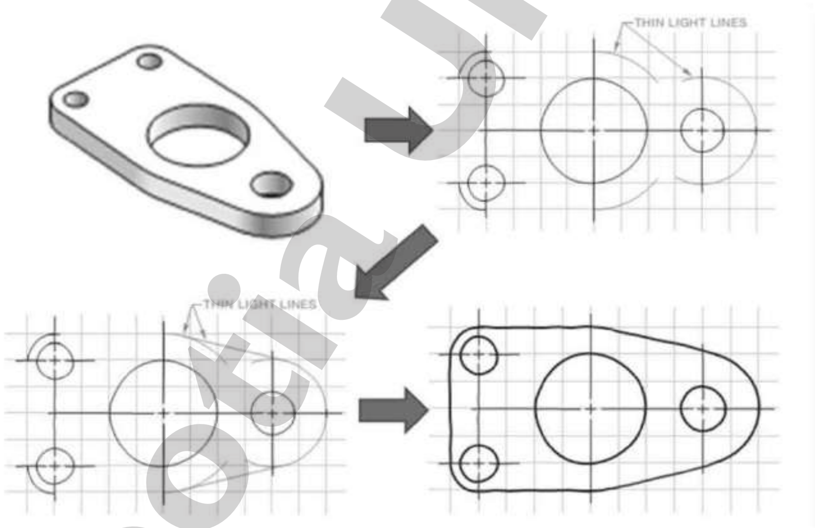
Work Instruction

Subject	**Engineering Graphics & Design**
Subject Code	**ES-MEP101**



Department of Mechanical Engineering
THE NEOTIA UNIVERSITY

ज्ञानम् आत्म प्रदीपाय

Contents

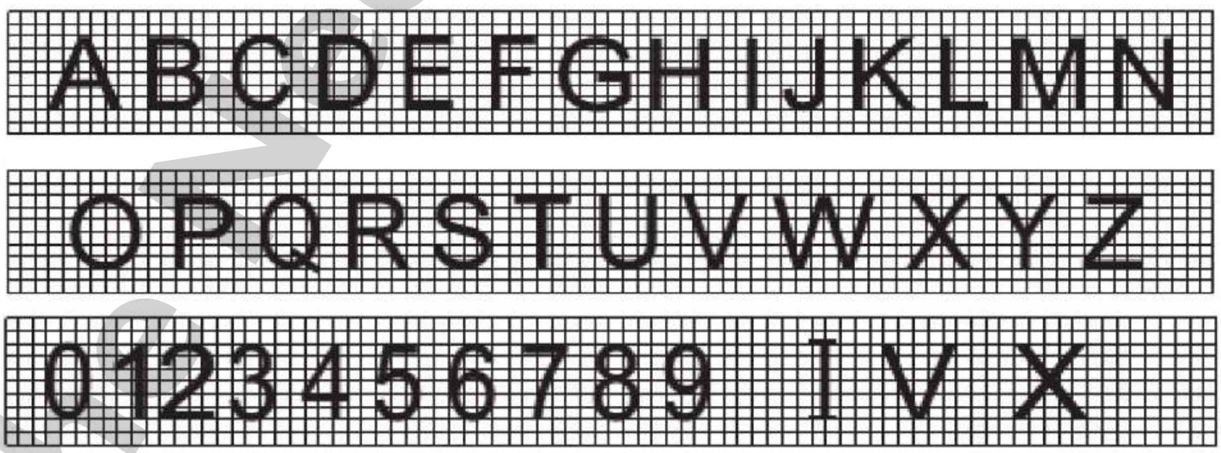
1. EXPERIMENT NO: ES-MEP 101/01
2. NAME OF THE EXPERIMENT: LINE, LETTERING & DIMENSIONING

3. OBJECTIVE:
LINE: In engineering drawing the details of various objects are drawn by different types lines. Each line has a definite purpose and sense of convey. Different conventions of lines are used to represent the details of the object accurately on the drawing.

Types of lines and their applications

Line	***Description***	***General Applications***
	Continuous thick	Visible outlines
	Continuous thin	Imaginary lines of intersection, Dimension lines. Projection lines, Leader lines Hatching lines, Outlines of revolved sections in place, Short centre lines
	Continuous thin (straight) with zigzags	Long object in breaking way
	Dashed thick	Hidden outlines
	Chain thin	Centre lines, Lines of symmetry, Trajectories
	Chain thin, thick at ends and changes of direction	Cutting planes
	Continuous thin, free-hand	Limits of partial or interrupted views and sections, if the limit is not a chain thin

LETTERING: In engineering drawing, lettering plays an important role as it explains those parts of the object which cannot be shown by lines. Thus, the lettering is the talk of drawing and therefore it should legible and uniform in appearance.



DIMESIONING: The main aim of a drawing is to represent the correct size of the object to be manufactured or constructed. So drawing must carry the proper dimensions and other information of the various parts of the object.

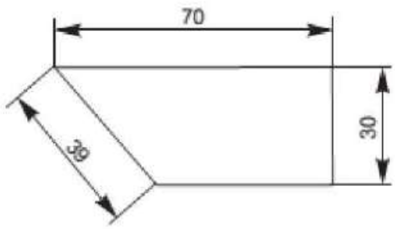
4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, Drawing paper, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE AND PROCEDURE:
Draw margin 20mm away from edges and make a title block at right bottom corner

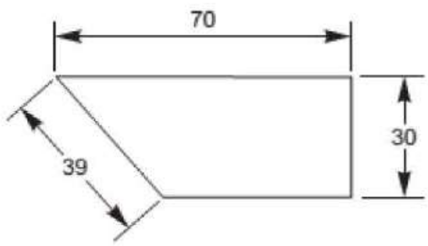
<table>
<tr><td colspan="2" rowspan="5">NAME OF INSTITUTE:

THE NEOTIA UNIVERSITY</td><td>NAME</td><td></td></tr>
<tr><td>ROLL NO.</td><td></td></tr>
<tr><td>DEPT.</td><td></td></tr>
<tr><td>DATE</td><td></td></tr>
<tr><td>CHKD BY</td><td></td></tr>
<tr><td>Scale:</td><td rowspan="2">TITLE:</td><td colspan="2" rowspan="2">DRAWING NO.</td></tr>
<tr><td></td></tr>
</table>

METHOD OF INDICATING DIMENSIONS
METHOD–1 (Aligned System)
Dimensions should be placed parallel to their dimension lines and preferably near the middle, above and clear-off the dimension line Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions may be written so that they can be read from the bottom or from the right side of the drawing. Dimensions on oblique dimension lines should be oriented as shown in figure below.



METHOD–2 (Uni-directional System)
Dimensons should be indicated so that they can be read from the bottom of the drawing only. Non horizontal dimension lines are interrupted, preferably near the middle, for insertion of the dimension shown in figure below.



6. SAFETY: Not applicable
7. DISPOSAL: Not applicable
8. REPORT/ ASSIGNMENT:
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/02
2. NAME OF THE EXPERIMENT: SCALES

3. OBJECTIVE:
The proportion by which we either reduce or increase the actual size of the object on a drawing is known as drawing to scale or simple scale.
The following are the main uses of scale in engineering practice:
1. The scales are used to prepare to reduced or enlarged size drawings
2. The scales are used to set off dimensions
3. The scales are used to measure distances directly.

4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, Drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE:

SCALE: 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. The scales are used to prepare drawing at:
1. Full size 2. Reduced size 3. Enlarged size

Types of Scale:
The types of scales normally used are:
a) Plain or simple scales, b) Diagonal scale, c) Comparative or Corresponding scale, d) Vernier scale, e) Chord scale or scale of chords.

Representative fraction (R.F.): The ratio of the dimension of the object shown on the drawing to its actual size is called the Representative Fraction (RF)

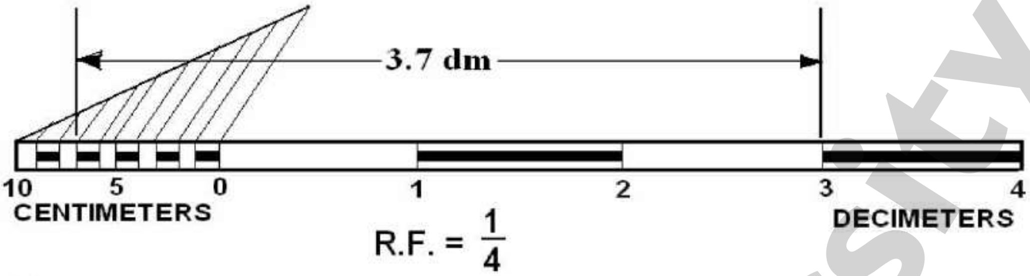
$$RF = \frac{\text{Drawing size of an object}}{\text{Its actual size}} \text{ (in same units)}$$

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

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.

