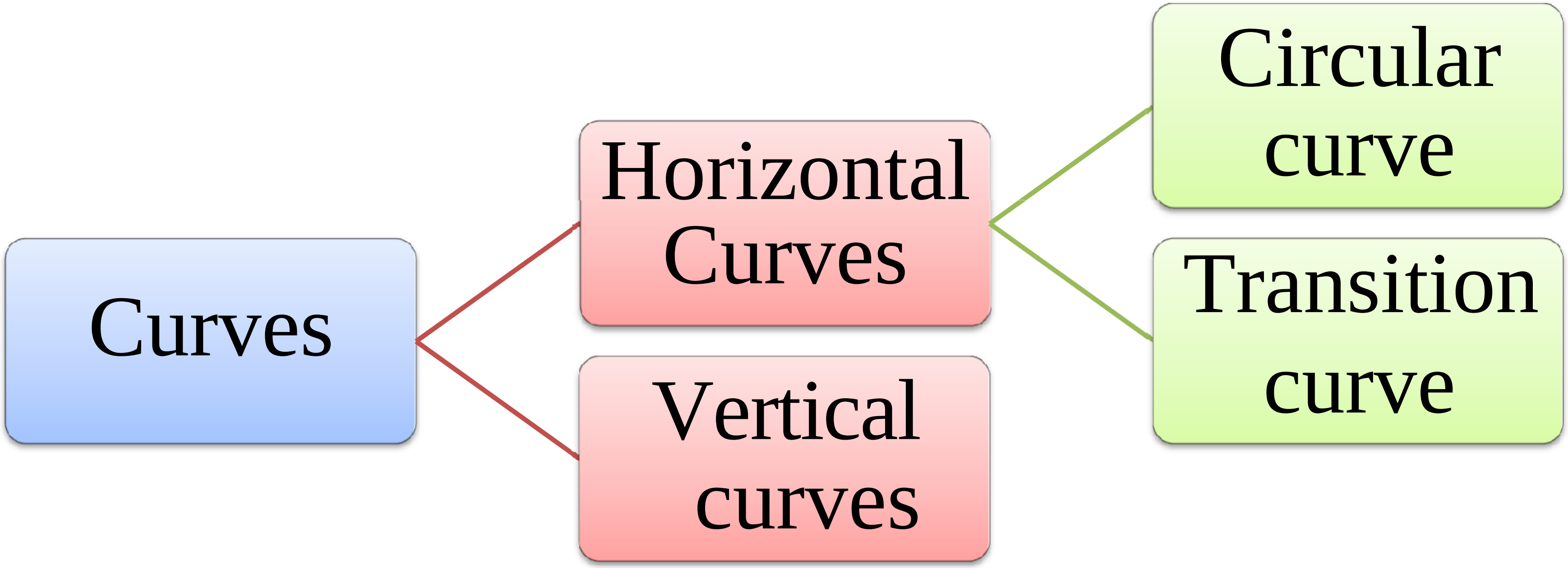
GOVERNMENT POLYTECHNIC DHANGAR

Subject:- Surveying-11

Introduction

- Generally used on Highway and Railway.
- Use for change the direction.
- Always tangential to the straight direction.
- The two line connected by a curve are called tangents.

Types of Curves



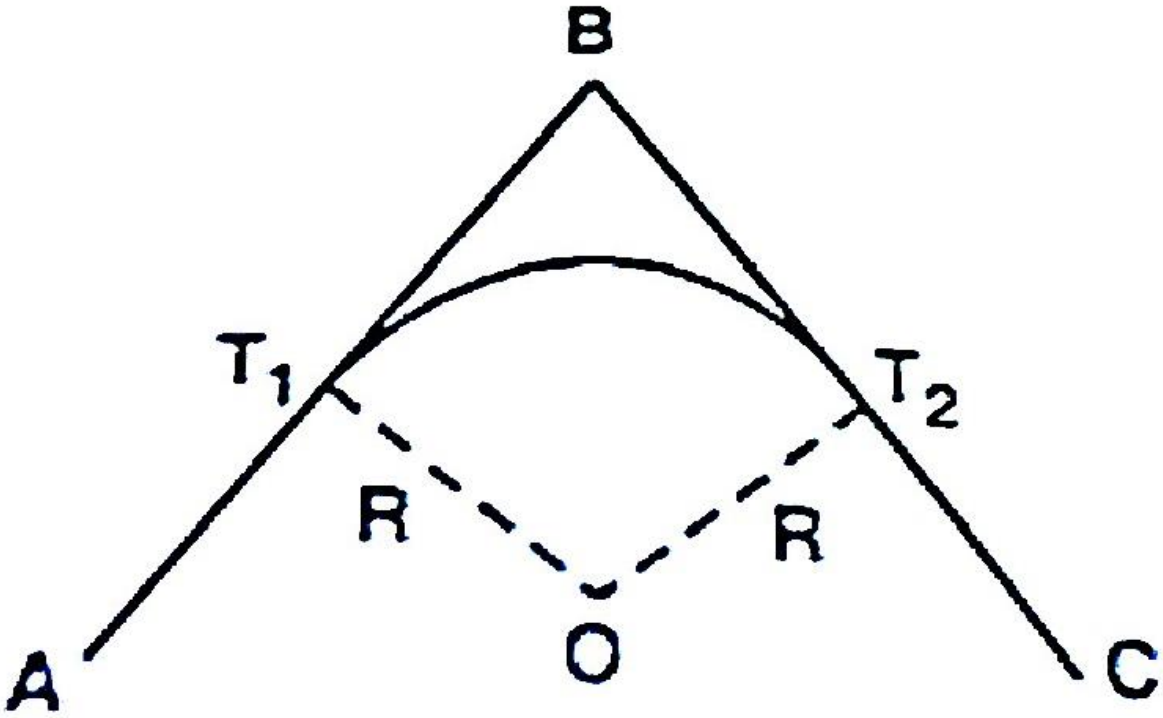
Types of Circular Curve

- There are three type of the circular curve.

  - Simple Curve
  - Compounded Curve
  - Reserve Curve

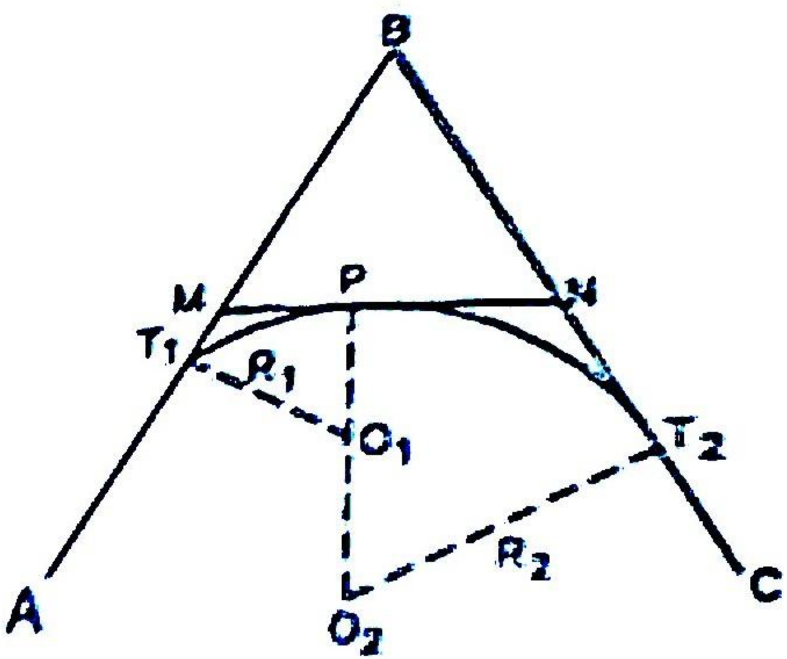
1. Simple Curve

- Consist of a single Arc.
- Tangential to both the straight line.



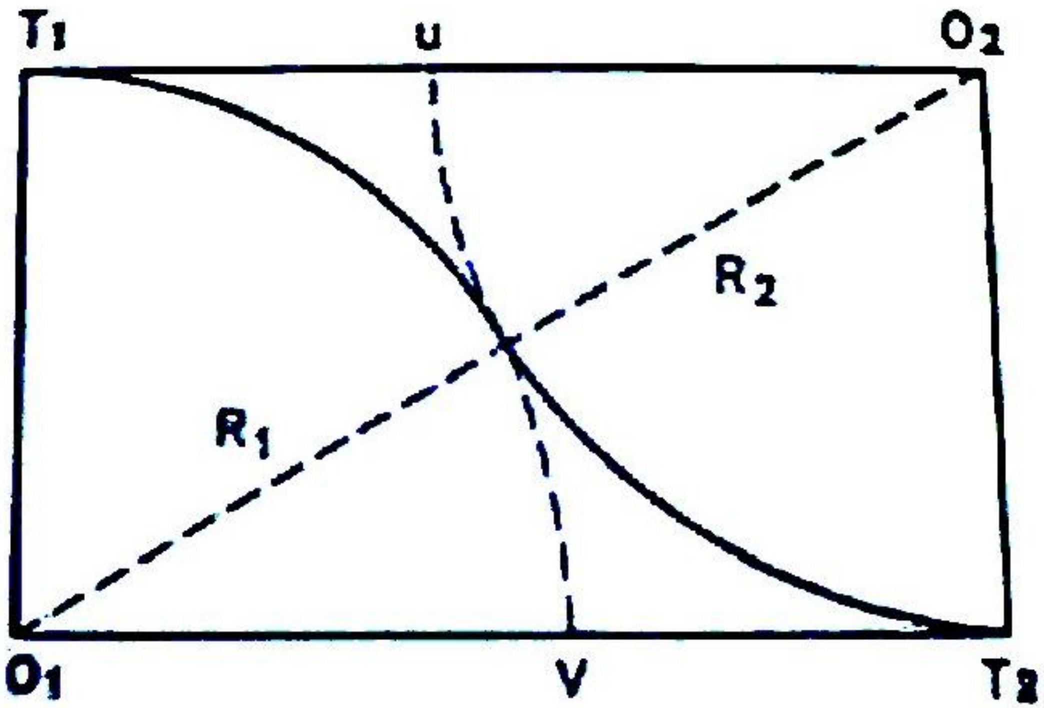
2. Compound Curve

- Two or more simple arc.
- In fig arc radius R_1 and centre O_1
- In fig arc radius R_2 and centre O_2



