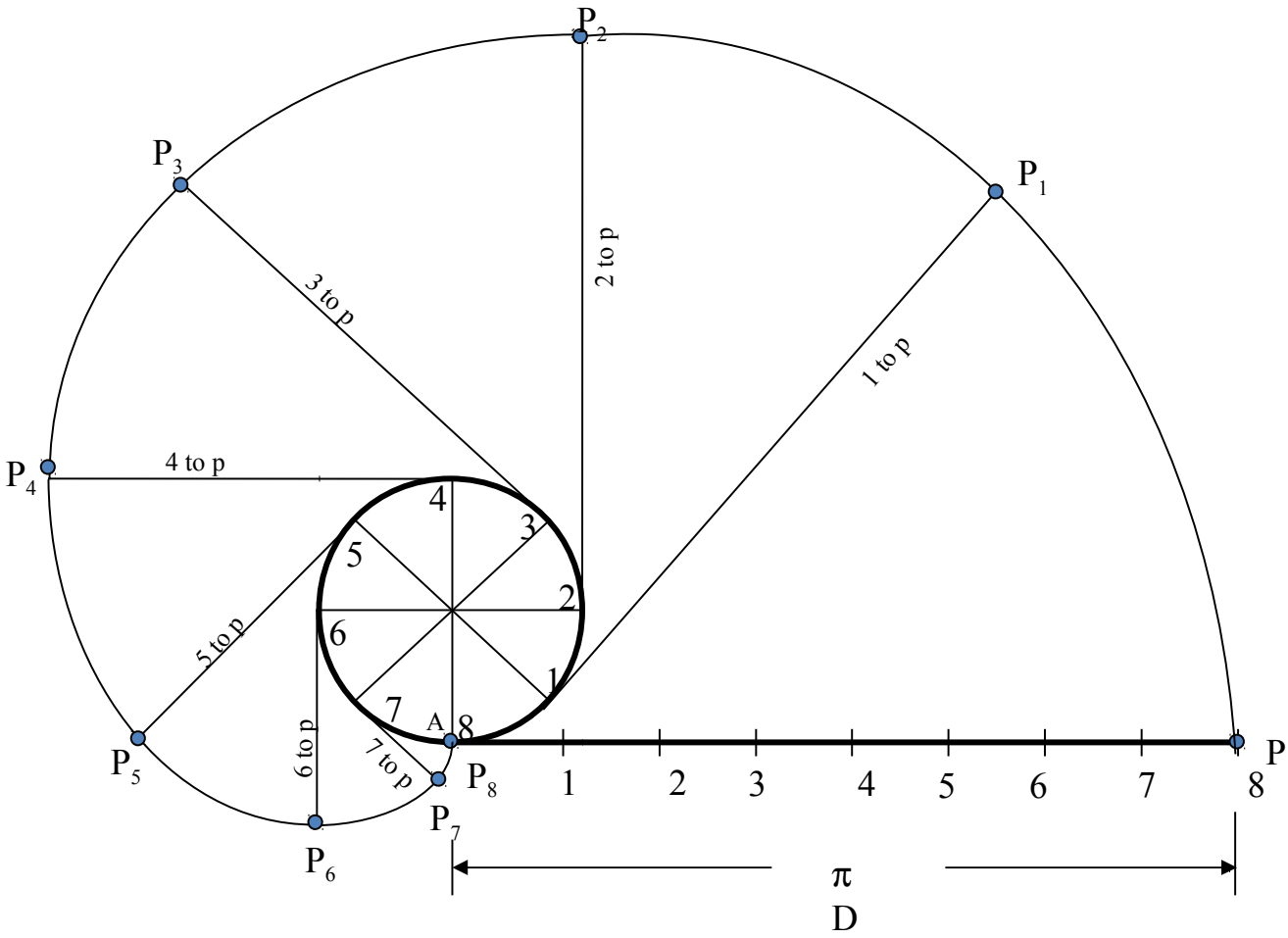
INVOLUTE:

T IS A LOCUS OF A FREE END OF A STRING
WHEN IT IS WOUND ROUND A CIRCULAR POLE

Problem no 17: Draw Involute of a circle.
String length is equal to the circumference of circle.

