ME 111: Engineering Drawing

Lecture 3

05-08-2011

SCALES AND Engineering Curves

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Definition

A scale is defined as the ratio of the linear dimensions of the object as represented in a drawing to the actual dimensions of the same.

Necessity

- **Drawings drawn with the same size as the objects are called full sized drawing.**

- **It is not convenient, always, to draw drawings of the object to its actual size. e.g. Buildings, Heavy machines, Bridges, Watches, Electronic devices etc.**

- **Hence scales are used to prepare drawing at**
  - **Full size**
  - **Reduced size**
  - **Enlarged size**

BIS Recommended Scales

Reducing scales 1:Y (Y>1)	1:2 1:20 1:200 1:2000	1:5 1:50 1:500 1:5000	1:10 1:100 1:1000 1:10000
Enlarging scales X:1 (X>1)	50:1 5:1	20:1 2:1	10:1
Full size scales			1:1

Intermediate scales can be used in exceptional cases where recommended scales can not be applied for functional reasons.

Types of Scale

- ***Engineers Scale :***

  The relation between the dimension on the drawing and the actual dimension of the object is mentioned numerically (like 10 mm = 15 m).

- ***Graphical Scale:***

  Scale is drawn on the drawing itself. This takes care of the shrinkage of the engineer's scale when the drawing becomes old.

Types of Graphical Scale

- Plain Scale
- Diagonal Scale
- Vernier Scale
- Comparative scale

Representative fraction (R.F.)

$$R.F. = \frac{\text{Length of an object on the drawing}}{\text{Actual Length of the object}}$$

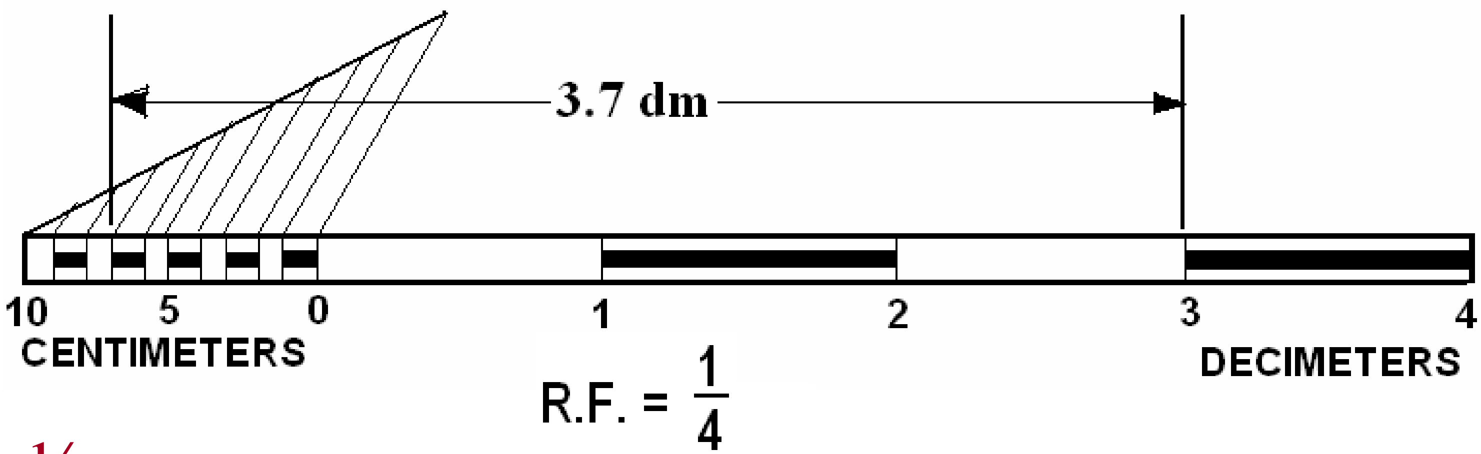
When a 1 cm long line in a drawing represents 1 meter length of the object,

$$R.F = \frac{1\,cm}{1\,m} = \frac{1\,cm}{1\,x\,100\,cm} = \frac{1}{100}$$

Plain scale

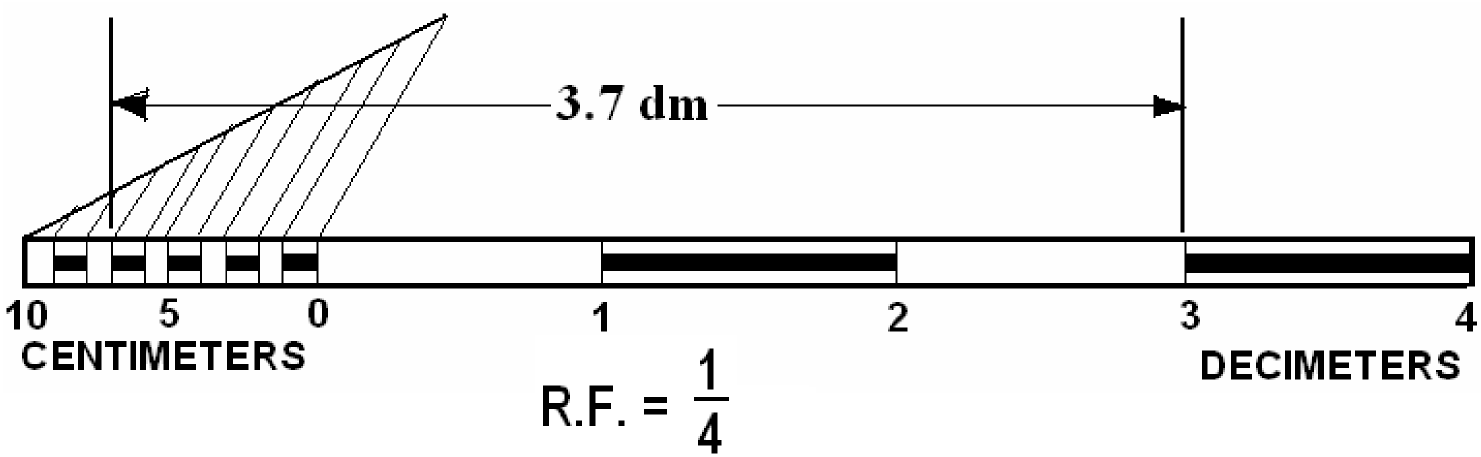
- A plain scale consists of a line divided into suitable number of equal units. The first unit is subdivided into smaller parts.
- The zero should be placed at the end of the 1st main unit.
- From the zero mark, the units should be numbered to the right and the sub-divisions to the left.
- The units and the subdivisions should be labeled clearly.
- The R.F. should be mentioned below the scale.

