KWARA STATE UNIVERSITY MALETE,

College of Engineering and Technology,
Department of Mechanical Engineering.
GET 215 (**Engineering Graphics**)
Lecture Notes
2016/17 Academic Session.

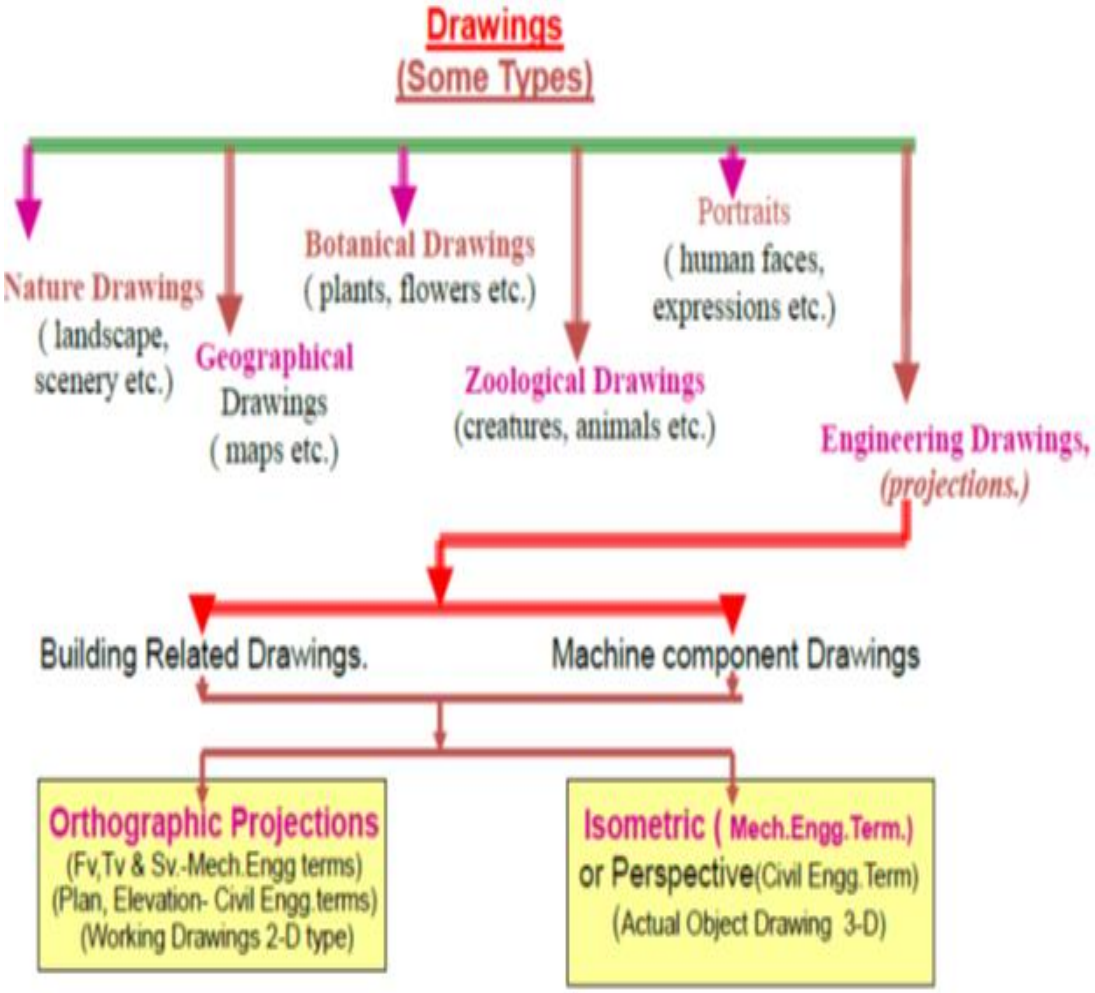
What is Engineering Graphics?

- **Engineering Graphics is:**
- The principal method of communication in the Engineering profession.
- It is the global language used by designers, technicians, and engineers to design, and construct details of engineering components.
- It is the representation of physical objects and their relationships.
- It is writing in the form of drawings, using straight and curved lines to represent the shape, size, and specification of physical objects.

COURSE SCHEDULE FOR 2016/17 SESSION:

S/N	Period	Topics	Instructors (Engineers)
1.	Week 2 (Aug. 22-26)	Introduction: Types of Engineering Drawing, Drawing Equipment, Code of Practice for Engineering Drawing	Owoseni
2.	Week 3 (Aug. 29 – Sep. 2)	Introduction: Drawing Equipment, Code of Practice for Engineering Drawing. Lines	Owoseni
3.	Week 4 (Sep. 5-9)	Lines, Lettering and Numbering	Owoseni
Week 5 (Sept. 12 - 16) PUBLIC HOLIDAY, SALAH BREAK			
4a	Week 6 (Sep. 12-16)	Drawing Sheets and Title Block, Dimensioning Style	Issa
4b	Week 6 (Sep. 12-16)	Drawing Sheets and Title Block, Dimensioning Style	Olawore
5a	Week 7 (Sep. 19-23)	Basic Line Constructions and Scales	Olawore
5b	Week 7 (Sep. 19-23)	Basic Line Constructions and Scales	Kolawole
6a	Week 8 (Sep. 26-30)	Geometric Construction and Engineering Curves: Parabola, Ellipse, Hyperbola. Techniques for Drawing Polygons and Normal Structures	Issa
6b	Week 8 (Sep. 26-30)	Geometric Construction and Engineering Curves: Parabola, Ellipse, Hyperbola. Techniques for Drawing Polygons and Normal Structures	Kolawole
7a	Week 9 (Oct. 3-7)	Geometric Construction and Engineering Curves: Parabola, Ellipse, Hyperbola. Techniques for Drawing Polygons and Normal Structures	Issa
7b	Week 9 (Oct. 3-7)	Geometric Construction and Engineering Curves: Parabola, Ellipse, Hyperbola. Techniques for Drawing Polygons and Normal Structures	Olawore
8a	Week 10 (Oct. 10-14)	Tangency	Issa
8b	Week 10 (Oct. 10-14)	Tangency	Kolawole
9a	Week 11 (Oct. 17-21)	Development	Olawore
9b	Week 11 (Oct. 17-21)	Development	Kolawole
10a	Week 12 (Oct. 24-28)	Orthographic Projection of Points, Lines and planes.	Issa
10b	Week 12 (Oct. 24-28)	Orthographic Projection of Points, Lines and planes.	Olawore
11a	Week 13 (Oct. 31-Nov. 4)	Orthographic Projection of Points, Lines and planes.	Issa
11b	Week 13 (Oct. 31-Nov. 4)	Orthographic Projection of Points, Lines and planes.	Kolawole
12a	Week 14 (Nov. 7-11)	Revisions	Olawore
12b	Week 14 (Nov. 7-11)	Revisions	Kolawole
14.	Weeks 15-16 (Nov. 20-Dec. 2)	Examination Break	
This is subject to modifications as determined by the Course Instructors.			

Types of Drawing



Engineering Graphics Instruments and their Use (Contd.)

- Drawing pencils (standard and clutch pencils)
- Eraser
- Adhesive tape, drawing pins or clips
- Pencil sharpener or blade
- Handkerchief, duster, or dusting brush
- Letter stencils, French curves, erasing shield, and templates.