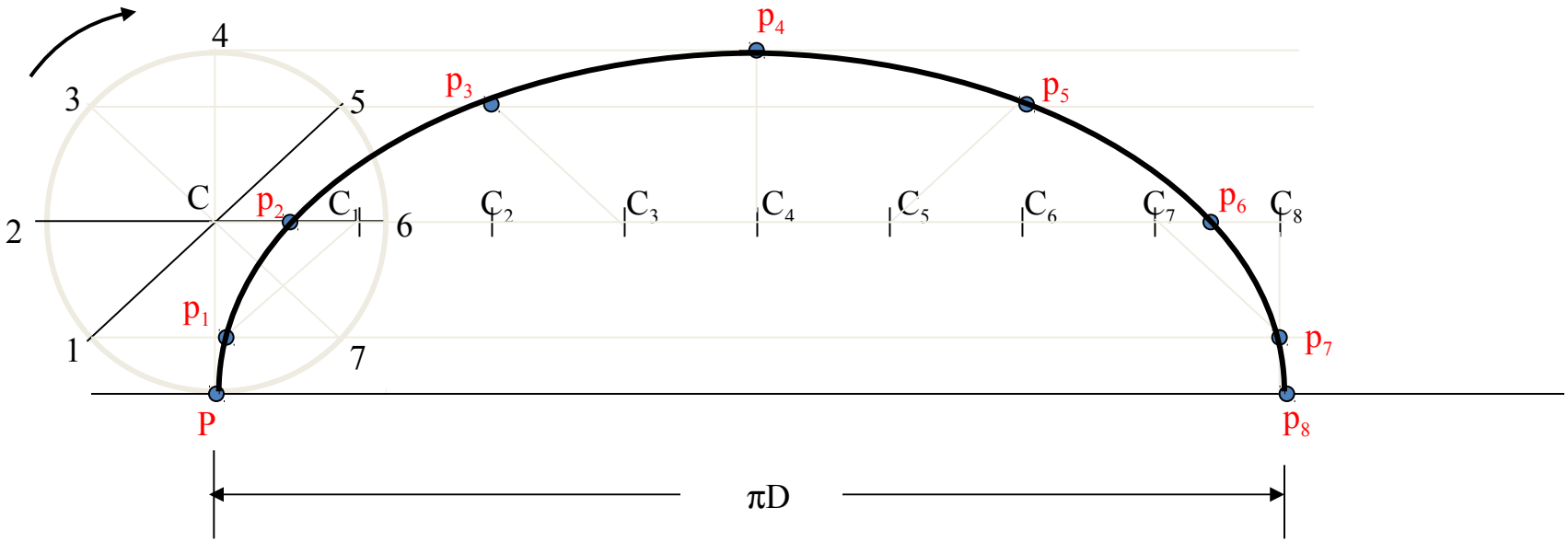
Solution Steps:

1) Point or end P of string AP is exactly πD distance away from A. Means if this string is wound round the circle, it will completely cover given circle. B will meet A after winding.
2) Divide πD (AP) distance into 8 number of equal parts.
3) Divide circle also into 8 number of equal parts.
4) Name after A, 1, 2, 3, 4, etc. up to 8 on πD line AP as well as on circle (in anticlockwise direction).
5) To radius C-1, C-2, C-3 up to C-8 draw tangents (from 1,2,3,4,etc to circle).
6) Take distance 1 to P in compass and mark it on tangent from point 1 on circle (means one division less than distance AP).
7) Name this point P1
8) Take 2-B distance in compass and mark it on the tangent from point 2. Name it point P2.
9) Similarly take 3 to P, 4 to P, 5 to P up to 7 to P distance in compass and mark on respective tangents and locate P3, P4, P5 up to P8 (i.e. A) points and join them in smooth curve it is an INVOLUTE of a given circle.



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



Solution 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 P.
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.

Involute
Method of Drawing Tangent & Normal

STEPS:
DRAW INVOLUTE AS USUAL.

MARK POINT Q ON IT AS DIRECTED.