Construct a scale of 1:4, to show centimeters and long enough to measure up to 5 decimeters.



- R.F. = ¼
- Length of the scale = R.F. × max. length = ¼ × 5 dm = 12.5 cm.
- Draw a line 12.5 cm long and divide it in to 5 equal divisions, each representing 1 dm.
- Mark 0 at the end of the first division and 1, 2, 3 and 4 at the end of each subsequent division to its right.
- Divide the first division into 10 equal sub-divisions, each representing 1 cm.
- Mark cm to the left of 0 as shown.

Question: Construct a scale of 1:4, to show centimeters and long enough to measure up to 5 decimeters



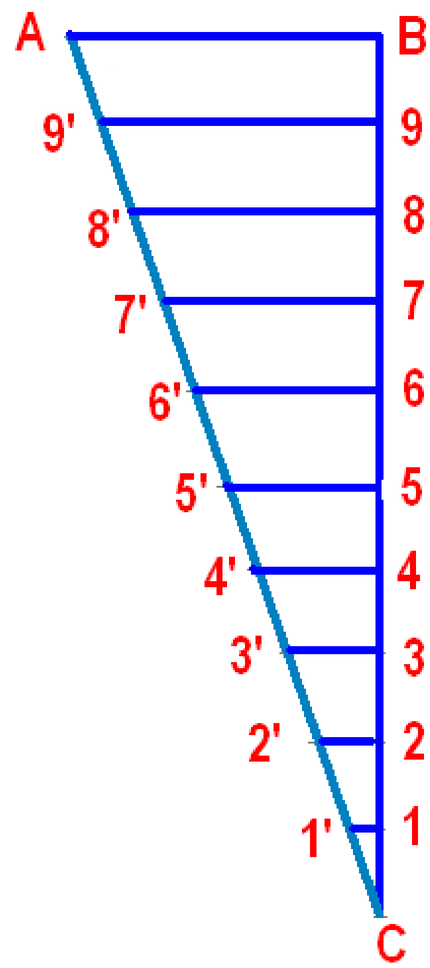
- **Draw the scale as a rectangle of small width (about 3 mm) instead of only a line.**
- **Draw the division lines showing decimeters throughout the width of the scale.**
- **Draw thick and dark horizontal lines in the middle of all alternate divisions and sub-divisions.**
- **Below the scale, print DECIMETERS on the right hand side, CENTIMERTERS on the left hand side, and R.F. in the middle.**

Diagonal Scale

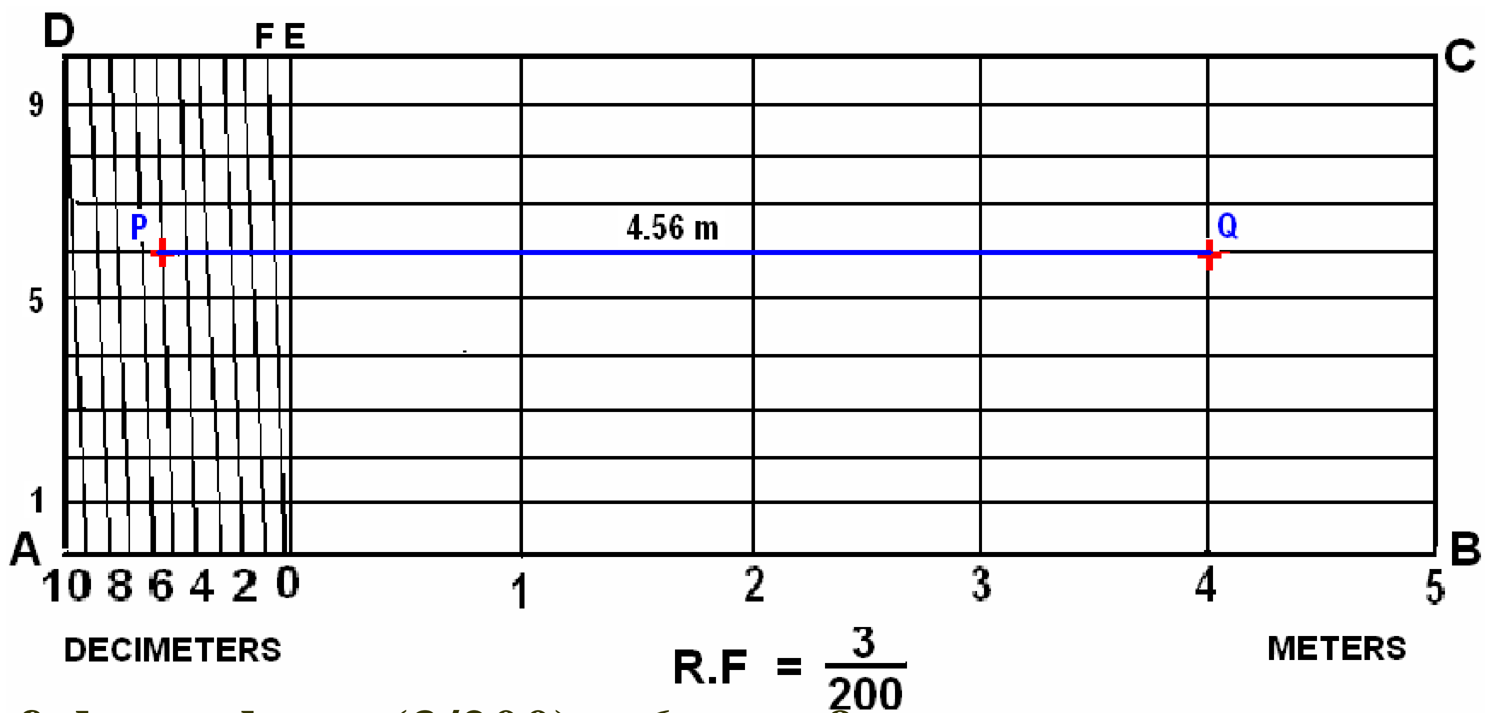
- **Through Diagonal scale, measurements can be up to second decimal (e.g. 4.35).**
- **Diagonal scales are used to measure distances in a unit and its immediate two subdivisions; e.g. *dm, cm & mm*, or *yard, foot & inch*.**
- **Diagonal scale can measure more accurately than the plain scale.**