Engineering Graphics Instruments

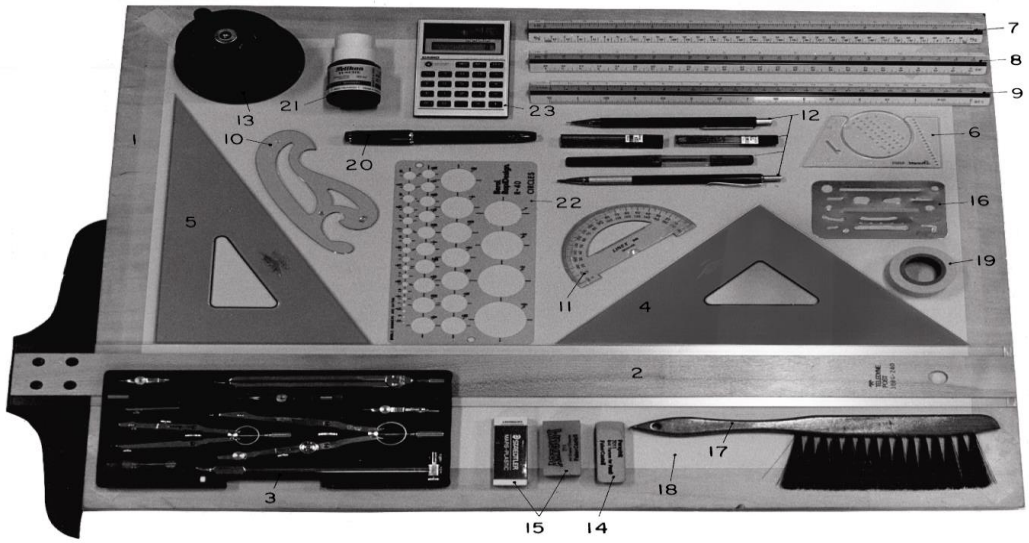
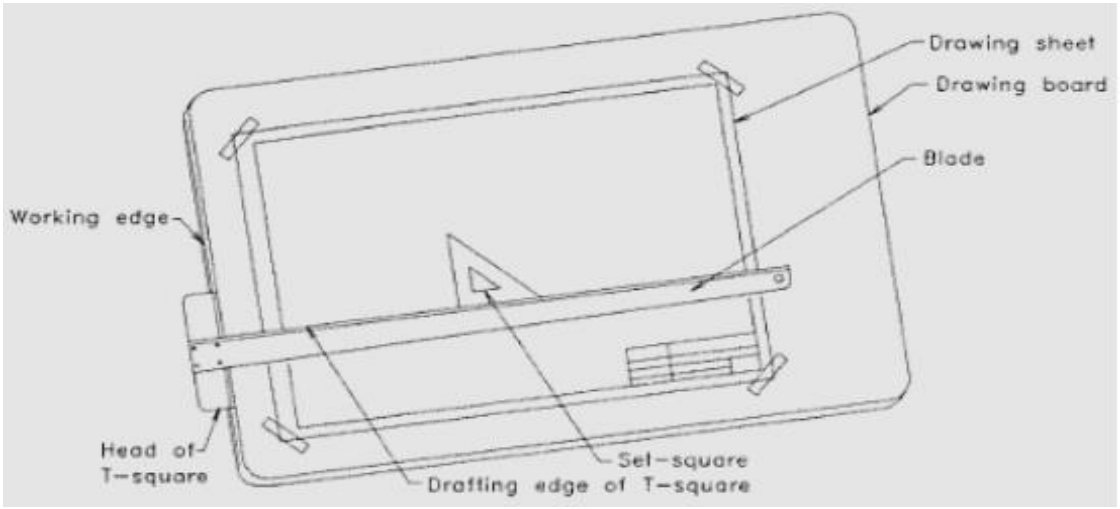


Figure 3-1
Principal Items of Equipment.

Drafting board with T-square in drawing position.



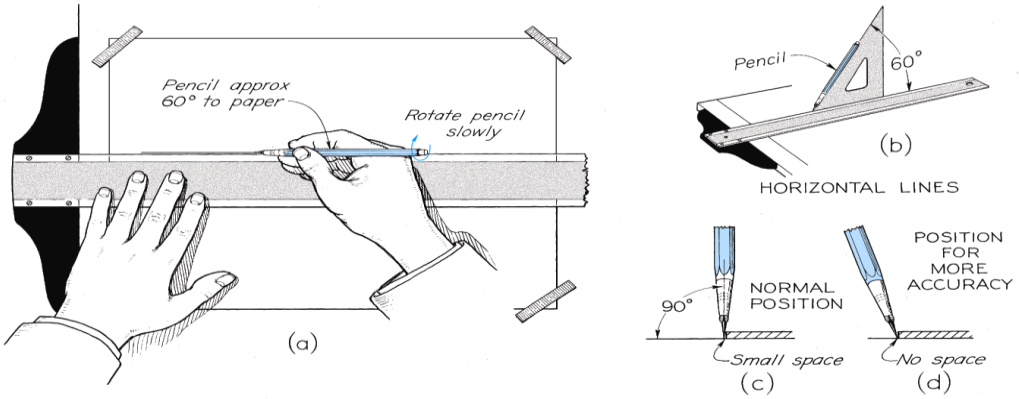


Figure 3-11
Drawing a Horizontal Line.

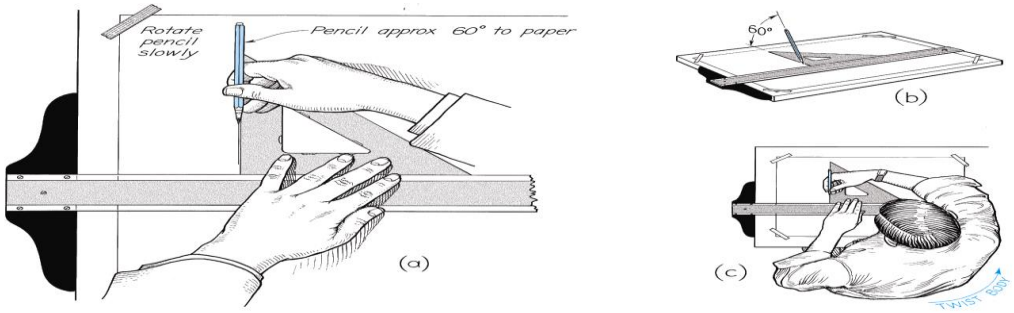


Figure 3-12
Drawing a Vertical Line.

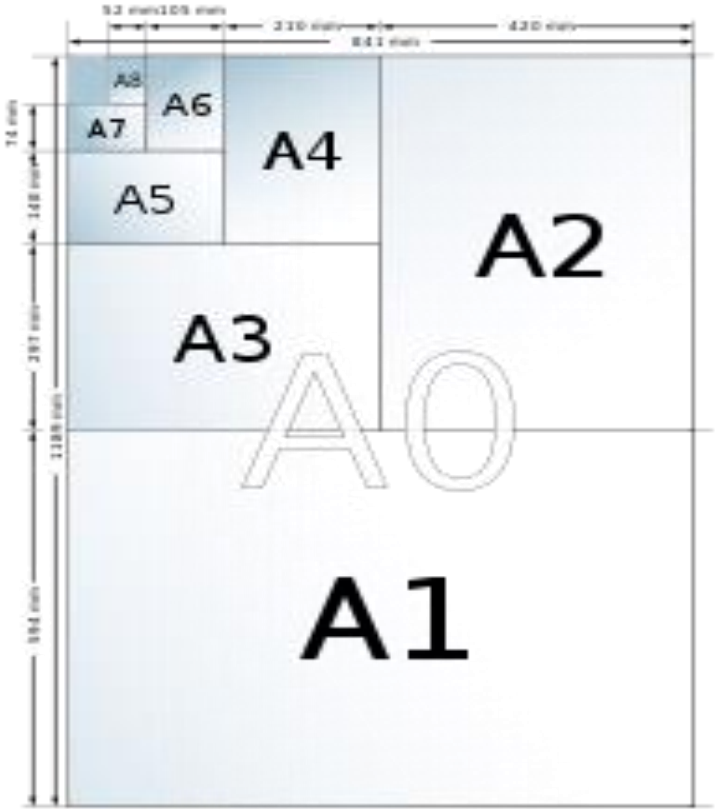
Drawing Pencils

- The conical and chisel points are shaped by grinding the cylindrical lead on the sandpaper pad.
- Mechanical clutch pencils of lead size 0.5 mm diameter are now available for drawings (Figure 1.8d).
- They are preferred because they can give better uniform line width and no sharpening is required.
- Lead grades of HB, H, and 2H are also used in mechanical clutch pencils.