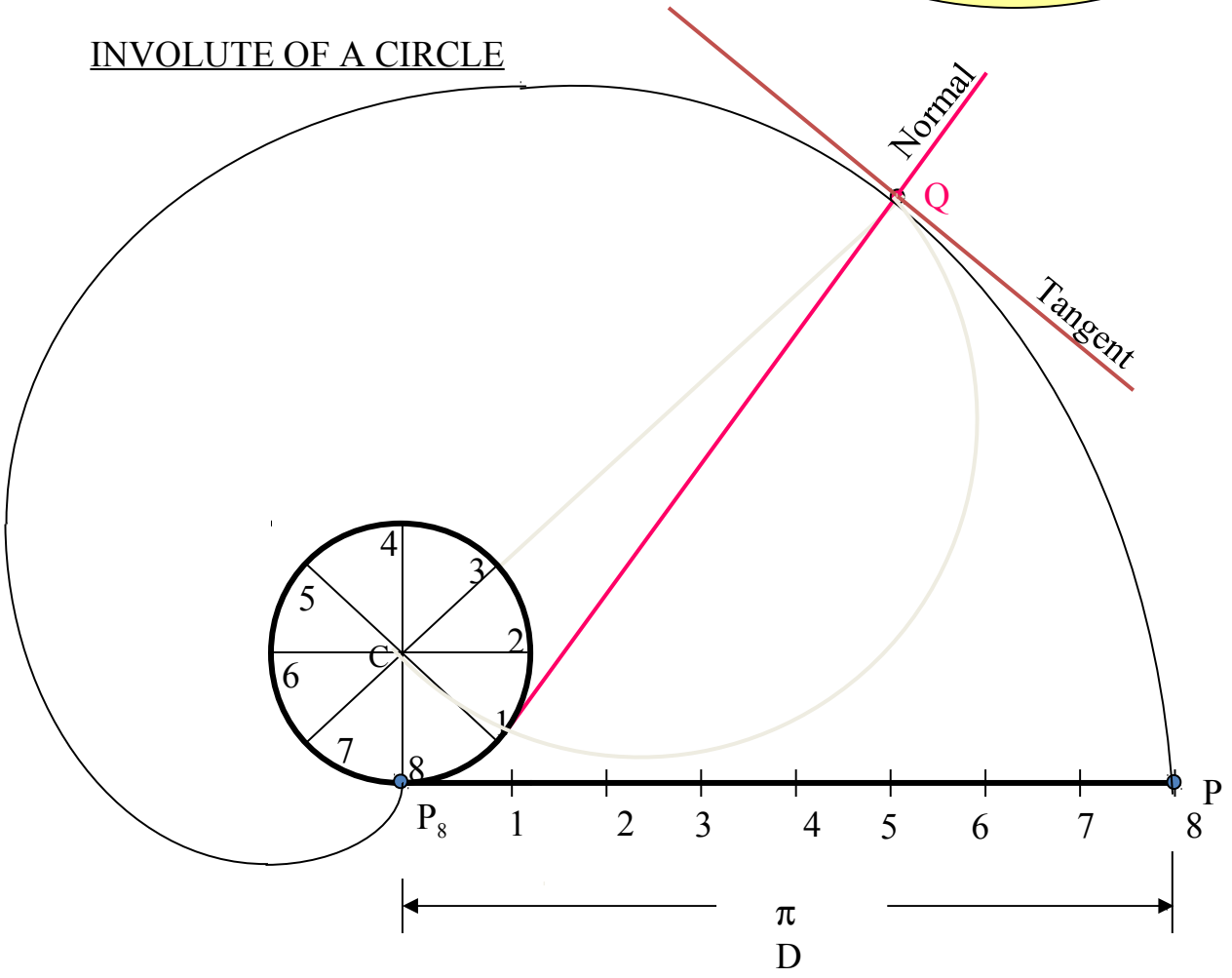
JOIN Q TO THE CENTER OF CIRCLE C. CONSIDERING CQ DIAMETER, DRAW A SEMICIRCLE AS SHOWN.

MARK POINT OF INTERSECTION OF THIS SEMICIRCLE AND POLE CIRCLE AND JOIN IT TO Q.

THIS WILL BE NORMAL TO INVOLUTE.

DRAW A LINE AT RIGHT ANGLE TO THIS LINE FROM Q.

IT WILL BE TANGENT TO INVOLUTE.



CYCLOID
Method of Drawing Tangent & Normal

STEPS:

DRAW CYCLOID AS USUAL.
MARK POINT Q ON IT AS DIRECTED.

WITH CP DISTANCE, FROM Q. CUT THE POINT ON LOCUS OF C AND JOIN IT TO Q.

FROM THIS POINT DROP A PERPENDICULAR ON GROUND LINE AND NAME IT N

JOIN N WITH Q.THIS WILL BE NORMAL TO CYCLOID.

DRAW A LINE AT RIGHT ANGLE TO THIS LINE FROM Q.

IT WILL BE TANGENT TO CYCLOID.