6. PROCEDURE

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



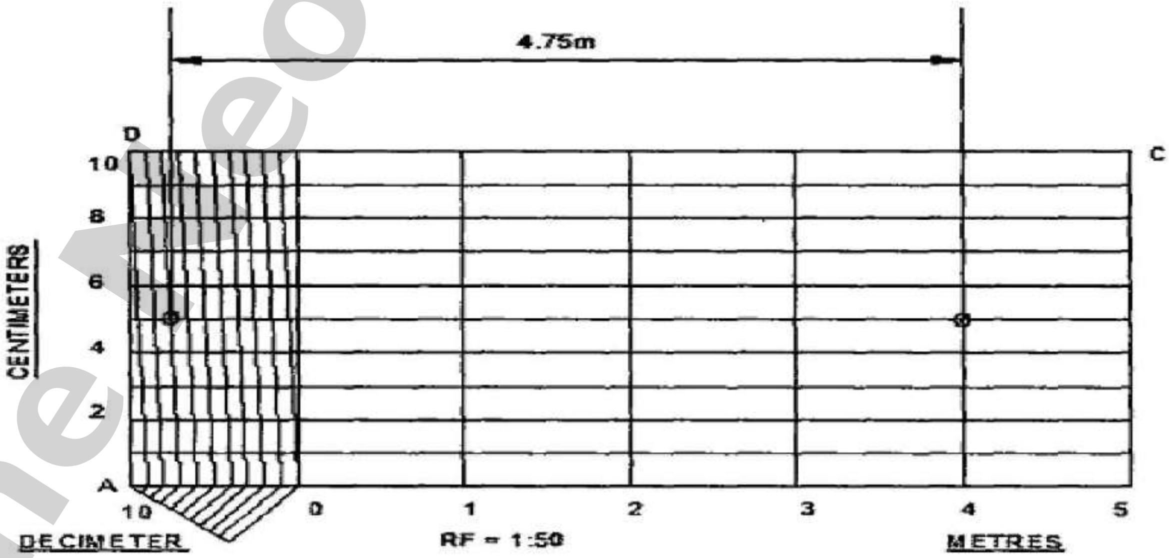
- R.F. = ¼
- Length of the scale = R.F. _ max. length = ¼ _ 5 dm = 12.5 cm.
- Draw a line 12.5 cm long and divide it in to 5 equal divisions, each representing 1 dm.
- Mark 0 at the end of the first division and 1, 2, 3 and 4 at the end of each subsequent division to its right.
- Divide the first division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

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.

Problem: Construct a diagonal scale 1/50, showing meters, decimeters and centimeters, to measure up to 6 meters. Mark a length 4.75 m on it.

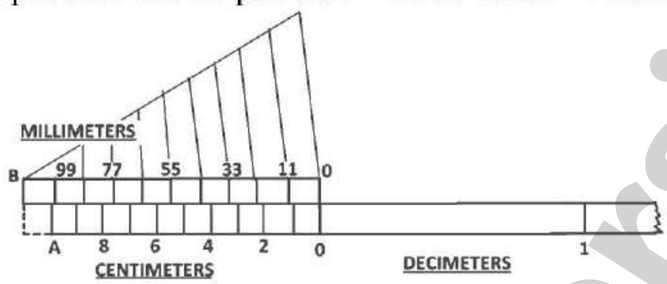
- Length of the scale = (1/50) x 6 x 100 cm = 12 cm
- Draw a line AB = 12 cm. Divide it in to 6 equal parts.
- Divide the first part A0 into 10 equal divisions.
- At A draw a perpendicular and step-off along it 10 equal divisions, ending at D.
- Join D to 9, the first sub-division from A on the main scale AB, forming the first diagonal.
- Draw the remaining diagonals, parallel to the first. Thus, each decimeter is divided into 1/10th division by diagonals.



Vernier scale:

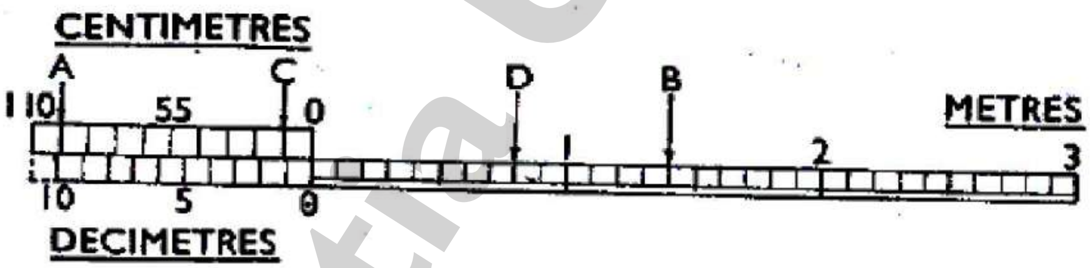
- Length A0 represents 10 cm and is divided in to 10 equal parts each representing 1 cm.

• 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 -1.0cm = 0.1cm or 1 mm.



Q.3 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) x(4 x100) = 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).



7. SAFETY: Not applicable

8. DISPOSAL: Not applicable

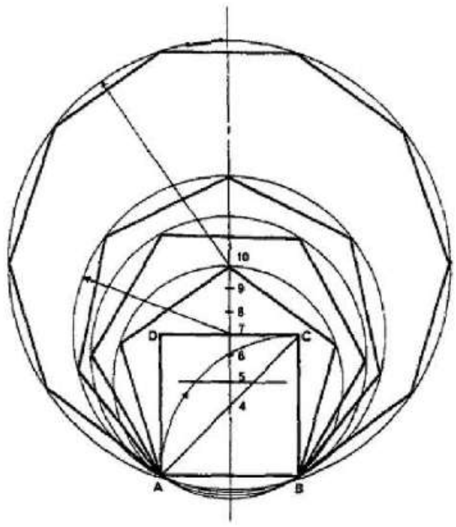
9. REPORT/ ASSIGNMENT:
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/03
2. EXPERIMENT NAME: GEOMETRICAL CONSTRUCTION AND CURVES

3. OBJECTIVE:
1. Engineering drawing consists of a number of geometrical constructions. A few methods are illustrated here without mathematical proofs.
2. Conic sections a) Parabola, used in arches, bridges, sound reflectors, light reflectors etc, b) Ellipse, used in arches, bridges, dams, monuments, glands & stuffing boxes, c) Hyperbola, used in cooling towers, water channels.
3. Cycloid, used in dial gauge.
4. Involute, used in gear tooth profile.
5. Archimedean spiral, used in helical gear tooth profile, profile of cams etc.

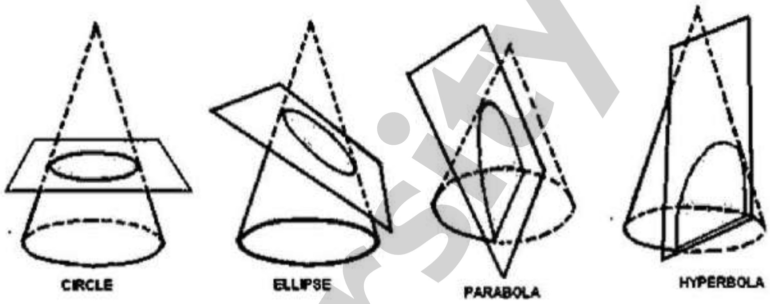
4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, Drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

To construct a regular figure ofgiven side length and of N sides on a straight line.
Construction:
1. Draw the given straight-line AB.
2. At B erect a perpendicular BC equal in length to AB.
3. Join AC and where it cuts the perpendicular bisector of AB, number the point 4.
4. Complete the square ABCD of which AC is the diagonal.
5. With radius AB and centre B describe arc AC as shown.
6. Where this arc cuts the vertical centre line number the point 6.
7. This is the centre of a circle inside which a hexagon ofside AB can now be drawn.
8. Bisect the distance 4-6 on the vertical centre line.
9. Mark this bisection 5. This is the centre in which a regular pentagon of side AB can now be drawn.
10. On the vertical centre line step off from point 6 a distance equal in length to the distance 5-6. This is the centre of a circle in which a regular heptagon of side AB can now be drawn.
11. If further distances 5-6 are now stepped off along the vertical centre line and are numbered consecutively, each will be the centre of a circle in which a regular polygon can be inscribed with side of length AB and with a number of sides denoted by the number against the centre.

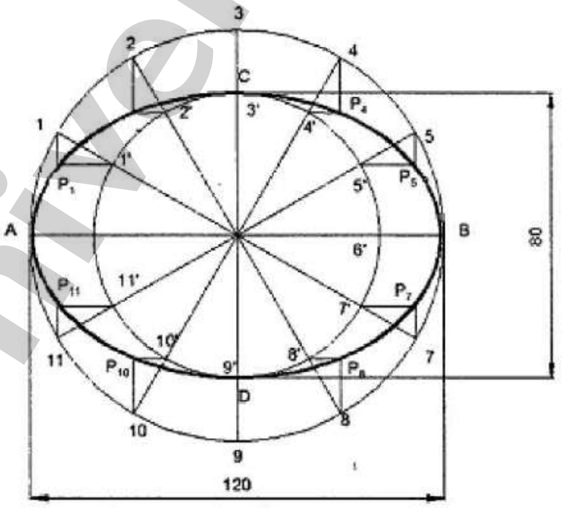


5. PRINCIPLE:
Conic curves (conics)
Curves formed by the intersection of a plane with a right circular cone. e.g. Parabola, hyperbola and ellipse. Right circular cone is a cone that has a circular base and the axis is inclined at 900 to the base and passes through the center of the base. Conic sections are always "smooth". More precisely, they never contain any inflection points. This is important for many applications, such as aerodynamics, civil engineering, mechanical engineering, etc. Figure 1. Shows a right cone and the various conic curves that can be obtained from a cone by sectioning the cone at various conditions.

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 and the fixed line is called Directrix.