Paper size

- Sizes of drawings typically comply with either of two different standards, ISO (World Standard) or ANSI/ASME Y14 (American), according to the following tables:

Paper size



Paper size

- ISO paper sizes
- **ISO A Drawing Sizes (mm)**
- **A4** 210 X 297
- **A3** 297 X 420
- **A2** 420 X 594
- **A1** 594 X 841
- **A0** 841 X 1189

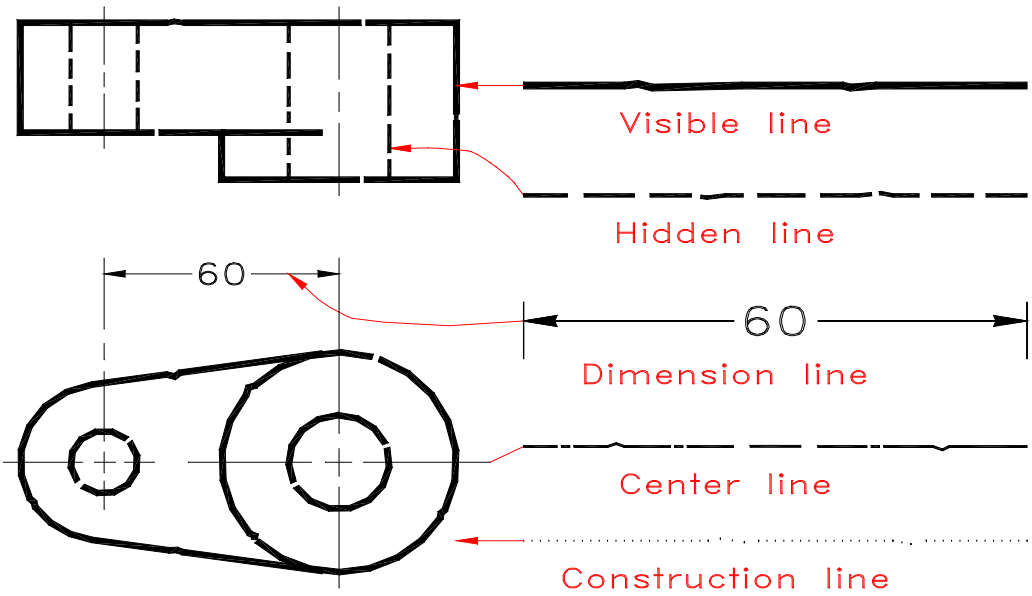
Lines

Line	Description
A	Continuous thick
B	Continuous thin
C	Continuous thin freehand
D	Continuous thin with zig-zags
E	Dashed thick
F	Dashed thin
G	Chain thin
H	Chain thin, thick at ends and changes of direction
J	Chain thick
K	Chain thin double dashed

USES OF LINES IN ENGINEERING DRAWING:

EXAMPLES:

Lines



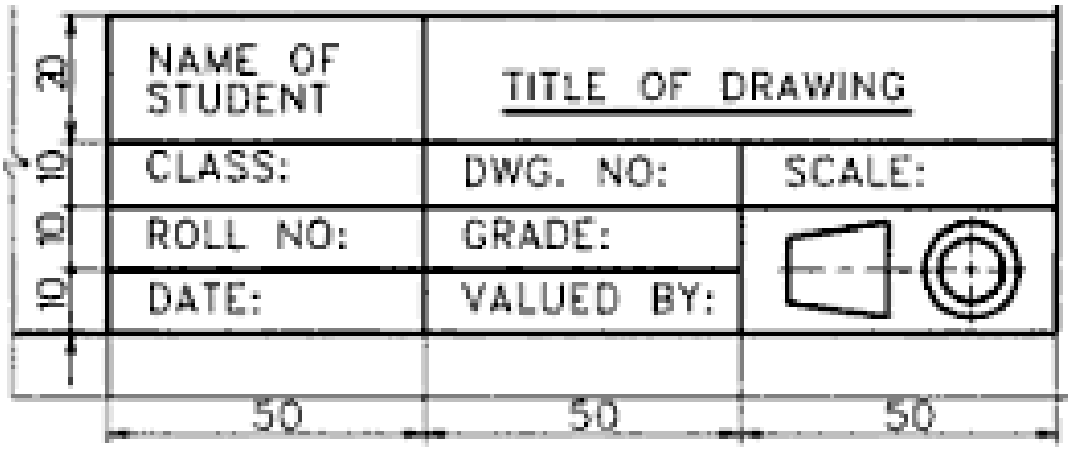
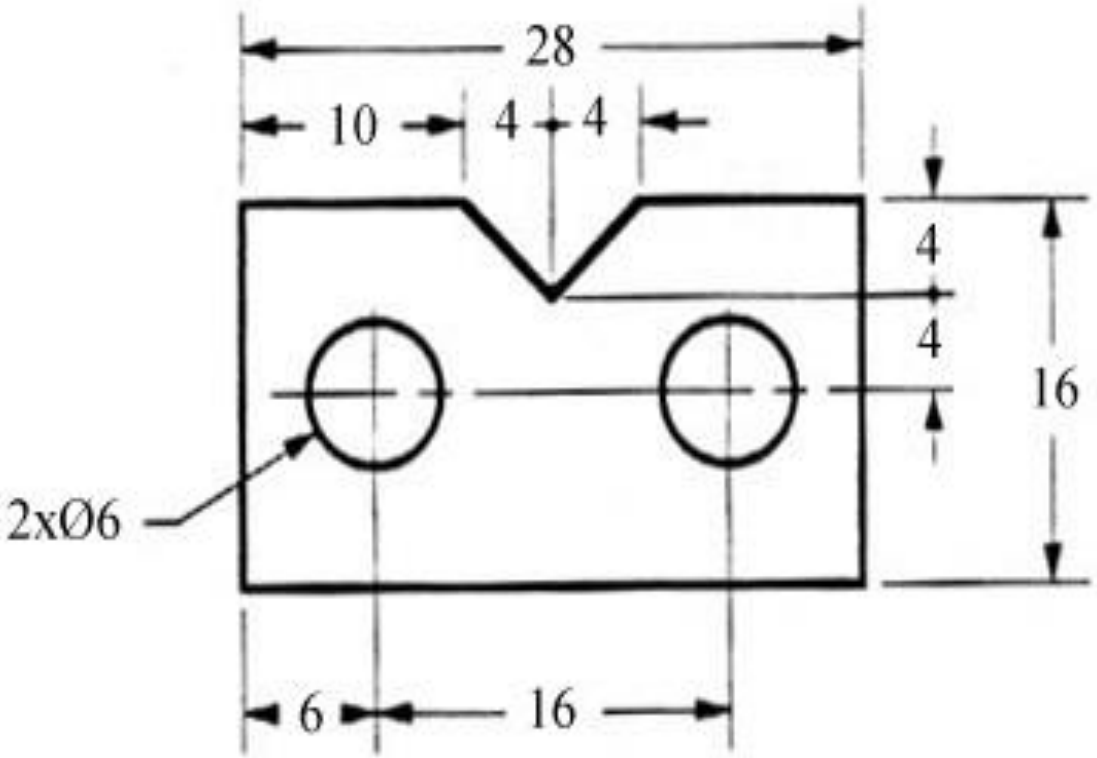


Fig. 1.14 Layout of the title block for class work.