Diagonal scale…..Concept

- At end B of line AB, draw a perpendicular.
- Step-off ten equal divisions of any length along the perpendicular starting from B and ending at C.
- Number the division points 9,8,7,…..1.
- Join A with C.
- Through the points 1, 2, 3, etc., draw lines parallel to AB and cutting AC at 1´, 2´, 3´, etc.
- Since the triangles are similar; 1´1 = 0.1 AB, 2´2 = 0.2AB, …. 9´9 = 0.9AB.
- Gives divisions of a given short line AB in multiples of 1/10 its length, e.g. 0.1AB, 0.2AB, 0.3AB, etc.

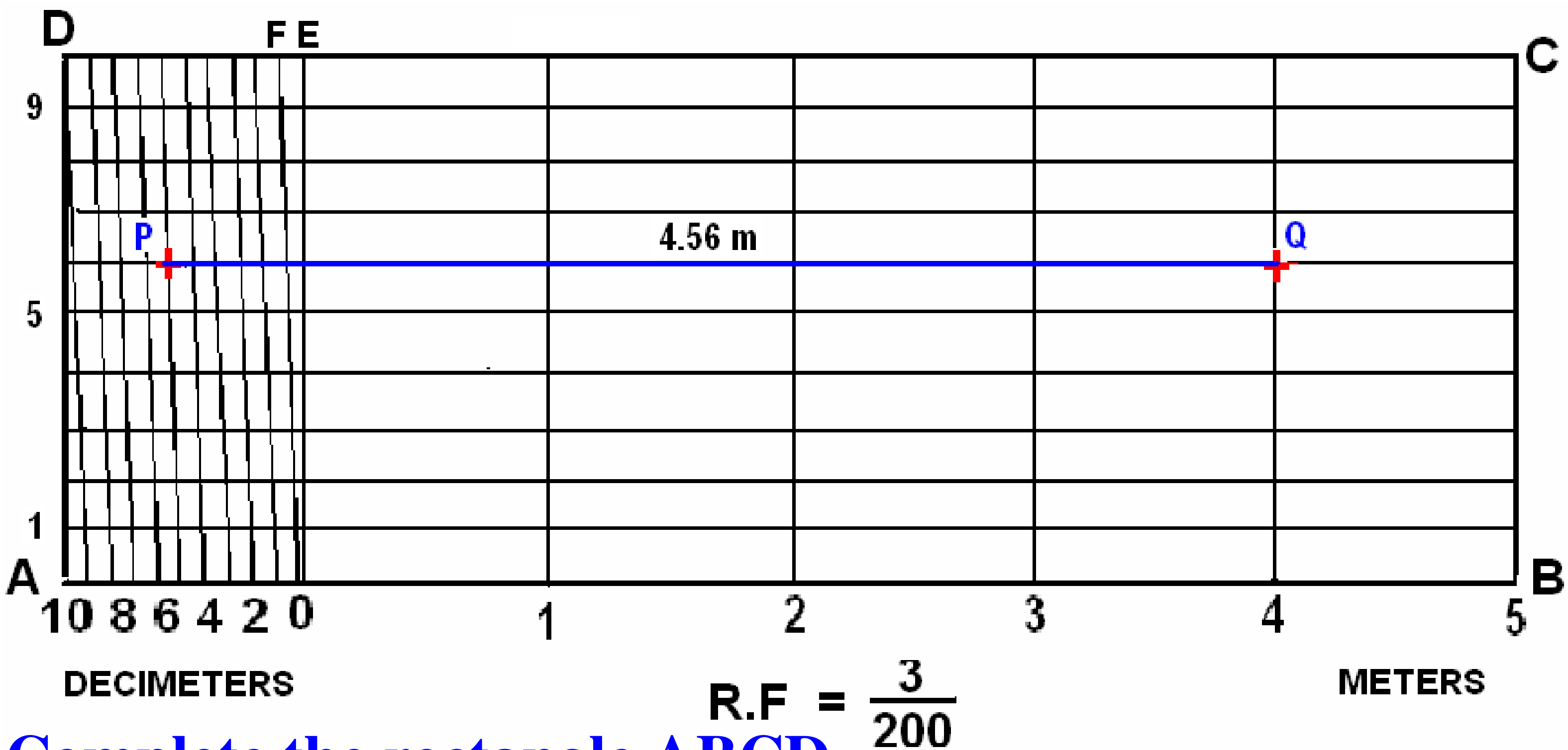


Construct a Diagonal scale of RF = 3:200 (i.e. 1:66 2/3) showing meters, decimeters and centimeters. The scale should measure up to 6 meters. Show a distance of 4.56 meters



- **Length of the scale = (3/200) x 6 m = 9 cm**
- **Draw a line AB = 9 cm . Divide it in to 6 equal parts.**
- **Divide the first part A0 into 10 equal divisions.**
- **At A draw a perpendicular and step-off along it 10 equal divisions, ending at D.**

Diagonal Scale



- Complete the rectangle ABCD.
- Draw perpendiculars at meter-divisions i.e. 1, 2, 3, and 4.
- Draw horizontal lines through the division points on AD. Join D with the end of the first division along A0 (i.e. 9).
- Through the remaining points i.e. 8, 7, 6, … draw lines // to D9.
- PQ = 4.56 meters

Vernier Scales

- Similar to Diagonal scale, Vernier scale is used for measuring up to second decimal.
- A Vernier scale consists of (i) a primary scale and (ii) a vernier.
- The primary scale is a plain scale fully divided in to minor divisions.
- The graduations on the vernier are derived from those on the primary scale.

