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@PASSKALBOT

**Sinhgad College Of Engineering**



# **ENGINEERING GRAPHICS**

**ENGINEERING CURVES**

**DEPARTMENT OF MECHANICAL  
ENGINEERING**

# Types of Engineering Curves

**1. Ellipse**

**2. Parabola**

**3. Hyperbola**

**Conic Sections**



**4. Involute of a Circle**

**5. Cycloid of a rolling circle**

**6. Archimedian Spiral**

**7. Helix upon a Cylinder**

# ENGINEERING CURVES

## Part- I {Conic Sections}

### ELLIPSE

1. Concentric Circle Method

2. Rectangle Method

3. Oblong Method

4. Arcs of Circle Method

5. Rhombus Method

6. Basic Locus Method  
(Directrix – focus)

### PARABOLA

1. Rectangle Method

2 Method of Tangents  
( Triangle Method)

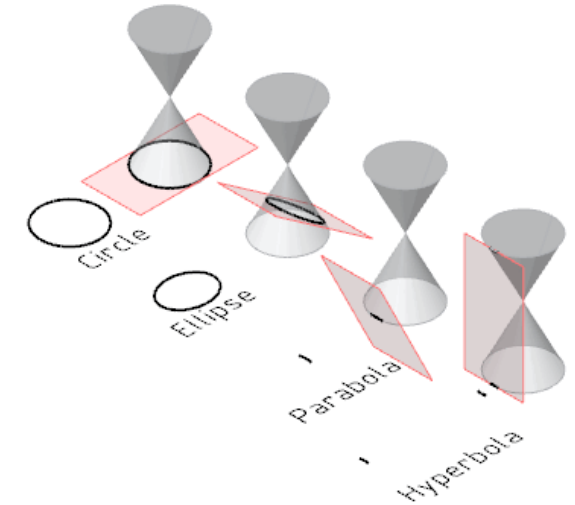
3. Basic Locus Method  
(Directrix – focus)

### HYPERBOLA

1. Rectangular Hyperbola  
(coordinates given)

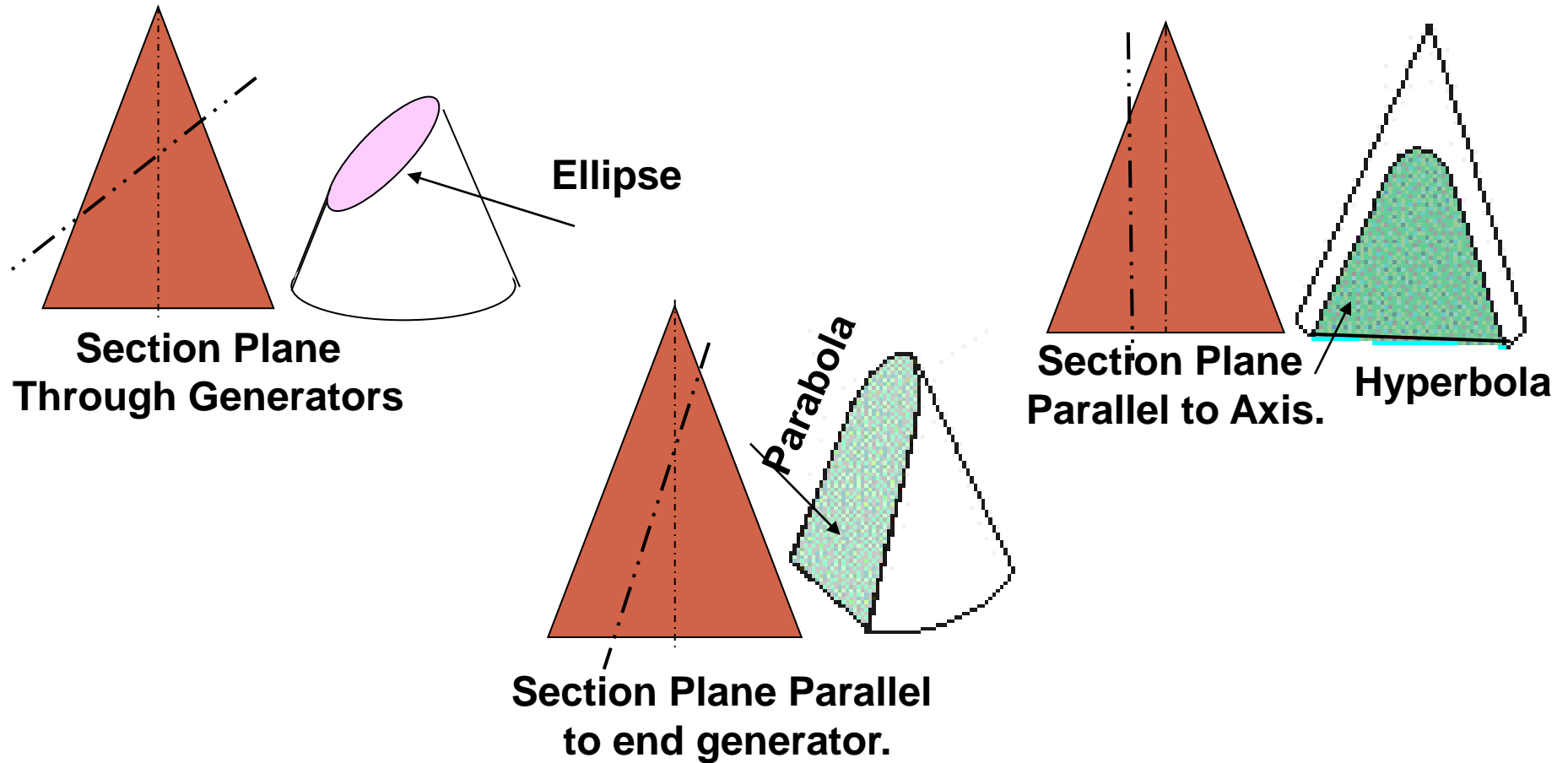
2 Rectangular Hyperbola  
(P-V diagram - Equation given)

3. Basic Locus Method  
(Directrix – focus)



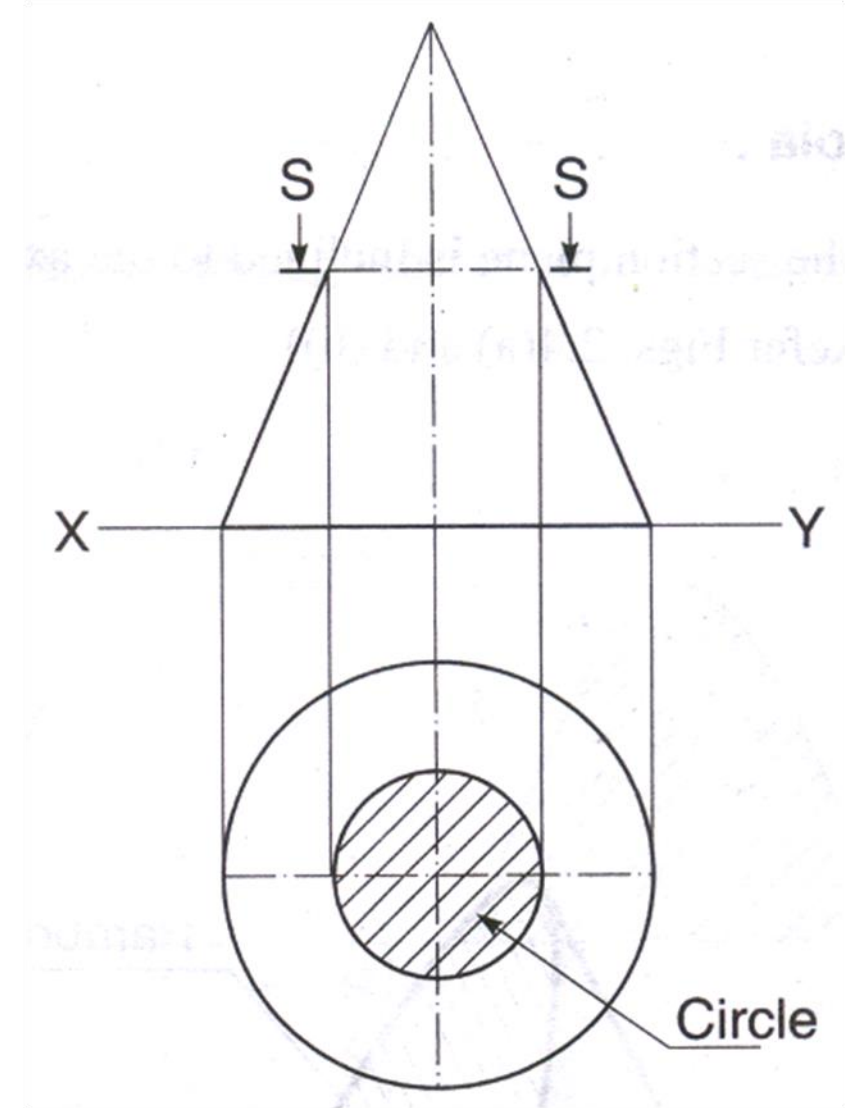
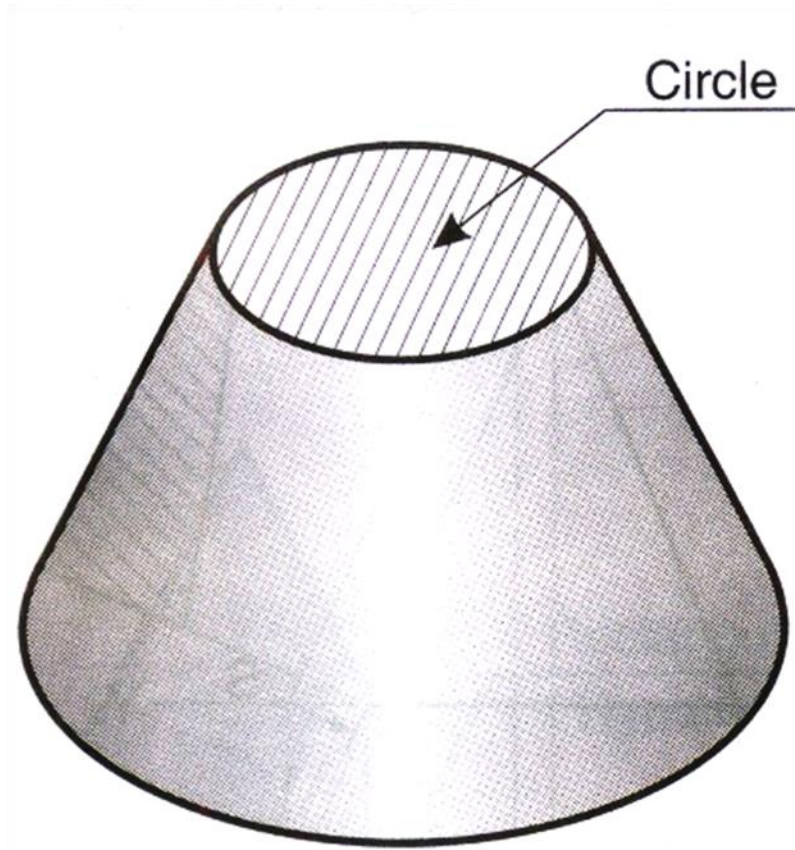
## CONIC SECTIONS

**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.**



# CIRCLE

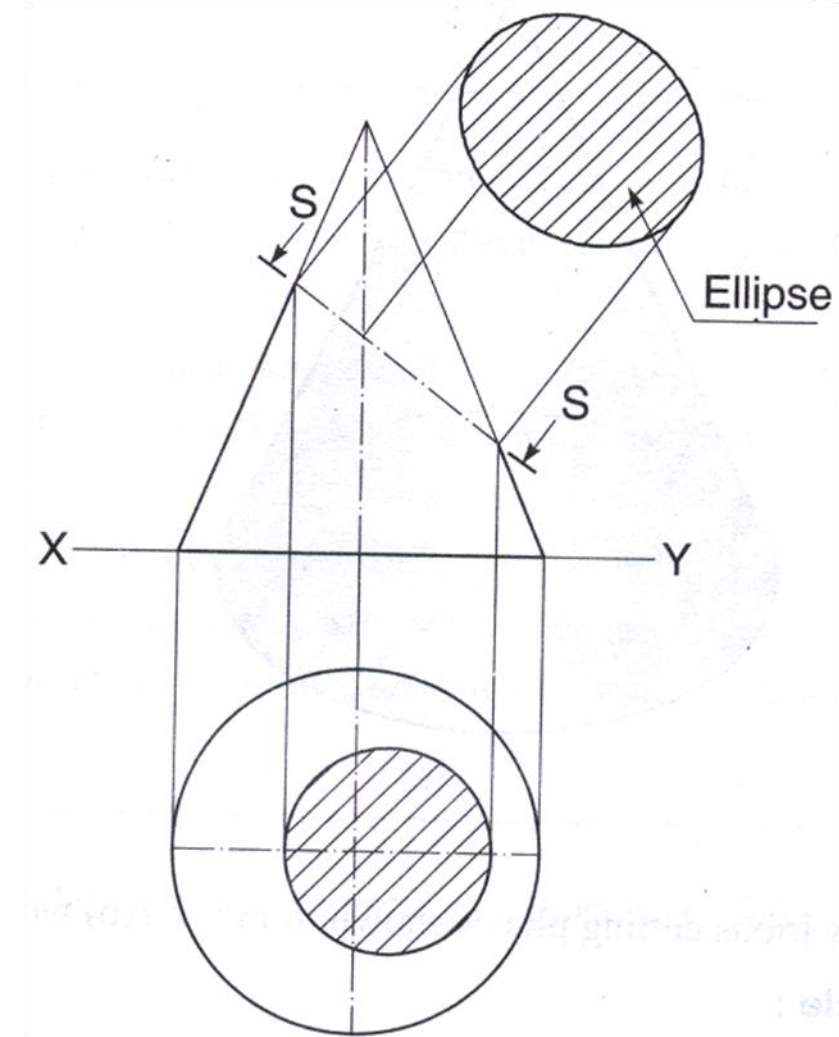
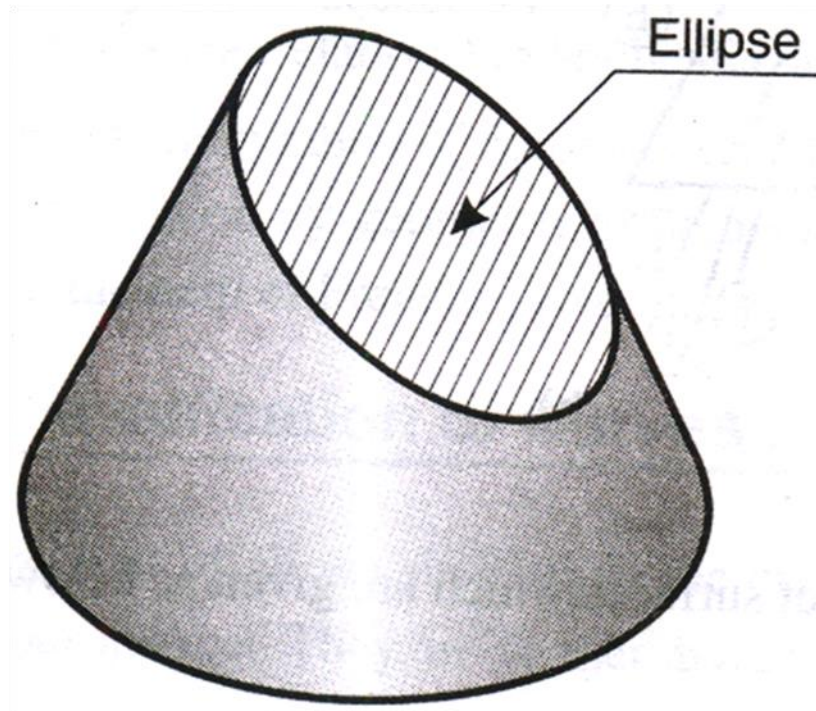
Section plane is parallel to the base .  
or  
perpendicular to the axis of the cone.



# ELLIPSE

Section plane is inclined to the axis of cone such that angle made by the section plane with the axis is greater than angle made by the generator of the cone with axis.