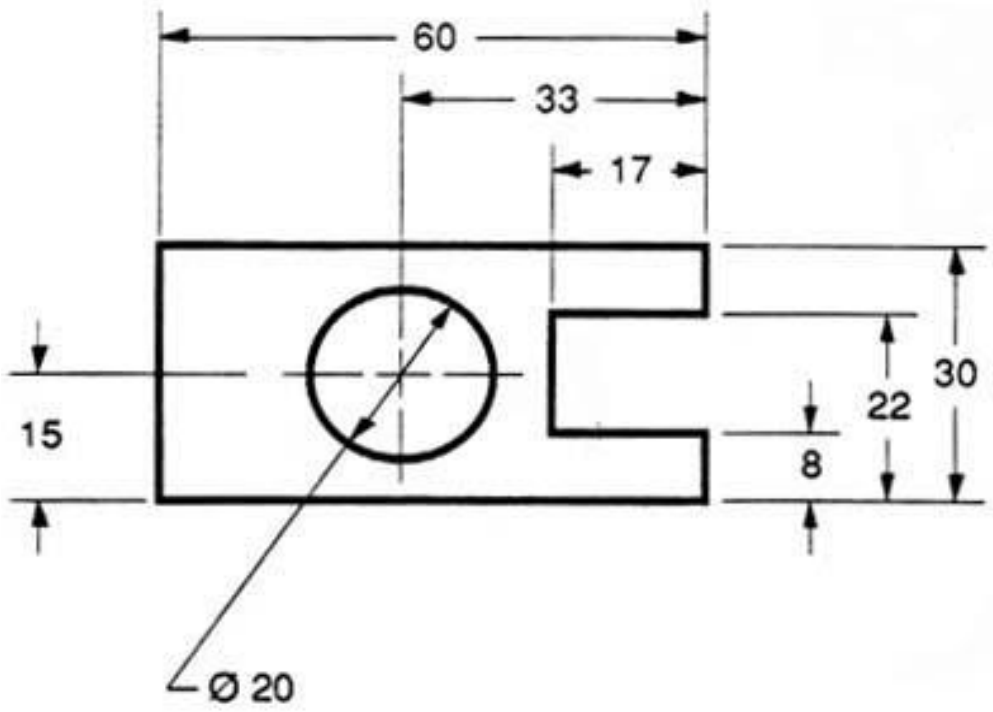
Dimensioning

- The **dimension line** is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end (figure 2:1).

Dimensioning (Contd.)



Dimensioning (Contd.)



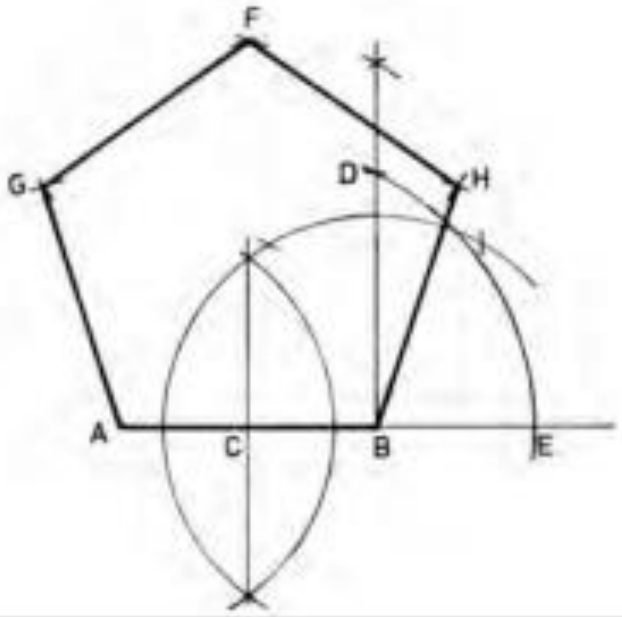
GET 215

CONSTRUCTION OF POLYGONS AND ELLIPSE

5.17 TO CONSTRUCT A REGULAR PENTAGON ON A GIVEN LINE

AB is the given line.

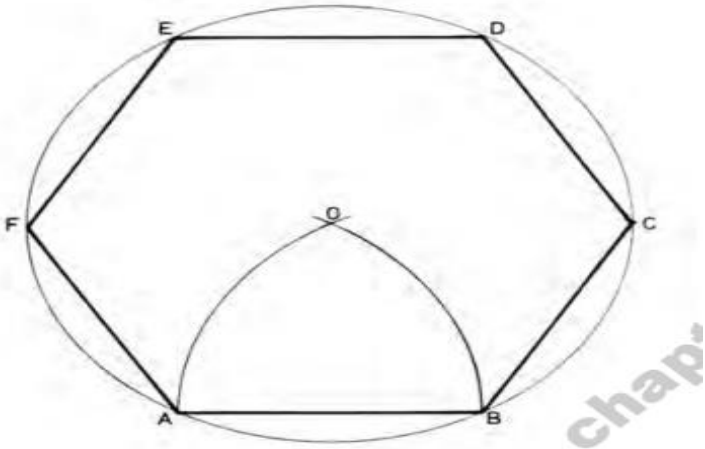
1. Bisect AB at C.
2. Erect a perpendicular at B (Ex 5.11), and mark off BD equal to AB.
3. With C as centre and radius CD, describe an arc to intersect AB produced at E.
4. From A and B, and with radius AE, describe arcs to intersect at F.
5. With radius AB and centres A, B and F, describe arcs to intersect at G and H.
6. Join FG, GA, FH and HB to complete the pentagon.



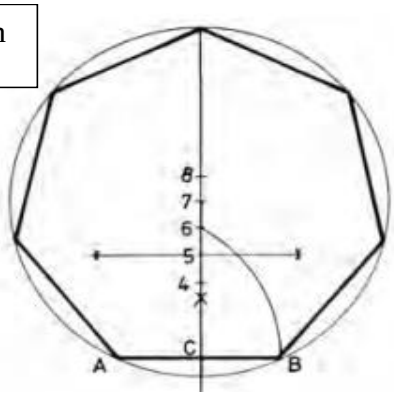
To construct a regular polygon, say a heptagon, on a given line

AB is the given line.

1. From A and B, and with radius AB, draw two equal arcs to intersect at O.
2. With radius OA or OB and centre O, draw a circle.
3. From A or B, using the same radius, step off arcs around the circle at C, D, E and F.
4. Join these points to complete the hexagon.



To construct a regular polygon, say a heptagon, on a given line



AB is the given line.

1. Bisect AB at C.
2. Along the bisector mark off C4 equal to AC.
3. With centre A and radius AB, describe an arc to intersect the bisector at 6.
4. Bisect distance 4–6 to give 5.
5. Add distance 4–5 to 6 to give 7 and so on. These points are the centres of circles around which AB will step that number of times.
6. With centre 7 and radius 7A, describe a circle. Step AB around seven times and join the points to give a heptagon.

THE ELLIPSE

An ellipse is a closed symmetrical curve with a changing diameter which varies between a maximum and minimum length.

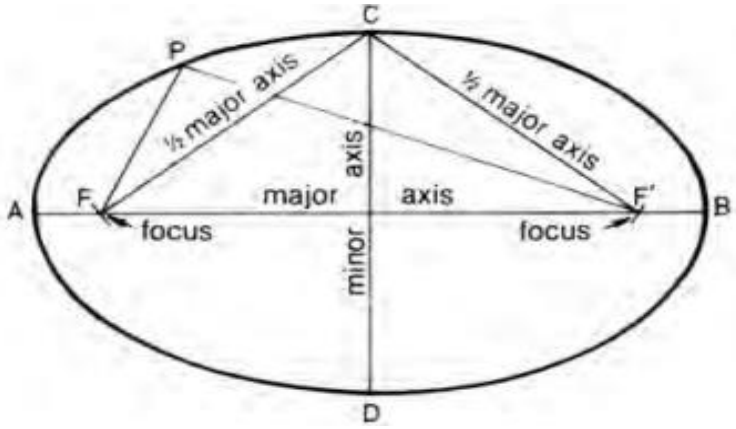
These two lengths are known as the major axis and axis respectively. The lengths of the axes may vary greatly, and it is upon their relative sizes that the shape of the ellipse depends.