Least count (LC) is the minimum distance that can be measured.

Forward Vernier Scale :

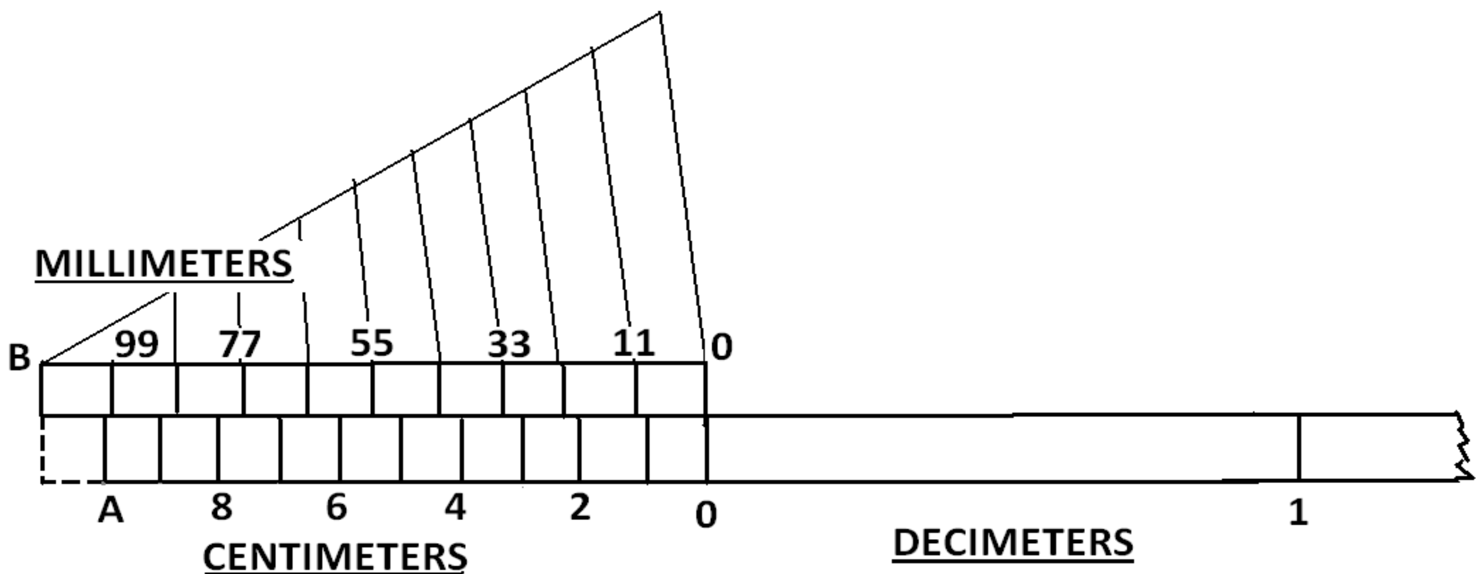
MSD>VSD; LC = MSD-VSD

Backward Vernier scale:

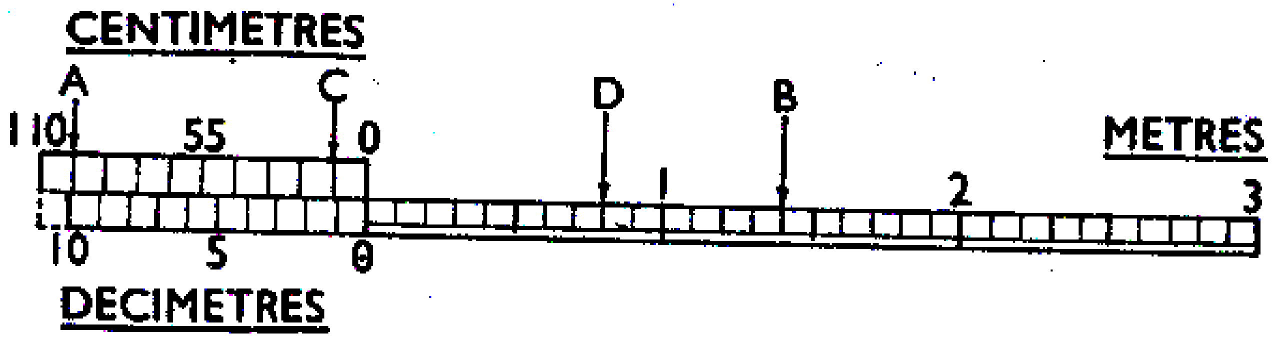
VSD>MSD; LC = VSD - MSD

Vernier scale…. Concept

- Length A0 represents 10 cm and is divided in to 10 equal parts each representing 1 cm.
- B0 = 11 (i.e. 10+1) such equal parts = 11 cm.
- Divide B0 into 10 equal divisions. Each division of B0 will be equal to 11/10 = 1.1 cm or 11 mm.
- Difference between 1 part of *A0* and one part of *B0* = 1.1 cm -1.0 cm = 0.1cm or 1 mm.