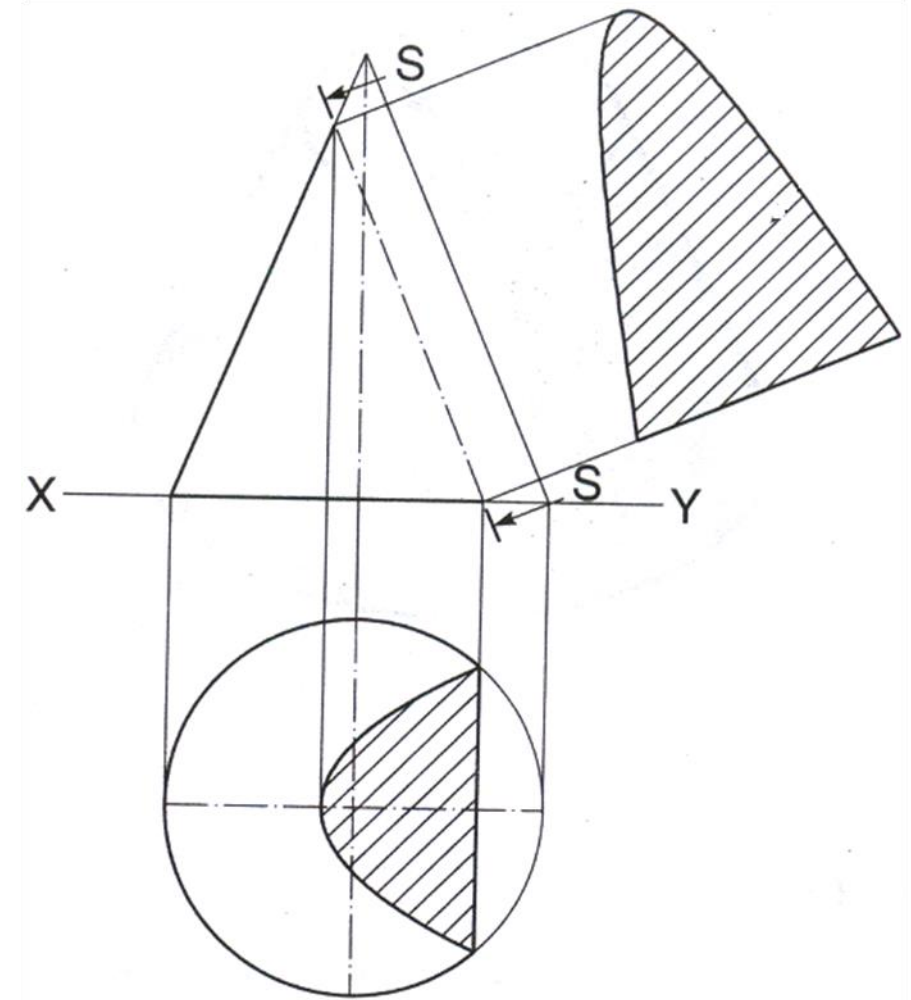
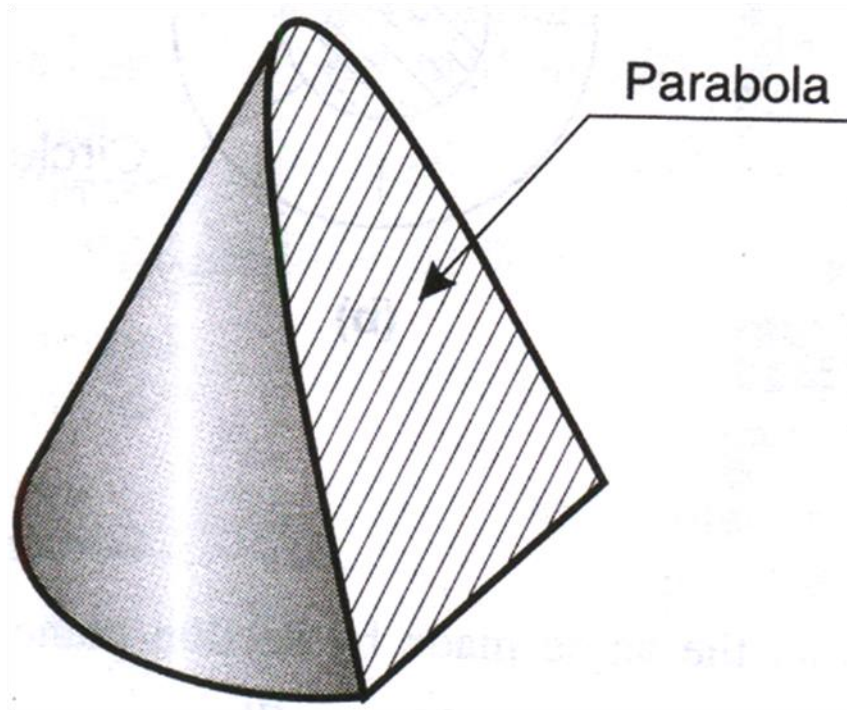
***Section plane through the generators***





# PARABOLA

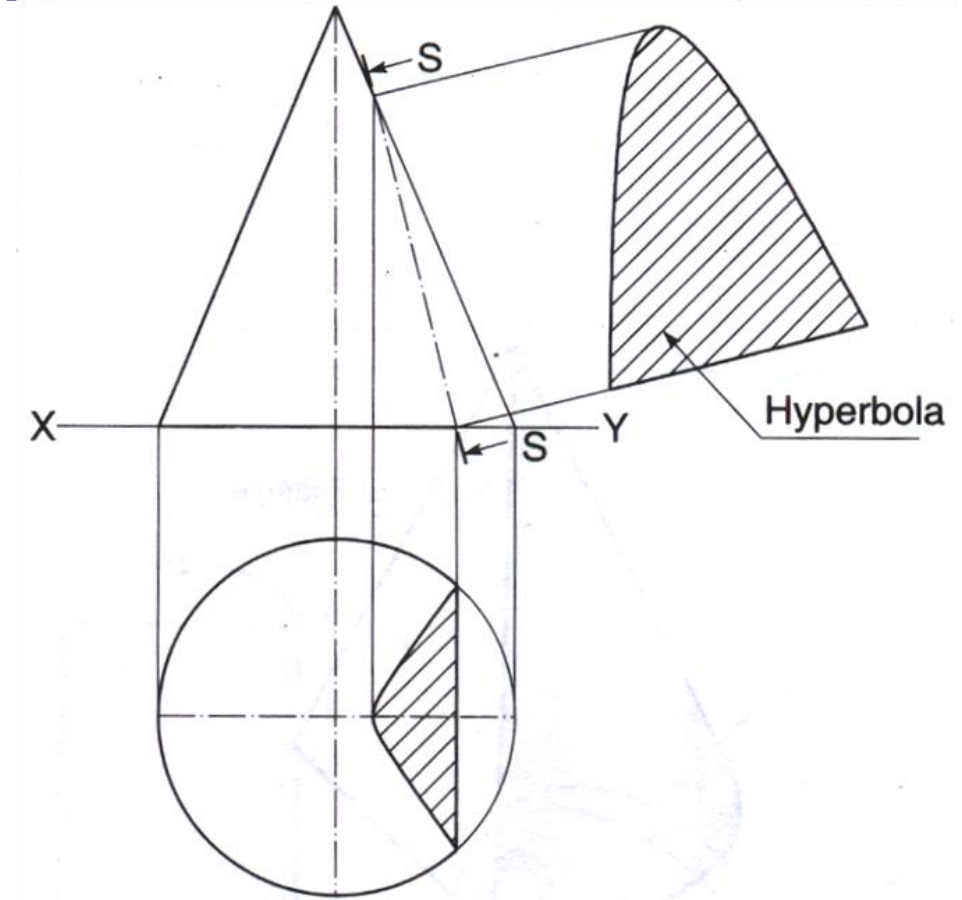
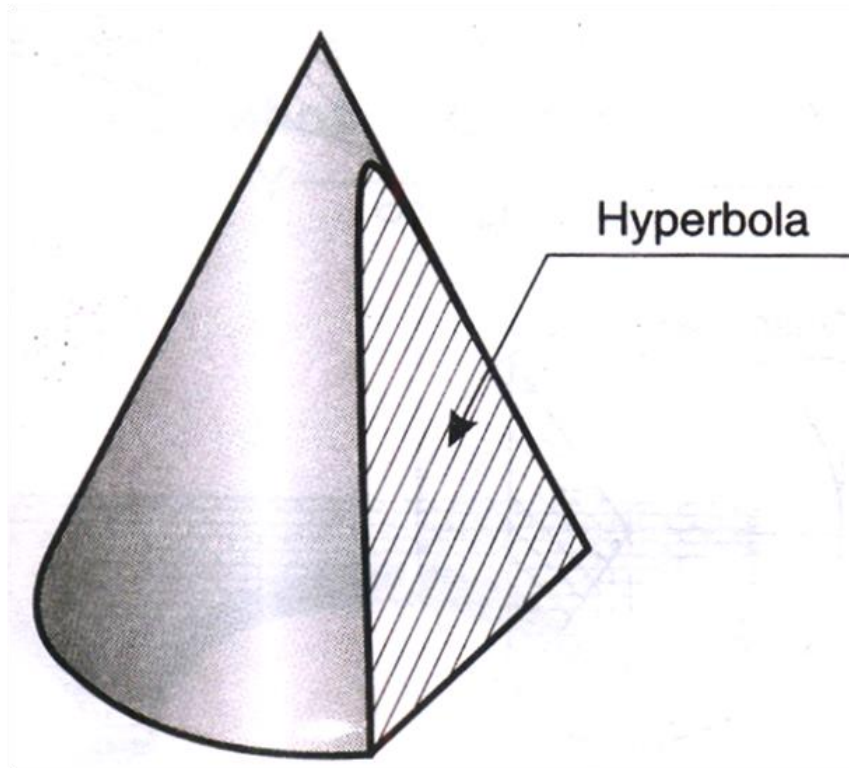
Section plane is inclined to the axis & parallel to one of the generator of the cone.





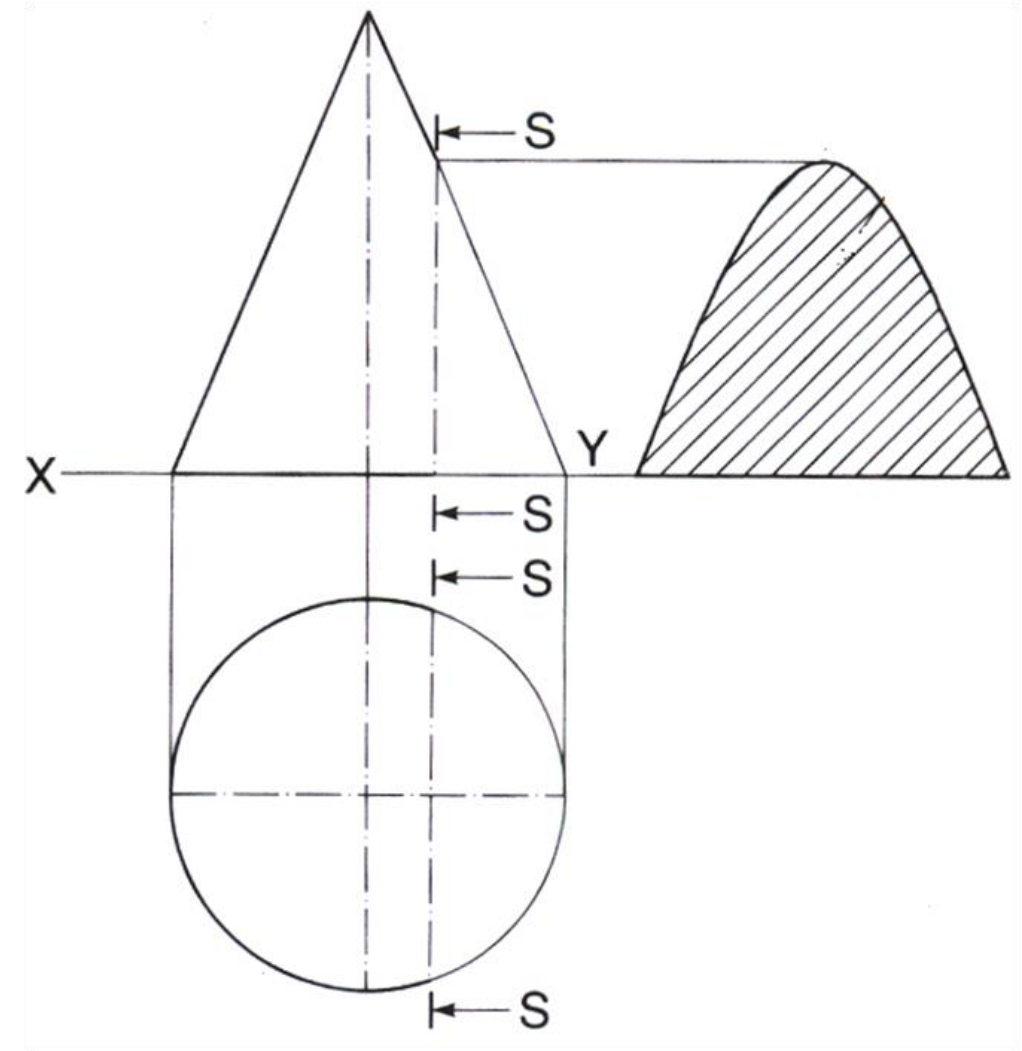
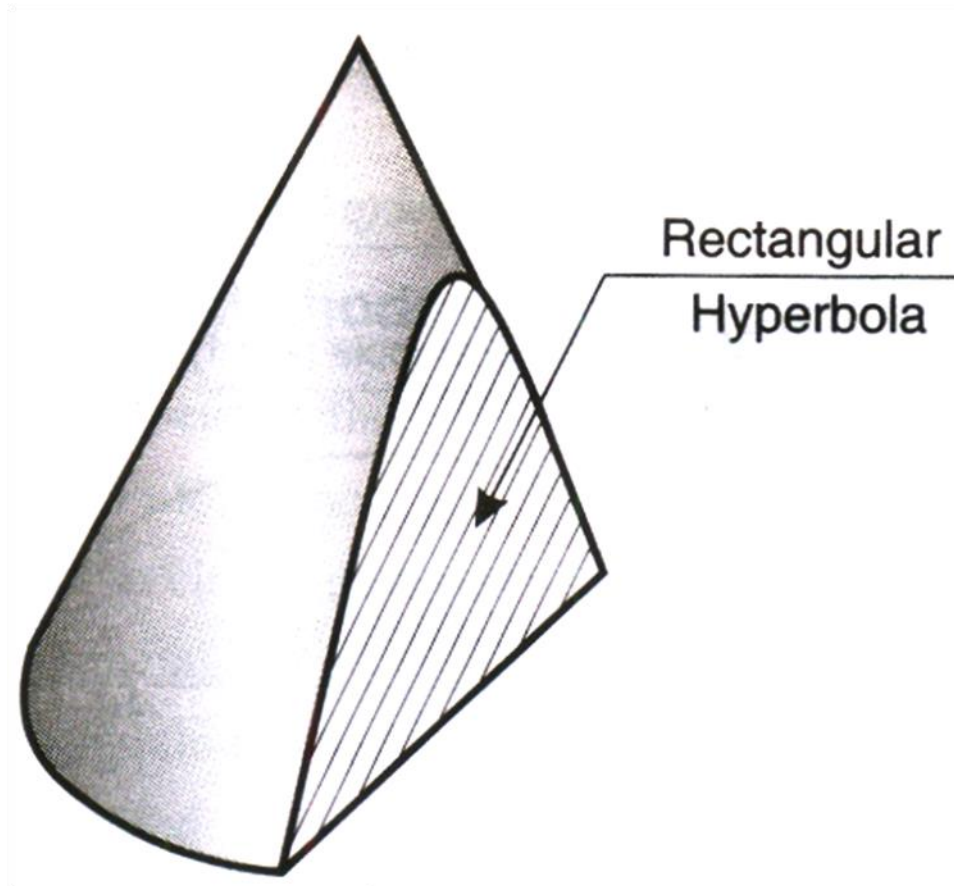
# HYPERBOLA

Section plane is inclined to the axis of cone such that angle made by the section plane with the axis is smaller than angle made by the generator of the cone with axis.