3. Reverse Curve

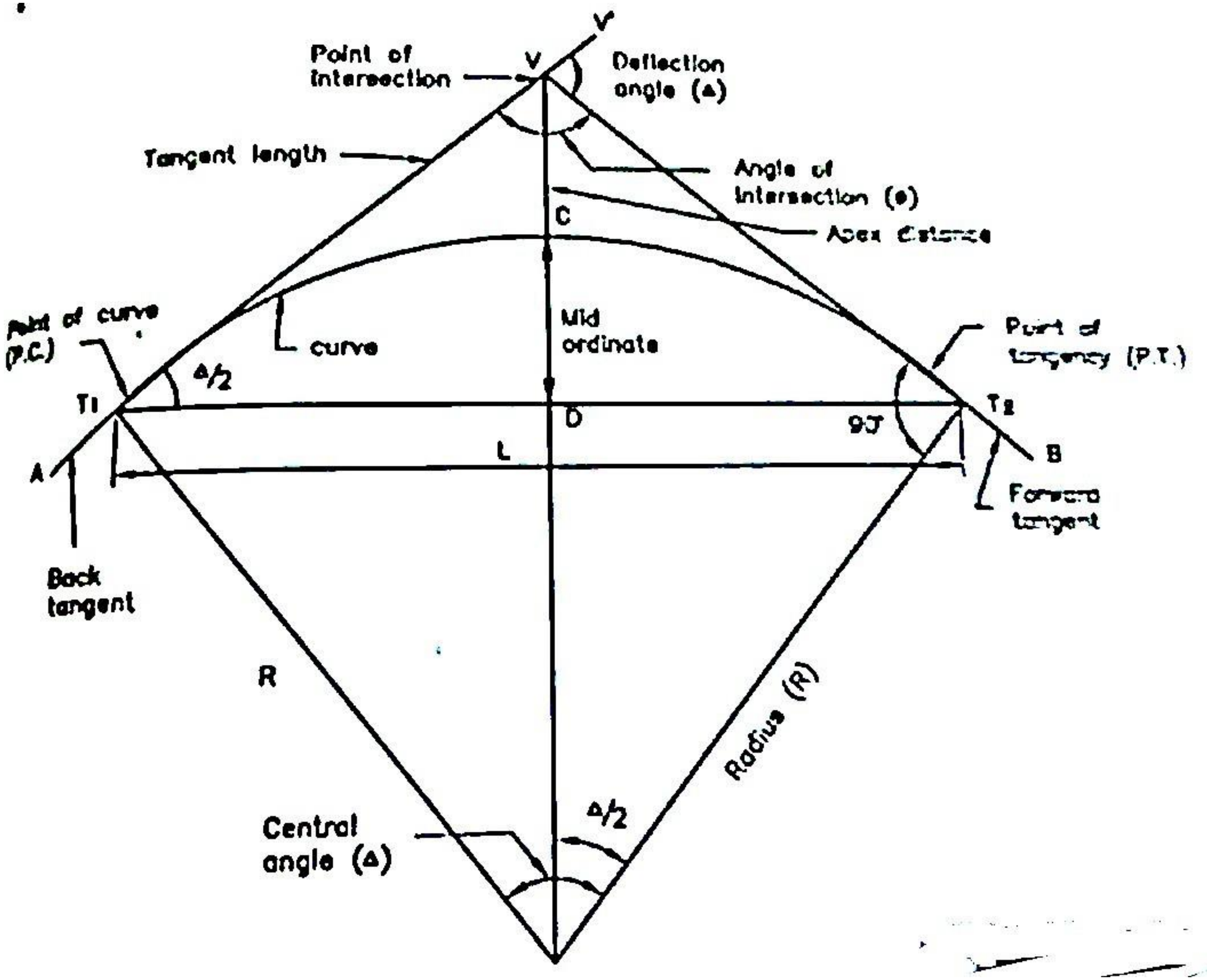
- Two circular arcs.
- Centre in opposite direction.
- Reverse curve are provided for low speeds roads and railway.



Definition and Notations for simple curve

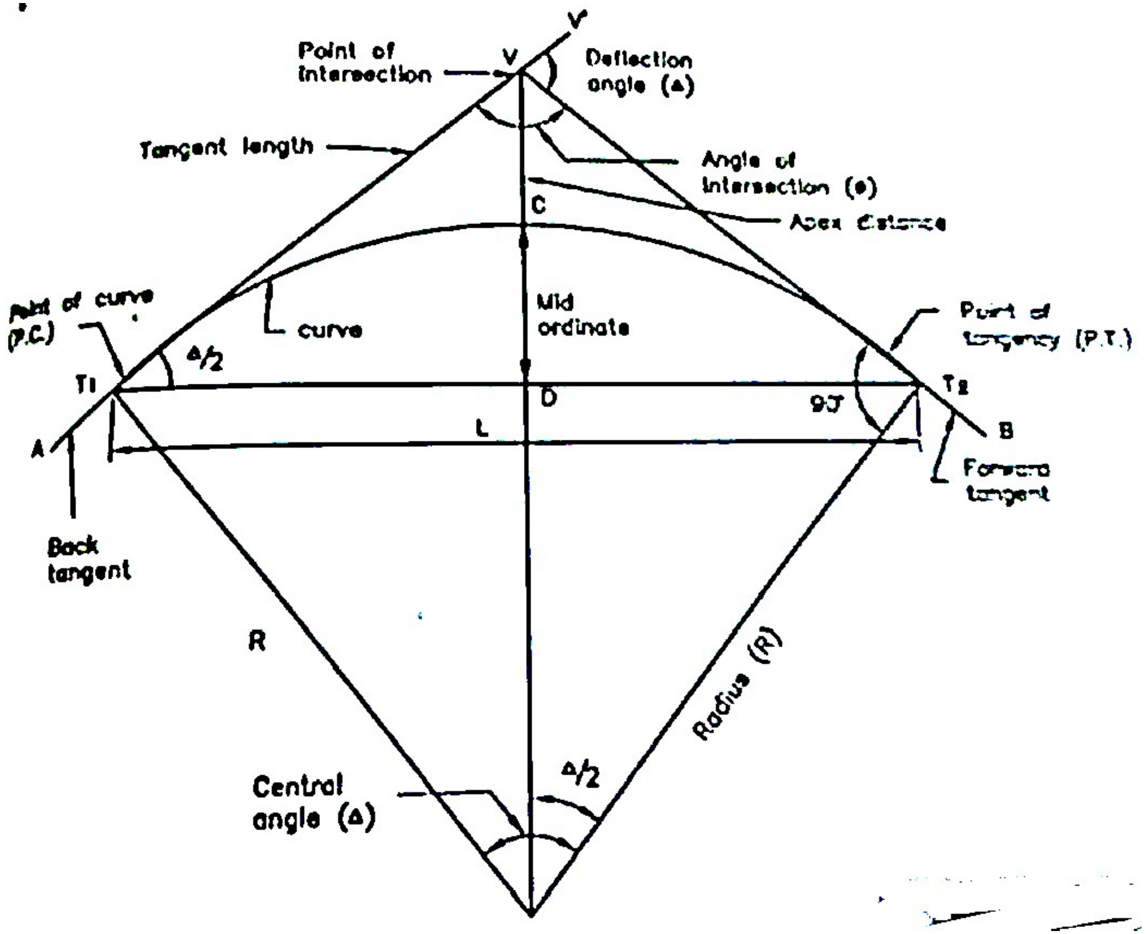
- **Back tangent point :-**
- The tangent (AT_1) previous to the curve is called tha curve is called tha back tangent or first tangent point.

- **Forward tangent Point :-**
- The tangent (T_2B) following the curve is called the forward tangent point or second



tangent point.

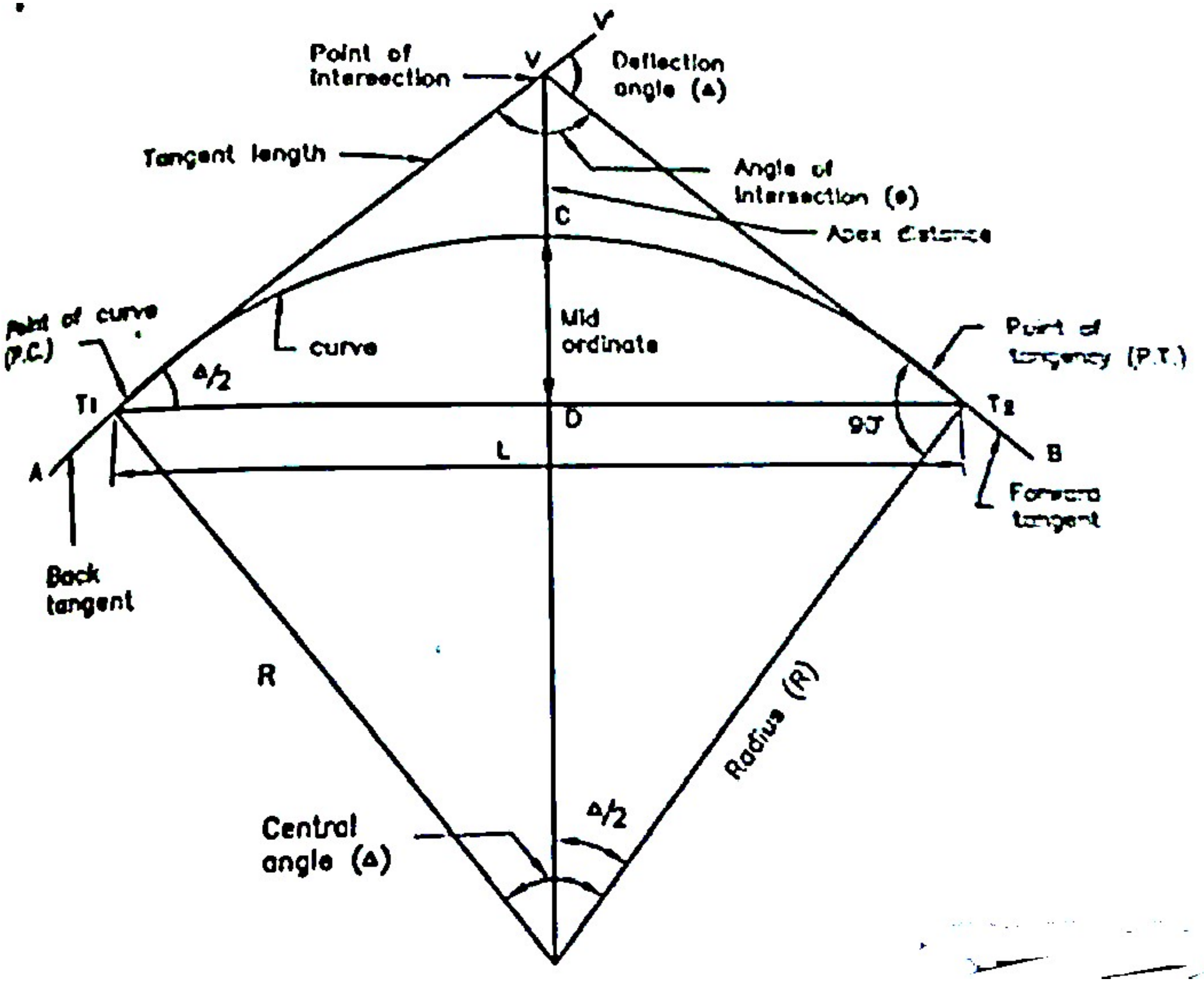
- **Point of Intersection (P.I) :-**
- If the tangents AT_1 and AT_2 are produced they will meet in a point, called the point of intersection (P.I).
- It is also called vertex (V)



- **Point of Curve (P.C) :-**
- It is the beginning point T_1 of a curve, at this point alignment is changes from a tangent to a curve.