ELLIPSE BY CONCENTRIC CIRCLE METHOD

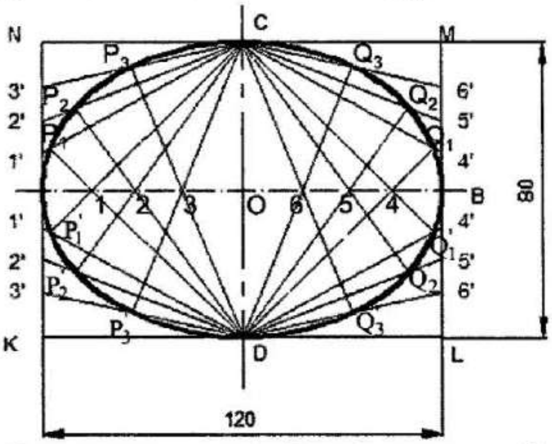


6. PROCEDURE

1. Draw the major and minor axes AB and CD and locate the centre O. 2. With centre 0 and major axis and minor axes as diameters, draw two concentric circles. 3. Divide both the circles into equal number of parts, say 12 and draw the radial lines. 4. Considering the radial line 0-1' -1, draw a horizontal line from I' to meet the vertical line from 1 at PI' 5. Repeat the steps 4 and obtain other points P_2, P_3, etc. 6. Join the points by a smooth curve forming the required ellipse.

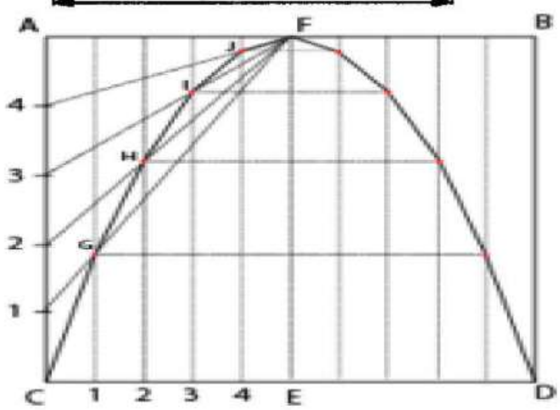
ELLIPSE BY OBLONG OR RECTANGLE METHOD

1. Draw the major and minor axes AB and CD and locate the centre O. 2. Draw the rectangle KLMN passing through A, D,B,C. 3. Divide AO and AN into same mumber ofequal parts, say 4. 4. Join C with the points 1',2',3'. 5. JoinD with the points 1,2,3 and extend till they meet the lines C~, C~, C~ "respectively at PI' Pz and P3 • 6. Repeat steps 3 to 5 to obtain the points in the remaining three quadrants. 7. Join the points by a smooth curve forming the required ellipse.

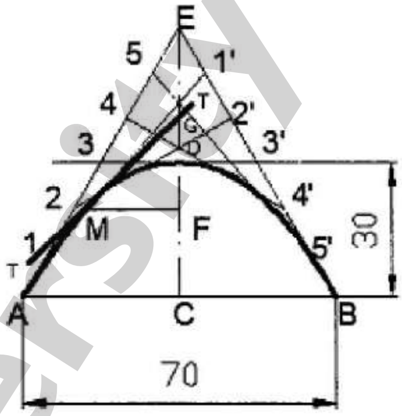


PARABOLA BY RECTANGLE METHOD

1. Draw the base AB and axis CD such that CD is perpendicular bisector to AB.
2. Construct a rectangle ABEF, passing through C.
3. Divide AC and AF into the same number of equal parts and number the points 'as shown.
4. Join 1,2 and 3 to D.
5. Through 1',2' and 3', draw lines parallel to the axis, intersecting the lines ID, 2D and 3D at PI' P_2 and P3 respectively.
6. Obtain the points P;, P~ and P~, which are symmetrically placed to PI' P_2 and P_3 with respect to the axis CD.
7. Join the points by a smooth curve forming the required parabola.



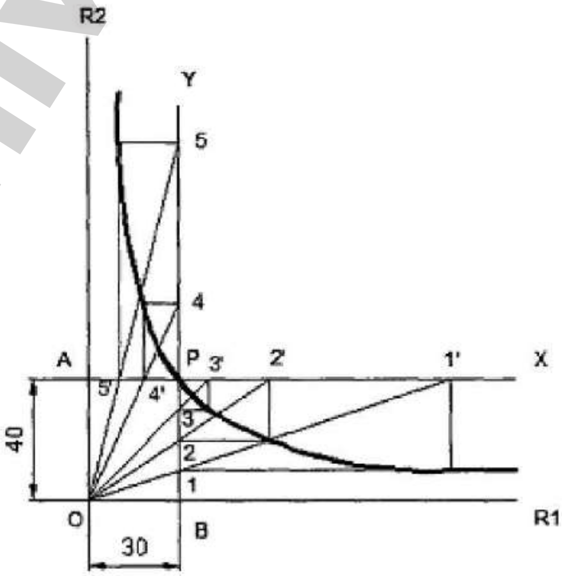
PARABOLA BY TANGENT METHOD



1. Draw the base AB and locate its mid-point C.
2. Through C, draw CD perpendicular to AB forning the axis
3. Produce CD to E such that DE = CD
4. Join E-A and E-B. These are the tangents to the parabola at A and B.
5. Divide AE and BE into the same number ofequal parts and number the points as shown.
6. Join 1-1' ,2- 2' ,3- 3' , etc., forming the tangents to the required parabola.
7. A smooth curve passing through A, D and B and tangential to the above lines is the required parabola.

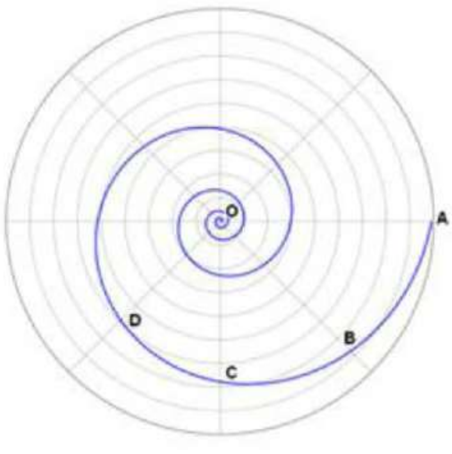
Constructing a Rectangular Hyperbola

Problem: Construct a rectangular hyperbola when a point P on it is at a distance 000 mm and 40 mm respectively from the two asymptotes.



- For a rectangular hyperbola, angle between the asymptotes is 90°. So, draw ORI and o~such that the angle RIOR2 is 90°.
- Mark A and B along o~ and ORI respectively such that OA =40 mm and OB=30 mm. From A draw AX parallel to ORI and from B draw BY parallel to oR2 . Both intersect at P.
- Along BP mark 1, 2, and 3 at approximately equal intervals. Join 01, 02, and 03, and extend them to meet AX at 11,21and 31respectively.
- From II draw a line parallel to o~ and from 1 draw a line parallel to ORI. From 2 and 3 draw lines parallel to ORI. They intersect at P2 and P3 respectively.
- Then along PAmark points 41 and 51 at approximately equal inervals. Join 041and 05 1and extend them to meet BY at 4 and 5 respectively.
- From'41and 51 draw lines parallel to o~ and from 4 and 5 draw lines parallel to ORI to intersect at P4 and Ps respectively.
- Join PI' P2 · P3 ,P, P4 , Ps by smooth rectangular hyperbola.

Archemedian Spiral: The curve traced out by a point moving in such a way that its movement towards or away from the pole is uniform with the increase in the vectorial angle from the starting line. Applications include teeth profile of helical gears, profile of cams, etc. A typical Archemedian spiral is shown in figure.

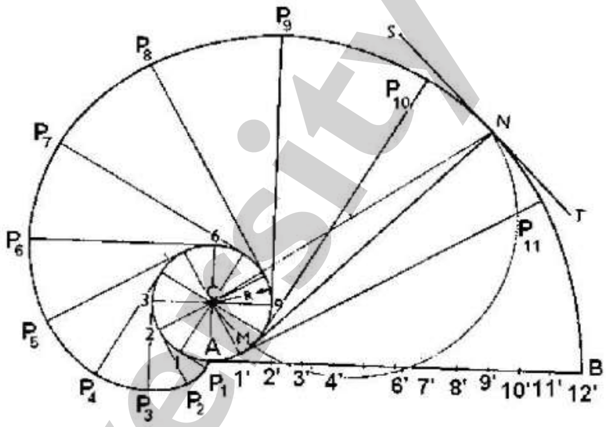


Involute

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.

Construction of Involute of circle

Draw the circle with C as center and CP as radius. Draw line PQ = 2ПCP, tangent to the circle at P Divide the circle into 12 equal parts. Number them as 1, 2 etc. Divide the line PQ into 12 equal parts and number as shown in figure. Draw tangents to the circle at 1, 2,3 etc. Locate points P1, P2 such that 1-P1 = P1′, 2-P2 = P2′…. Join P, P1, P2…. The tangent to the circle at any point on it is always normal to the its involute. Join CN. Draw a semicircle with CN as diameter, cutting the circle at M. MN is the normal.