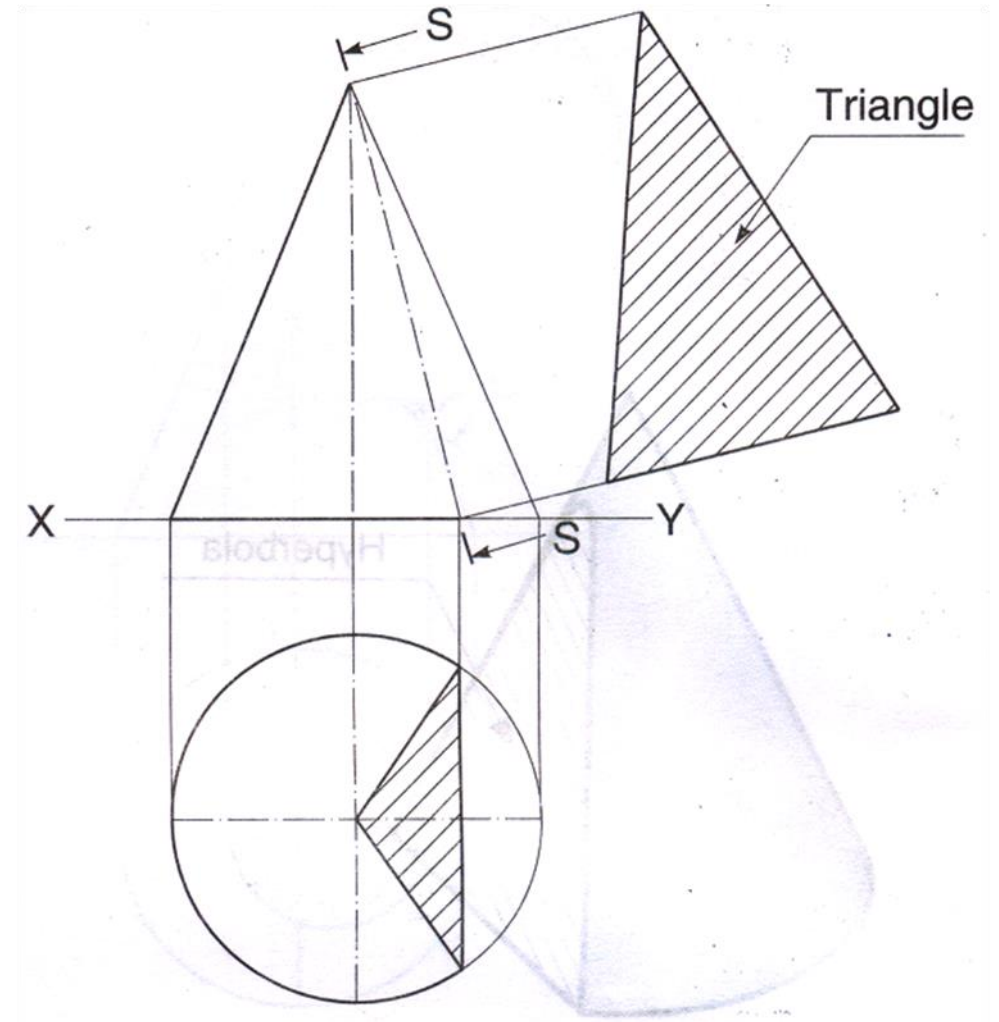
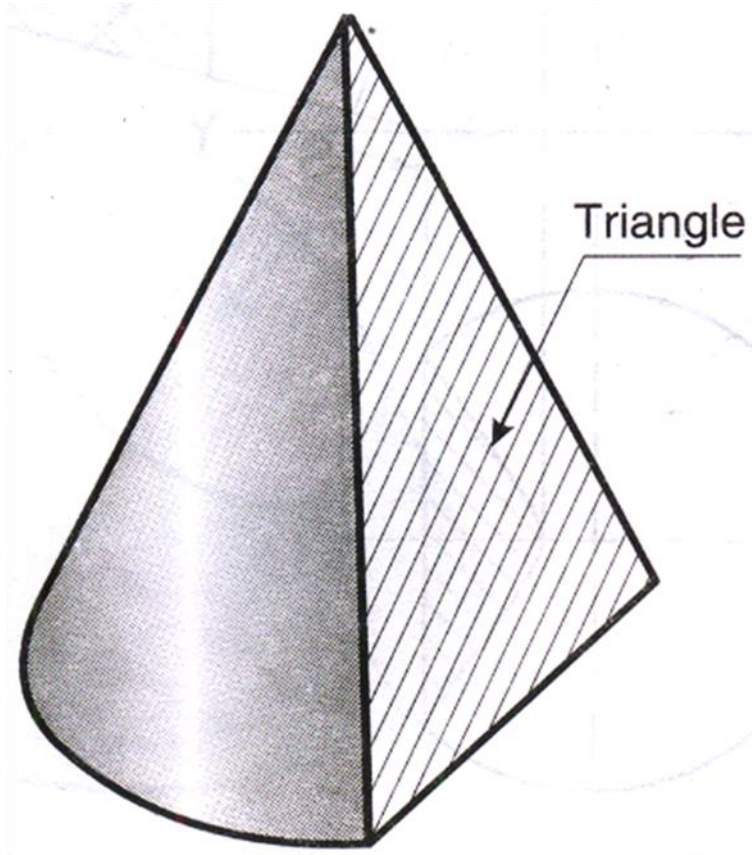
# RECTANGULAR HYPERBOLA

Section plane is parallel to the axis of the cone and not passing through the apex.

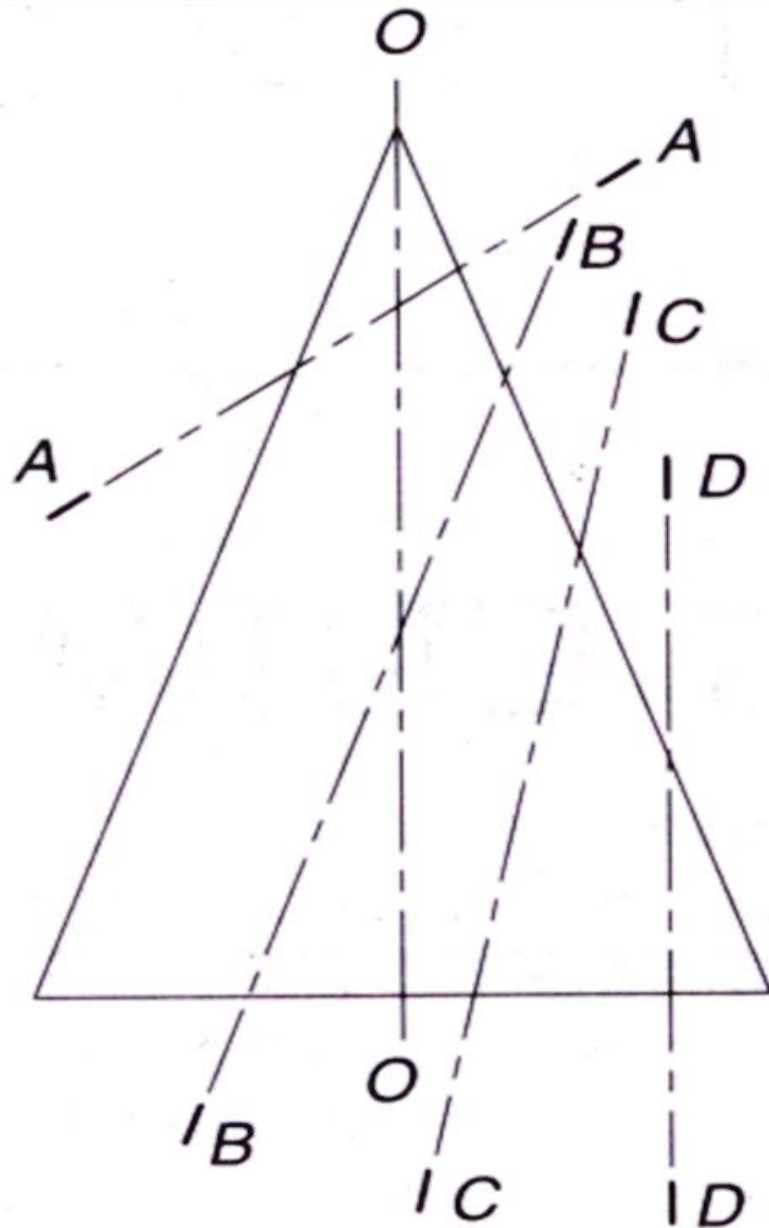


# TRIANGLE

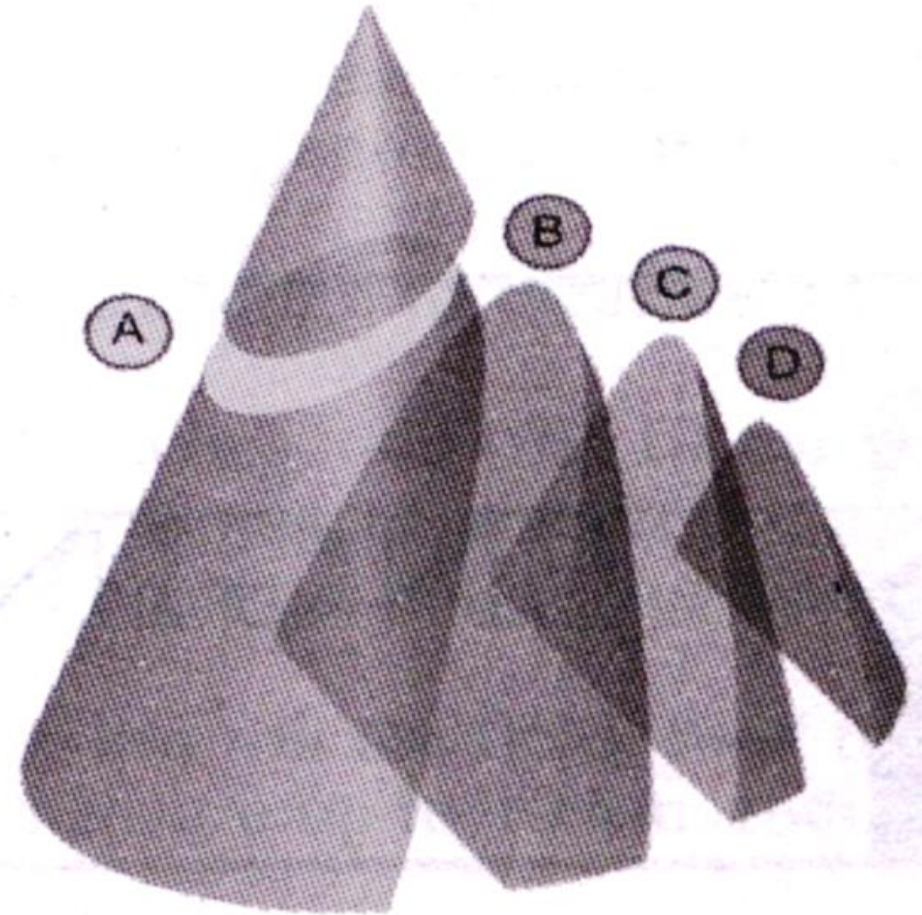
Section plane passing through the apex of the cone.







$O-O = \text{Axis}$



Ⓐ Ellipse

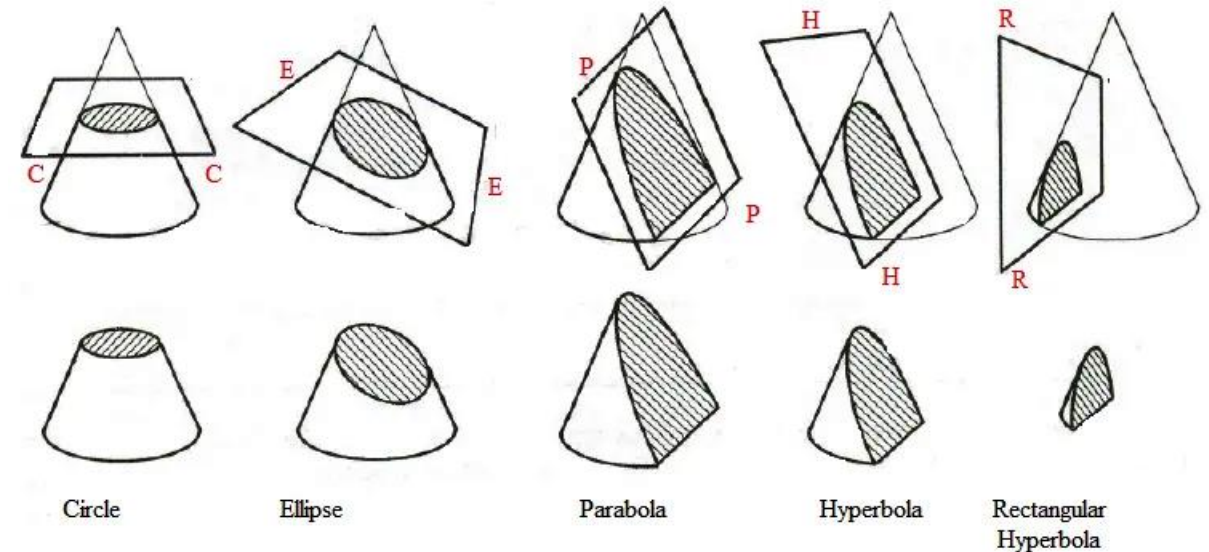
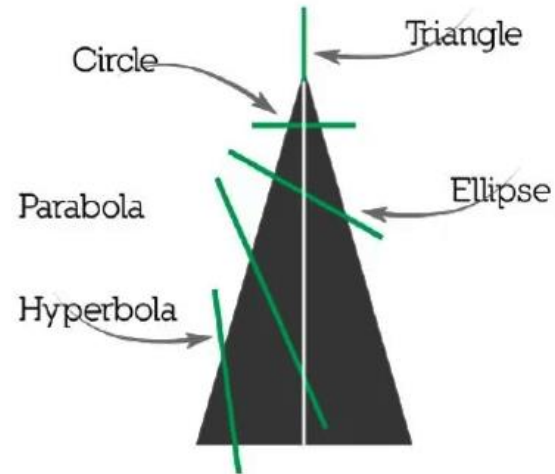
Ⓑ Parabola

Ⓒ Hyperbola

Ⓓ Rectangular hyperbola

## APPLICATION OF ENGINEERING CURVES

**Definition of Engineering Curves** – When a cone is cut by a cutting plane with different positions of the plane relative to the axis of cone, it gives various types of curves like Triangle, Circle, ellipse, parabola, and hyperbola. These curves are known as conic sections



Different methods to have types of conic sections on a cone we need to cut a cone as per following:

To get Triangle: We have to cut cone from apex to centre of the base (vertically)

To get Circle: We have to cut cone by a cutting plan which should parallel to base or perpendicular to axis of cone.

To get Ellipse: We have to cut cone in such a way that the cutting plane remains inclined to axis of cone and it cuts all generators of cone.

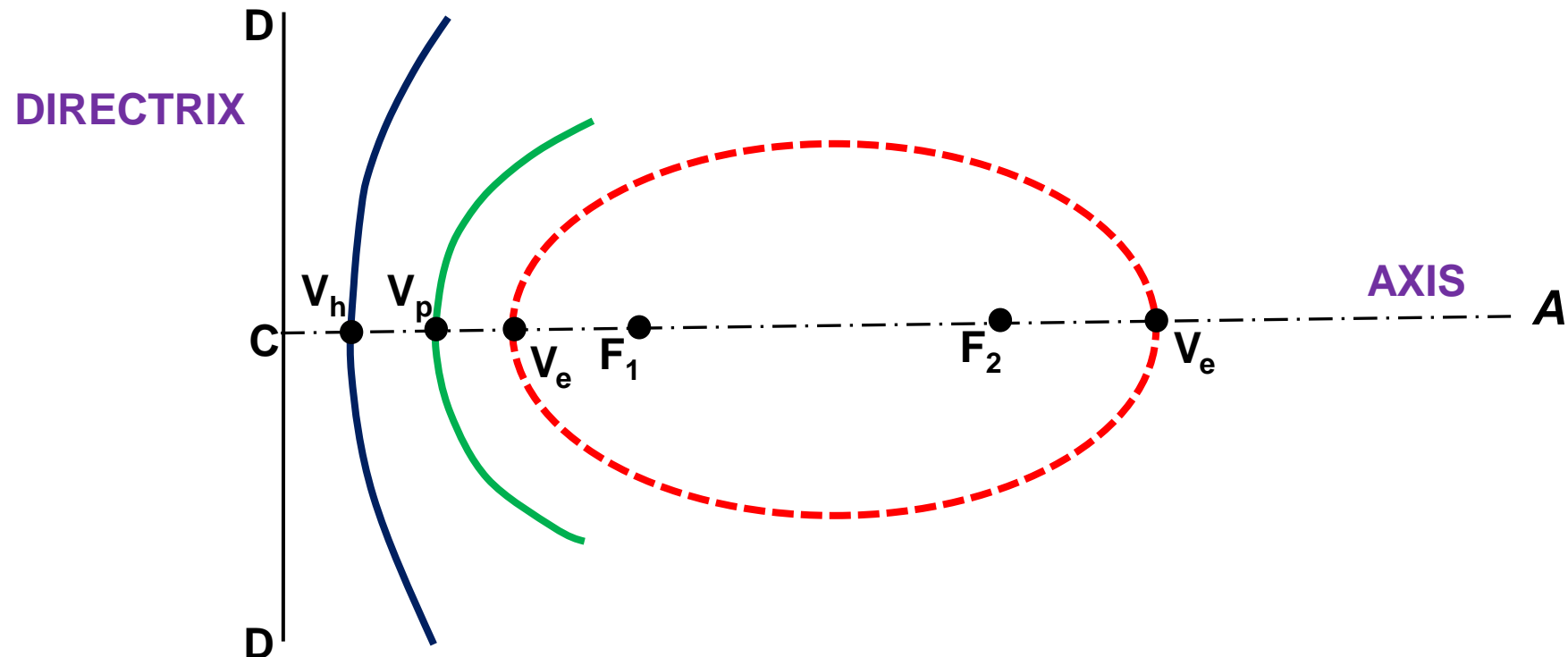
To get Parabola: We have to cut a cone by a cutting plane which should inclined to axis of cone but remains parallel to one of the generators of cone.