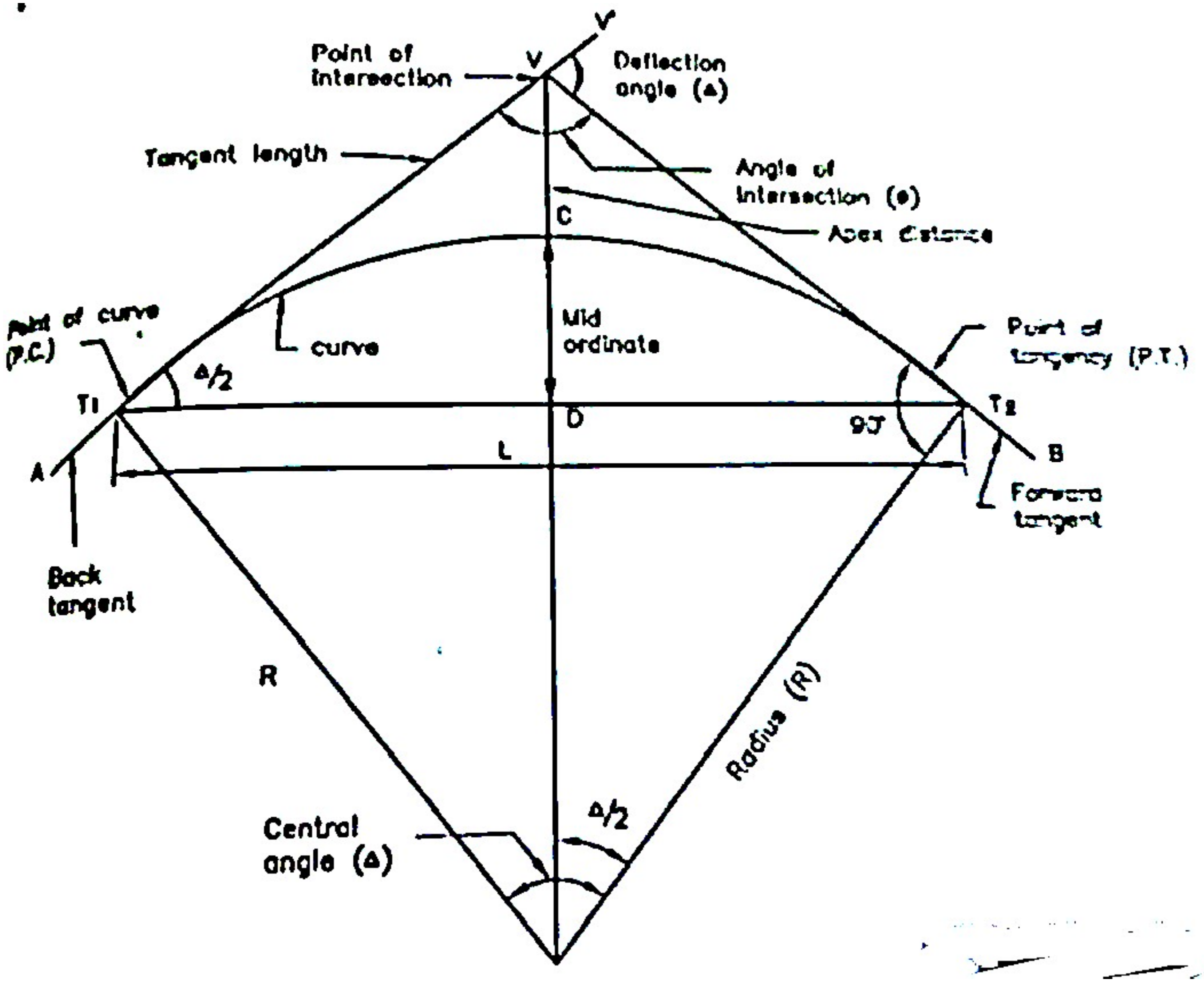
- **<u>Point of tangency (P.T) :-</u>**
- The end point of the curve (T_2) is called the point of tangency.

- **<u>Intersection angle (Φ) :-</u>**
- The angle AVB between tangent AV and tangent VB is called intersection angle.



- **Deflection angle (Δ) :-**
- The angle at P.I between tangent AV produce and VB is called the deflection angle.

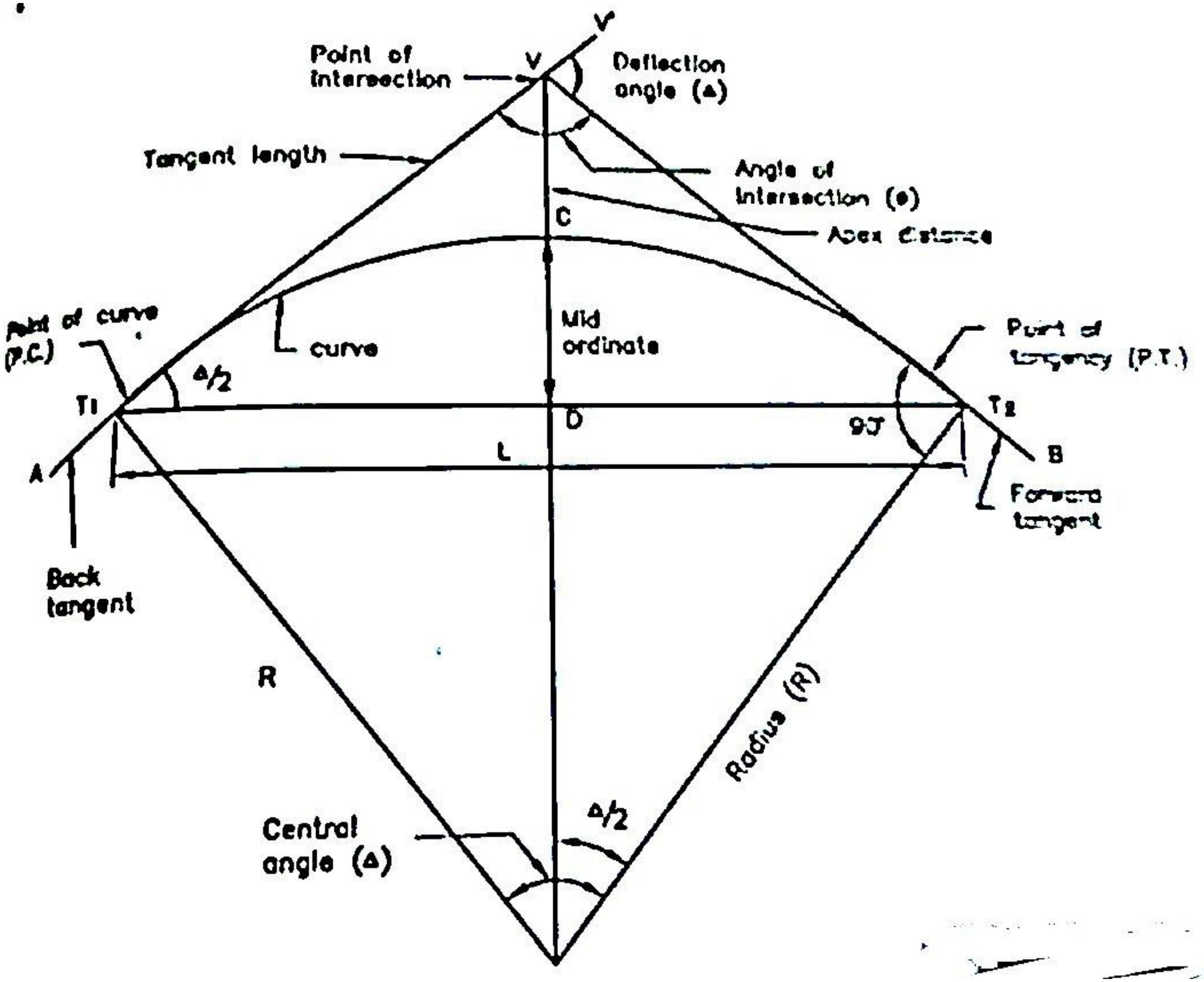
- **Tangent distance :-**
- It is the distance between the P.C to P.I, it is also distance between



the P.I to P.T

- **External distance (E) :-**
- It is the distance from the mid point of the curve to P.I.

- **Length of Curve (l) :-**
- It is the total length of curve from P.C to P.T.