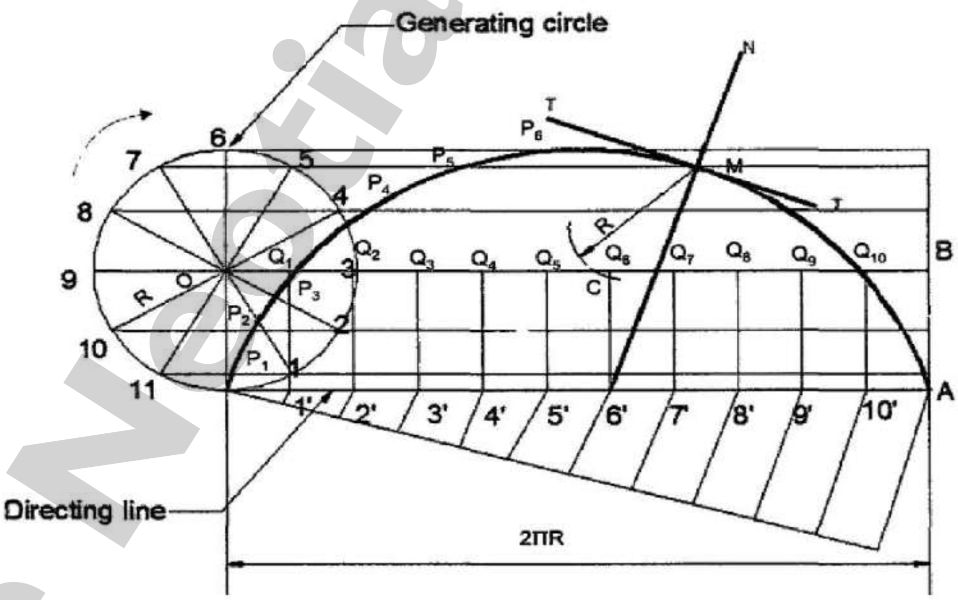
Cycloid

A cycloid is a curve generated by a fixed point on the circumference of a circle, when it rolls without slipping along a straight line.

Construction

1. With centre O and radius R, draw the given generating circle. 2. Assuming point P to be the initial position ofthe generating point, draw a line PA, tangential and equal to the circumference of the circle. 3. Divide the line PA and the circle into the same number of equal parts and number the points. 4. Draw the line OB, parallel and equal to PA. OB is the locus of the centre of the generating circle. 5. Errect perpendiculars at 1', 2', etc., meeting OB at Q1, Q2, Q3 etc. 6. Through the points 1,2,3 etc., draw lines parallel to PA. 7. With centre 0, and radius R, draw an arc intersecting the line through 1 at P1, P2 is the

position of the generating point, when the centre of the generating circle moves Q1. 8. Similarly locate the points P2, P3etc. 9. A smooth curve passing through the points P, P1, P2, P3 etc., is the required cycloid



5. SAFETY: Not applicable
6. DISPOSAL: Not applicable
7. REPORT/ ASSIGNMENT:

Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/04
2. NAME OF EXPERIMENT: PROJECTIOS OF POINTS, LINES AND LAMINA

3. OBJECTIVE:
The basic objective is to understand about the projection of points, lines & surfaces.
Practical solid geometry or descriptive geometry deals with the representation of points, lines, planes or surfaces and solids on a flat surface, in such a manner that their relative positions and true forms can be accurately determined.
Four method of projection are commonly used in engineering drawing
1. Orthographic projection 2. Isometric projection 3. Oblique projection 4. Perspective projection

4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

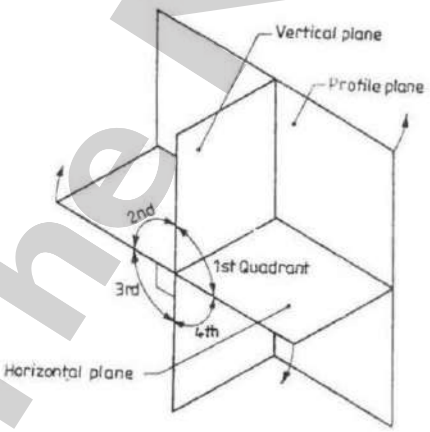
5. PRINCIPLE:

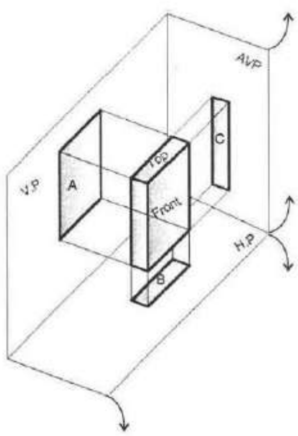
Projection
As per the optical physics, an object is seen when the light rays called visual rays coming from the object strike the observer's eye. The size of the image formed in the retina depends on the distance of the observer from the object.

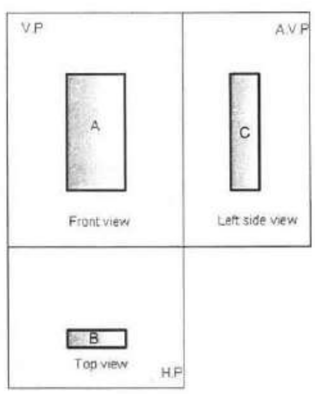
Types of Projections
(i) Orthographic Projections, (ii) Isometric projection, (iii) Oblique projection, (iv) Perspective projection.

Orthographic Projection
'ORTHO' means right angle and orthographic means right angled drawing. When the projectors are perpendicular to the plane on which the projection is obtained, it is known as orthographic projection.

First Angle Projection Method
In first angle projection, the object is imagined to be positioned in the first quadrant. The view from the front of the object is obtained by looking at the object from the right side of the quadrant and tracing in correct sequence, the points of intersection between the projection plane and the rays of sight extended. The object is between the observer and the plane of projection (vertical plane). Here, the object is imagined to be transparent and the projection lines are extended from various points of the object to intersect the projection plane. Hence, in first angle projection, any view is so placed that it represents the side of the object away from it.







6. PROCEDURE:

Projection of Points

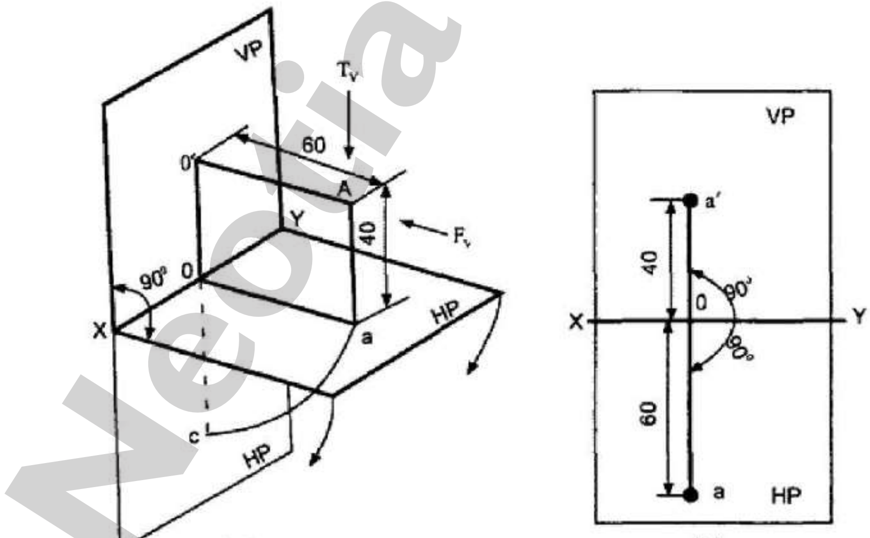
The position of a point in engineering drawing is defined with respect to its distance from the three principle planes i.e., with respect to the VP, HP, & PP. A point may lie in space in anyone of the four quadrants. The positions of a point are:

1. First quadrant, when it lies above H.P and in front of V.P.
2. Second quadrant, when it lies above HP and behind V.P.
3. Third quadrant, when it lies below H.P and behind V.P.
4. Fourth quadrant, when it lies below H.P and in front of V.P.

Problem: ***Point A is 40 mm above HP and 60 mm in front of V.P. Draw its front and top view.***
Solution

1. The point A lies in the I Quadrant
2. Looking from the front, the point lies 40 mm above H.P. A-a_1 is the projector perpendicular to V.P. Hence a_1 is the front view of the point A and it is 40 mm above the xy line.
3. To obtain the top view ofA, look from the top. Point A is 60mm in front of V.P. Aa is the projector perpendicular to H.P Hence, a is the top view of the point A and it is 60 mm in front of xy.
4. To convert the projections a_1 and a obtained in the pictorial view into orthographic projections the following steps are needed.