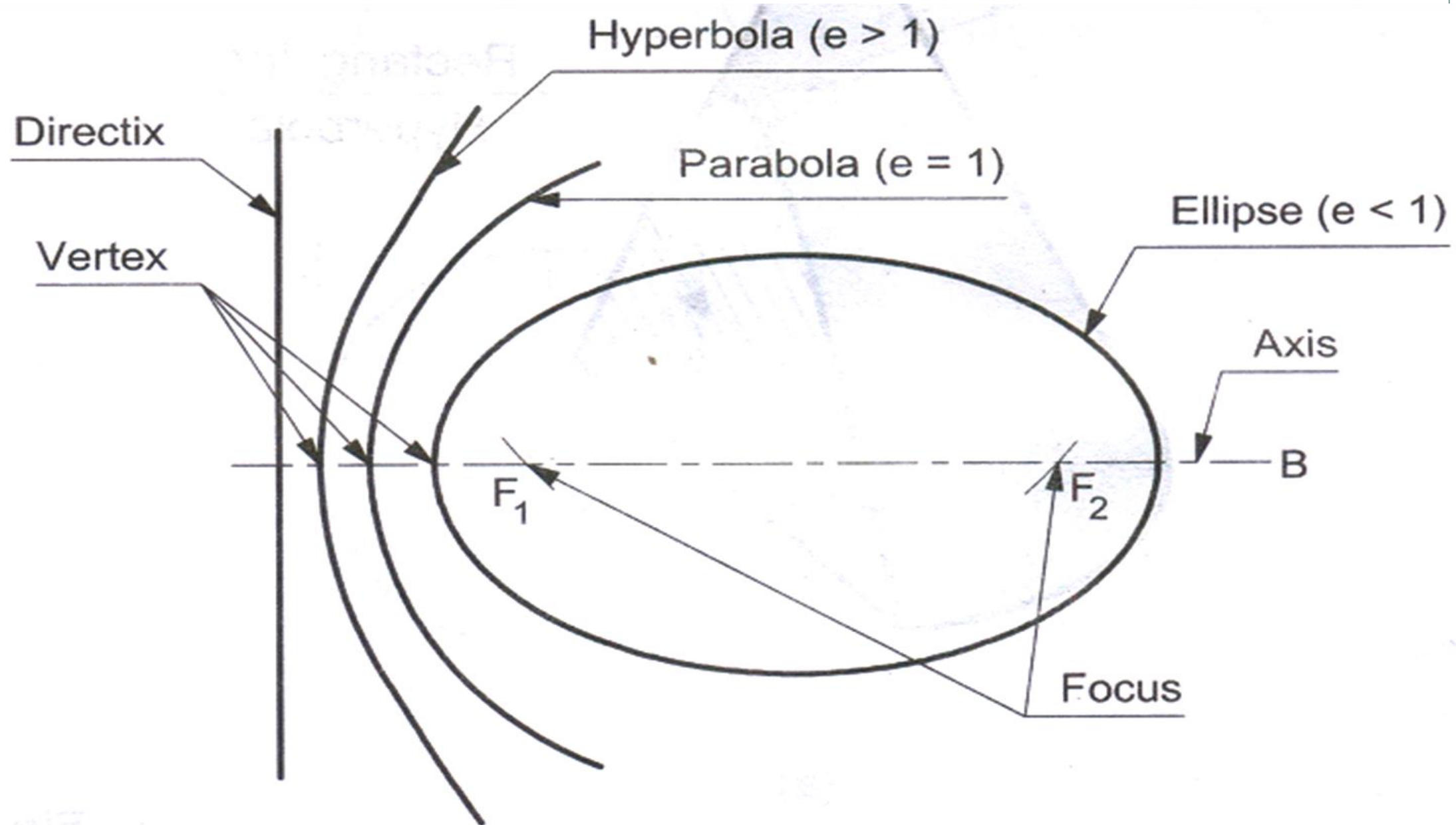
**Eccentricity ( $e$ ) =  $VF / VC$**

**$e < 1$  ----- ellipse ----- [  $(VF / VC) < 1$  ]**

**$e = 1$  ----- parabola ----- [  $(VF / VC) = 1$  ]**

**$e > 1$  ----- hyperbola ----- [  $(VF / VC) > 1$  ]**





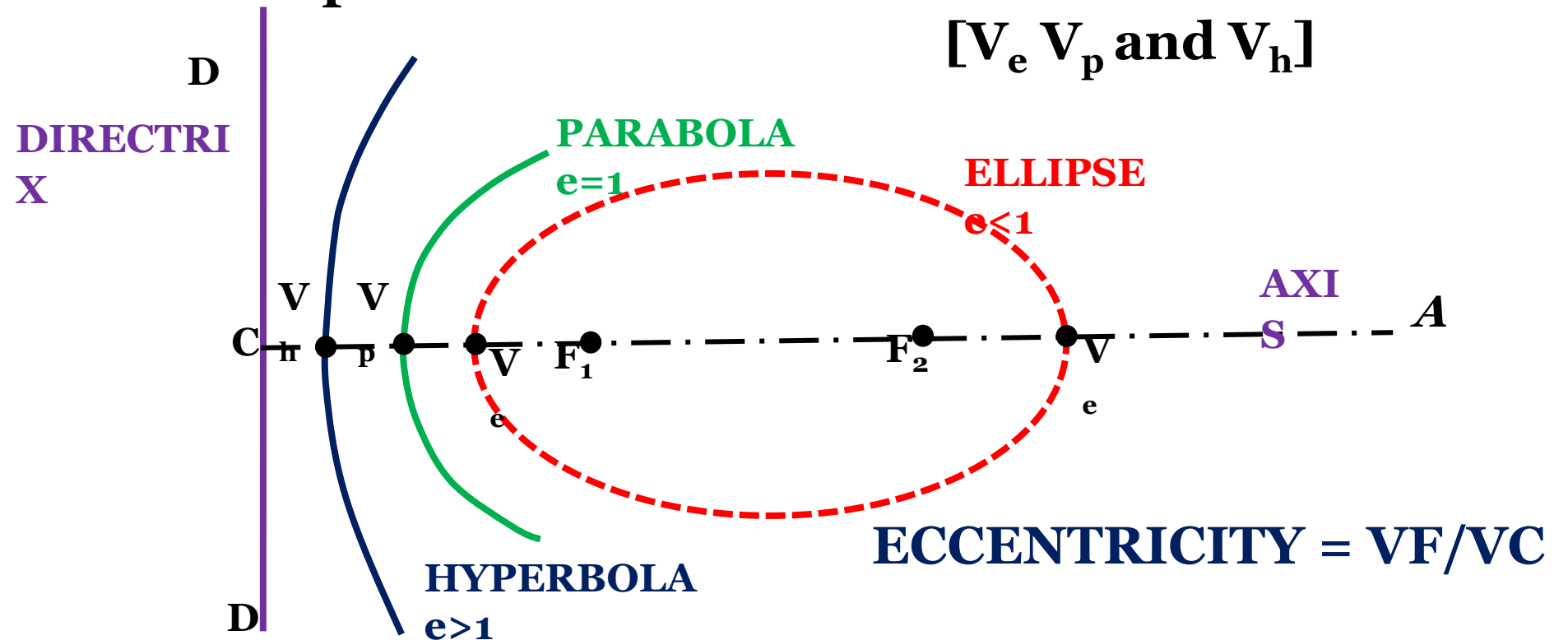


**Focus** – A fixed point [ $F_1$  AND  $F_2$ ]

**Directrix** – A fixed straight line [D-D]

**Axis** – A line passing through the focus and perpendicular to the directrix [C-A]

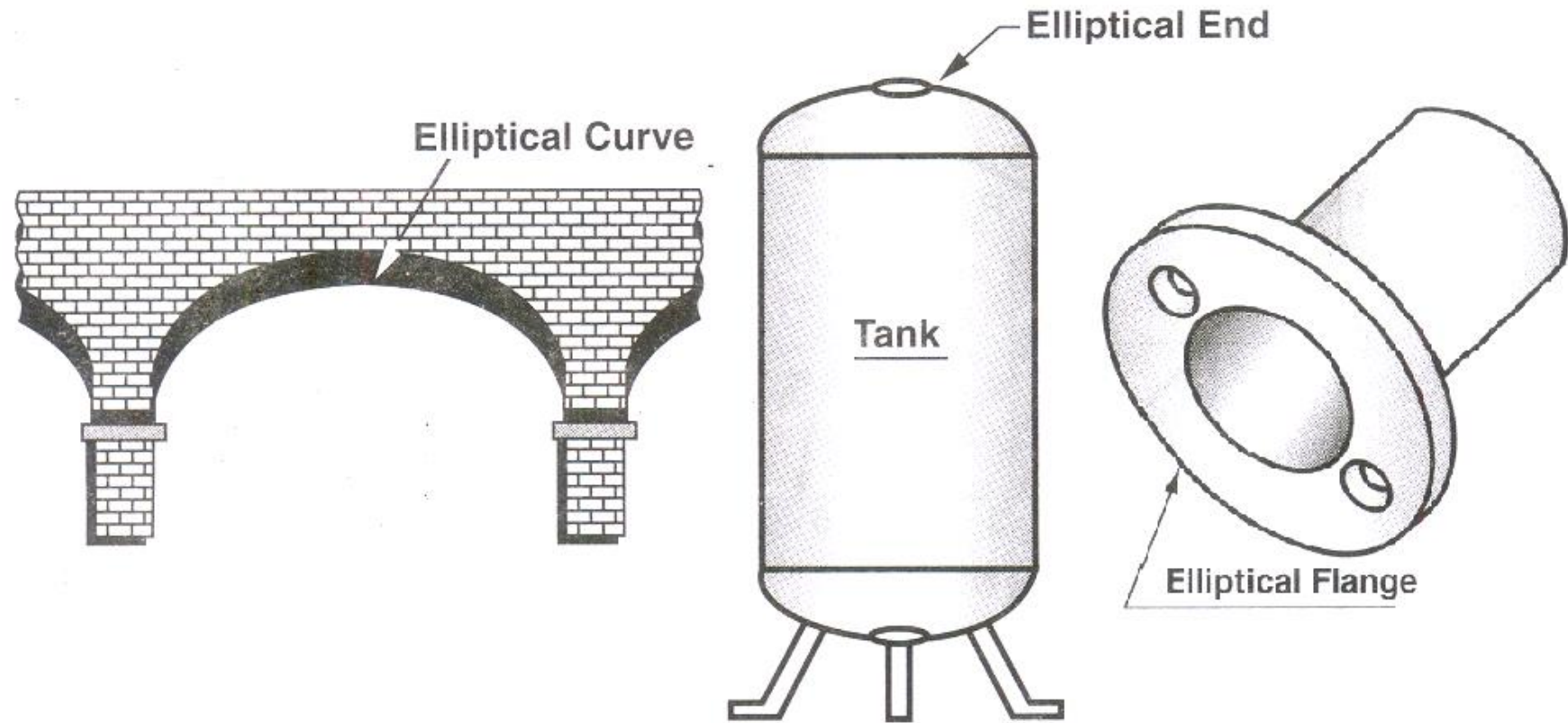
**Vertex** – The point at which conics intersects the axis [ $V_e$   $V_p$  and  $V_h$ ]



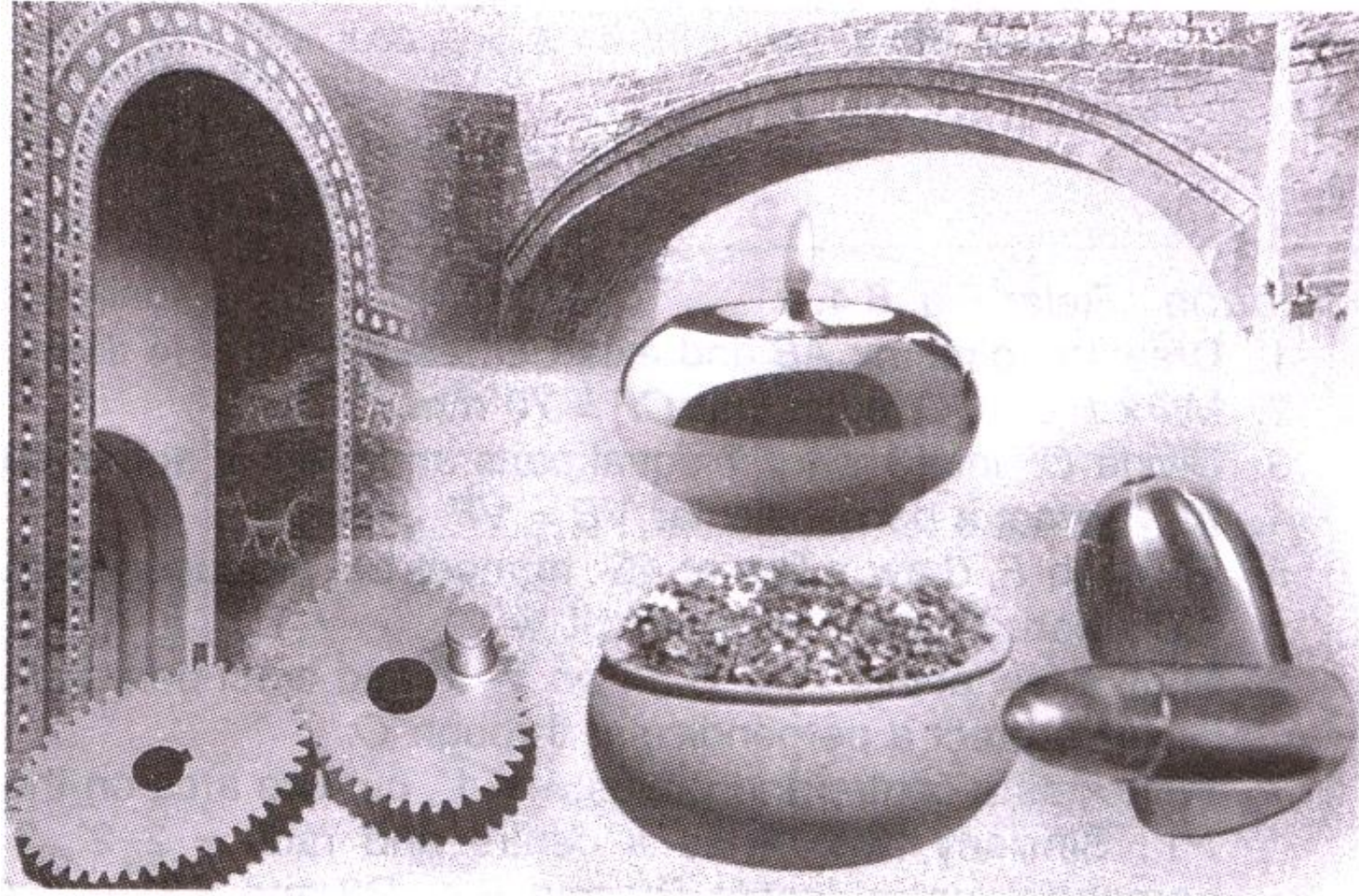
# Applications of Ellipse

- 1. Arches of Bridges.**
  - 2. Pipes Bends.**
  - 3. Elliptical Gears.**
  - 4. The ends of Cylindrical Tanks are elliptical in shape.**
  - 5. Elliptical Path is followed by earth around the sun.**
  - 6. Milk Tankers.**
  - 7. Shape of Tunnels [Entry/Exit]**
  - 8. To measure the time required to cover the distance [e.g. Missiles]**
- 1. Designing of Kitchen Accessories [e.g. Hot Pot, Steel pots ]**
  - 2. Automobile Parts [e.g. Petrol Tanks, Head lights]**
  - 3. Shape of Eggs.**

# Application of Ellipse



Arches, Bridges, Elliptical Gears, Fancy Lamps, Bullet Nose, Stuffing Box.