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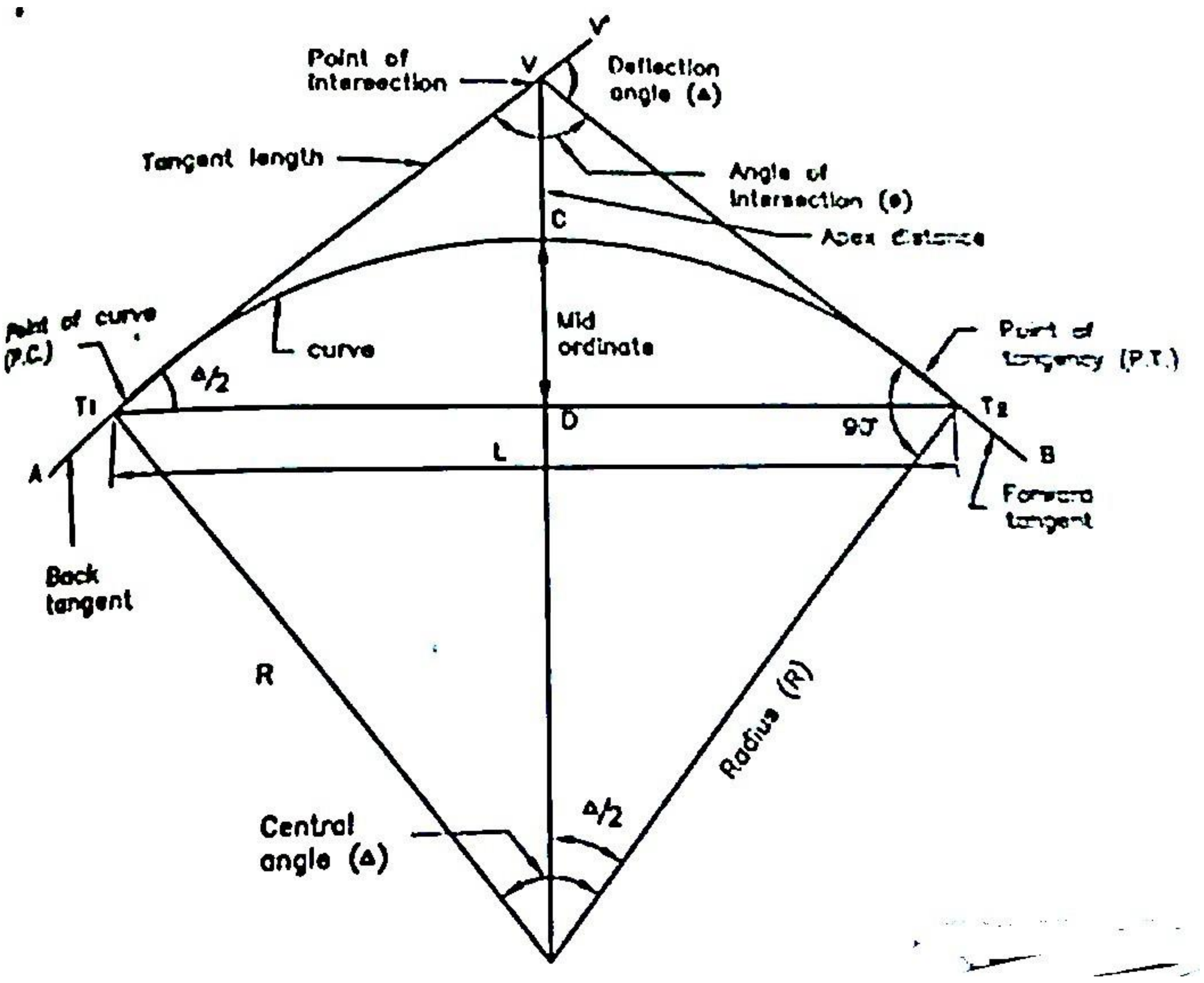
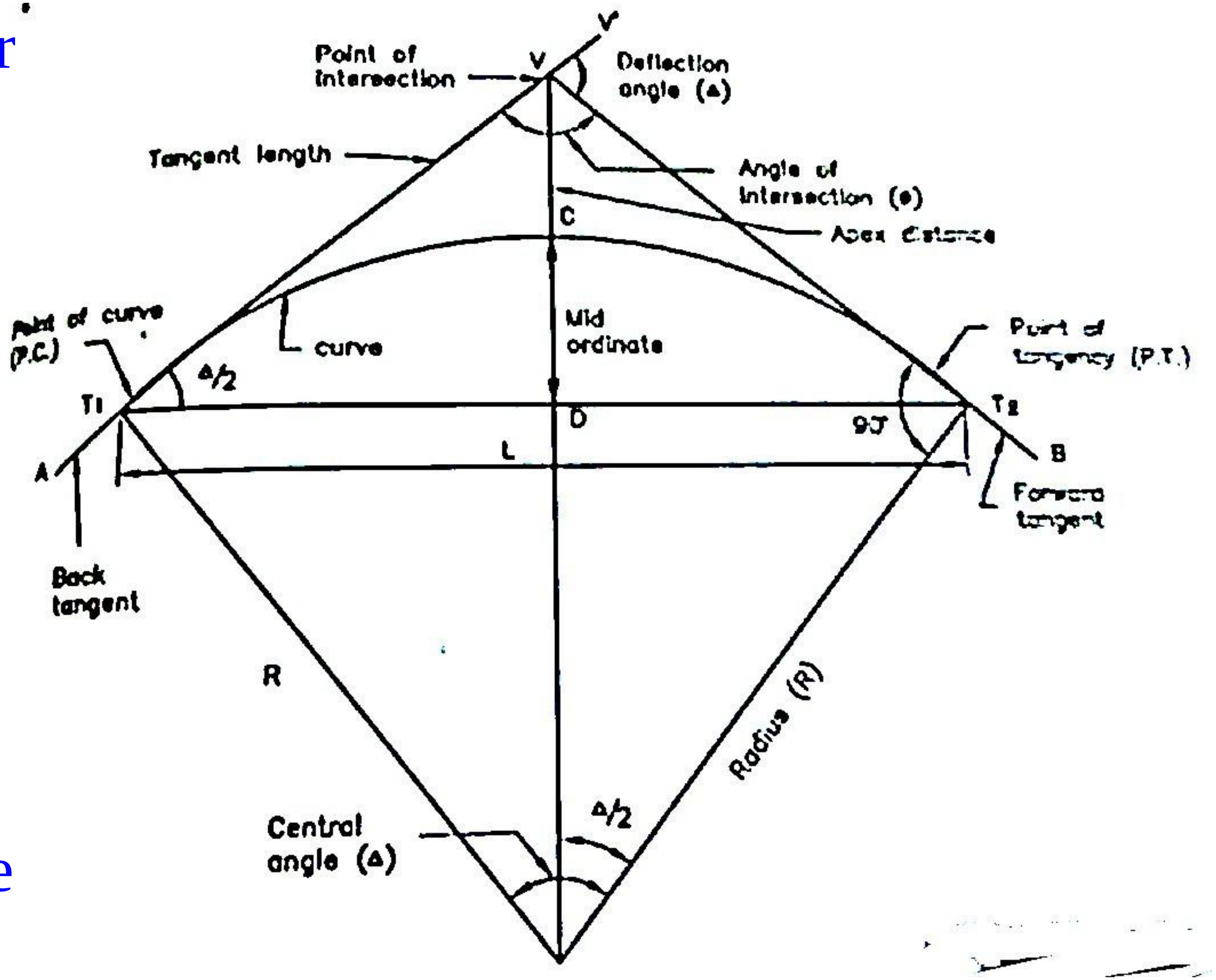
- **Long Chord :-**
- It is chord joining P.C to P.T T1, T2 is a long chord.

- **Normal chord :-**
- A chord between two successive regular station on a curve is called normal chord.

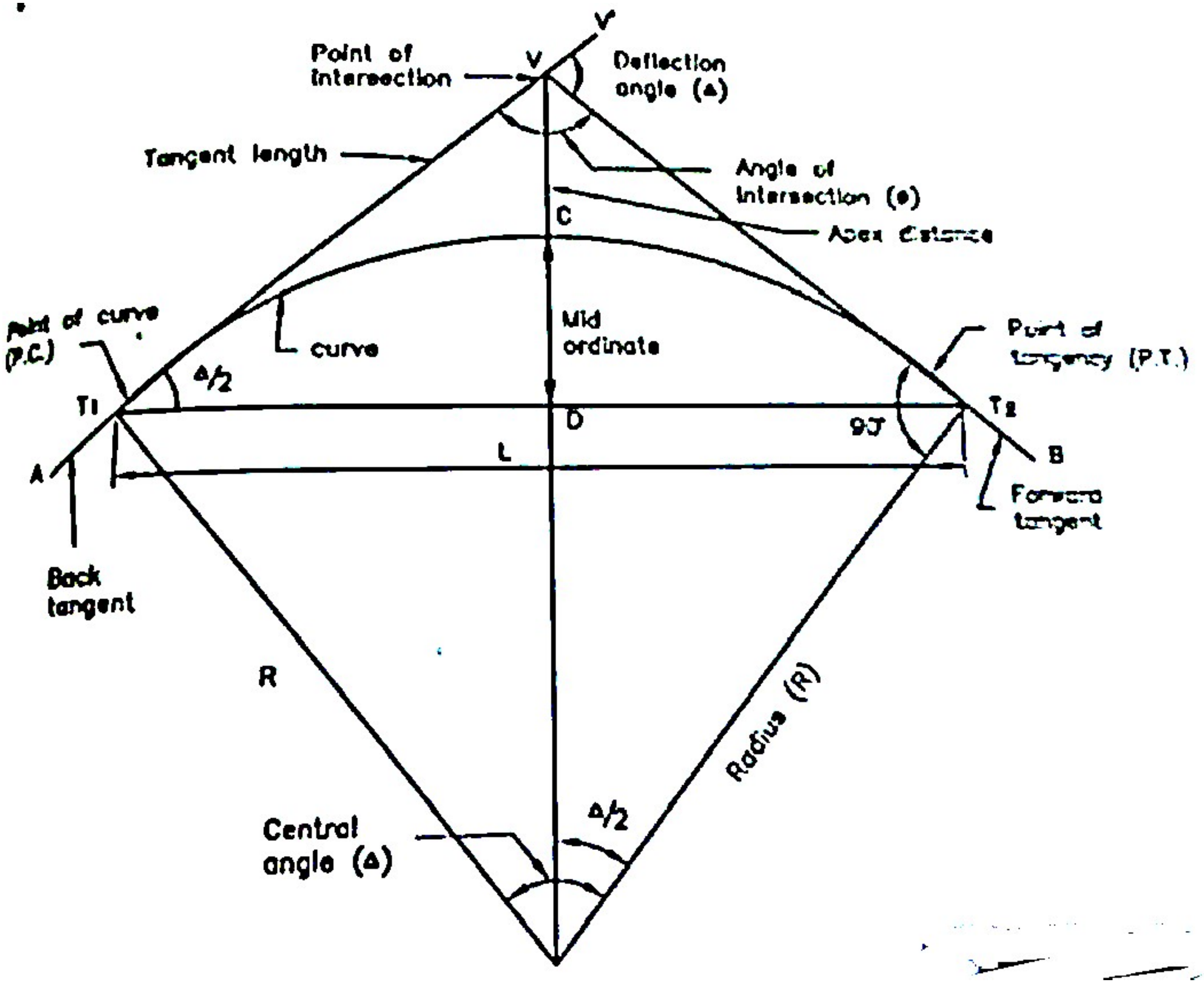


- **Sub Chord :-**
- The chord shorter than normal (Shorter than 20m) is called Sub chord.



- **Versed sine :-**
- The distance between mid point of long chord (D) and the apex point C is called versed sine.

- **Right hand curve :-**
- If the curve deflect to the right of the direction of the progress of survey, it is called right hand curve.



- **Left hand curve :-**
- If the curve deflect to the left of the direction of the progress of survey, it is called left hand curve.

Designation of Curve

- The sharpness of Curve is designated by two ways :-

1) By radius (R)
2) By degree of curvature (D)

1) By radius (R) :-

- In this method the curve is known by the length of its radius (R).
- Ex :-
- 200m curve means the curve having radius 200m.
- 6 chain curve means the curve having radius 6 chain.

2) **By Degree of Curvature :-**

- In this method curve is designated by degree.
- The degree of curvature can be divided in to two ways.

1. Chord definition :-

- The angle subtended at the centre of curve by a chord of 20m is called degree of curvature.
- Ex :- If the angle subtended at the centre of the curve by a chord of 20m is 5^0 the curve is called 5^0 degree curve.

2. Arc definition :-

- The angle subtended at the centre of the curve by an arc of 20m length is called degree of curve.
- Used in America, Canada, India.