(a) Rotate the H.P about the xy line through 90° in the clock wise direction as shown.
(b) After rotation, the first quadrant is opened out and the H.P occupies the position vertically below the V.P line. Also, the point a on H.P will trace a quadrant of a circle with o as centre and o-a as radius. Now a occupies the position just below o. The line joining a_1 and a, called the projector, is perpendicular to xy



(a) (b)

Projection of Straight Line

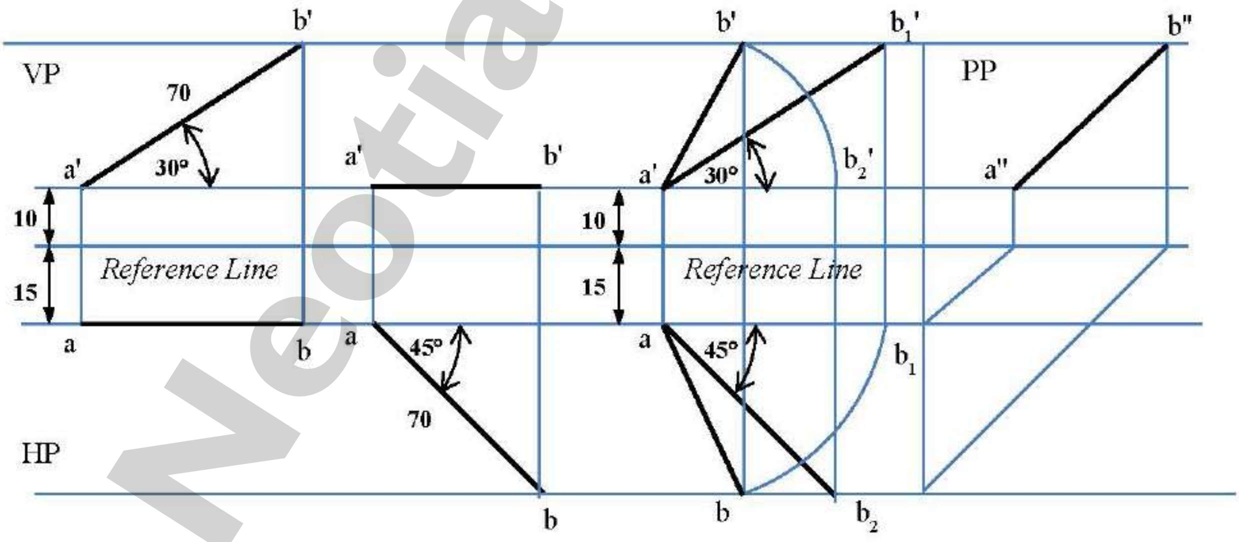
The shortest distance between two points is called a straight line. The projectors of a straight line are drawn therefore by joining the projections of its end points. The possible projections of straight. lines with respect to V.P and H.P in the first quadrant are as follows:

1. Perpendicular to one plane and parallel to the other.
2. Parallel to both the planes.
3. Parallel to one plane and inclined to the other.
4. Inclined to both the planes

Problem:
A straight line AB of true length 70 mm has its end A 10 mm above HP and 15 mm in front of VP. Draw the projections, (A) The line AB is parallel to VP and makes an angle 30° with HP, (B) The line AB is parallel to HP and makes an angle 45° with VP, and (C) The straight line AB Makes angle with both planes, 30° with HP and 45° with VP.

Solution (A):
1. A is 10 mm above H.P mark a', 10 mm above reference line.
2. A is 15 mm in front of V.P. Hence mark a 15 mm below reference line.
3. To obtain the front view a'b' as AB is parallel to V.P and inclined at an angle with H.P, a'b' will be equal to its true length and inclined at an angle of 30° to H.P. Therefore, draw a line from a' at an angle 30° to reference line and mark b' such that a'b' = 70 mm = true length.
4. To obtain the top view ab; since the line is inclined to H.P its projection on H.P (its top view) is reduced in length. From b' draw a projector to intersect the horizontal line drawn from a at b. ab is the top view of AB

Solution (B):
1. A is 10 mm above H.P mark a', 10 mm above reference line.
2. A is 15 mm in front of V.P. Hence mark a 15 mm below reference line.
3. To obtain the Top view ab as AB is parallel to H.P and inclined at an angle with V.P, ab will be equal to its true length and inclined at an angle of 45° to V.P. Therefore, draw a line from a at an angle 45° to reference line and mark b such that ab = 70 mm = true length.
4. To obtain the front view a'b'; since the line is inclined to V.P its projection on V.P (its front view) is reduced in length. From b draw a projector to intersect the horizontal line drawn from a' at b'. a'b' is the front view of AB;

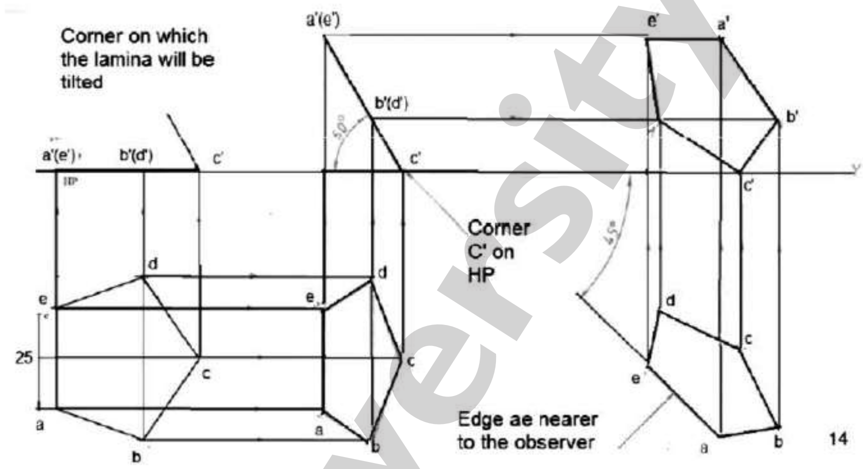


(A) (B) (C)

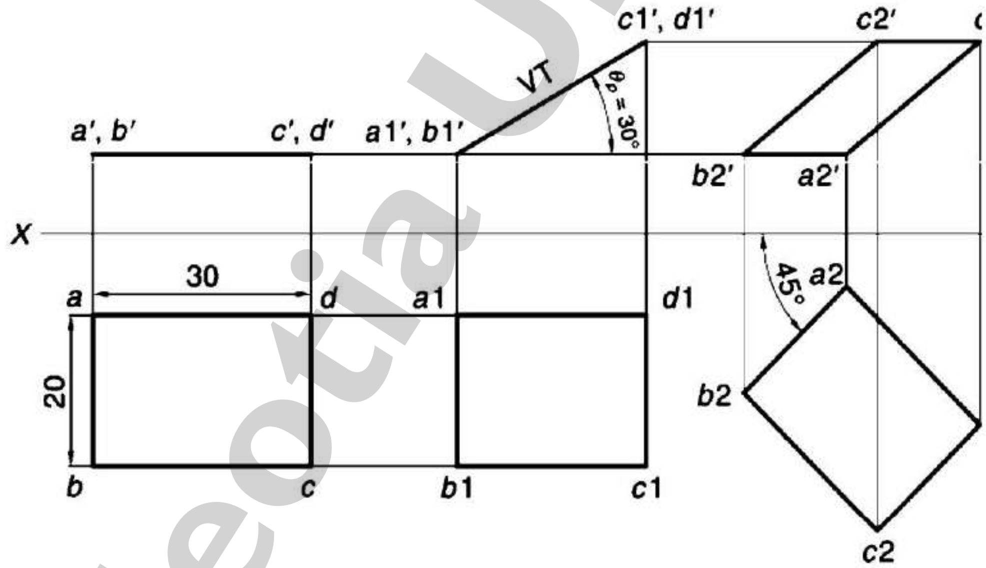
Solution (C):
It is a combining stage of solution (A) and solution (B).
(i) Draw the projections a'b_1' and ab_2 making an angle 30° and 45° respectively with reference line, after location of the projections a' and a, from the given position of the end point A.
(ii) Obtain the projections a'b_2' and ab_1 parallel to reference line, by rotation.
(iii) Draw the lines parallel to the reference line passing through b_1' and b_2 respectively.
(iv) With centre a' and radius a'b_2', draw an arc meeting the horizontal line passing through b_1' at b'.
(v) With centre a and radius a'b_1', draw an arc meeting the horizontal line passing through b_2 at b.
(vi) Join a',b', and a,b forming the required final projections.

Projection of Straight Line

Problem: A Pentagonal plane lamina of edge 25 mm is resting on HP with one of its corners touching it such that the plane surface makes an angle of 60° with HP. Two of the edges containing the corner on which the lamina rests make equal inclinations with HP. When the edge opposite to this corner makes an angle of 45° with VP and nearer to the observer, draw the TV and FV of the lamina.



Problem: A rectangular plane ABCD of size 30 mm × 20 mm inclined to H.P by an angle 30°, its shorter edge being parallel to H.P and inclined to V.P by an angle 45°. Draw its projections.



7. SAFETY: Not applicable
8. DISPOSAL: Not applicable
9. REPORT/ ASSIGNMENT:

Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

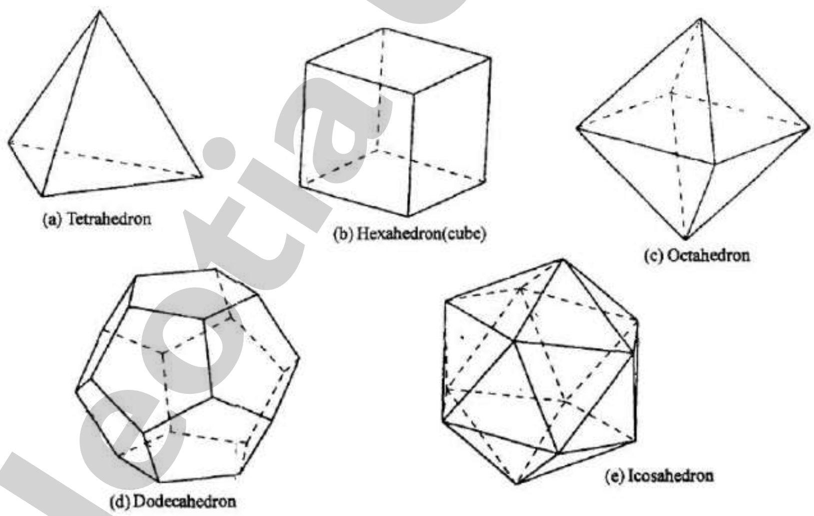
1. EXPERIMENT NO: ES-MEP101/05
2. NAME OF THE EXPERIMENT: PROJECTIOS OF SOLIDS

3. OBJECTIVE: After completing of lesion, we will learn about the projections of solids in various positions and with their axes in various relations with the HP, the VP and the PP ,such as perpendicular to one of the reference planes and parallel to the other two. Parallel to one and inclined to the other two.