# Application of Ellipse

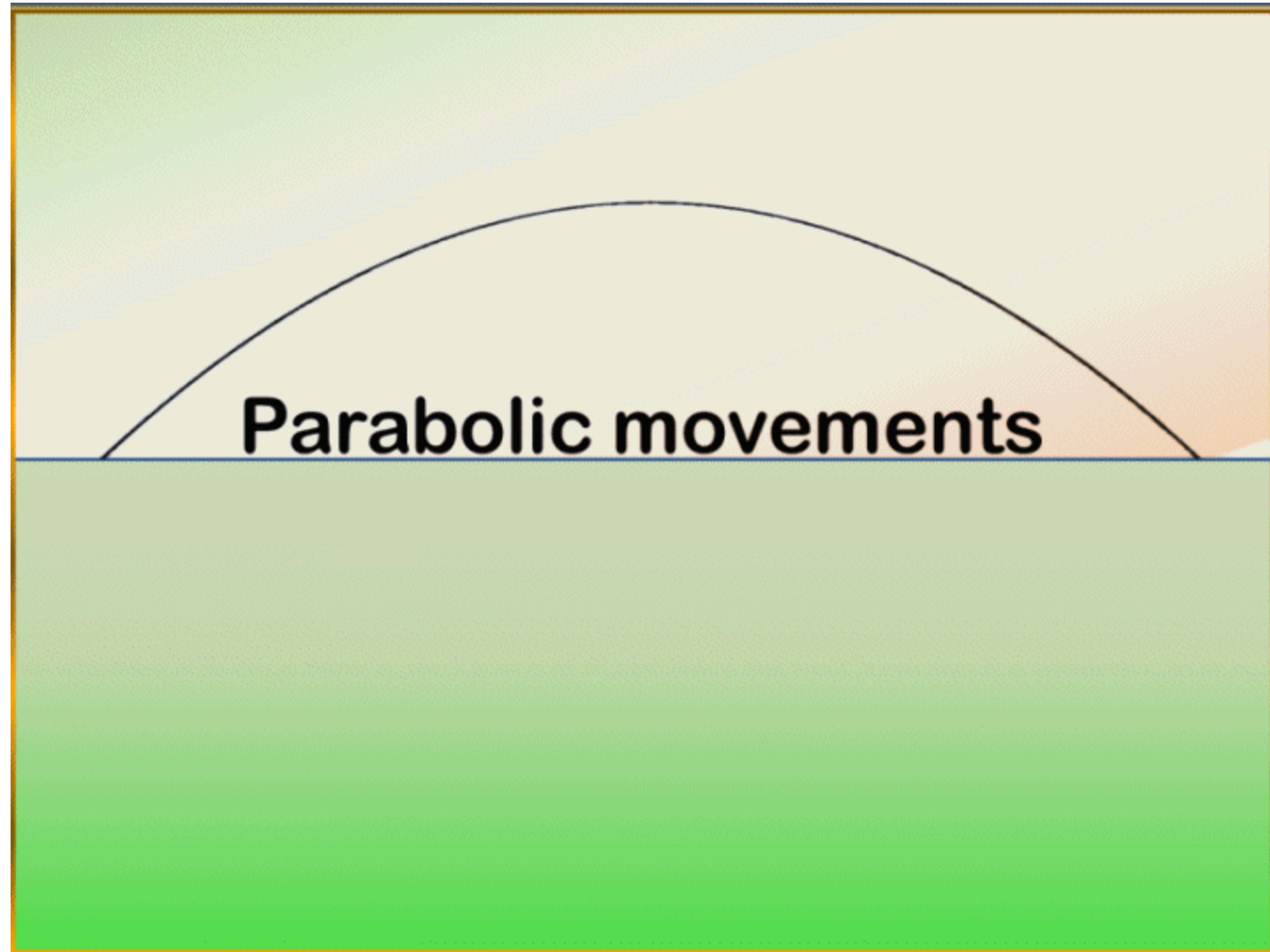


# Application of Ellipse

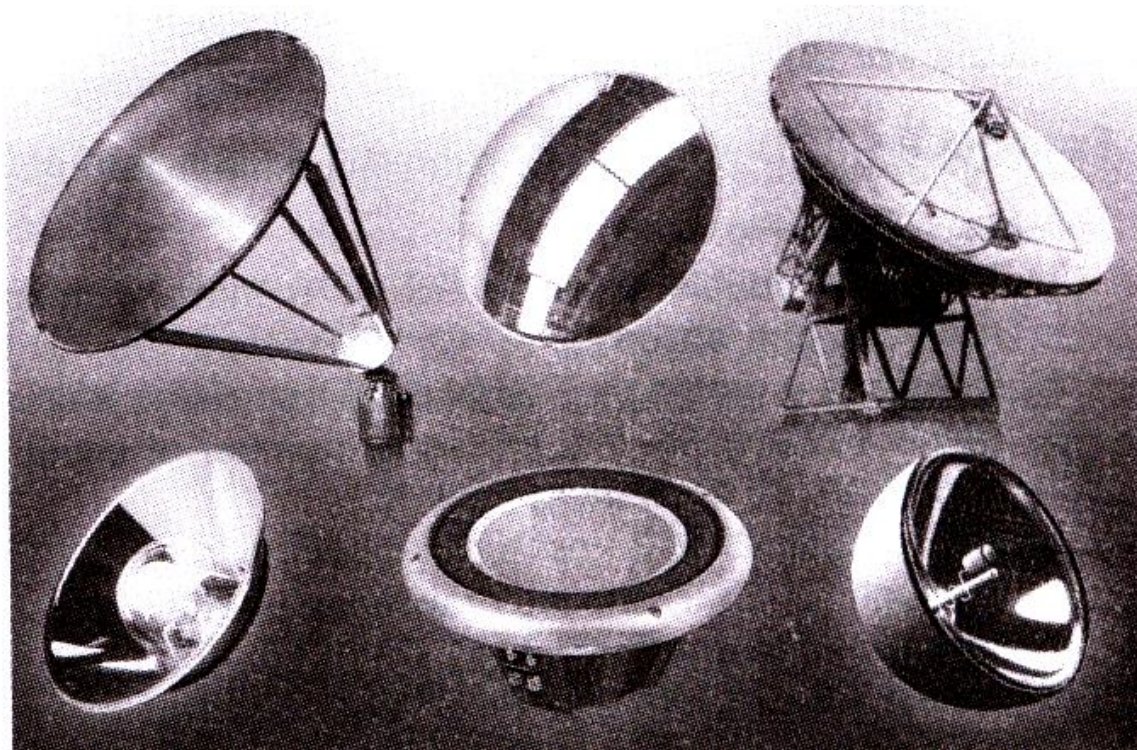




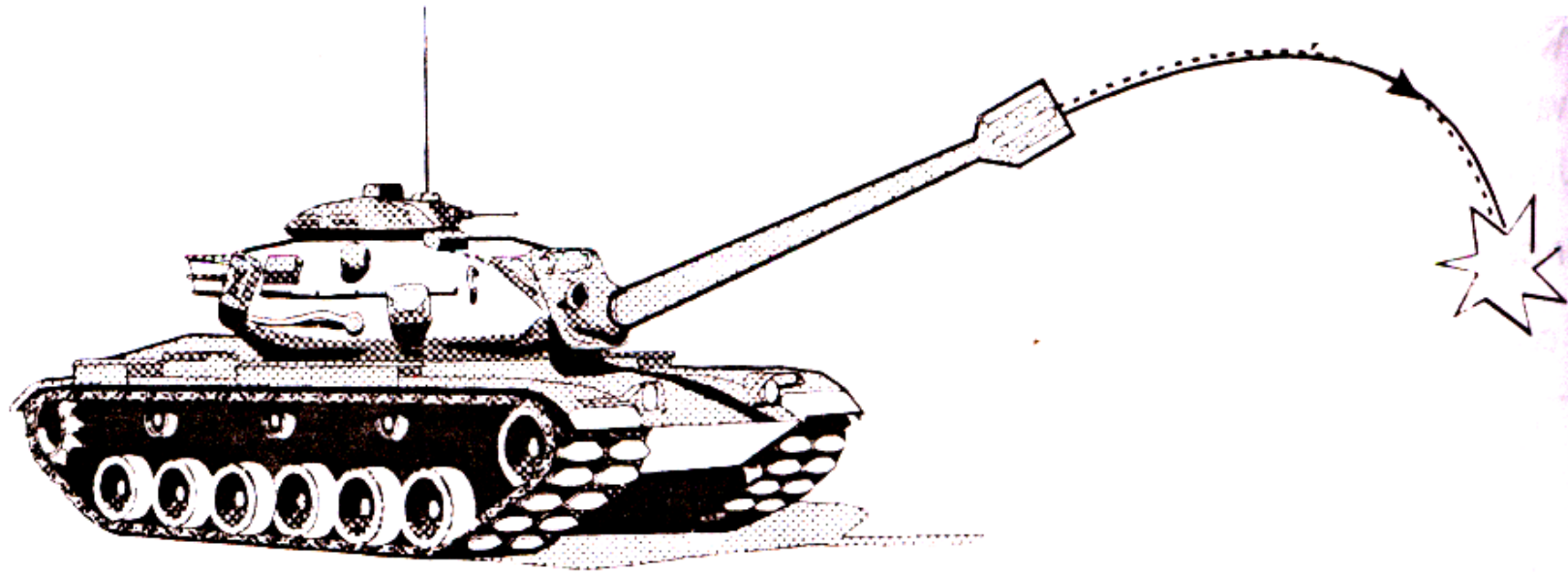




**The Parabolic curves are used on light reflectors, solar concentrators, Telecommunication dishes, Sound reflectors, Parabolic mirrors Cantilever beams, Missiles trajectory etc.**



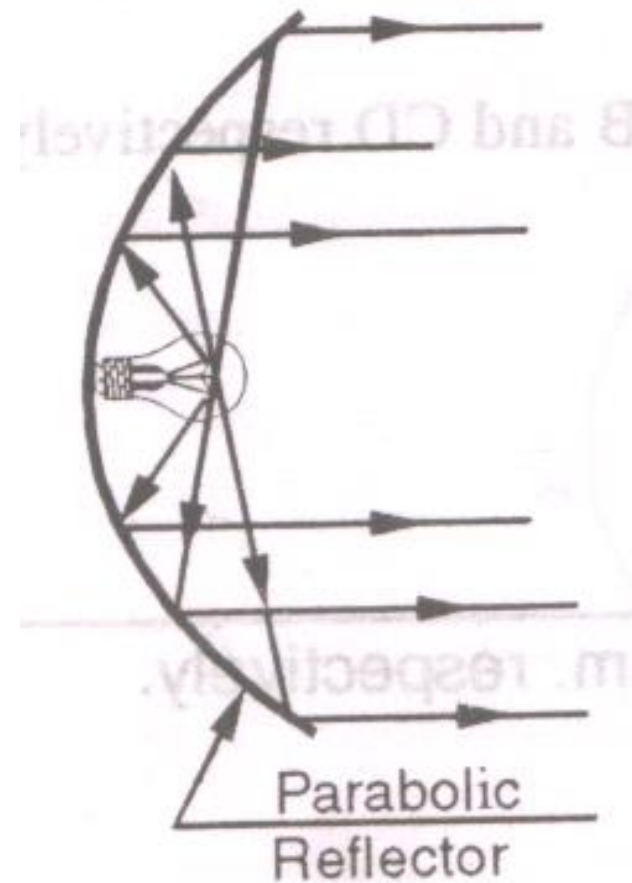
Applications of Parabola

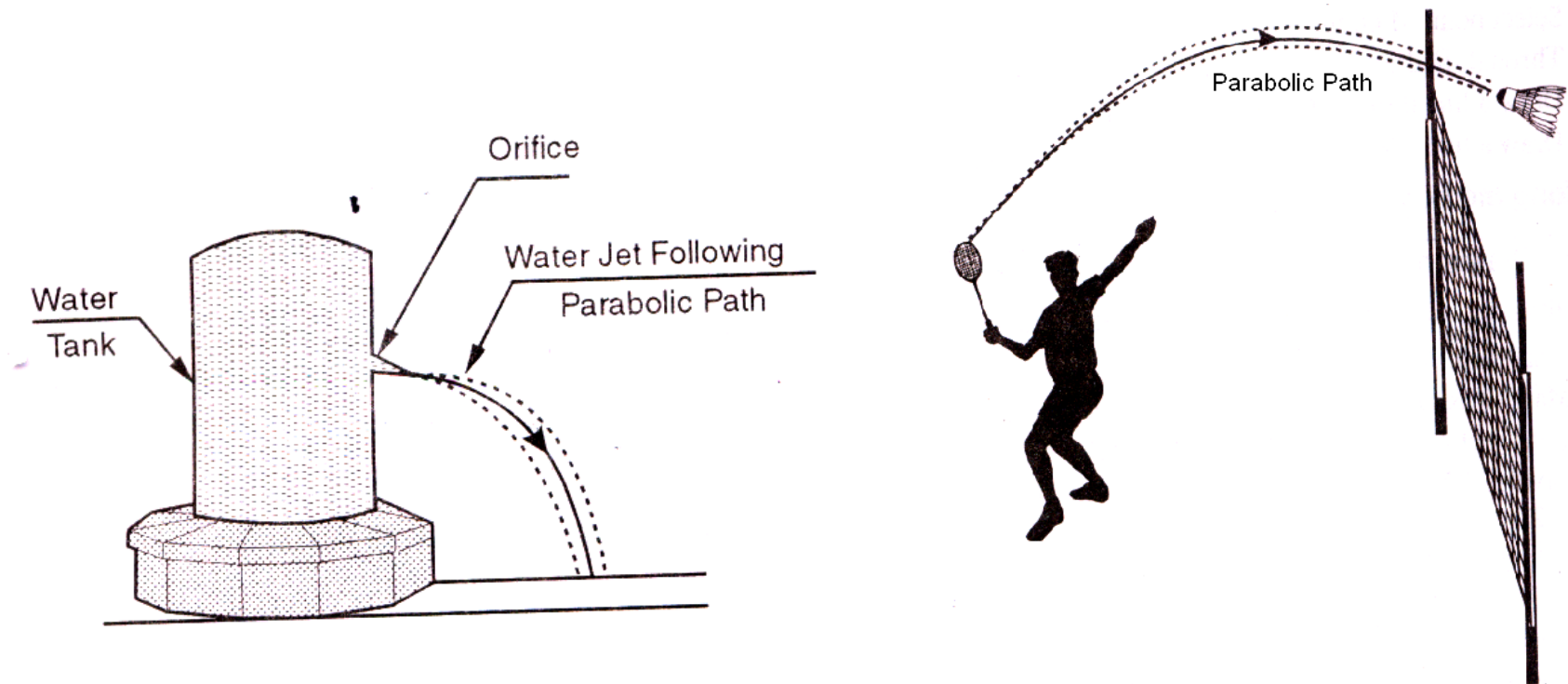


The Projected missiles follow the parabolic path.

# LIGHT REFLECTOR

Light reflector for parallel beams used in the head lamps of the vehicle are parabolic in shape.





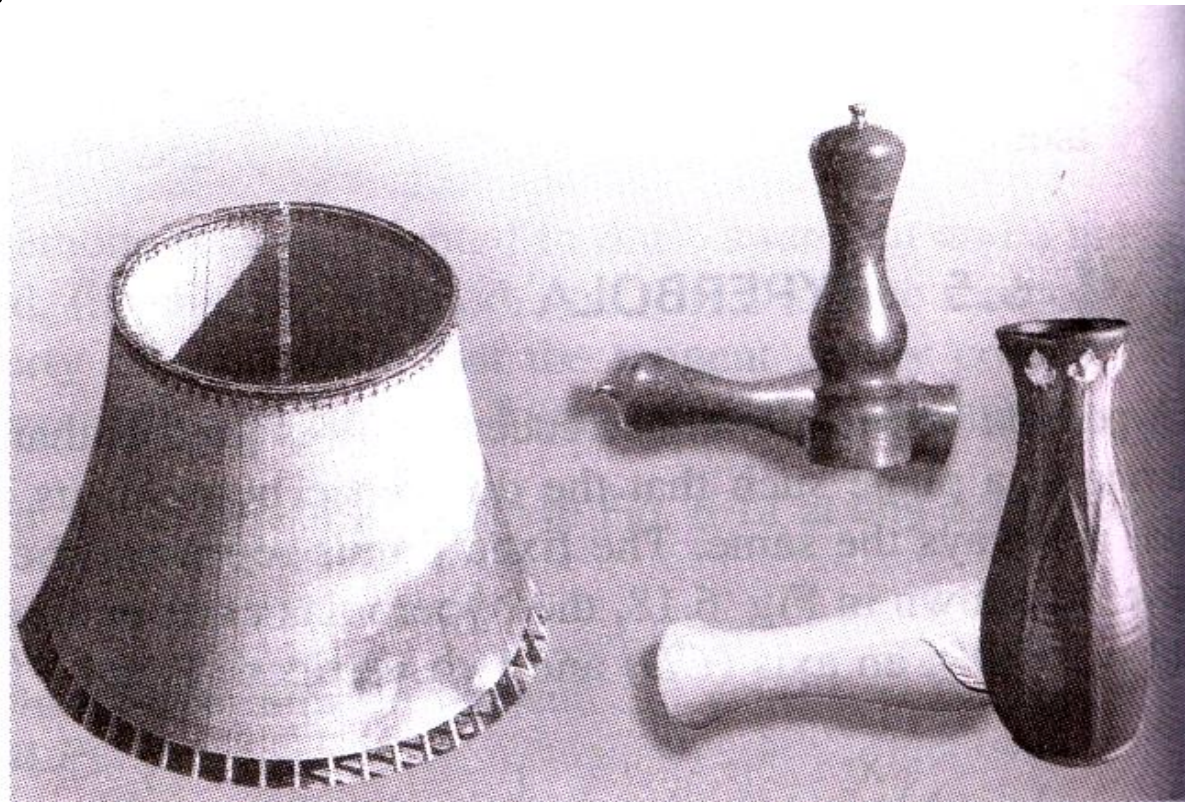
The movement of objects in space under the influence of gravity follow a parabolic path.



# Application of Hyperbola

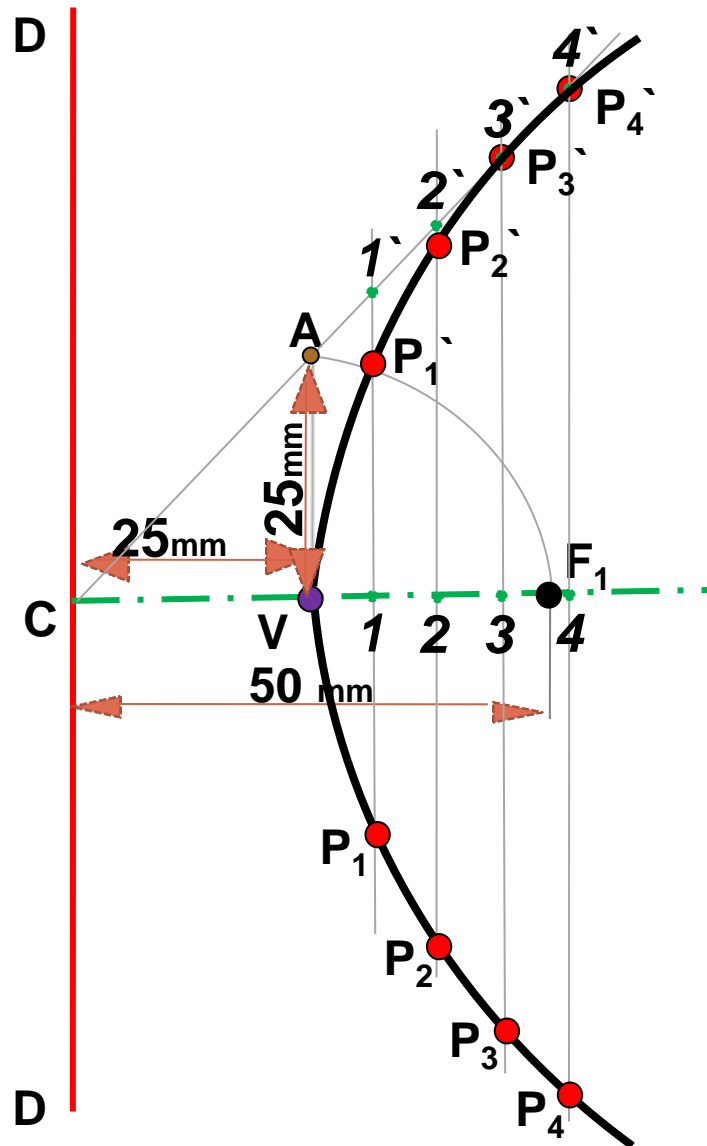
Hyperbolic curves are applied in designing cooling towers, Hydraulic mirrors, flower vases, curved wooden objects etc.