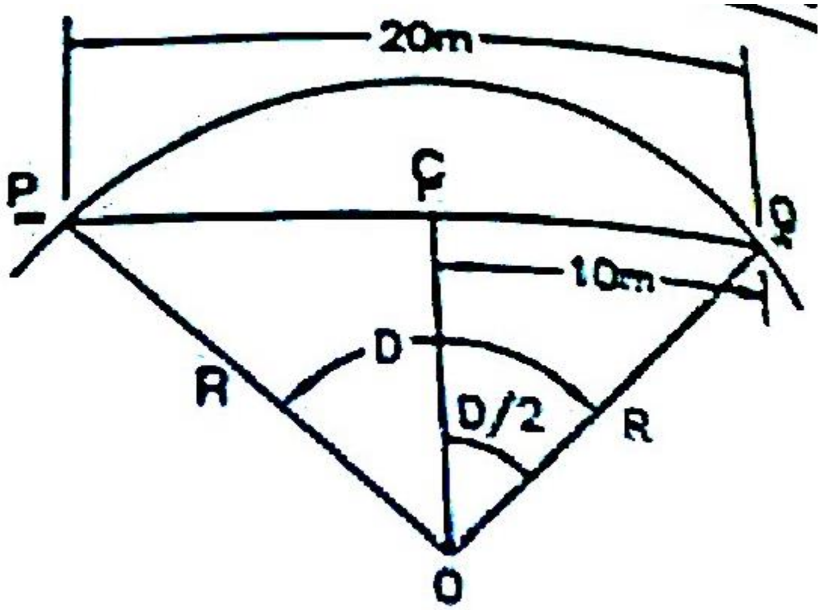
Relation Between Radius and Degree of Curve

By Chord Definition

By Arc Definition

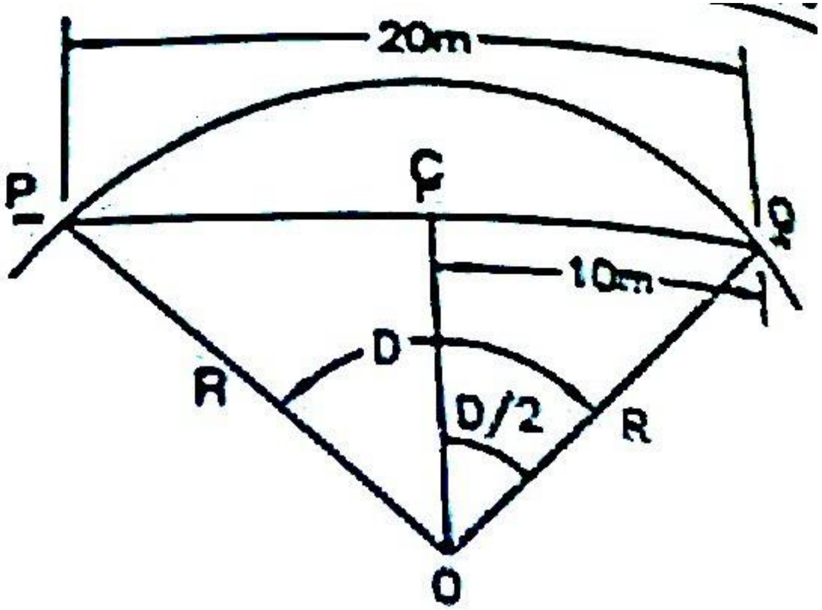
By Chord Definition

- The angle subtended at the centre of curve by a chord of 20m is called degree of curve.



- R = Radius of curve
- D = Degree of Curve
- PQ = 20 m = Length of Chord

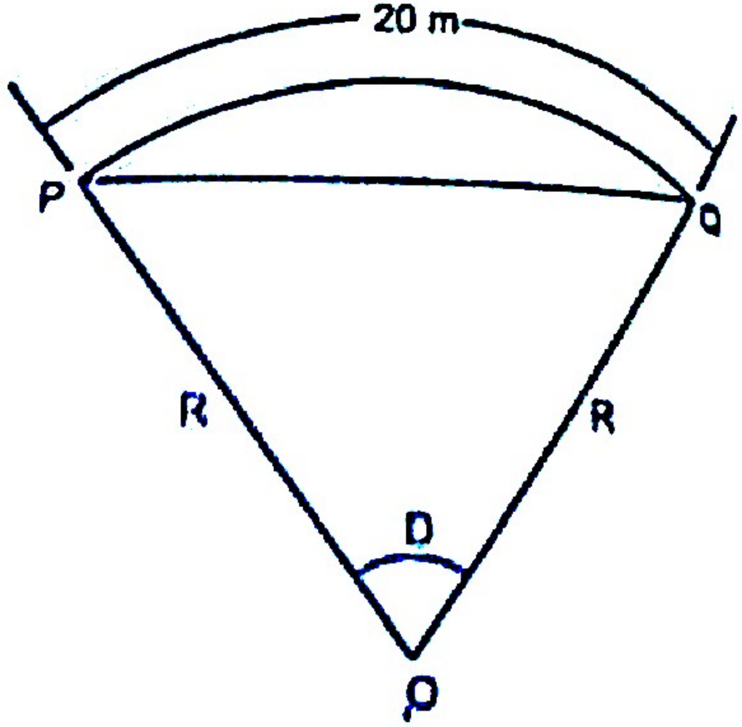
- From triangle PCO
- Sin $\frac{D}{2} = \frac{10}{R}$
- R $= \frac{10}{\text{Sin } \frac{D}{2}}$
- When D is small, Sin $\frac{D}{2}$ may be taken equall to $\frac{D}{2}$



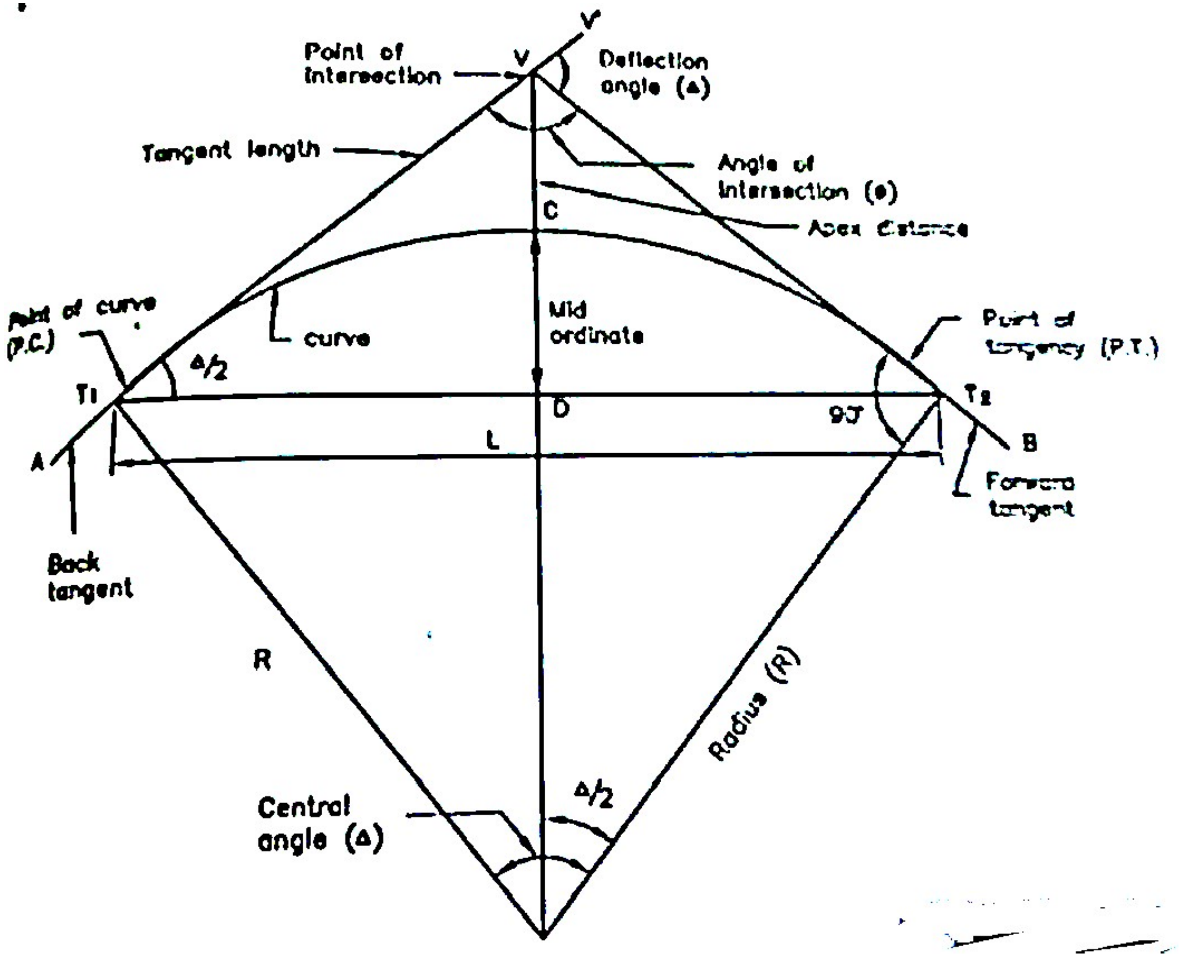
- Sin $\frac{D}{2} = \frac{D}{2}$
- R $= \frac{10}{\frac{D}{2} \text{ X } \frac{\pi}{180}}$
- R $= \frac{10\ X\ 360}{\pi\ D} = \frac{1146}{D}$

By Arc Definition

- The angle subtended at the centre of curve by an arc of 20m length is called degree of curve.
- $\frac{2\,\pi\,R}{360} = \frac{20}{D}$
- $R = \frac{20\ X\ 360}{2\,\pi\,D}$
- $R = \frac{1145.92}{D}$



Elements of Simple Circular Curve



Length of Curve (l)

❖ **If curve designated by radius**

- l = length of arc $T_1\ C\ T_2$
- $l = R\,\Delta$ (Where Δ is in radian)
- $l = \dfrac{R\,\Delta\,\pi}{180}$ (Where Δ is in Degree)

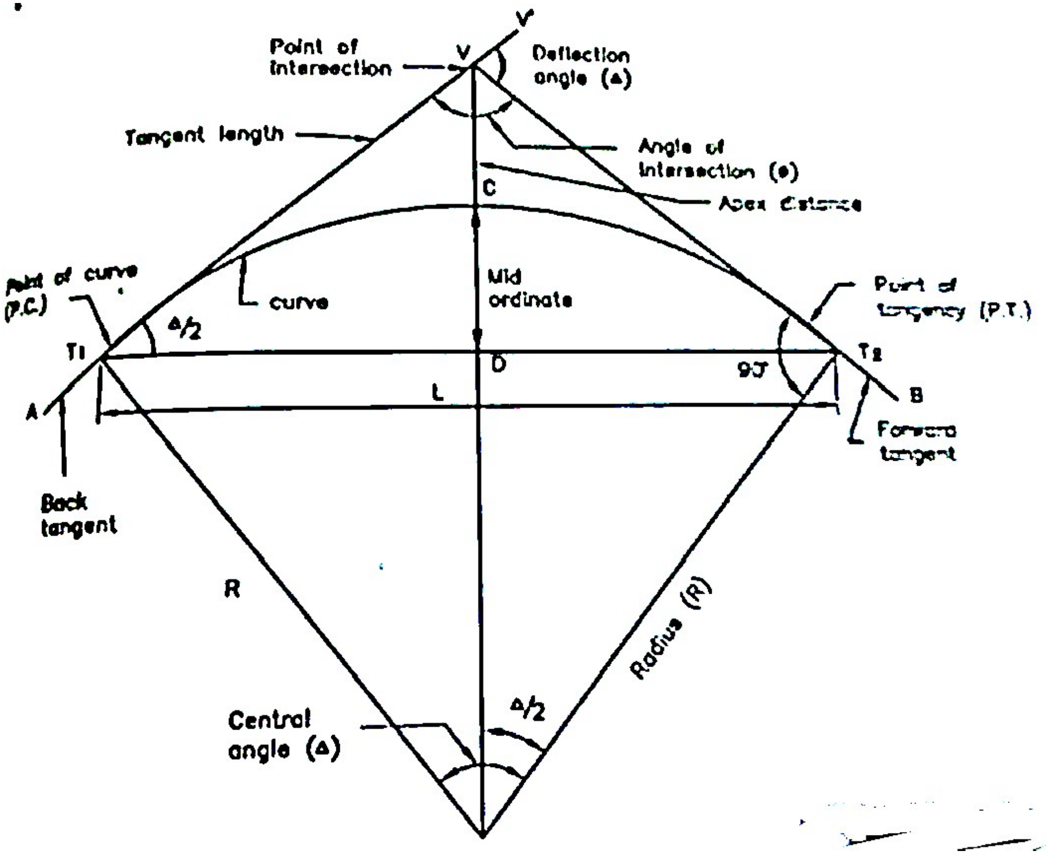
❖ **If curve designated by degree**

- Length of arc = 20 m
- Length of curve = $l = \dfrac{20\,\Delta}{D}$ m

  (D = degree of curve for 20 m arc)