4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE:

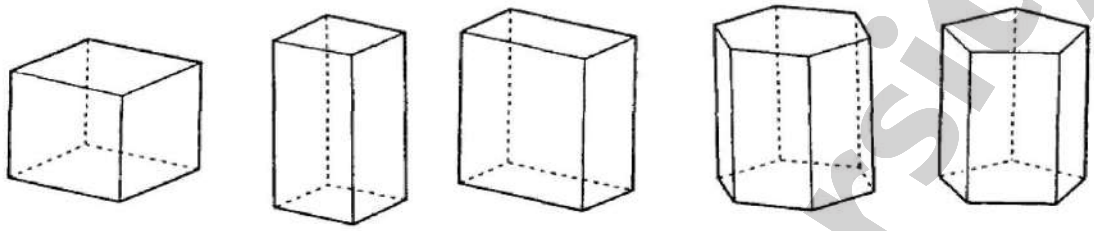
Solid
A solid is a 3-D object having length, breadth and thickness and bounded by surfaces which may be either plane or curved, or combination of the two. Solids are classified under two main headings
1. Polyhedron and 2. Solids of revolution
A regular polyhedron is solid bounded only by plane surfaces (faces). Its faces are formed by regular polygons of same size and all dihedral angles are equal to one another. when faces of a polyhedron are not formed by equal identical faces, they may be classified into prisms and pyramids. Five regular polyhedral are shown in figure below.



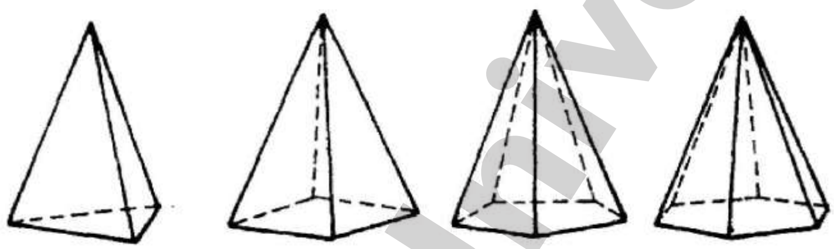
(a) Tetrahedron (b) Hexahedron(cube) (c) Octahedron (d) Dodecahedron (e) Icosahedron

Prism
A prism is a polyhedron having two equal ends called the bases parallel to each other. The two bases are joined by faces, which are rectangular in shape. The imaginary line passing through the centres of the bases is called the axis of the prism. A prism is named after the shape of its base. For example, a prism with square base is called a square prism, the one with a pentagonal base is called a pentagonal prism, and so on.

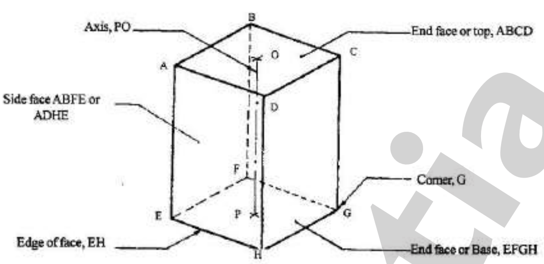
Pyramids
A pyramid is a polyhedron having one base, with a number of isosceles triangular faces, meeting at a point called the apex. The imaginary line passing through the centre of the base and the apex is called the axis of the pyramid. The pyramid is named after the shape of the base. Thus, a square pyramid has a square base and pentagonal pyramid has pentagonal base and so on.

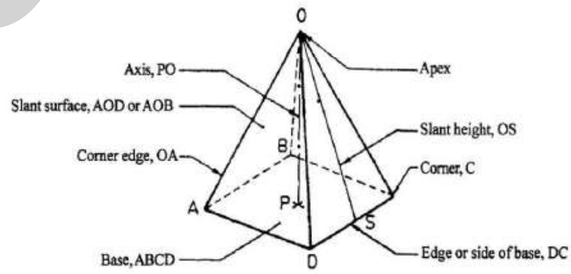


Cube Right prism Right rectangulr prism Right pentagonal prism Hexagonal prism

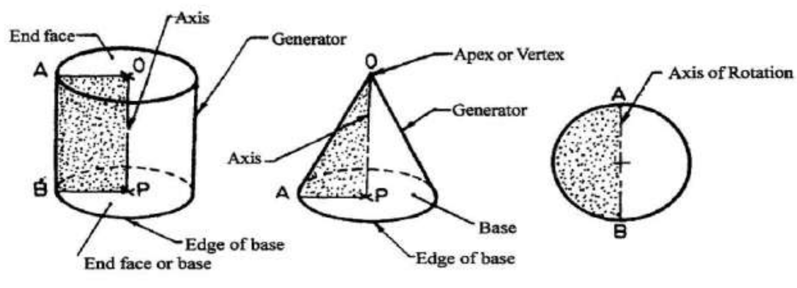


Triangular Square Pentagonal Hexagonal

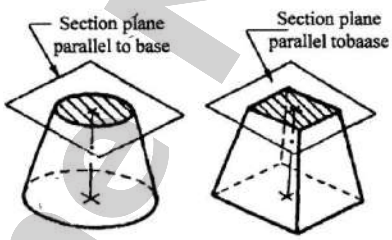




Solids of Revolution and If a plane surface is revolved about one of its edges, the solid generated is called a solid of revolution. The examples are (i) Cylinder, (ii) Cone, (iii) Sphere.



(a) Cylinder (b) Cone (c) Sphere

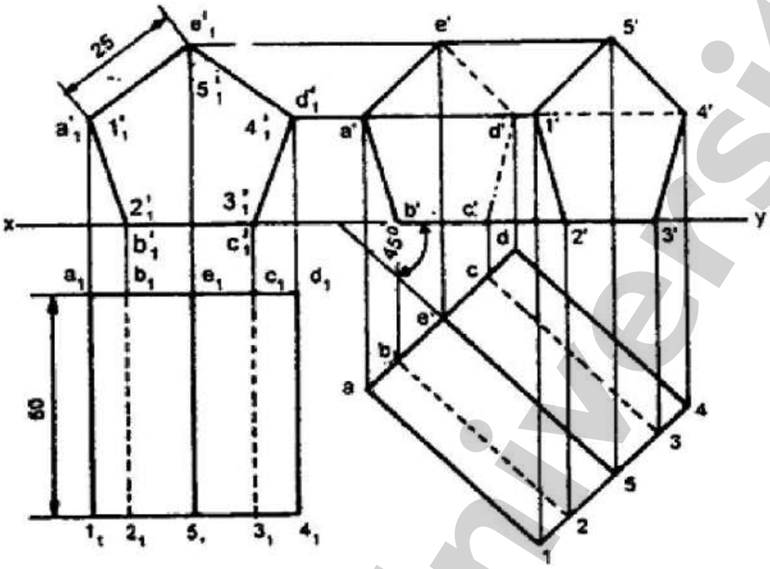


Frustums and Truncated Solids

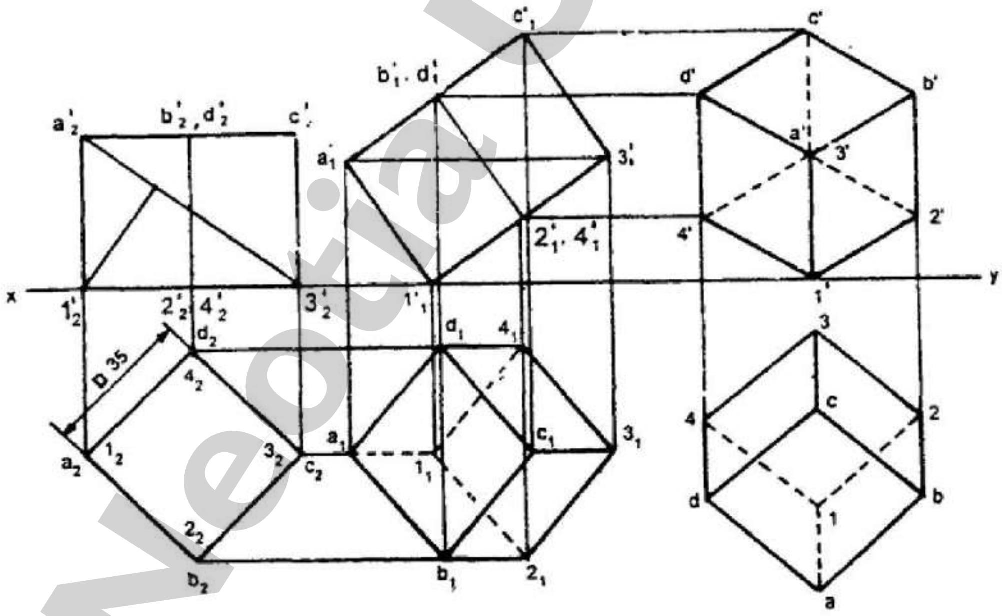
If a cone or pyramid is cut by a section plane parallel to its base and the portion containing the apex or vertex is removed, the remaining portion is called frustum of a cone or pyramid.