The theory of hyperbola is useful in deciding the location of a ship in long range navigation.



# **DIRECTRIX FOCUS METHOD**





## CONSTRUCTION OF PARABOLA BY DIRECTRIX FOCUS METHOD

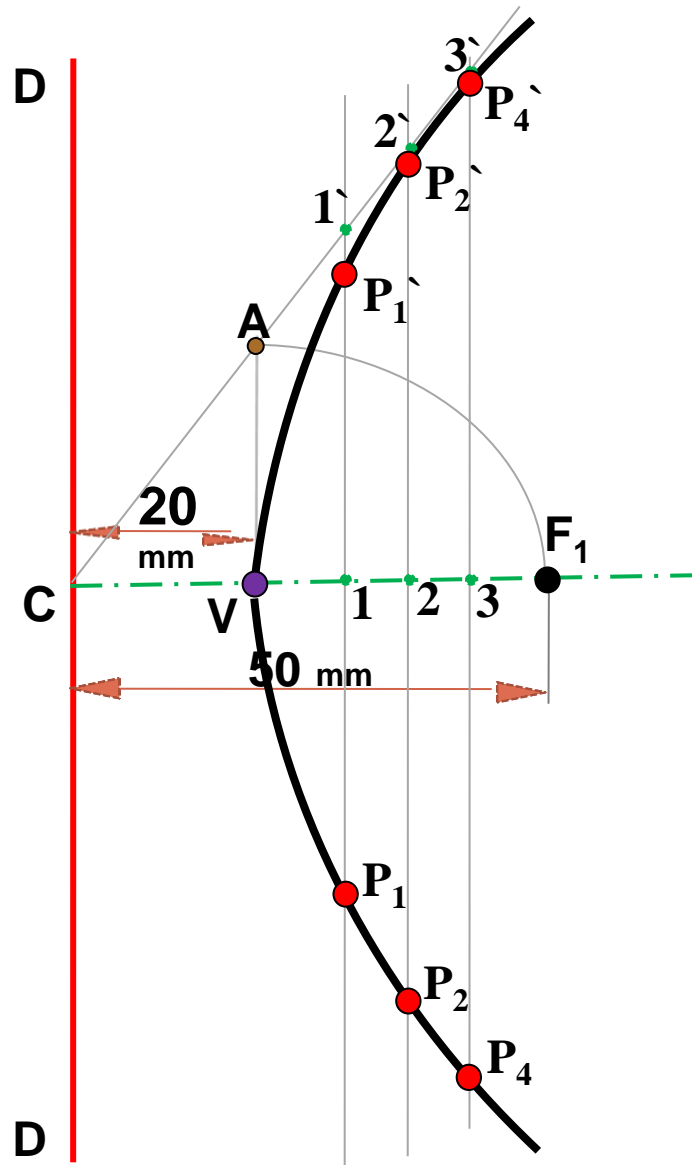
Construct a parabola when the distance of the focus from the directrix is 50 mm

Eccentricity for Parabola  $e = 1$

*Therefore  $VC = VF = 25\text{mm}$*

*Vertex of parabola will be equidistant from directrix and focus*

## CONSTRUCTION OF HYPERBOLA BY DIRECTRIX FOCUS METHOD

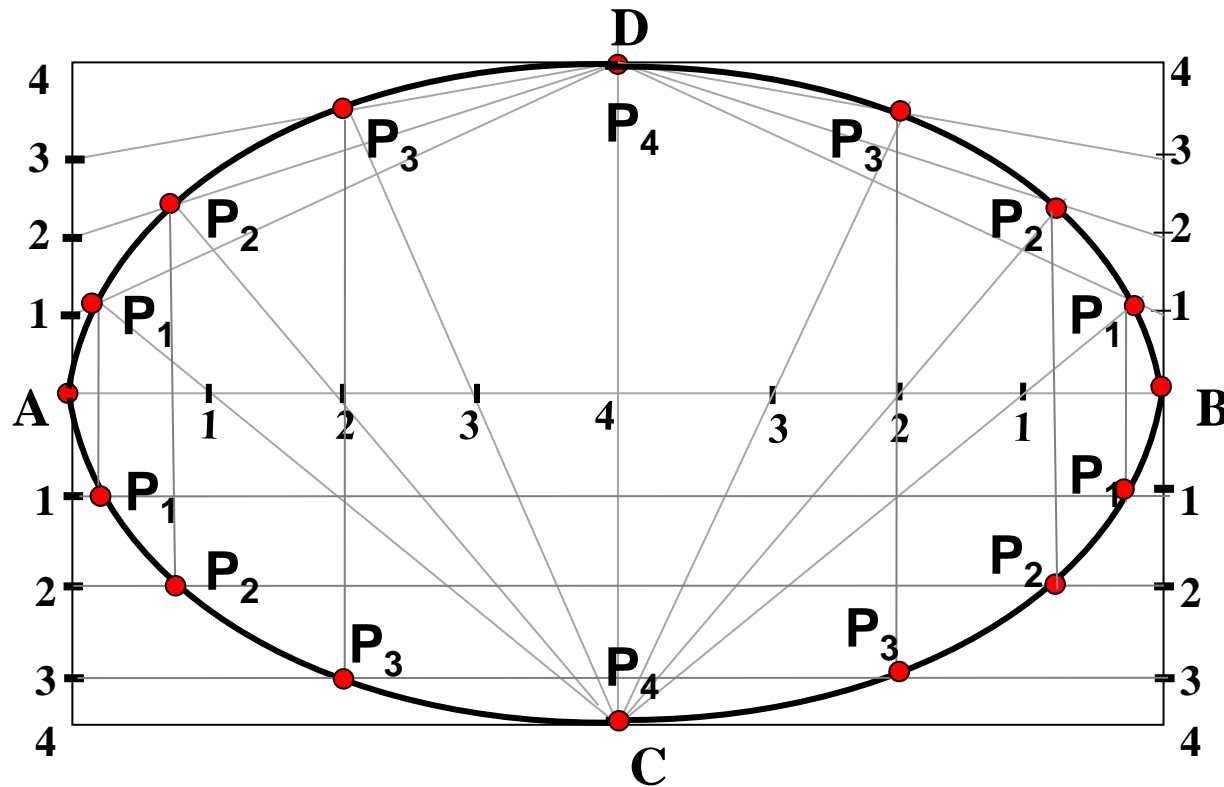


The distance of a focus from the directrix is 50 mm. A point moves in such a way that the eccentricity is equal to  $3/2$ . Draw the locus of the point & name the curve.

# AXIS

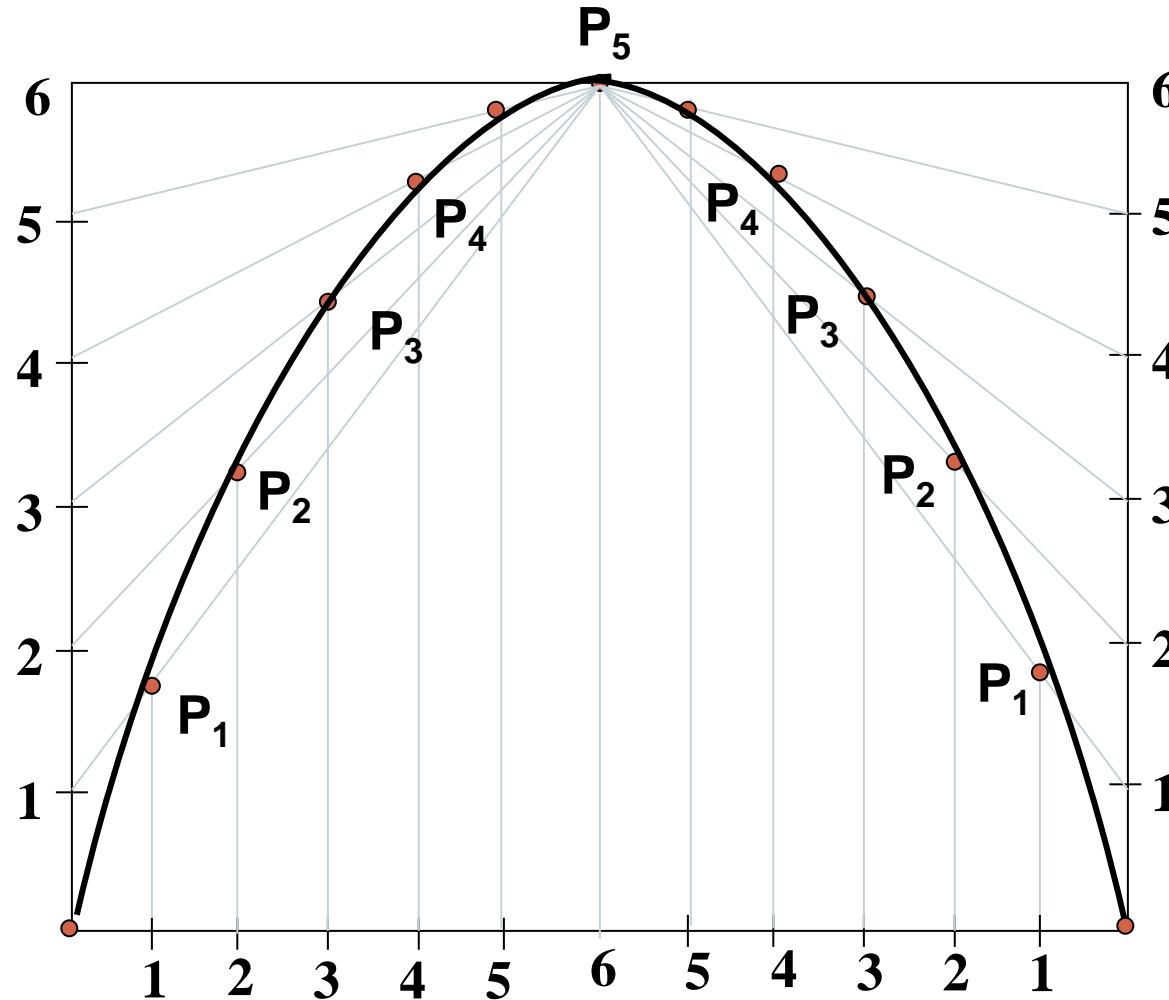
## Problem 2

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



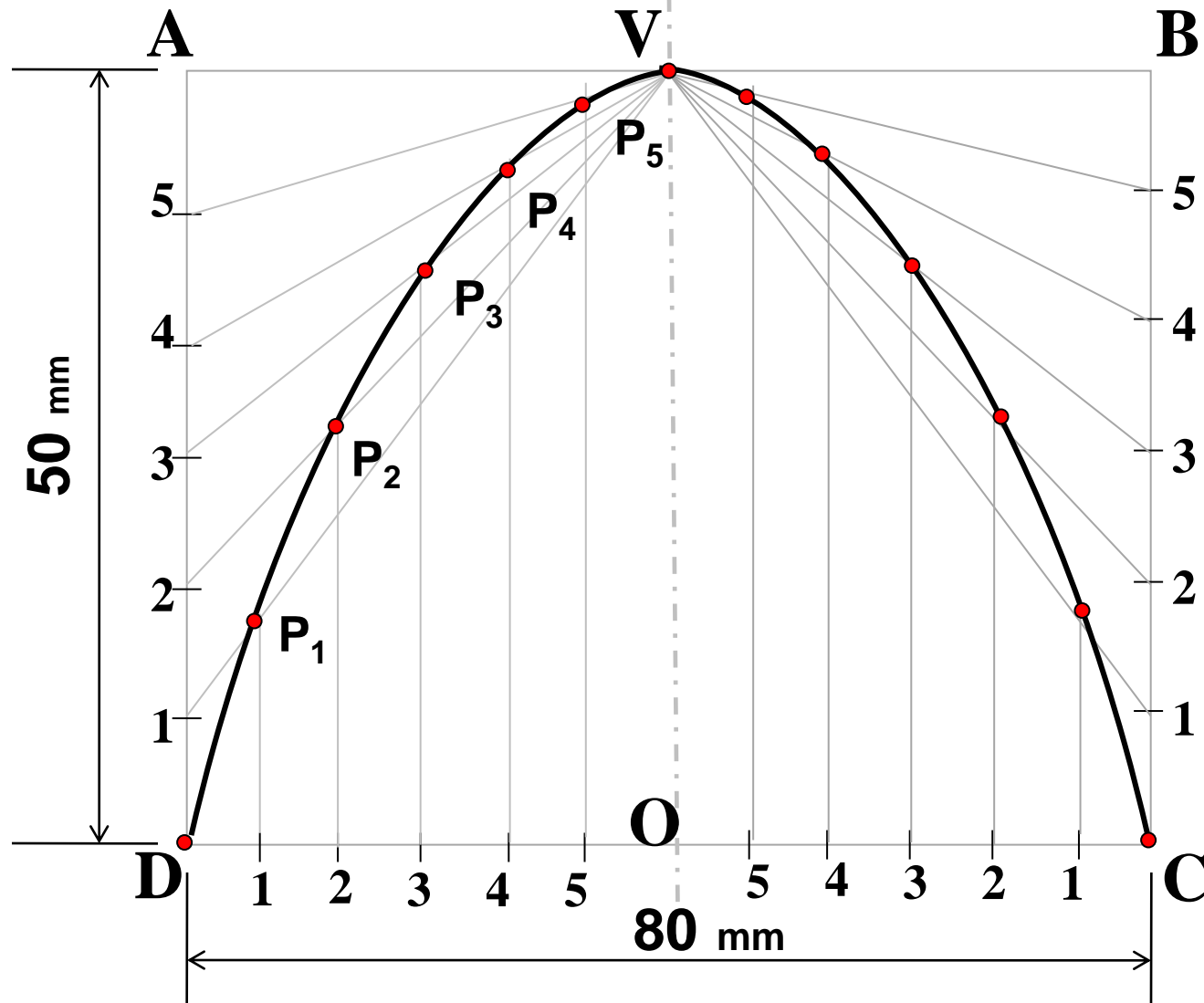
**ELLIPSE**  
*BY*  
**RECTANGLE METHOD**

**PROBLEM 1: Draw parabola by rectangle method when the base is 150 mm and axis height is 80 mm.**



**PARABOLA**  
by  
**RECTANGLE METHOD**

Draw a parabola having base length 80 mm & axis height 50 mm by the rectangle method.



CONSTRUCTION OF  
PARABOLA BY OBLONG  
METHOD

## **INVOLUTE OF A CIRCLE**

**Involute is a part of Differential geometry. This is more meaningful in engineering drawings as a scholarly subject and has industry wise applications.**

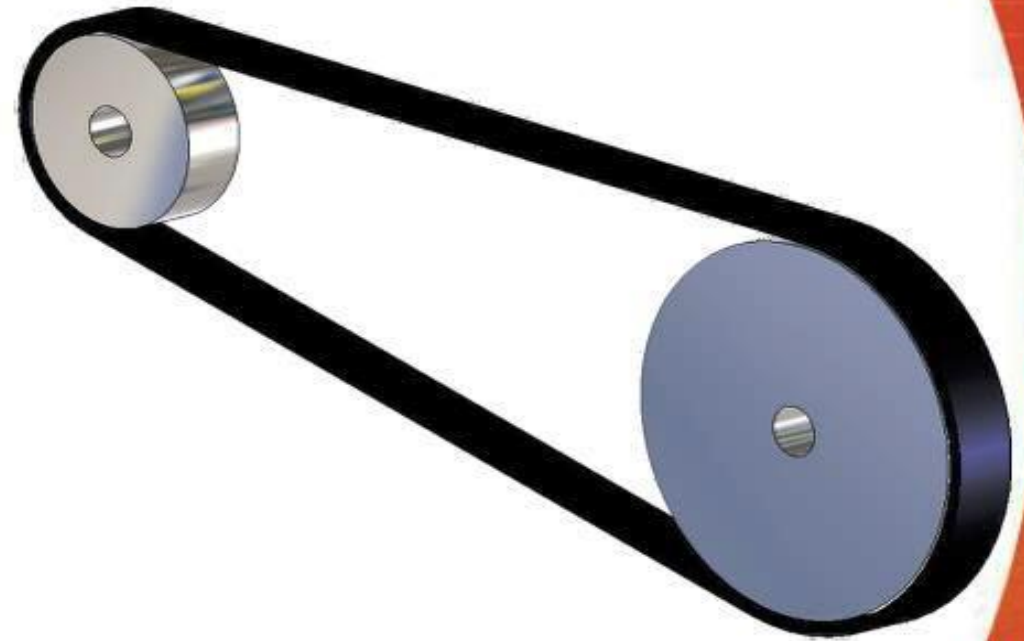
**One of the major application of Involute of circle is in designing of gears for revolving parts where gear tooth follow the shape of involute.**

**The basic application of involute usage is in winding clocks & toys wherein a winding key is used to motion the spiral spring in a circular involute.**