Tangent Length (T)

- VT_1 and VT_2 are the tangent lengths
- $T = VT_1 = VT_2 =$ tangent length



- From $\Delta\, V\, T_1\, O$

- $\tan \frac{\Delta}{2} = \frac{VT_1}{OT_1} = \frac{T}{R}$

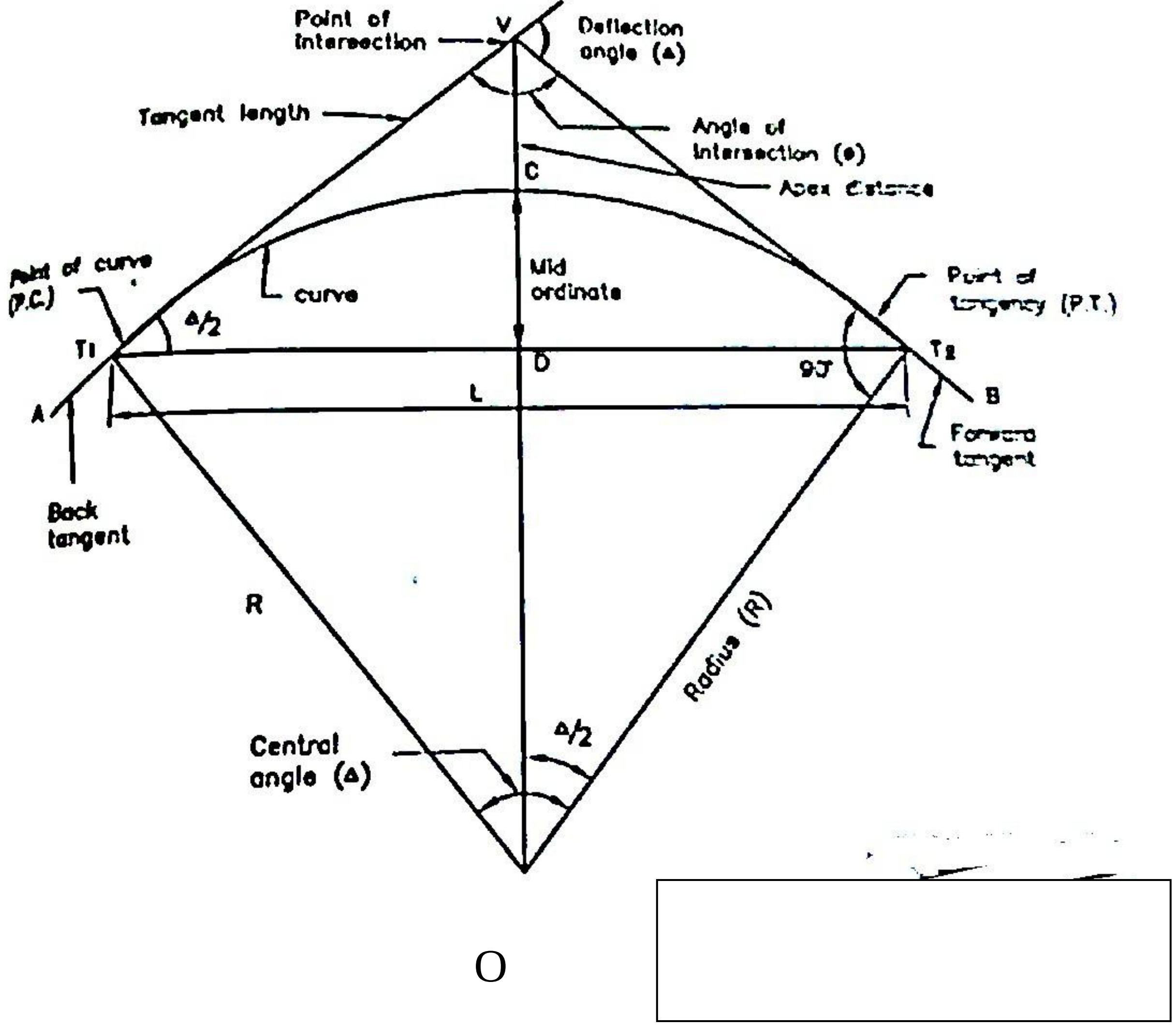
  ($\angle VT_1O$ and $\angle VT_2O$ are right angle)

- $T = R \tan \frac{\Delta}{2}$

- From triangle VT_1O
- $\text{Cos}\,\frac{\Delta}{2} = \frac{OT_1}{OV} = \frac{R}{OV}$
- $\text{OV} = \frac{R}{\text{Cos}\,\frac{\Delta}{2}} = \text{R Sec}\,\frac{\Delta}{2}$
- $\text{E} = \text{OV} - \text{OC}$

$= \text{R Sec}\,\frac{\Delta}{2} - \text{R}$

$= \text{R (Sec}\,\frac{\Delta}{2} - 1)$

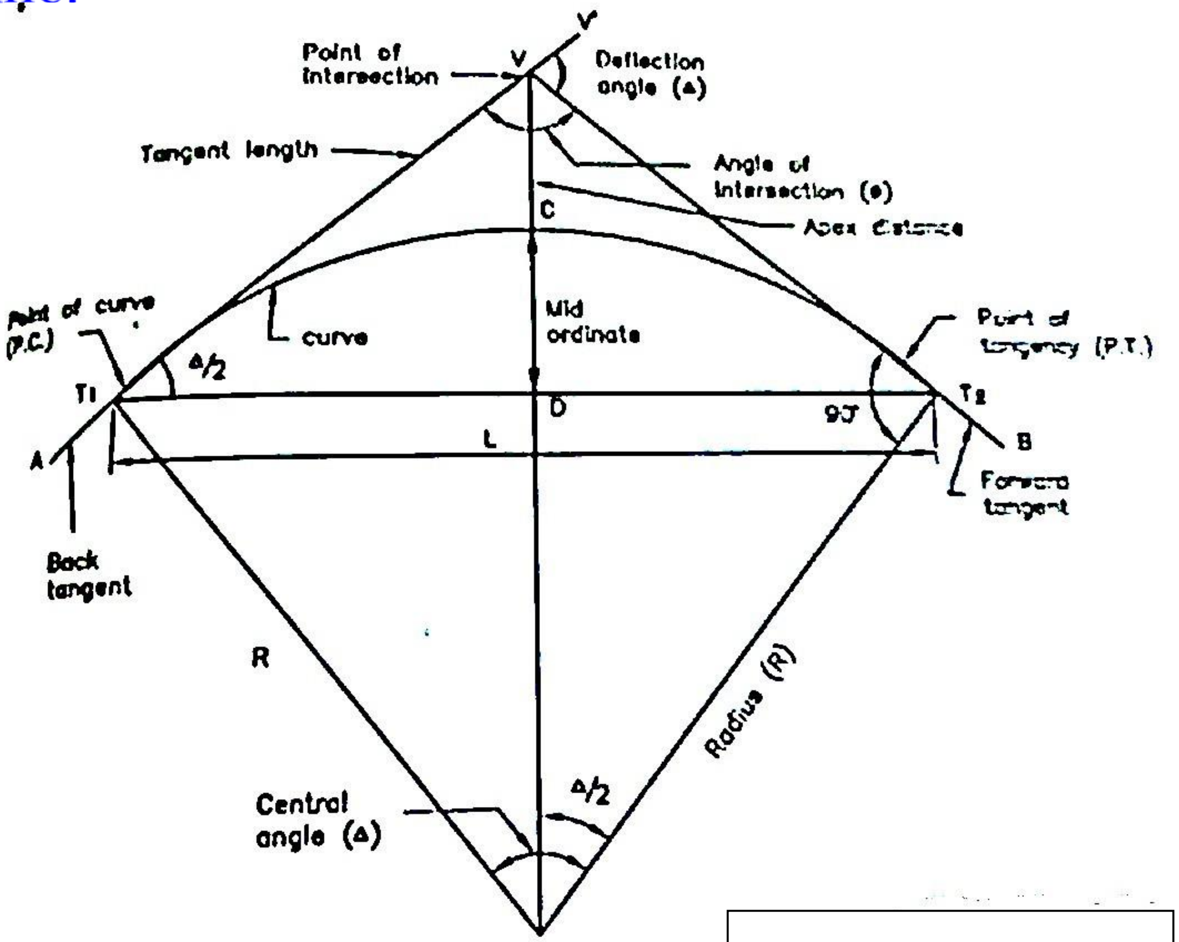


Mid Ordinate (M)

- In the fig, CD is the mid ordinate.
- It is also called versed sine.
- Mid ordinate = M
- M = CD = OC – OD
- From ΔT_1DO
- $\text{Cos}\,\frac{\Delta}{2} = \frac{OD}{OT_1} = \frac{OD}{R}$
- $OD = R\ \text{Cos}\,\frac{\Delta}{2}$
- M = OC – OD

$$= R - R\ \text{Cos}\,\frac{\Delta}{2}$$

$$= R\ (1 - \text{Cos}\,\frac{\Delta}{2})$$



Setting Out of Simple Circular Curve

- First of all, tangent point should be located on the ground very accurately.

❖ **Location of Tangent Point :-**

✓ First of all surveyor study the working plan.

✓ Knowing offsets to certain points on both tangents and marked on ground.

✓ Both the tangent AV and BV, intersect at a point V, known as point of intersection.

✓ Set the theodolite at V and measure the angle AVB = Ø

✓ Deflection angle = Δ = 180 - Ø

- Calculate the tangent length = T = R tan $\frac{\Delta}{2}$
- Now select point T_1 on line AV at a distance T from V.
- Similarly select point T_2 on line BV at a distance T from V.