An ellipse may be defined geometrically as the curve traced out by a point (P) which moves so that the sum of its distances from two fixed points (F and F') is constant and equal in length to the major axis

As can be seen in the figure below; AB is the major axis, CD is the minor axis, and F and F' are the focal points.

From the definition of an ellipse, FP + PF' = AB and also

CF + CF' = AB



TO CONSTRUCT OF AN ELLIPSE

The various means of drawing ellipse includes;

Four-centre method

Isometric ellipse

Concentric circle method

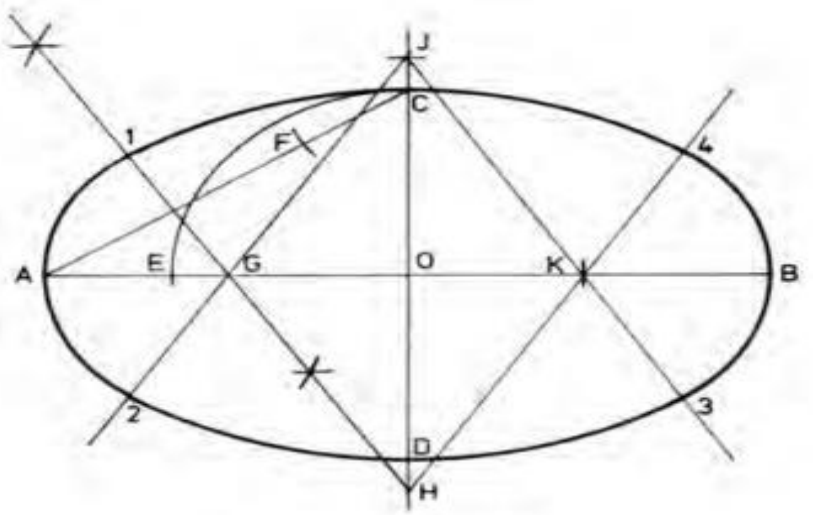
Intersecting arcs method

Rectangular method

Four-centre method

This is used when given the major axis AB and the minor axis CD.

1. Draw the major and minor axes to intersect at O. Join AC.
2. With centre O and radius OC, describe an arc to intersect AO at E.
3. With centre C and radius AE, describe an arc to intersect AC at F.
4. Draw the perpendicular bisector of AF to intersect AO at G and CD (produced) at H. G and H are the centres of two arcs for forming half of the ellipse.
5. Make OJ = OH and OK = OG to give two more centres for the other half of the ellipse.
6. Join JG, HK and JK, and produce all three.
7. With centres H, J, G and K, and radii HC, JD, GA and KB respectively, describe arcs to form the ellipse. The tangent points of the four arcs are at points 1, 2 3 and 4.

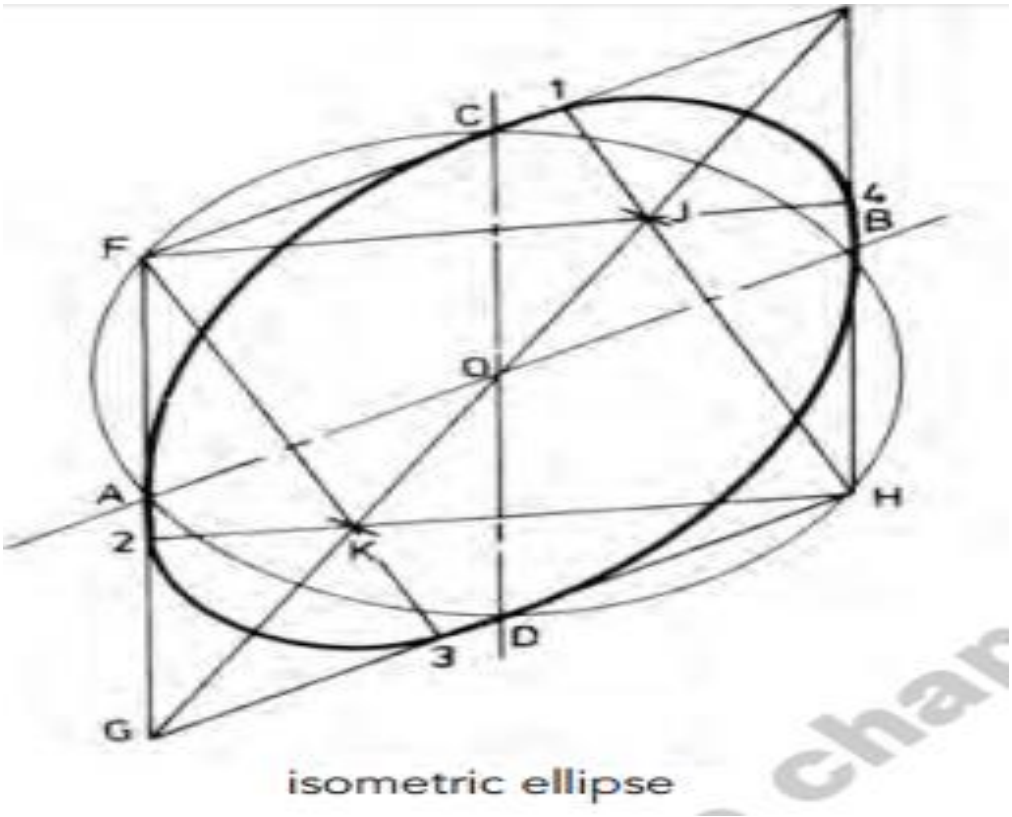


four-centre ellipse

The isometric ellipse

This is used when given the centre O and the radius of the circle AO required for isometric representation.

1. Draw the isometric axes (any two lines 60° apart) to intersect at O.
2. With centre O and radius AO, describe a circle to intersect the isometric axes at A, D, B and C.
3. Through these four points draw lines parallel to the isometric axes to intersect at E, F, G and H.
4. Draw the long diagonal GE to pass through O.



isometric ellipse

GET 215
(Engineering Graphics)

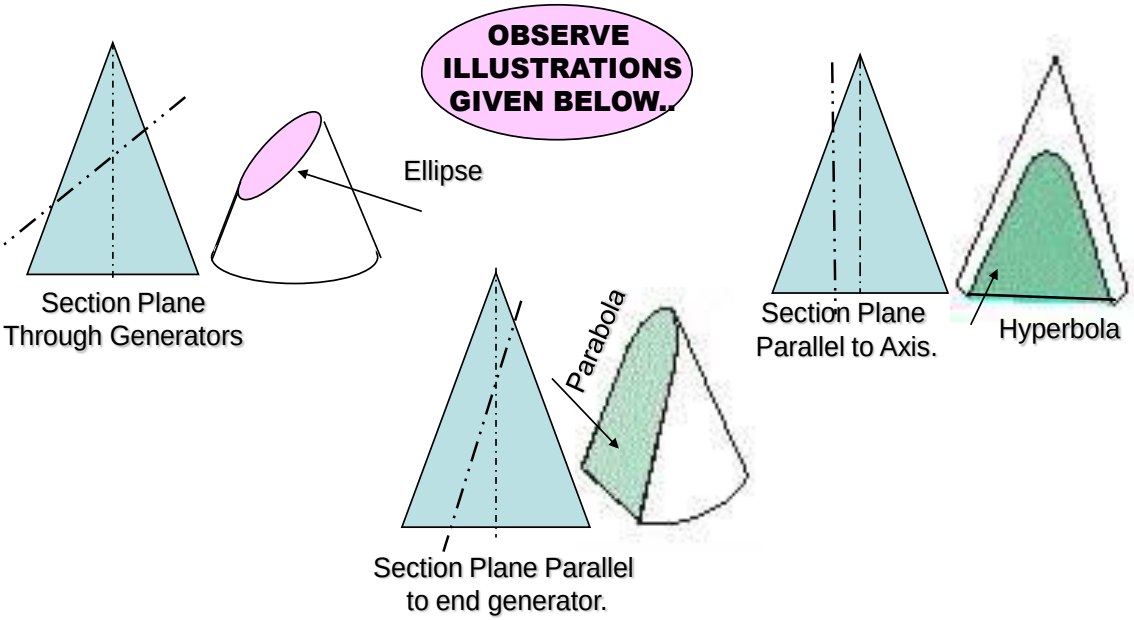
Topic:

CONSTRUCTION OF PARABOLA AND HYPERBOLA

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.