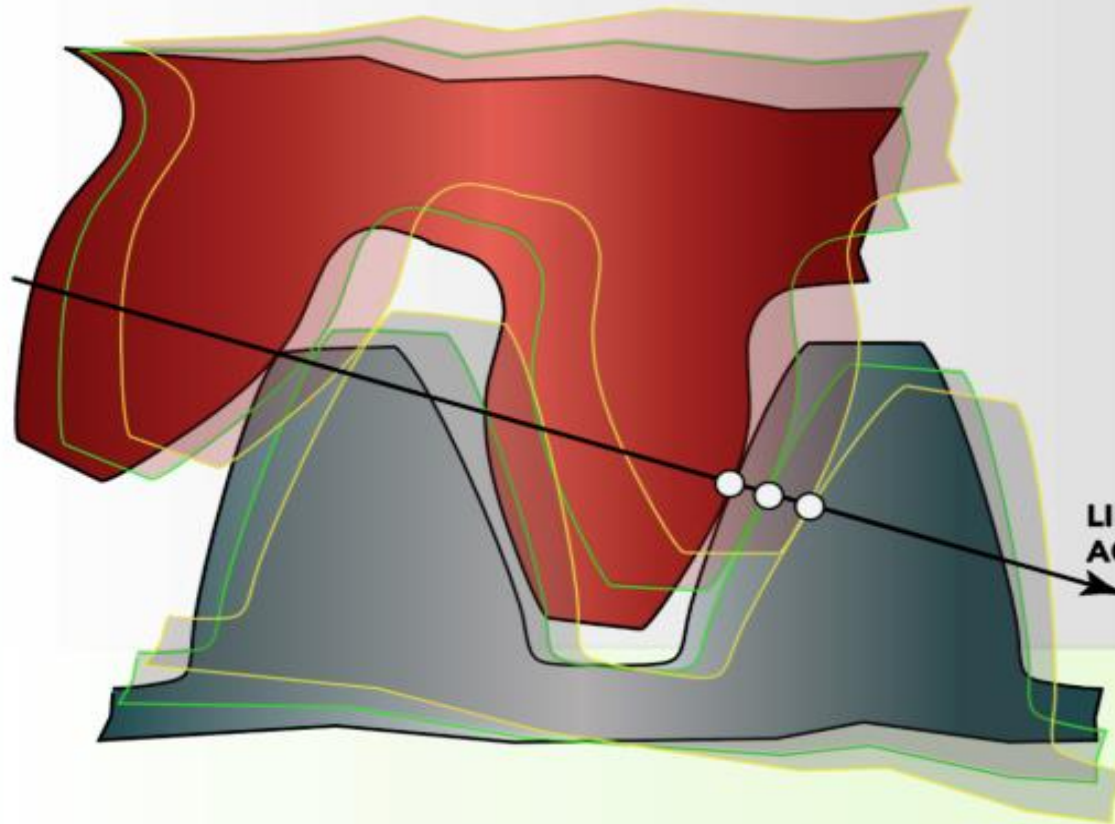
# Applications of Involutes

- Involutes are used to determine the length of belts used in pulleys and other machines
- Involutes are also used to calculate the amount of material required to create tyres and wheels

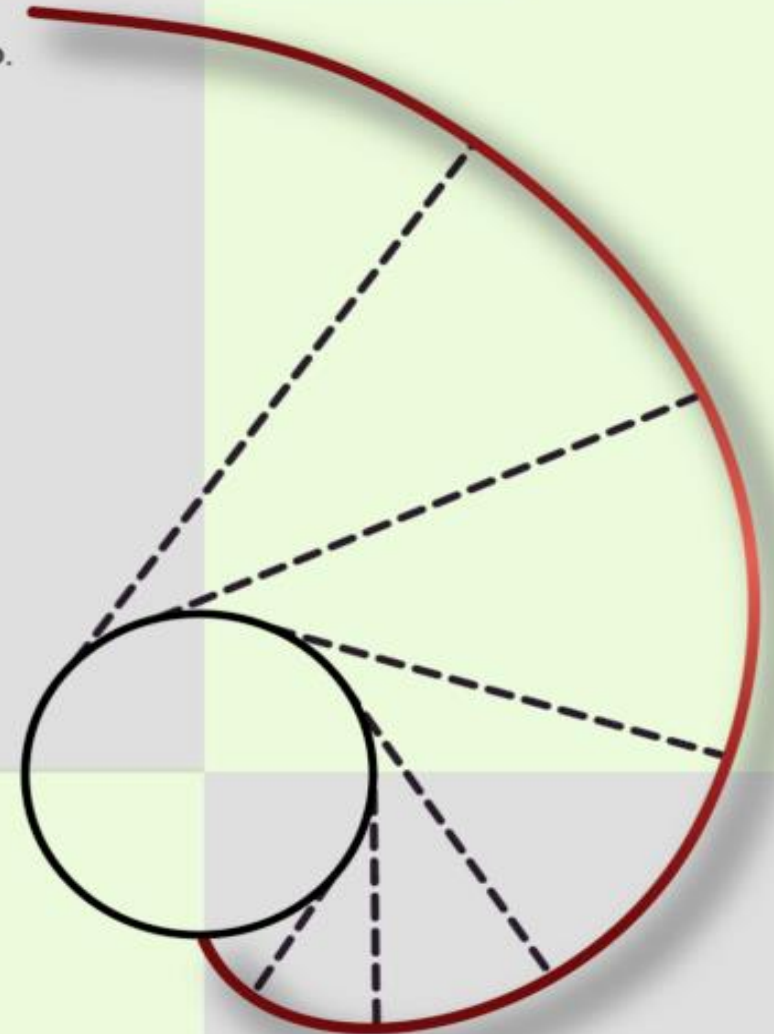


## INVOLUTE GEAR MESH FOR TRADITIONAL TOOTH GEOMETRY

THINK OF THE INVOLUTE AS THE LINE  
TRACED BY A STRING PINNED TO A CIRCLE O.D.  
... AND THEN WRAPPED AROUND THAT O.D.



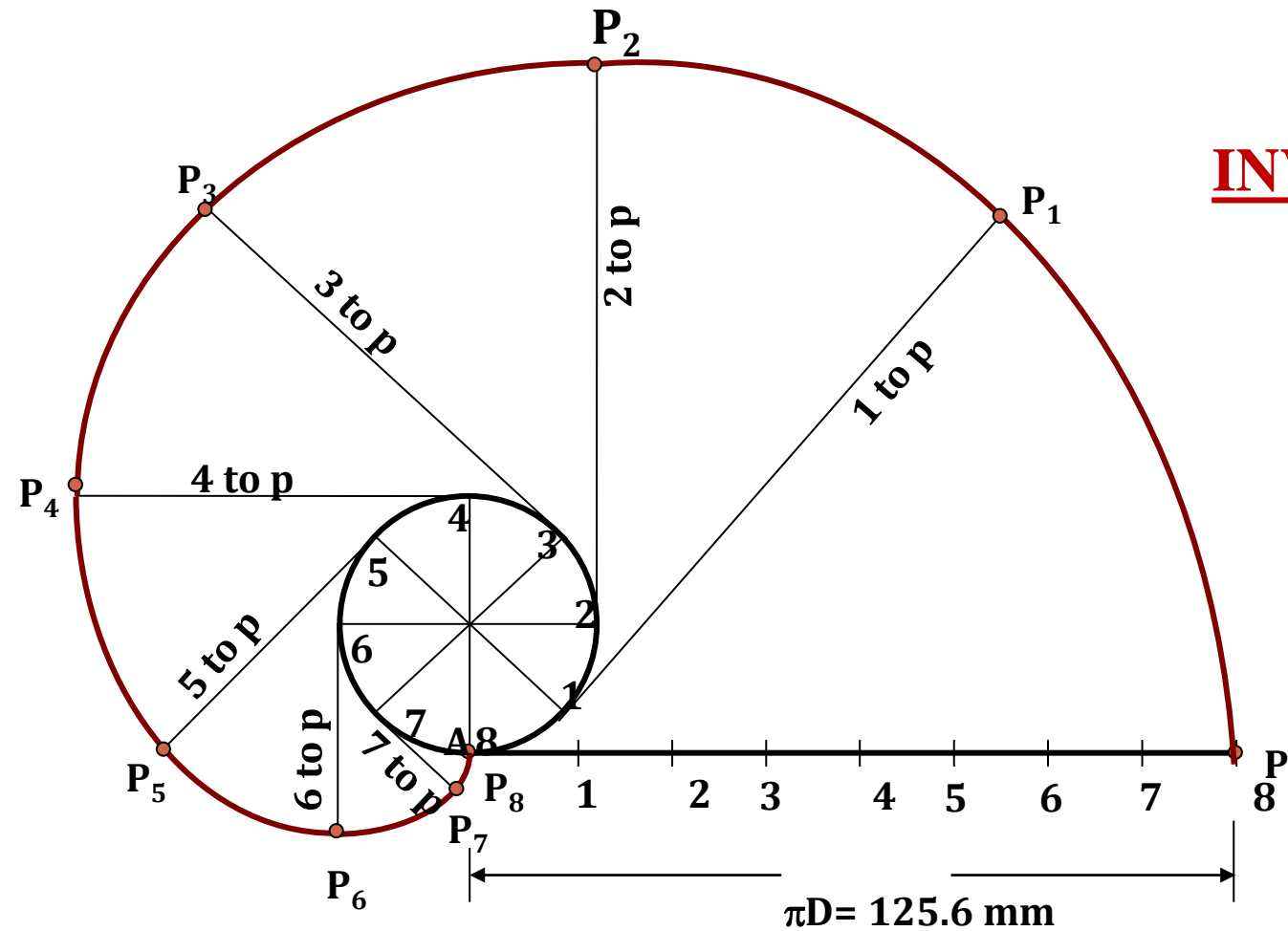
INVOLUTE-SHAPED TEETH ALLOW SMOOTH TRAVEL OF CONTACT (MESHING)  
SO CONTACT POINTS TRACE THE INVOLUTE CURVES OF MATING TEETH  
AND LIE ON A TANGENT COMMON TO THE MATING GEARS' BASE CIRCLES.

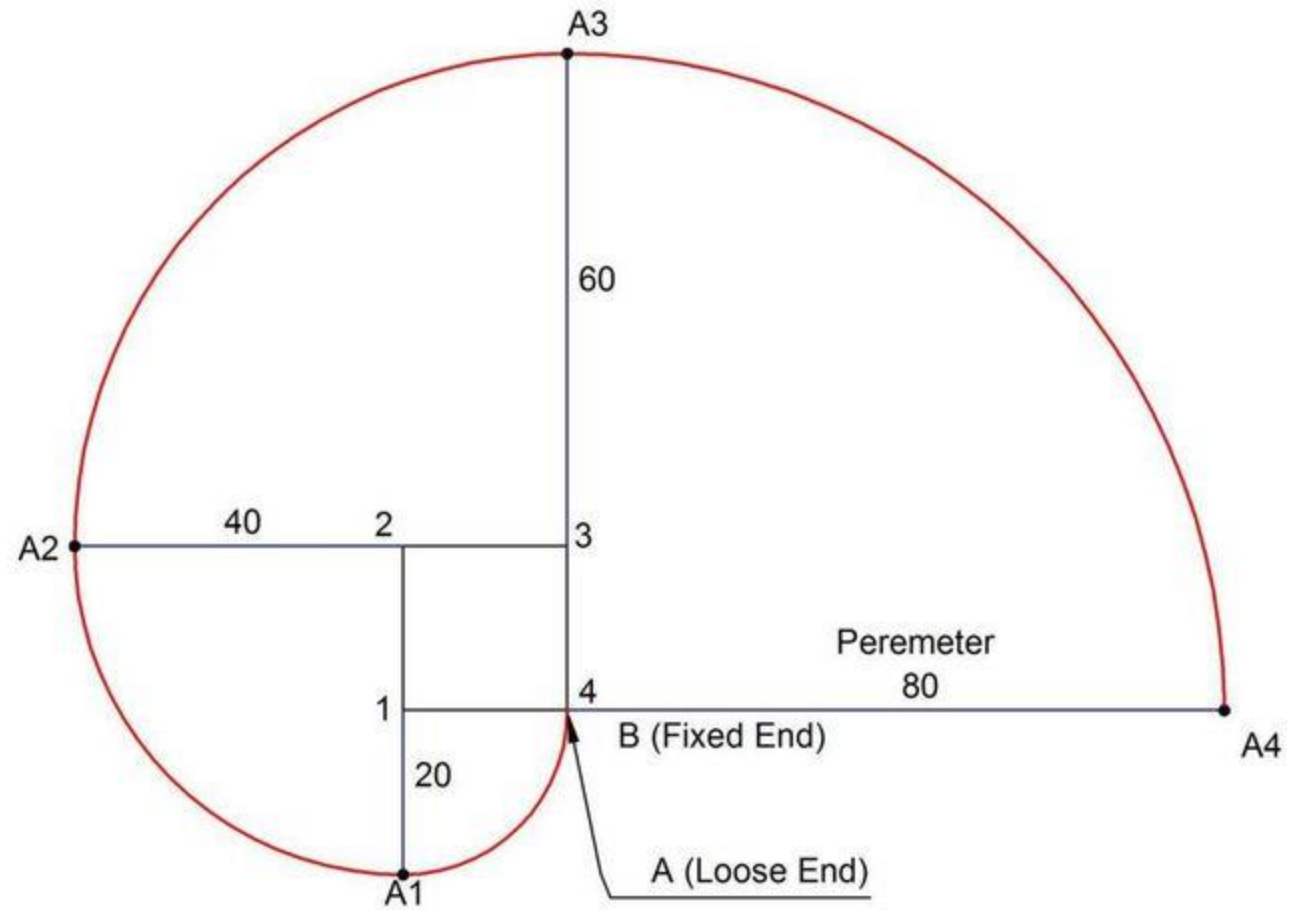


## **Involute**

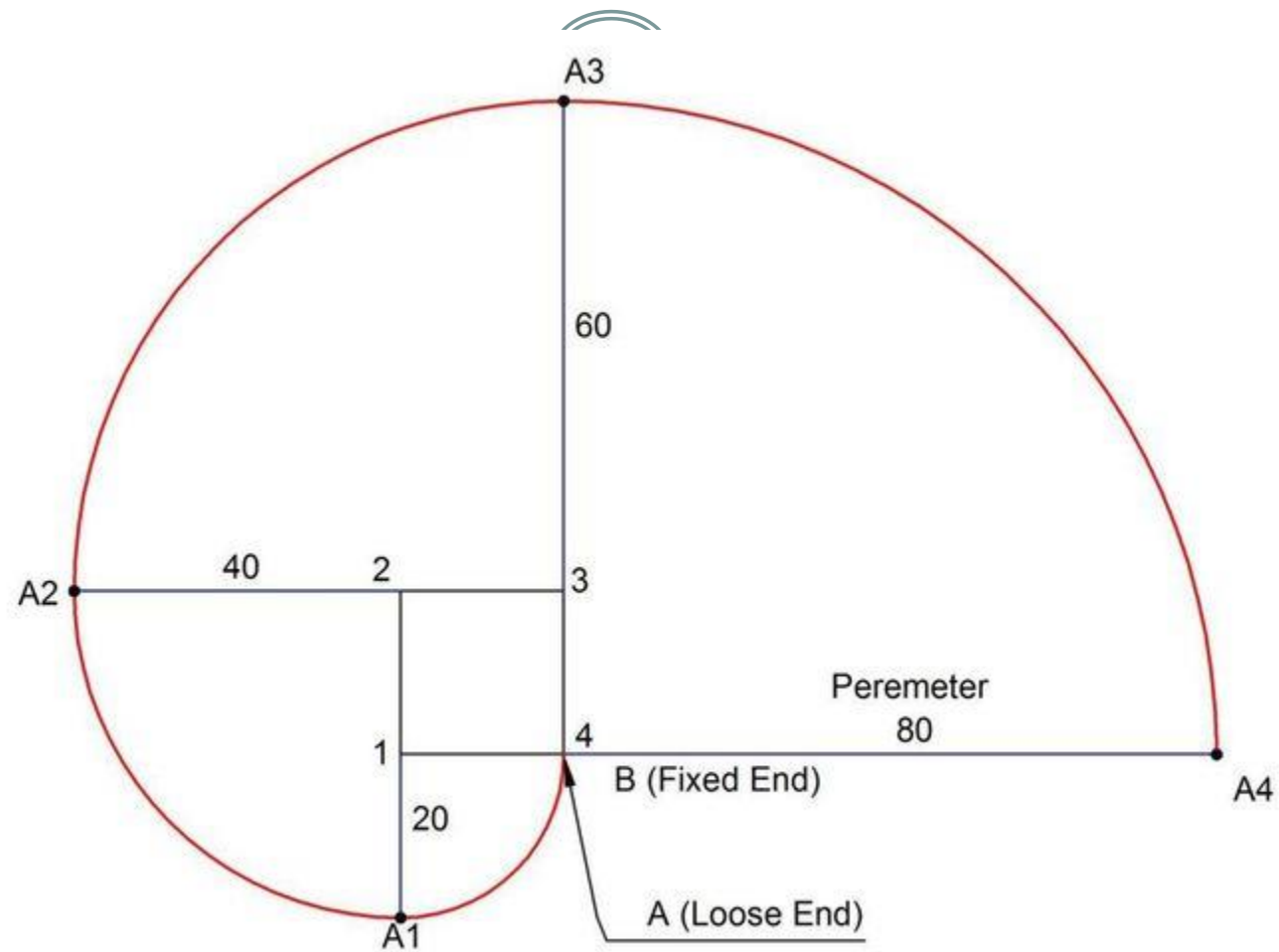
An Involute is a curve traced by the free end of a thread unwound from a circle or a polygon in such a way that the thread is always tight and tangential to the circle or side of the polygon

**Problem No.1 : Draw an Involute of circle of diameter 40 mm**  
**Problem No.2 : Draw an Involute of circle of diameter 50 mm**