Question: **Draw a Vernier scale of R.F. = 1/25 to read up to 4 meters. On it show lengths 2.39 m and 0.91 m**



- **Length of Scale = (1/25) × (4 × 100) = 16 cm**
- **Draw a 16 cm long line and divide it into 4 equal parts. Each part is 1 meter. Divide each of these parts in to 10 equal parts to show decimeter (10 cm).**
- **Take 11 parts of dm length and divide it in to 10 equal parts. Each of these parts will show a length of 1.1 dm or 11 cm.**
- **To measure 2.39 m, place one leg of the divider at *A* on 99 cm mark and other leg at *B* on 1.4 mark. (0.99 + 1.4 = 2.39).**
- **To measure 0.91 m, place the divider at *C* and *D* (0.8 +0.11 = 0.91).**

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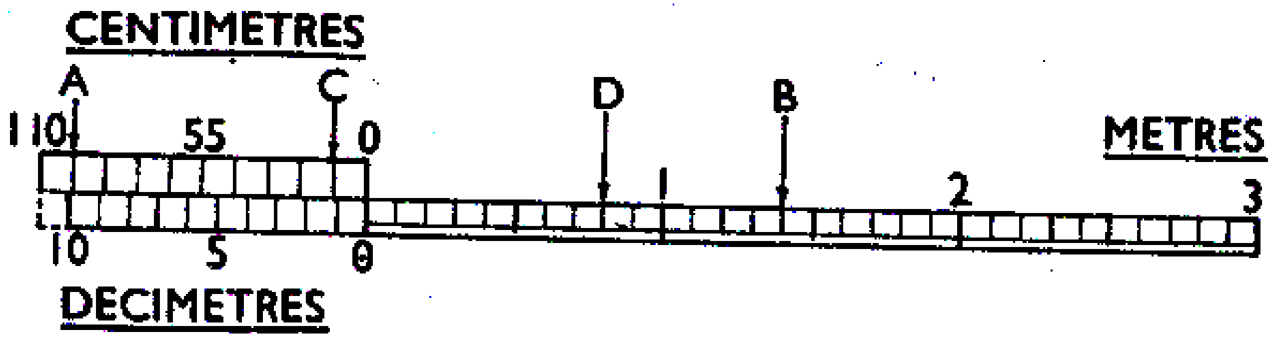

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- **Take 11 parts of dm length and divide it in to 10 equal parts. Each of these parts will show a length of 1.1 dm or 11 cm.**
- **To measure 2.39 m, place one leg of the divider at *A* on 99 cm mark and other leg at *B* on 1.4 mark. (0.99 + 1.4 = 2.39).**
- **To measure 0.91 m, place the divider at *C* and *D* (0.8 +0.11 = 0.91).**

Engineering Curves

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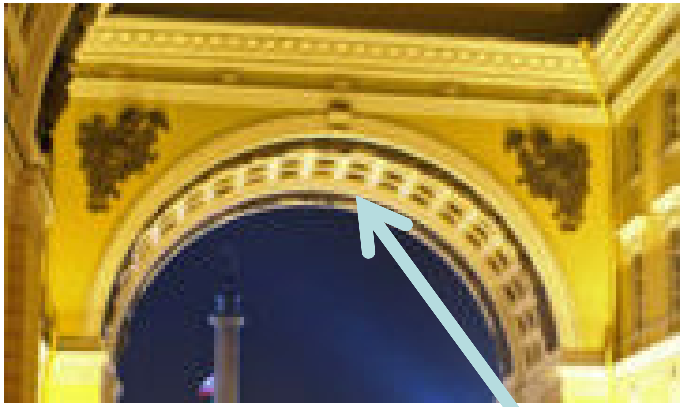
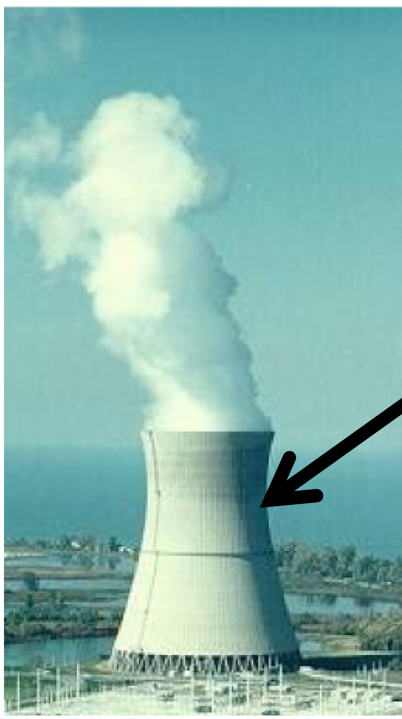
Common Engineering Curves

Parabolic shape



Elliptical shape

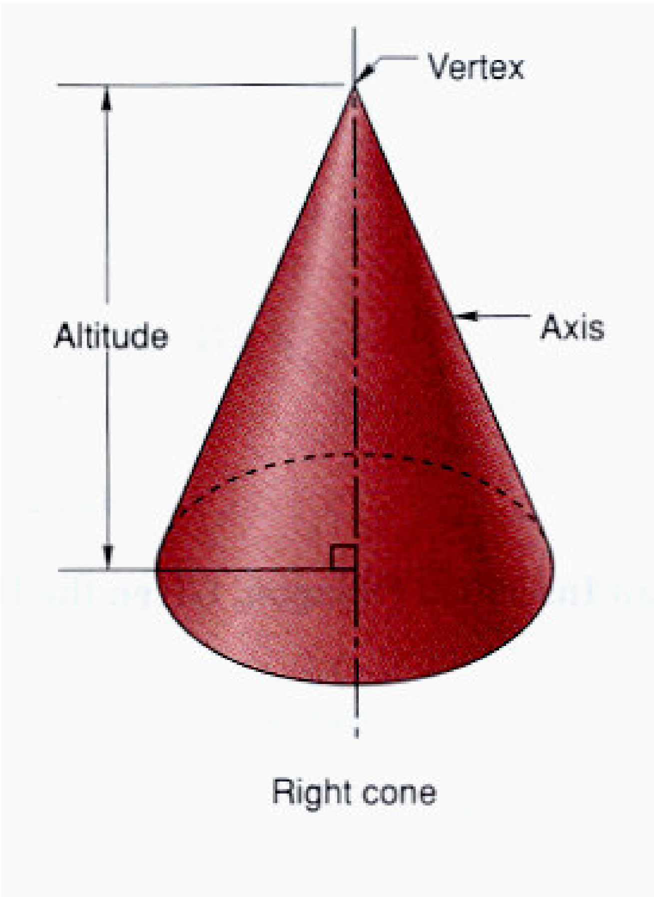


Hyperbola

spiral

Conic curves (conics)

Curves formed by the intersection of a plane with a right circular cone. **e.g. Parabola, hyperbola and ellipse**