Conic is defined as locus of a point moving in a plane such that the ratio of its distance from a fixed point (F) to the fixed straight line is always a constant. This ratio is called as eccentricity (e).

Ellipse: eccentricity is always <1

Parabola: eccentricity is always=1

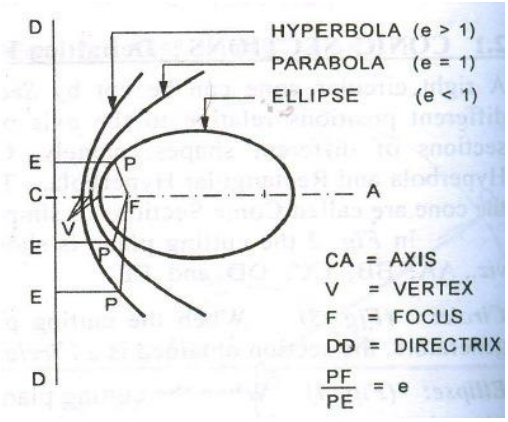
Hyperbola: eccentricity is >1

The fixed point is called the **Focus**

The fixed line is called the **Directrix**

Axis is the line passing though the focus and perpendicular to the directrix

Vertex is a point at which the conic cuts its axis



PARABOLA

METHODS FOR GENERATING PARABOLA

1.Rectangle Method

2 Method of Tangents
(Triangle Method)

3.Basic Locus Method
(Directrix – focus)

PARABOLA
RECTANGLE METHOD

PROBLEM 1: Draw a parabola having a vertical distance of 60 mm and the horizontal distance 120 mm.

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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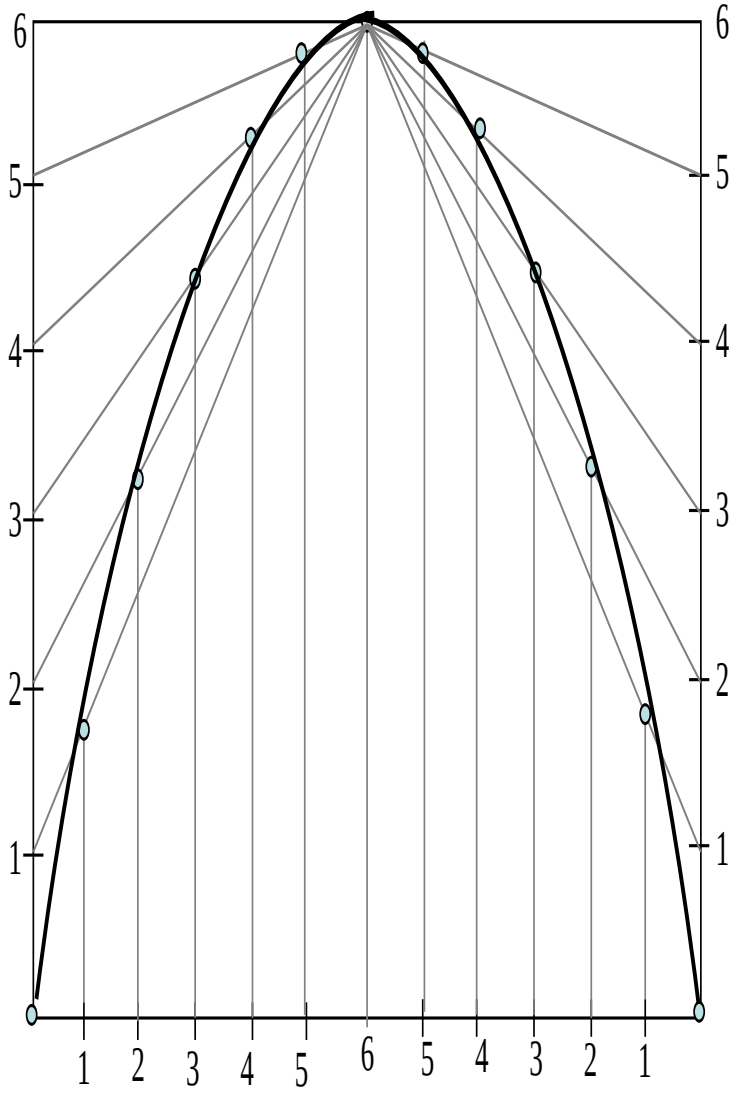


PROBLEM 2: Point F is 50 mm from a vertical straight line AB. Draw locus of point P, moving in a plane such that it always remains equidistant from point F and line AB.

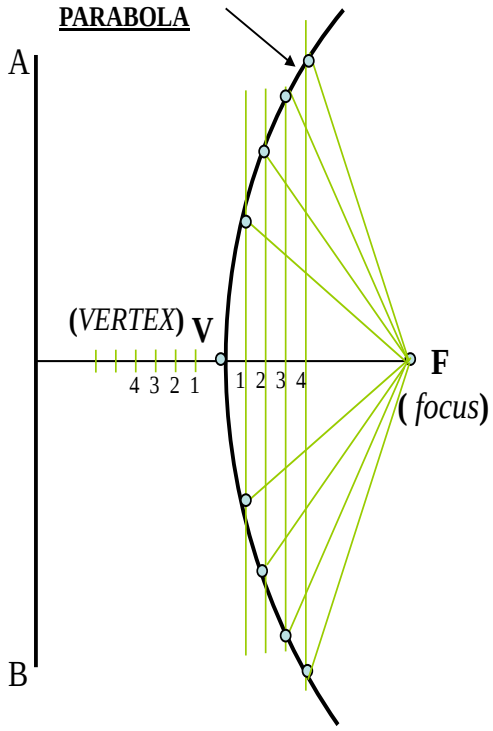
PARABOLA

DIRECTRIX-FOCUS METHOD

SOLUTION STEPS:

1. Locate center of line, perpendicular to AB from point F. This will be initial point P.
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 F-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.
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