Chainage of tangent Point :-

- ✓ The distance of any point from the beginning of the chain line is called chainage of that point.
- ✓ Point A is the starting point of the chain line. Chainage of point V, B, D are measure from the point A.
- ✓ Chainage of T1 = chainage of V – T (tangent Length)
- ✓ Chainage T2 = chainage of T1 + length of curve (l)
- ✓ $l = \frac{R\,\Delta\,\pi}{180}$

❖ Normal Chord and Sub Chord :-

- ✓ On the alignment of the curve, at a certain distance interval pegs are driven in to the ground.
- ✓ The distance between the two pegs is normally kept equal to 20 m.
- ✓ The distance is known as peg interval.
- ✓ If the peg are driven at 20m interval, the peg station are called main peg stations.
- ✓ The chord joining the tangent point T_1 and the first main peg station is called first sub chord.
- ✓ All the chord joining adjacent peg station are called full chord or normal chord.
- ✓ The length of normal chord is generally taken equal to 20m.
- ✓ The chord joining last main peg station and the tangent point T_2 is called last sub chord.

Method of setting out of Simple circular curve

- Angular Method
- Linear method

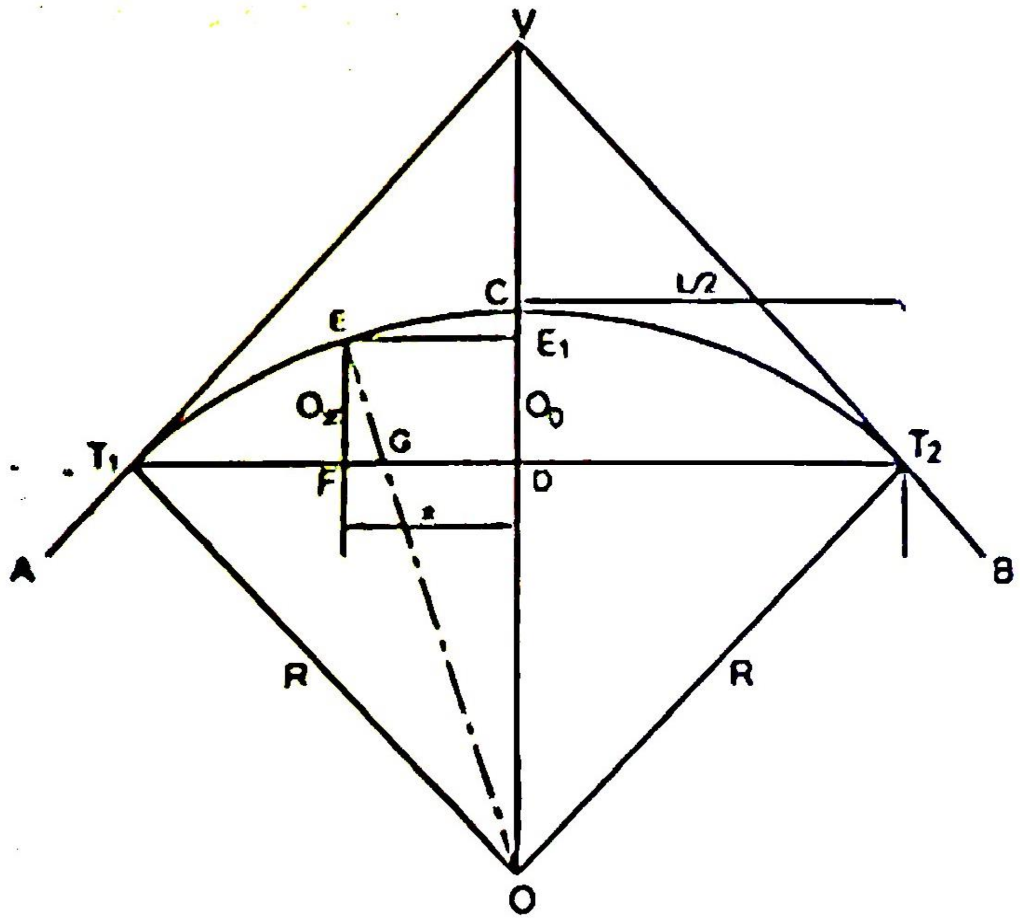
Linear Method

- Only chain or tap are required.
- Angle measurement instrument are not used.
- Method are used where high degree of accuracy is not required.
- Method is used where curve is very short.

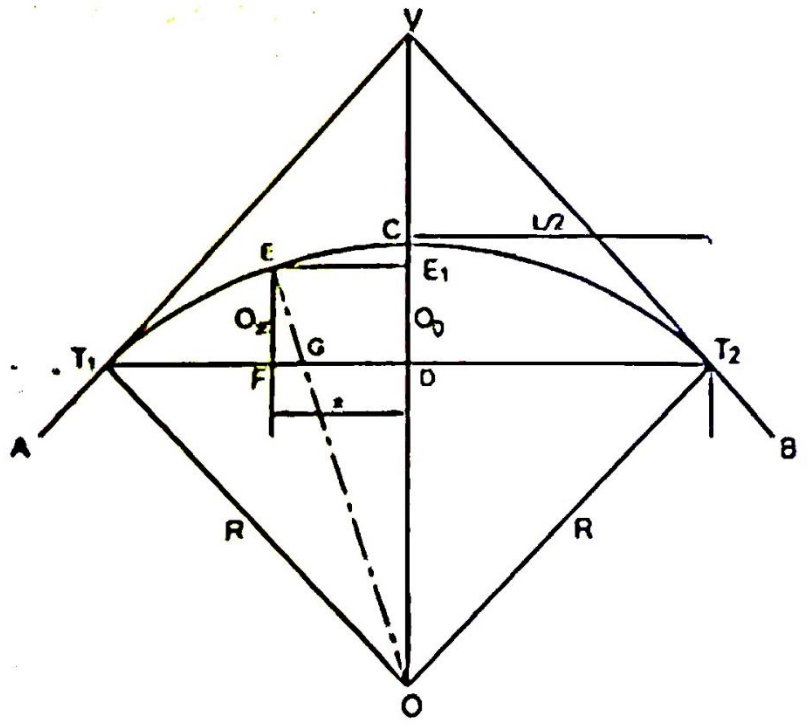
Linear methods are

i. By offset or ordinate from the long chord.
ii. By successive bisection of arcs or chords.
iii. By offsets from the tangents
iv. By offsets from chords produce

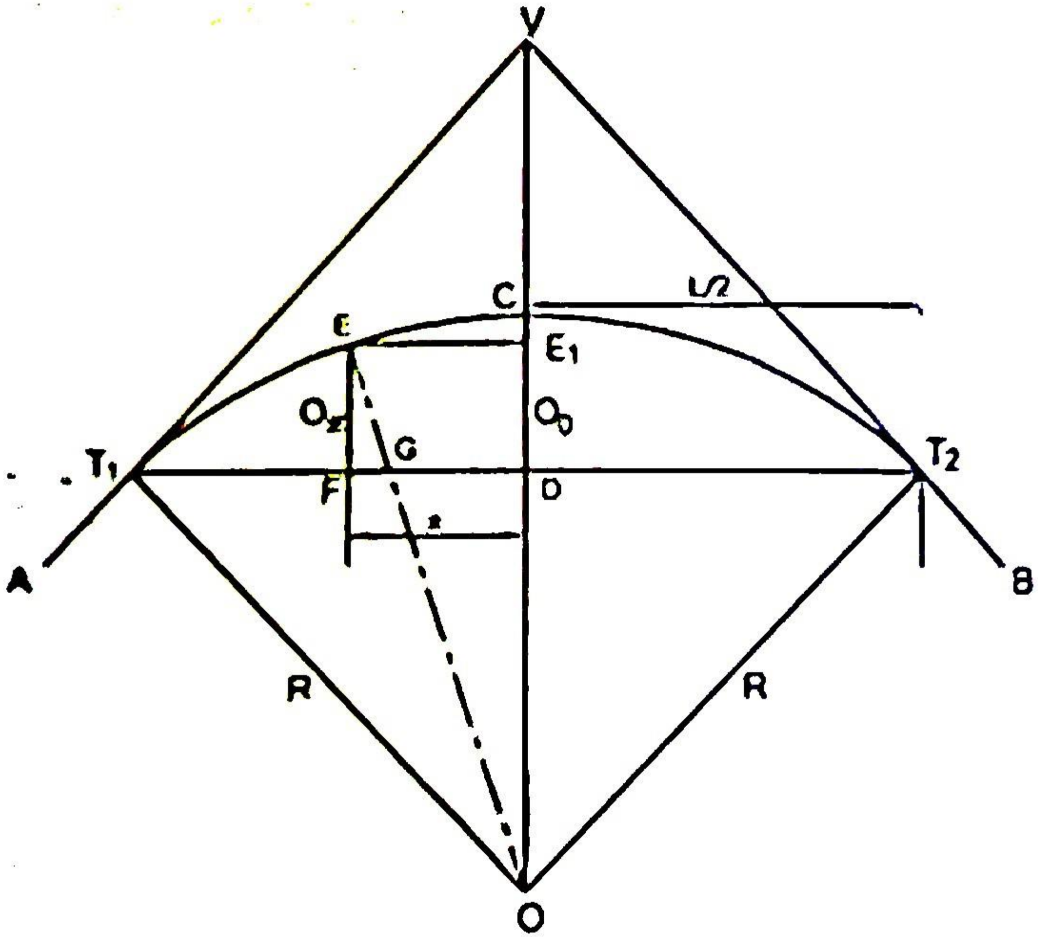
By offset or ordinate from the long chord.