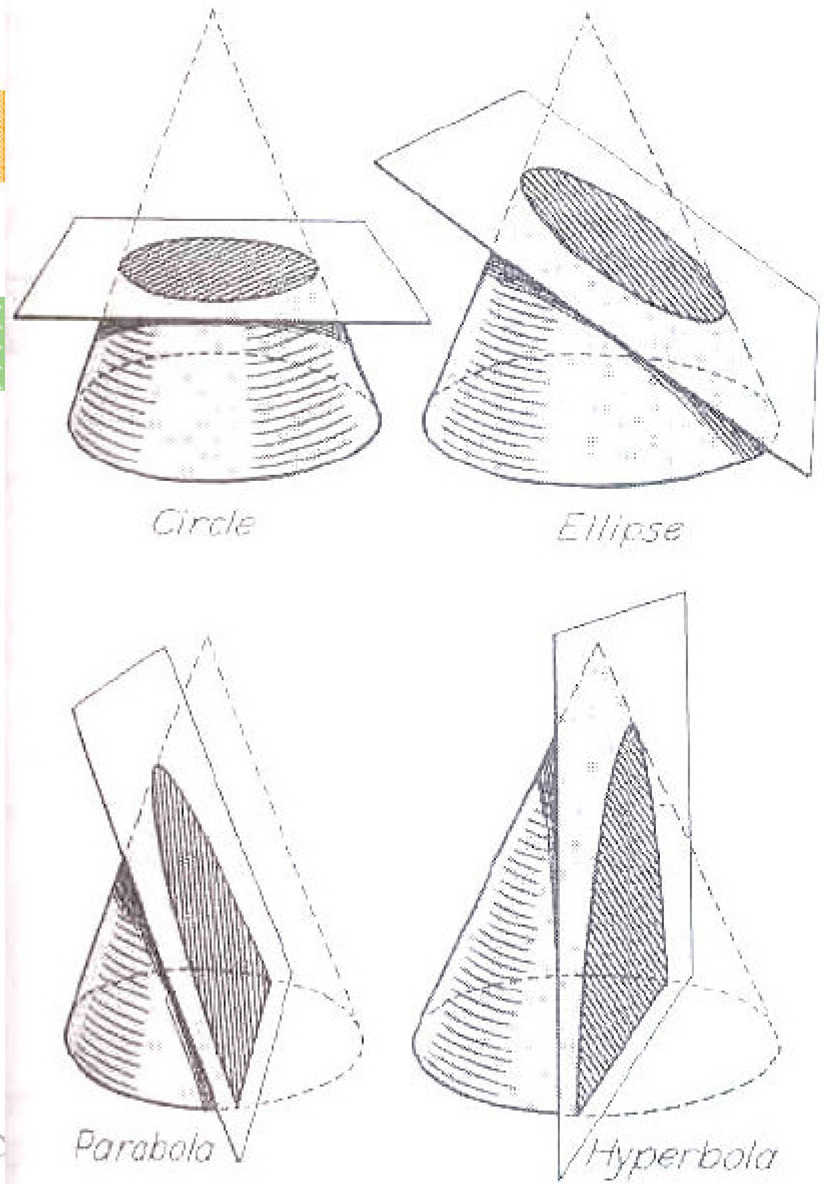


Right circular cone is a cone that has a circular base and the axis is inclined at 90^0 to the base and passes through the center of the base.

Basic Conic Shapes

- All from a CONE
  - Circle
  - Ellipse
  - Parabola
  - Hyperbola

Conic sections are always "smooth". More precisely, they never contain any inflection points. This is important for many applications, such as aerodynamics, civil engg., mechanical engg, etc.