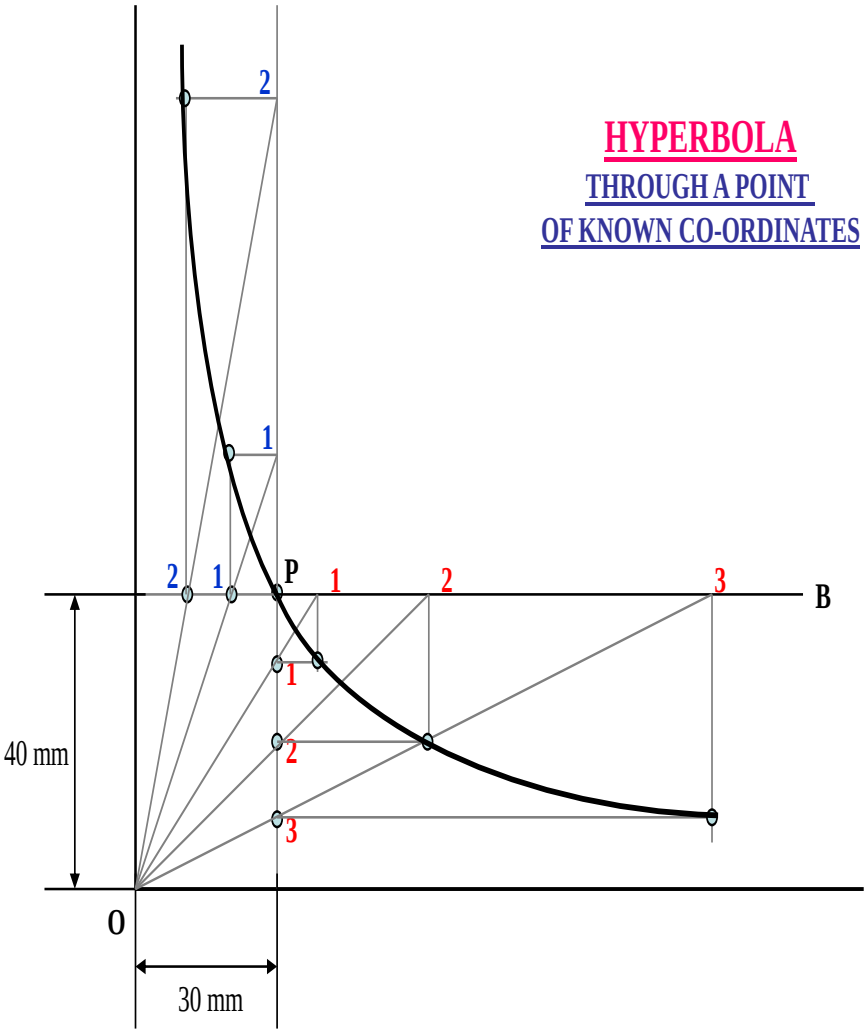
METHODS OF GENERATING HYPERBOLA

1.Rectangular Hyperbola (coordinates given)

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

3.Basic Locus Method (Directrix – focus)

Problem No.3: Point P is 40 mm and 30 mm from horizontal and vertical axes respectively. Draw Hyperbola through it.



Solution

Steps:

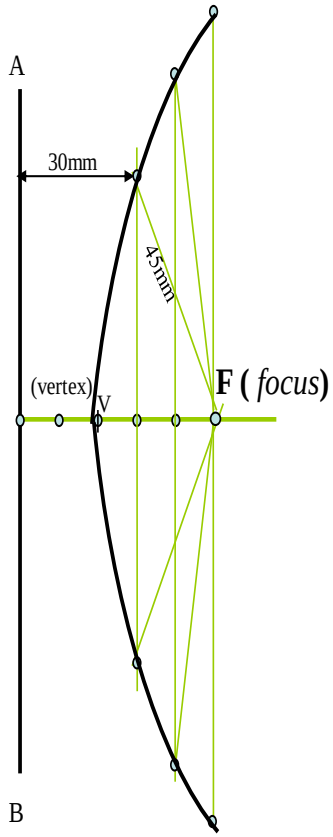
1. Extend horizontal line from P to right side.
2. Extend vertical line from P upward.
3. On horizontal line from P, mark some points taking any distance and name them after P- 1, 2,3,4 etc.
4. Join 1-2-3-4 points to pole O. Let them cut part [P-B] also at 1,2,3,4 points.
5. From horizontal 1,2,3,4 draw 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 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 }**

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 30. 40 and 50 mm distances from line AB, draw three vertical lines to the right side of it.
6. Now with 45, 60 and 75 mm 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 Hyperbola.



HYPERBOLA
DIRECTRIX
FOCUS METHOD

GET 215
(Engineering Graphics)

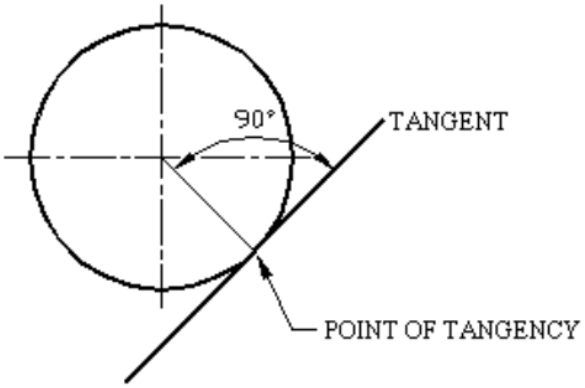
Topic:
Fundamentals of Drafting:
Principles of Tangency

Objectives:

1. To define a tangent.
2. To draw a tangent using geometrical constructions.
3. To recognise the general principles of tangency.
4. To apply the principles of tangency to drawing problems.

The definition

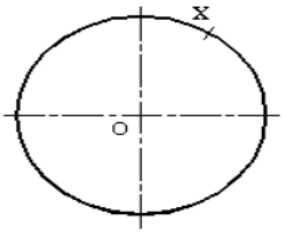
A tangent is a straight line which touches a circle at the point of tangency without intersecting it. At the point of tangency any radius forms a right angle with a tangent.



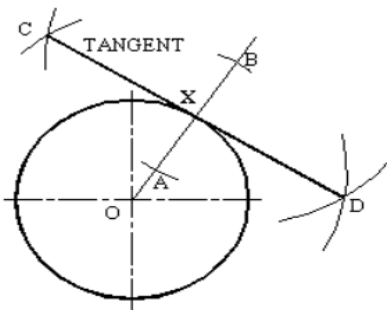
Geometrical constructions of tangent

1. To draw a tangent to a given point on the circumference of the circle.

1. Given:
   A point X is given on the circumference of a circle of any radius.

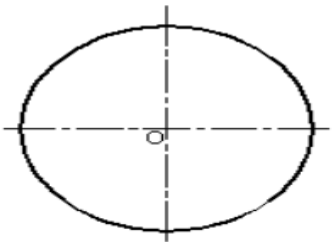


2. Construction
   - i) Join OX and produce the line outside the circumference of the circle.
   - ii) Mark points A and B, such that AX=XB.
   - iii) Draw perpendicular bisector CD.
   - iv) CD is the required tangent.

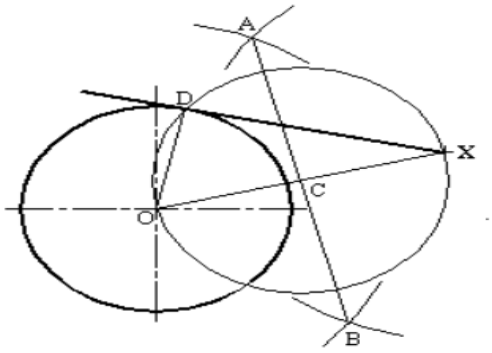


2. To draw a tangent to a circle from a given point outside the circle.

1. Given:
   A point X is given outside the circle of any radius.



2. Construction
   - i) Join OX.
   - ii) Bisect OX at C.
   - iii) Draw a circle with centre C, radius CX.
   - iv) The circle intersects the given circle at D.
   - v) Join DX, which is the required tangent.



General principles of tangency

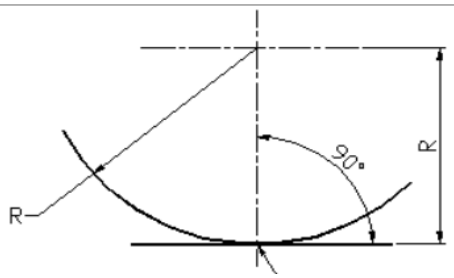
In geometrical construction, it is common to join arcs with straight lines and arcs with other arcs. To do this with accuracy, it requires a knowledge of the principles of tangency.