6. PROCEDURE:

Problem: A pentagonal prism with side of base 25mm and axis 50mm long lies on one of its faces on H.P., such that its axis is inclined at 45° to V.P. Draw the projections.



Problem: A cube of edge 35mm is resting on H.P on one of its corners with a solid diagonal perpendicular to V.P. Draw the projections of the cube.



7. SAFETY: Not applicable

8. DISPOSAL: Not applicable

9. REPORT/ ASSIGNMENT:

Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/06
2. NAME OF THE EXPERIMENT: SECTION OF SOLIDS

3. OBJECTIVE:
In engineering industries, when the internal structure of an object is complicated, it is very difficult to visualize the object from its orthographic views since there will be several hidden lines. In such case, the internal details are shown by sectional views. Sectional views are an important aspect of design and documentation since it is used to improve clarity and reveal interior features of parts.

4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE:
Sectional drawings are multi-view technical drawings that contain special views of a part or parts, that reveal interior features. A primary reason for creating a section view is the elimination of hidden lines, so that a drawing can be more easily understood or visualized. Traditional section views are based on the use of an imaginary cutting plane that cuts through the object to reveal interior features. This imaginary cutting plane is controlled by the designer and are generally represented by any of the following:
(a) Full section view, where the section plane go completely through the object. Example shown in fig. 1.
(b) Half section view, where the section plane go half-way through the object. Example shown in figure 2.

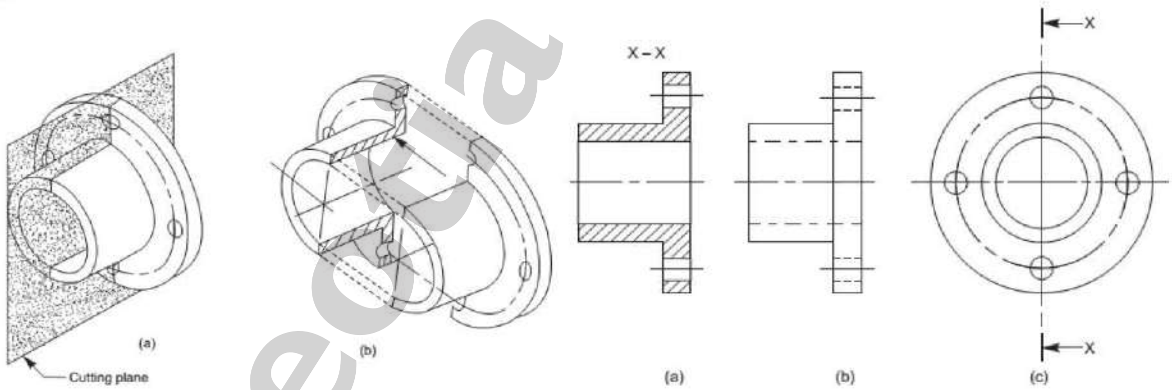


Figure 1. Illustrates a full Section view

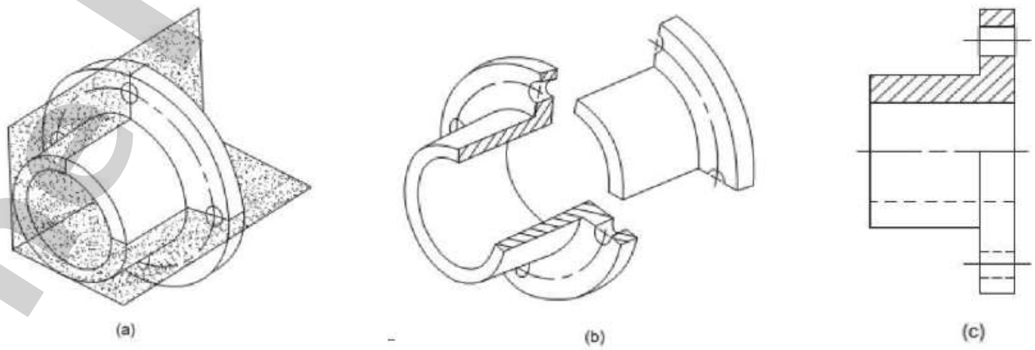


Figure 2. Illustrating a half section view

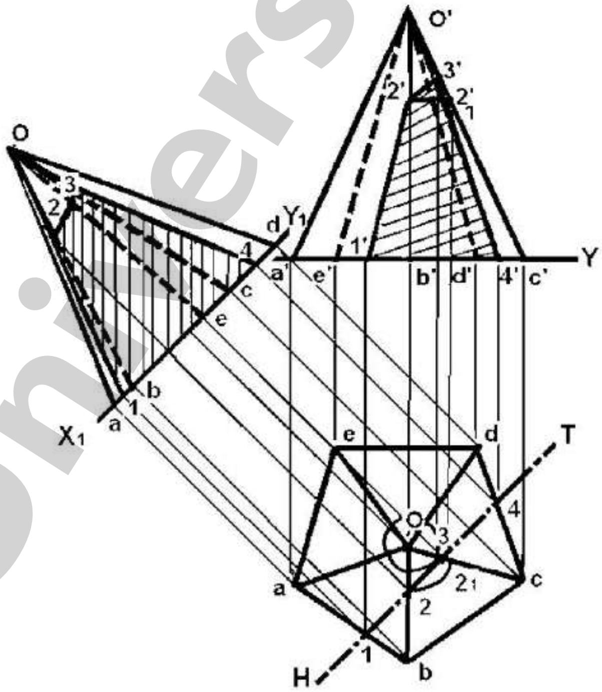
6. PROCEDURE:

Problem 1: A pentagonal pyramid has its base on the HP. Base of the pyramid is 30 mm in side, axis 50 mm long. The edge of the base nearer to VP is parallel to it. A vertical section plane, inclined at 45° to the VP, cuts the pyramid at a distance of 6 mm from the axis. Draw the top view, sectional front view and the auxiliary front view on an AVP parallel to the section plane.

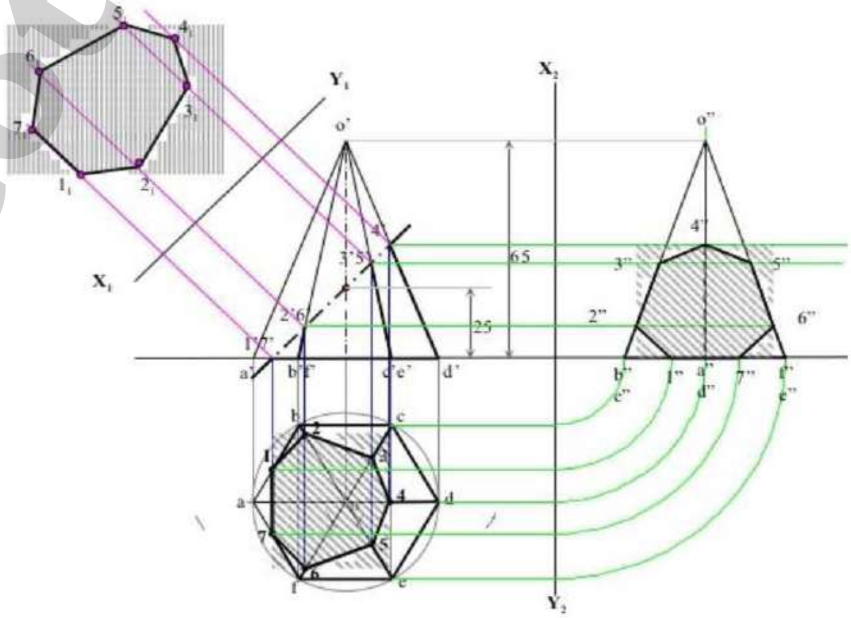
Solution:

The solution is shown in figure below. The Front view and top view of the pyramid is first drawn. The vertical section which is inclined at 45° to VP is shown by the line HT inclined at 45° to XY line. Since the section plane passes through a point 6 mm from the axis of the pyramid, a circle of radius 6 mm is drawn in the top view. The line HT is drawn such that it is tangent to this circle. The sectional front view of the object is obtained by drawing vertical projectors and its intersection with the respective slant edges in the front view. Since point 2 (in the top view) is in the line ob, which is vertical, the projection of point 2' is obtained in the following manner. With centre o and radius o-2, draw an arc to intersect the line o-c at 2_1. Project point 2_1 in the top view to point 2' in the Front view. Draw a horizontal projector from 2' to intersect the line o'-b' at 2'. The section front view is shown by the hatched area in the front view.

The auxiliary front view is drawn to obtain the true shape of the section. This is obtained by the auxiliary projection method shown in figure below.