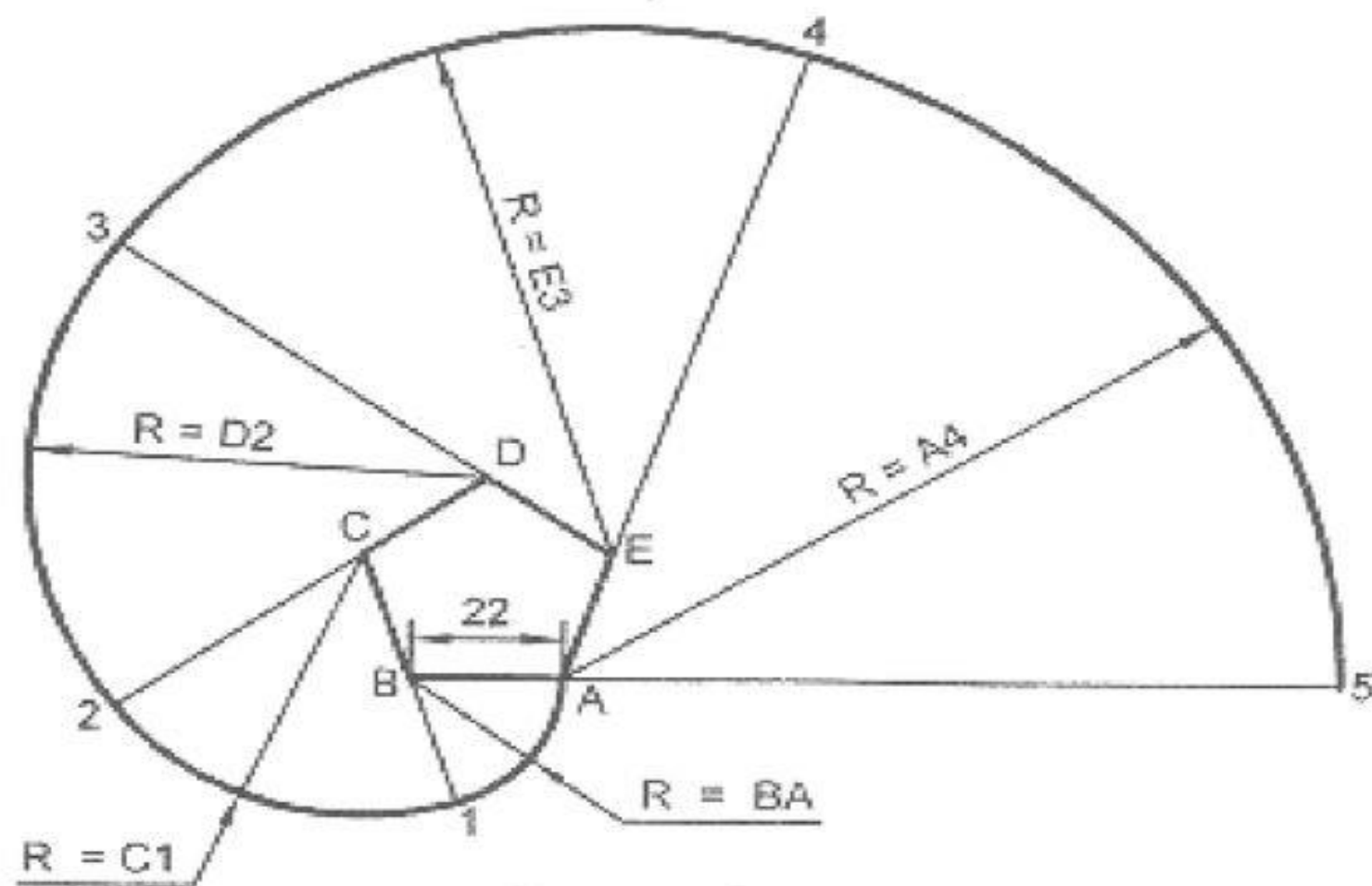


# Involute Of Square





# Involute of a Pentagon

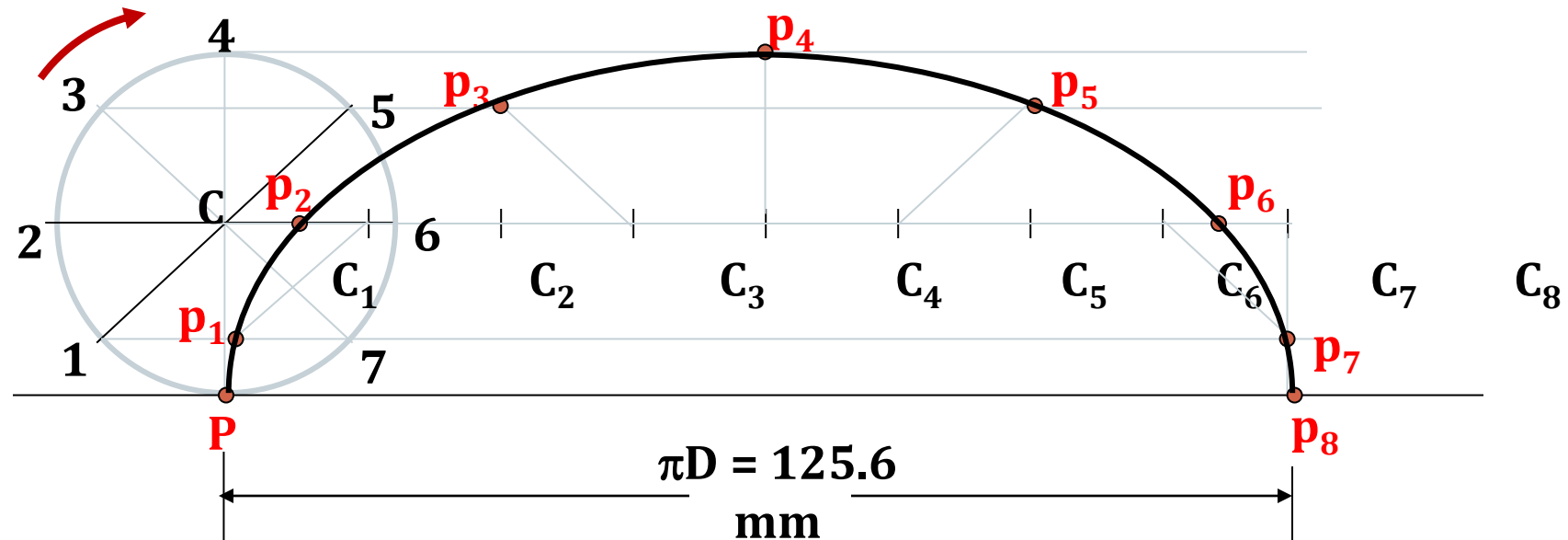


# Cycloid

A Cycloid is generated by a point on the circumference of a circle rolling along a straight line without slipping

## CYCLOID OF A ROLLING CIRCLE

**PROBLEM 1. Draw a cycloid of rolling circle of diameter 40 mm**  
**PROBLEM 2. Draw a cycloid of rolling circle of diameter 50 mm**

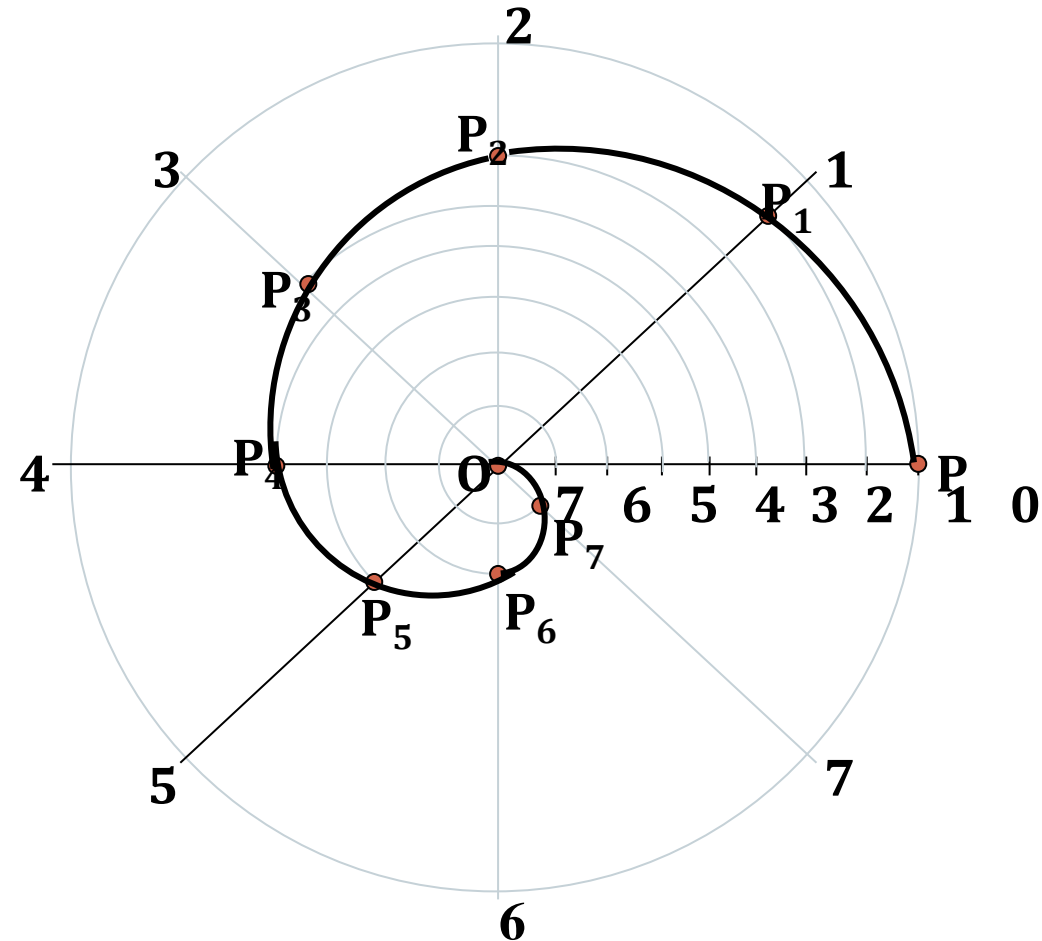


# Archimedean spiral

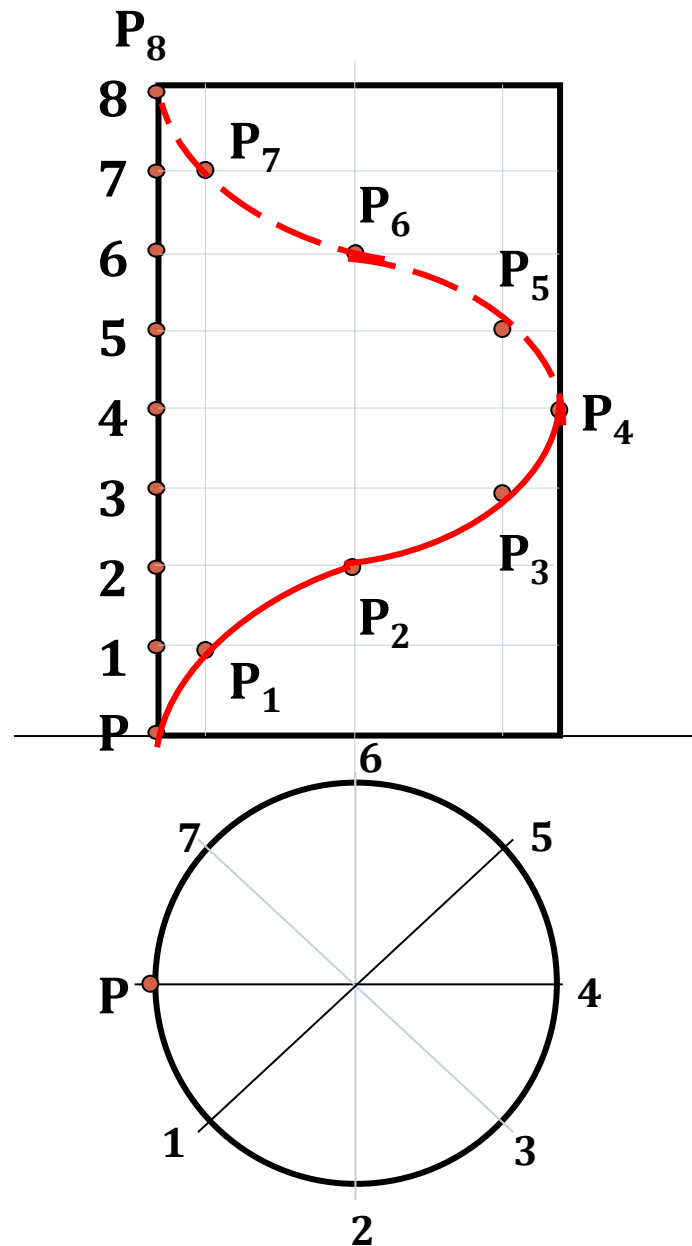
The **Archimedean spiral** is the locus of a point which moves around a centre at uniform angular velocity and at the same time moves away from the centre at uniform linear velocity.

**Problem 1 :** Draw an Archimedian spiral of diameter 120 mm for one Convolution  
**Problem 2 :** Draw an Archimedian spiral of radius 80mm for one convolution

**ARCHEMEDIAN**  
**SPIRAL**







## HELIX (UPON A CYLINDER)

**PROBLEM:** Draw a helix on a cylinder of base diameter 60 mm and axis height 60mm



**PROBLEM:** Draw a helix of one convolution, upon a cone, diameter of base 70 mm, axis 90 mm and 90 mm pitch.  
(The axial advance during one complete revolution is called The *pitch* of the helix)

**SOLUTION:**

Draw projections of a cone

Divide circle and axis in to same no. of equal parts. ( 8 )

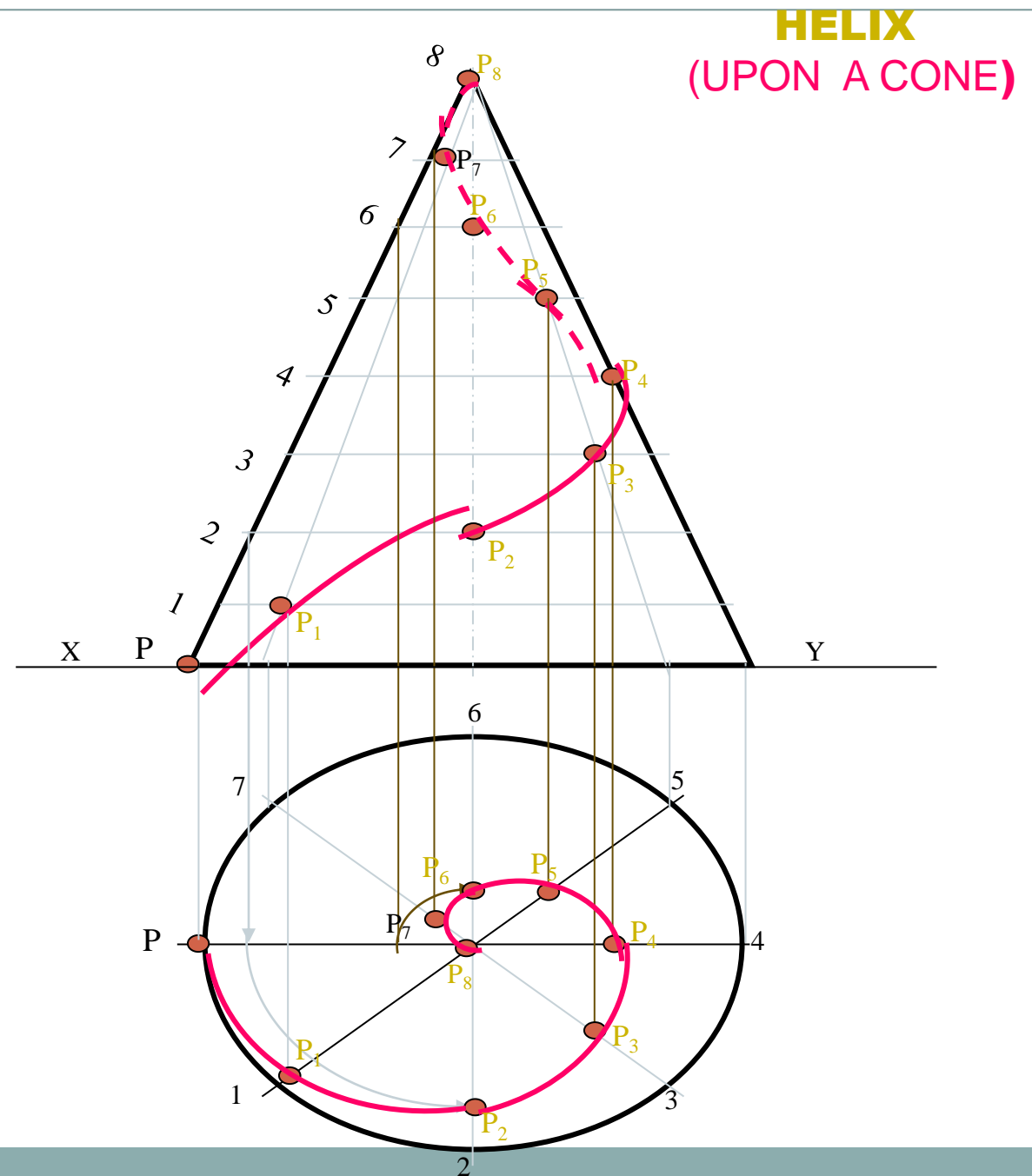
Name those as shown.

Mark initial position of point 'P'

Mark various positions of *P* as shown in animation.

Join all points by smooth possible curve.

Make upper half dotted, as it is going behind the solid and hence will not be seen from front side.



Thank You