There are three general principles:

1. To join an arc with a straight line

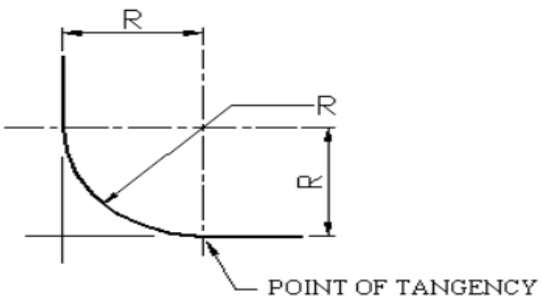
Principle 1: To join an arc with a straight line

1. The principle
   To draw an arc of given radius to touch a given straight line, then the point of tangency is the point that lies on a line through the centre of the arc, at a distance equals to the given radius, and at 90^0 to the given straight line.

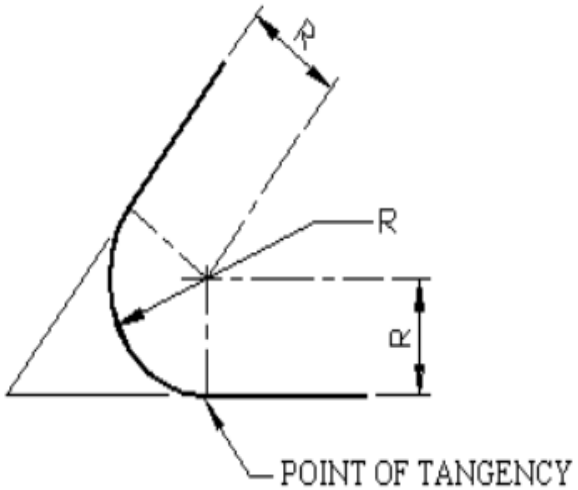


2. Practical applications

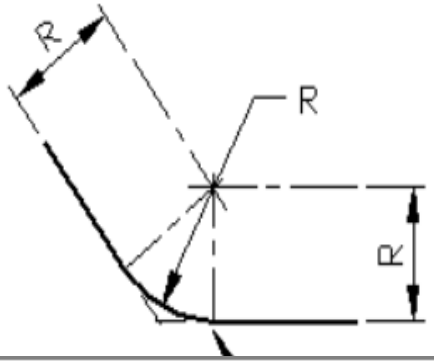
(i) To draw an arc of radius R tangential to the arms of a right angle.



(ii) To draw an arc of radius R tangential to two straight lines forming an acute angle.



(iii) To draw an arc of radius R tangential to two straight lines forming an obtuse angle.

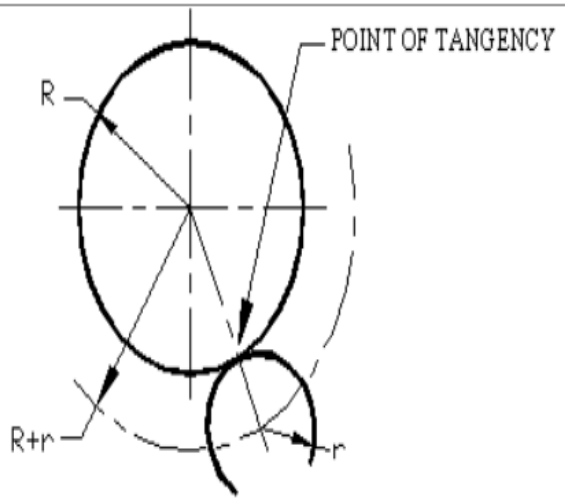


2. To join two arcs externally

Principle 2: To join two arcs externally

1. The principle

To draw an arc of a given radius r to touch a second arc, radius R, externally, then the point of tangency lies on a line joining the centres of the two arcs. The distance between the centres of the arcs is R+r.

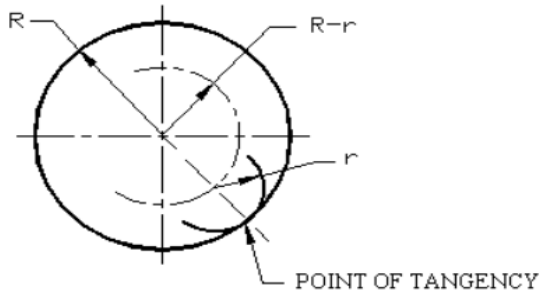


3. To join two arcs internally

Principle 3: To join two arcs internally

1. The principle

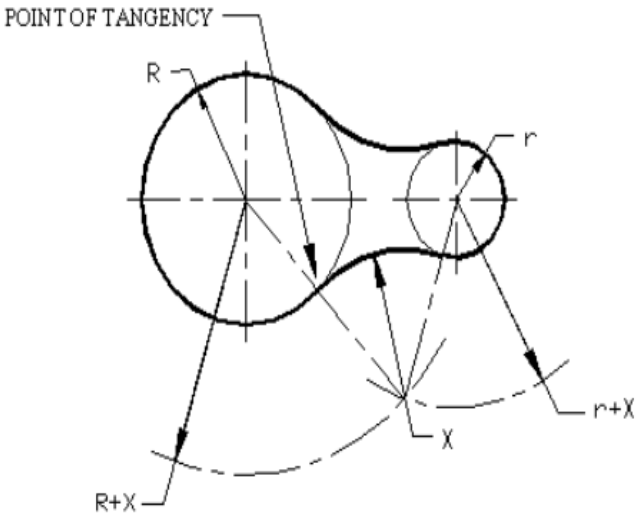
To draw an arc of a given radius r to touch a second arc, radius R, internally, then the point of tangency lies on a line joining the centres of the two arcs. The distance between the centres of the arcs is R-r.



CLASS WORK 1

Practical applications

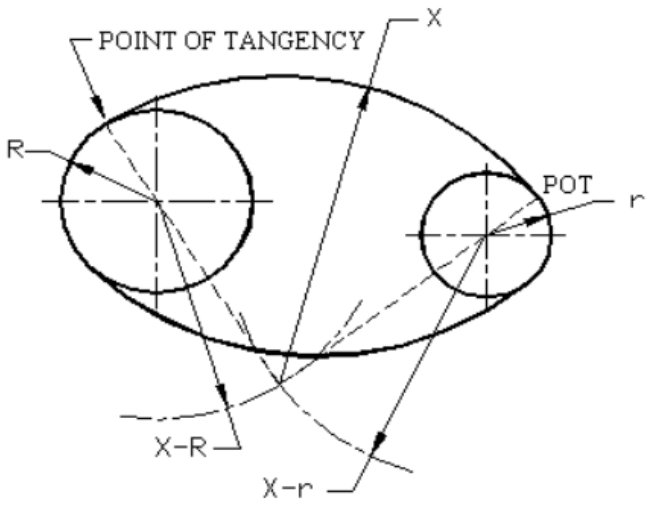
(i) To draw an arc of radius X blending two circles of radii R and r respectively.



CLASS WORK 2

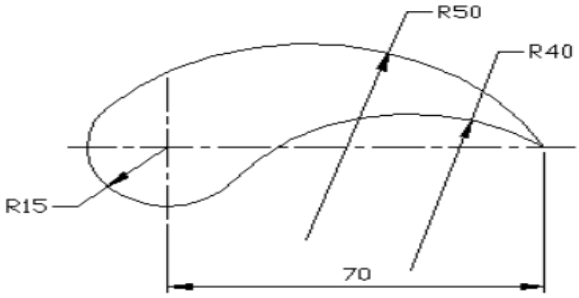
2. Practical applications

(i) To draw an arc of radius X blending two circles of radii R and r internally.



CLASS WORK 3

Draw the following figure and determine the points of tangency.



Solution