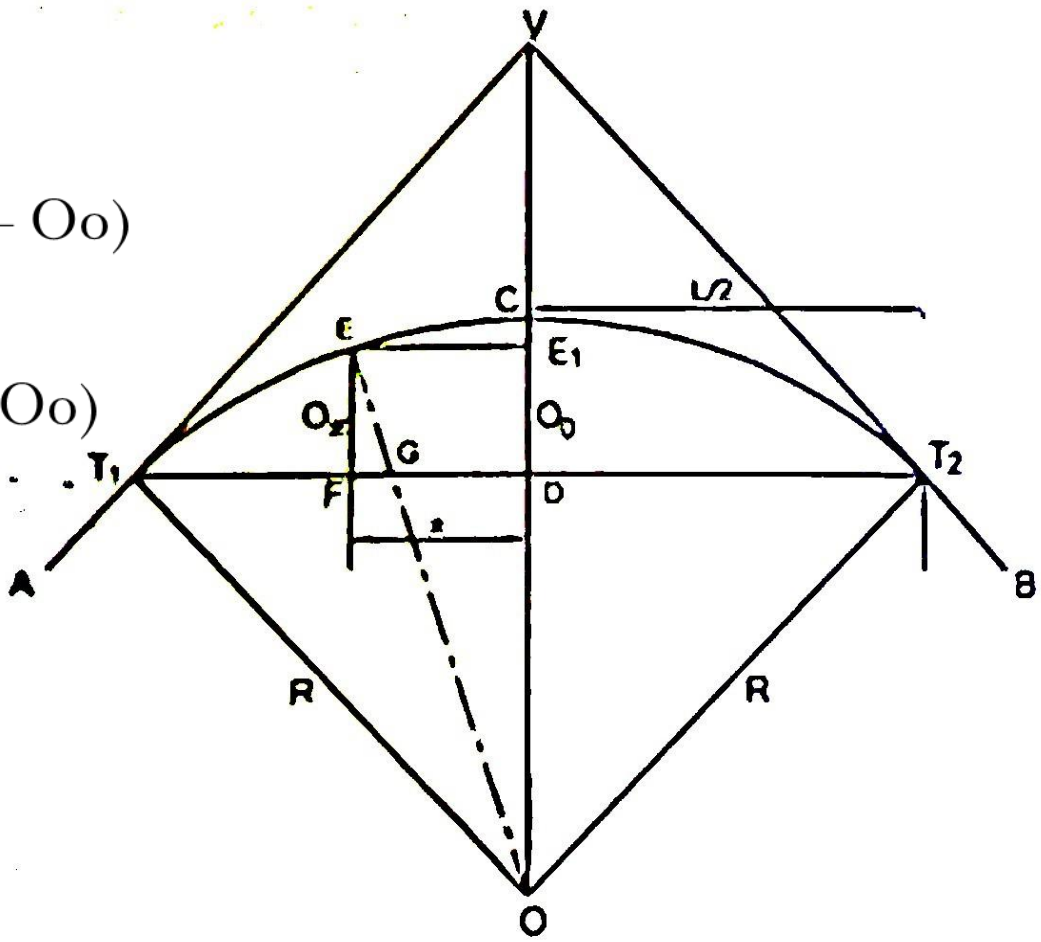
- R = Radius of curve
- O_o = Mid-Ordinate
- O_x = Ordinate at distance x from the mid point of the chord.
- T_1 and T_2 = Tangent Points
- L = Length of Long chord



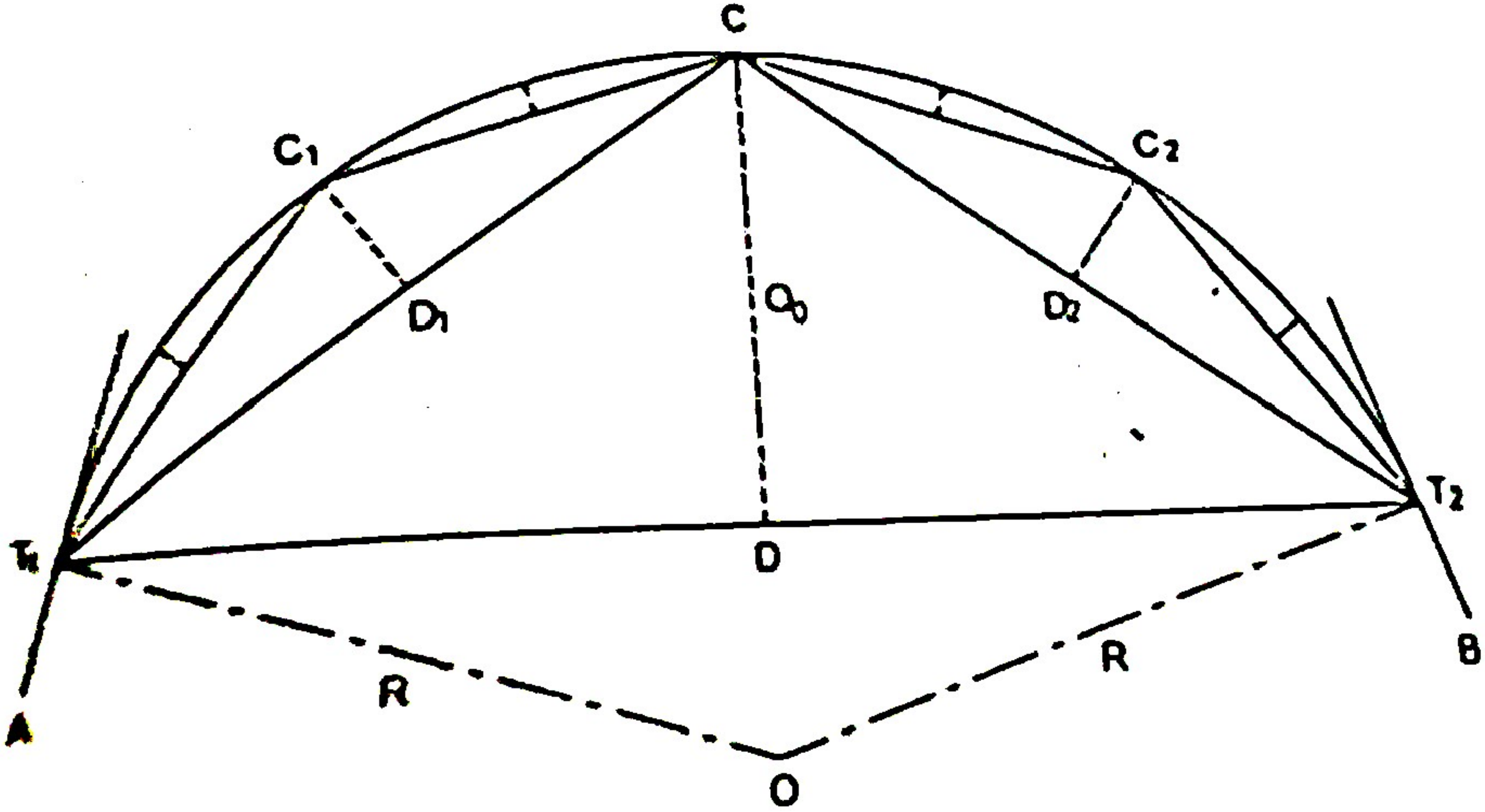
- To obtain equation for O_o :-
- From triangle OT_1D,
- $(OT_1)^2 = (DT_1)^2 + (OD)^2$
- $R^2 = \left(\frac{L}{2}\right)^2 + (OD)^2$
- $OD = \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$
- $O_o = R - OD$
- $O_o = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$



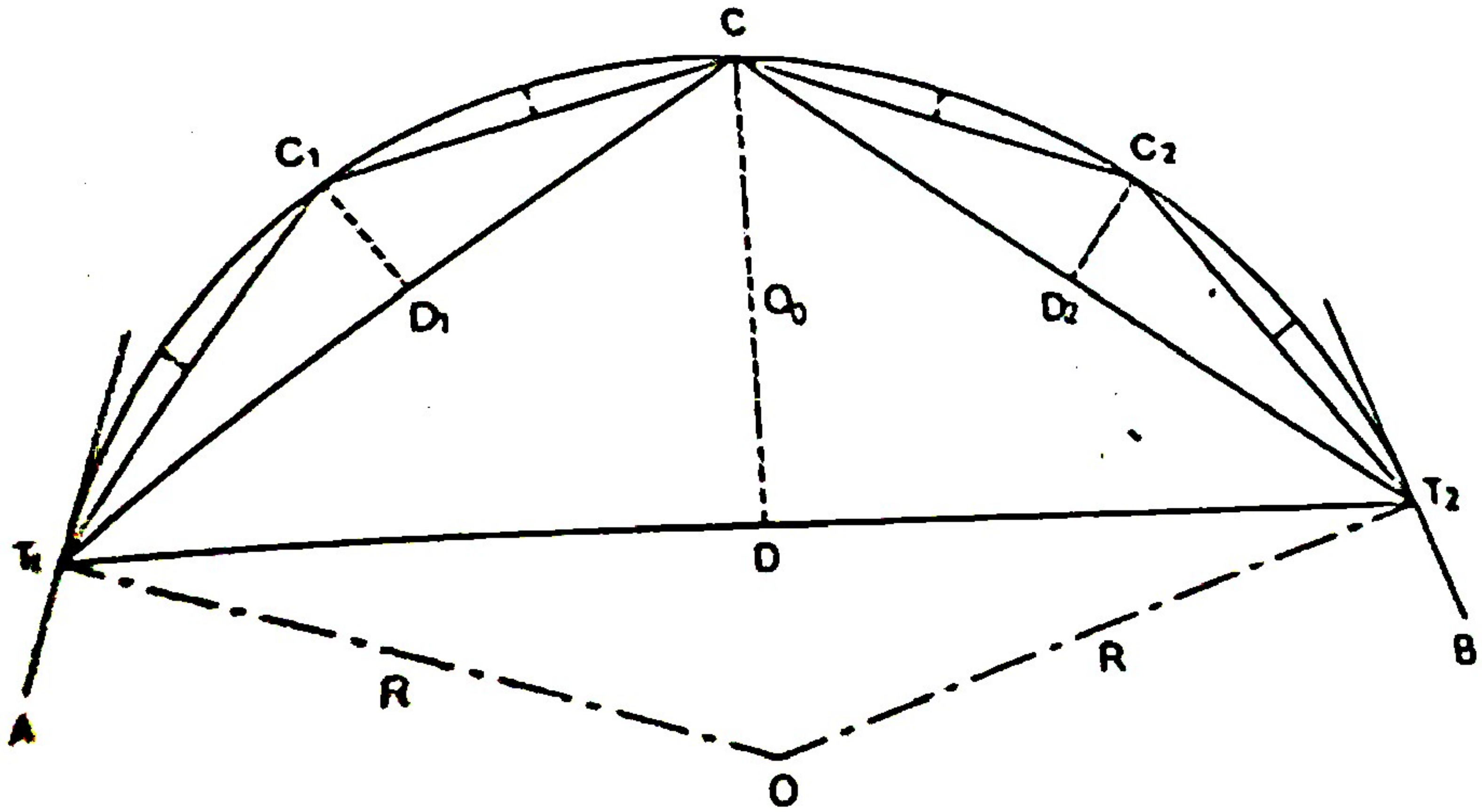
- In order to calculate ordinate Ox to any point E, draw the line EE_1, parallel to the long chord $T_1 T_2$. joint EO to cut long chord in G.
- $Ox = EF = E_1D$
- $= E_1O - DO$
- $= \sqrt{(EO)^2 - (EE_1)^2} - (R - Oo)$
- $Ox = \sqrt{(R)^2 - (X)^2} - (R - Oo)$



2. By successive bisection of arcs or chords.



- Joint point T_1 and T_2 and bisect long chord at D.
- Erect perpendicular DC at D equall to mid ordinate (M)
- Mid ordinate = M = CD = $R(1 - \cos\frac{\Delta}{2})$



- $O_o = R - \sqrt{R^2 - \left(\frac{L}{2}\right)^2}$
- Joint T_1C and T_2C and bisect them at D_1 and D_2 respectively.
- At D1 and D2 set out perpendicular offsets $C_1D_1 = C_2D_2 = (1 - \cos\frac{\Delta}{4})$ and obtain C_1 and C_2 on the curve.