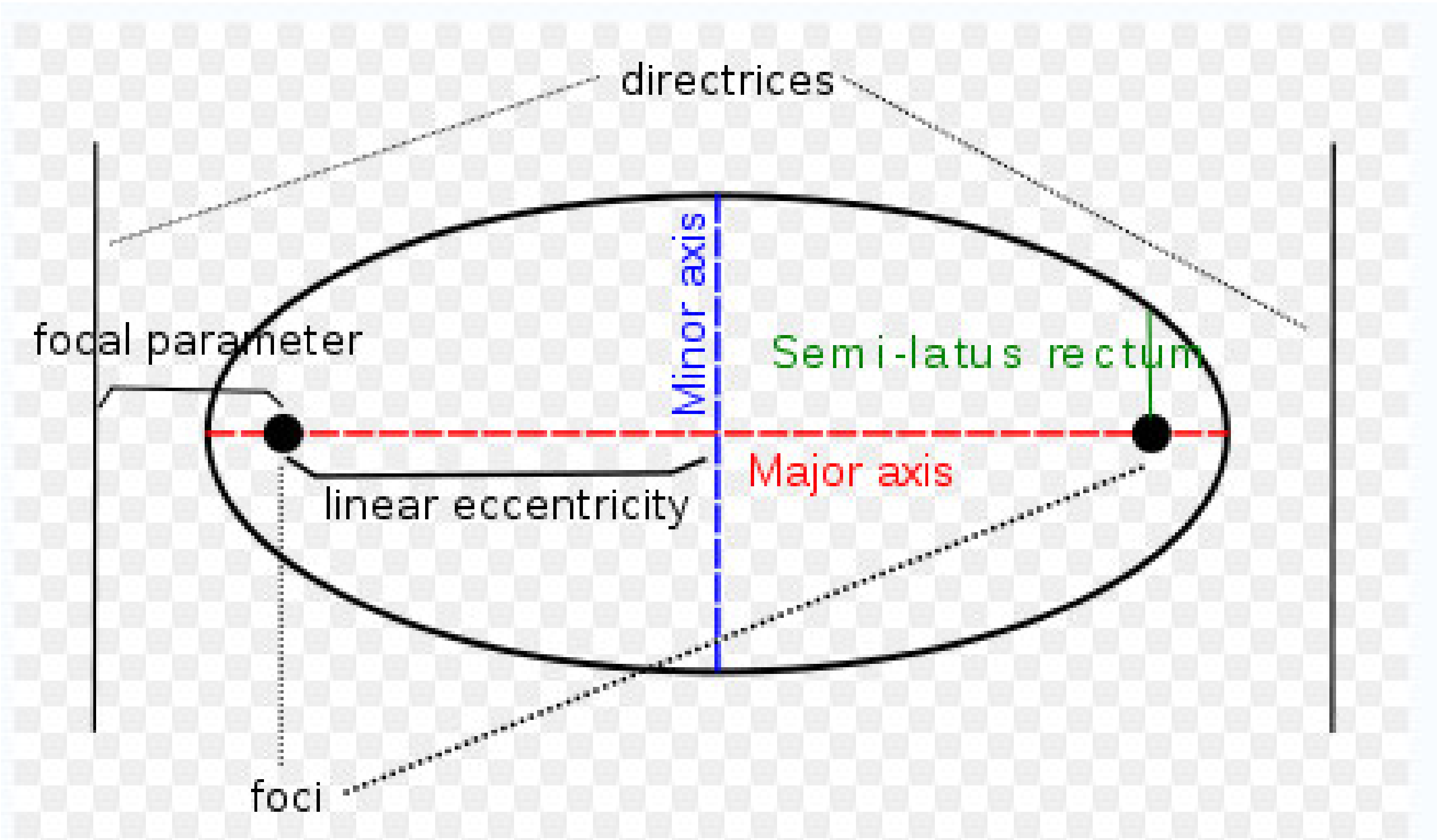


Conic

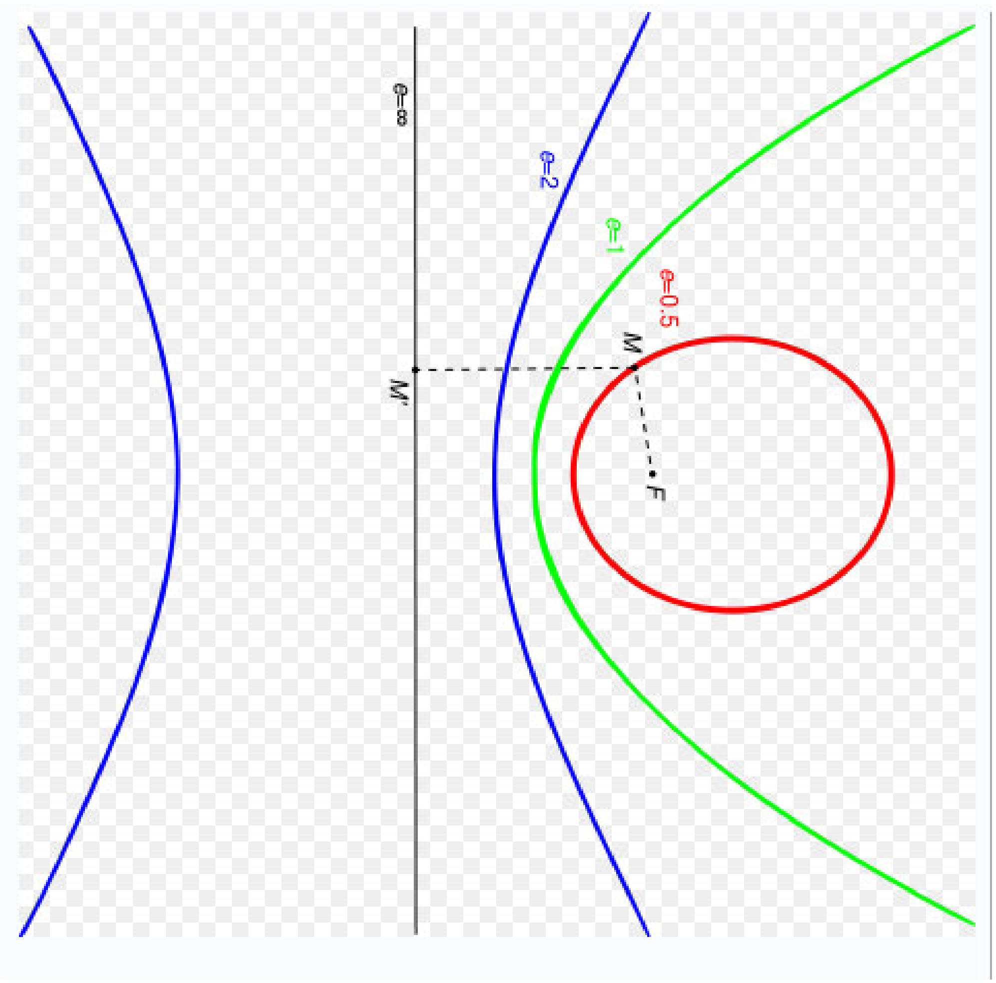
Conic is defined as the locus of a point moving in a plane such that the ratio of its distance from a fixed point and a fixed straight line is always constant.

Fixed point is called Focus

Fixed line is called Directrix



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



When eccentricity

< 1 → Ellipse

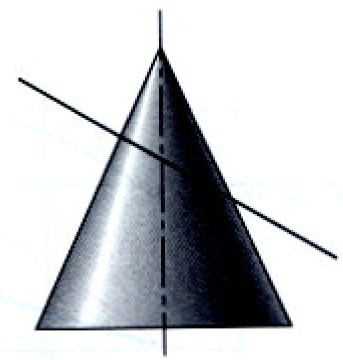
=1 → Parabola

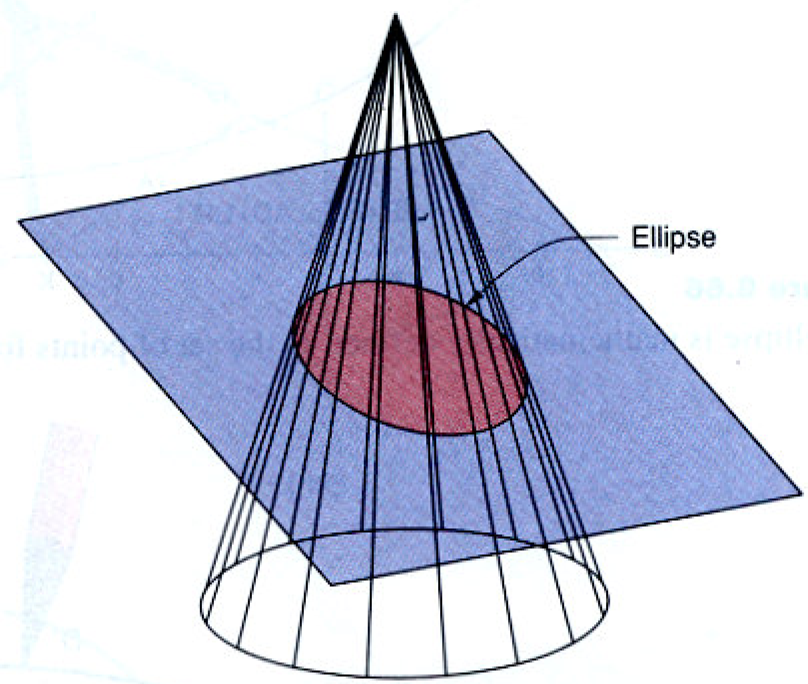
> 1 → Hyperbola

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.



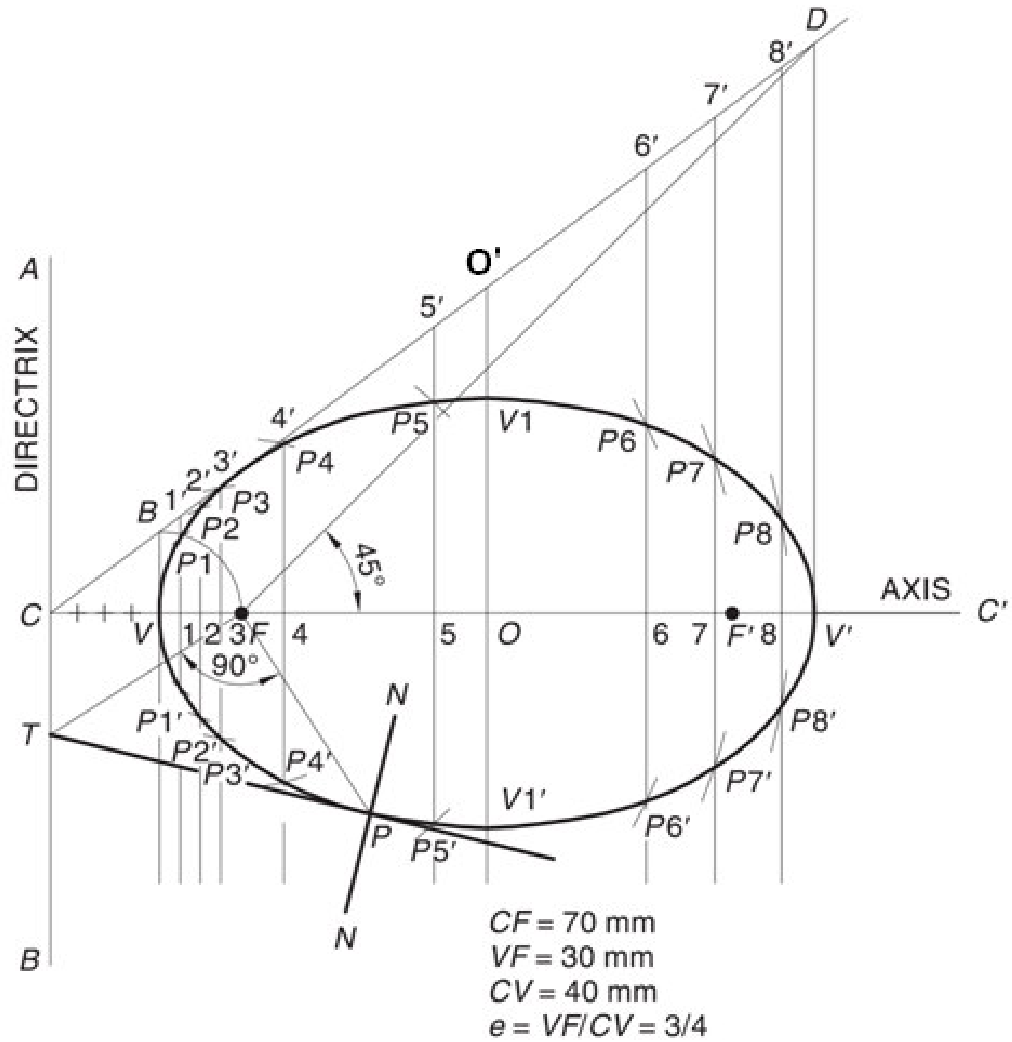


Focus-Directrix or Eccentricity Method

Given : the distance of focus from the directrix and eccentricity

Example : Draw an ellipse if the distance of focus from the directrix is 70 mm and the eccentricity is 3/4.

1. **Draw the directrix AB and axis CC'**
2. **Mark F on CC' such that CF = 70 mm.**
3. **Divide CF into 7 equal parts and mark V at the fourth division from C. Now, e = FV/ CV = 3/4.**
4. **At V, erect a perpendicular VB = VF. Join CB. Through F, draw a line at 45° to meet CB produced at D. Through D, drop a perpendicular DV' on CC'. Mark O at the midpoint of V– V'.**



Focus-Directrix or Eccentricity Method (Continued)

5. With F as a centre and radius = 1–1’, cut two arcs on the perpendicular through 1 to locate P1 and P1’. Similarly, with F as centre and radii = 2–2’, 3–3’, etc., cut arcs on the corresponding perpendiculars to locate P2 and P2’, P3 and P3’, etc. Also, cut similar arcs on the perpendicular through O to locate V1 and V1’.

6. Draw a smooth closed curve passing through V, P1, P/2, P/3, …, V1, …, V’, …, V1’, … P/3’, P/2’, P1’.

7. Mark F’ on CC’ such that V’ F’ = VF.