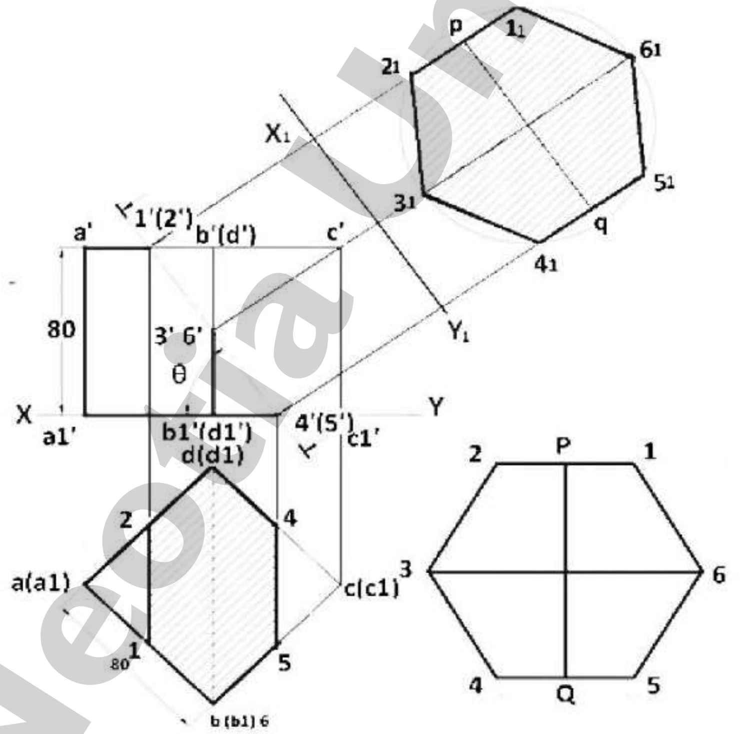


Problem 2: A hexagonal pyramid, base 30 mm side and axis 65 mm long is resting on its base on the HP, with two edges of the base parallel to the VP. It is cut by a section plane perpendicular to VP and inclined at 45° to the HP, intersecting the axis at a point a point 25 mm above the base. Draw the front view, sectional top view, sectional side view, and true shape of the section.



Problem 3: A cube of 80 mm long edges has its vertical faces equally inclined to the VP. It is cut by an AIP in such a way that the true shape of the cut part is a regular hexagon. Determine the inclination of the cutting plane with the HP. Draw FV, sectional TV and true shape of the section.

Solution:
The solution is shown in figure below. Draw TV and FV of the cube. As the true shape of the section is a hexagon, the cutting plane must cut the prism at 6 points. The cutting plane will cut two edges of the top, two edges of the base and two vertical edges. The Points of intersection at two vertical edges will be farthest from each other. These points will represent the two opposite corners of the hexagon and the distance between them will be equal to b(b1)– d(d1).
Draw a line 3–6 = b(b1)– d(d1). Draw a circle with 3–6 as a diameter. Inscribe a hexagon 1– 2–3–4–5–6 in it as shown. Measure the distance between 1–2 and 4–5, i.e., PQ. In the front view, locate 3' at the midpoint of b'(d')– b1'(d1'). With 3' as a centre and radius = ½(PQ), cut arcs on a' b' and b1' c1' to locate 1' and 4' respectively. Join 1'–4' for the required cutting plane. Measure θ.
Draw X1 Y1 parallel to 1'–4'. Redraw hexagon 1–2–3–4–5–6 as 11–21–31–41–51–61 such that pq is parallel to X1 Y1. Project all the corners of the hexagon in FV. 2, 6' and 5' will coincide with 1', 3' and 4' respectively. Project 1', 2', 3', etc., to 1, 2, 3, etc., on the corresponding edges in TV to obtain the section. 3 and 6 will coincide with d(d1) and b(b1) respectively



7. SAFETY: Not applicable

8. DISPOSAL: Not applicable

9. REPORT/ ASSIGNMENT:
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/07
2. NAME OF THE EXPERIMENT: DEVELOPMENT OF SURFACES

3. OBJECTIVE:

A layout of the complete surface of a three-dimensional object on a plane is called the development of the surface or flat pattern of the object. The development of surfaces is very important in the fabrication of articles made of sheet metal. The objects such as containers, boxes, boilers, hoppers, vessels, funnels, trays etc., are made of sheet metal by using the principle of development of surfaces.

4. TOOLS/ APPARATUS:

Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE:

The method to be followed for making the development of a solid depends upon the nature of its lateral surfaces. Based on the classification of solids, the following are the methods of development.

a. Parallel-line Development

It is used for developing prisms and single curved surfaces like cylinders in which all the edges / generators of lateral surfaces are parallel to each other.

b. Radial-line Development

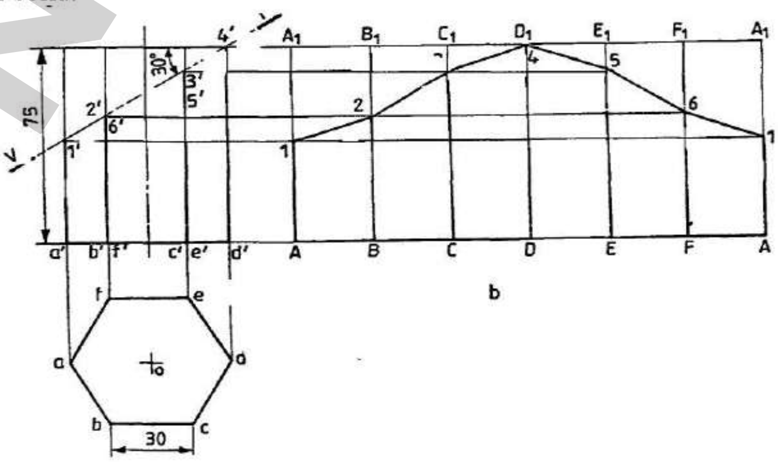
It is employed for pyramids and single curved surfaces like cones in which the apex is taken as centre and the slant edge or generator (which are the true lengths) as radius for its development.

6. PROCEDURE:

Problem 1: A hexagonal prism of side of base 30 mm and axis 70 mm long is resting on its base on HP. such that a rectangular face is parallel to VP. It is cut by a section plane perpendicular to VP and inclined at 30° to HP. The section plane is passing through the top end of an extreme lateral edge of the prism. Draw the development of the lateral surface of the cut prism.

Solution:

(i) Draw the projections of the prism.
(ii) Draw the section plane VT.
(iii) Draw the development AA_1-A_1A of the complete prism following the stretch out line principle.
(iv) Locate the point of intersection 1,2 etc., between VT and the edges of the prism.
(v) Draw horizontal lines through 1,2etc., and obtain 1,2, etc., on the corresponding edges in the development.
(vi) Join the points 1,2, etc., by straight lines and darken the sides corresponding to the retained portion of the solid.



Problem: A hexagonal pyramid with side of base 30 mm and height 75 mm stands with its base on RP and an edge of the base parallel to VP. It is cut by a plane perpendicular to VP, inclined at 45° to H.P and passing through the mid-point of the axis. Draw the (sectioned) top view and develop the lateral surface of the truncated pyramid

Solution:

(i) Draw the two views of the given pyramid and indicate the cutting plane.

(ii) Locate the points of intersection 1', 2', 3', 4',5' and 6' between the slant edges and the cutting plane.

(iii) Obtain the sectional top view by projecting the above points.

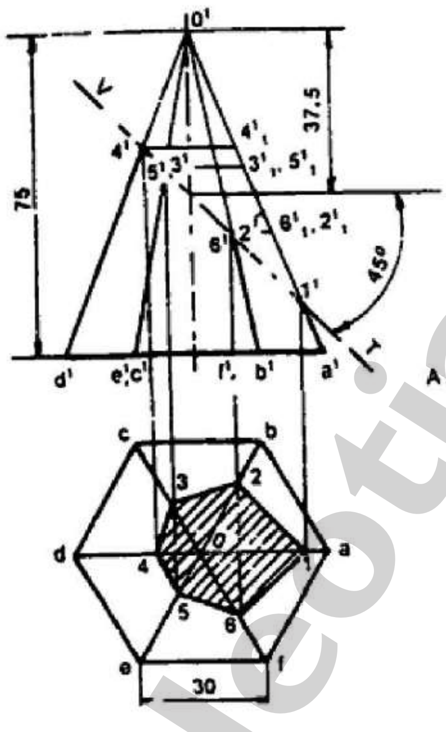
(iv) With o as centre and radius equal to the true length of the slant edge draw an arc.

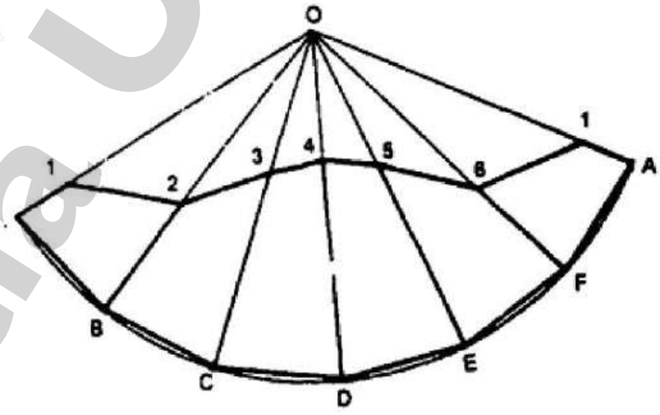
(v) With radius equal to the side of the base 30 mm, step-off divisions on the above arc.

(vi) Determine the true length 0'2', 0'3', etc., of the slant edges 0'2', 0'3', etc.

(vii) Mark 1,2,3 etc., along OA,OB,OC etc., corresponding to the true lengths 0111, 0121, $0_1 3_1$,etc., in the development.

(viii) Join 1,2,3 etc., by straight lines and darken the sides corresponding to the truncated portion of the solid.





DEVELOPMENT

7. SAFETY: Not applicable

8. DISPOSAL: Not applicable

9. REPORT/ ASSIGNMENT:

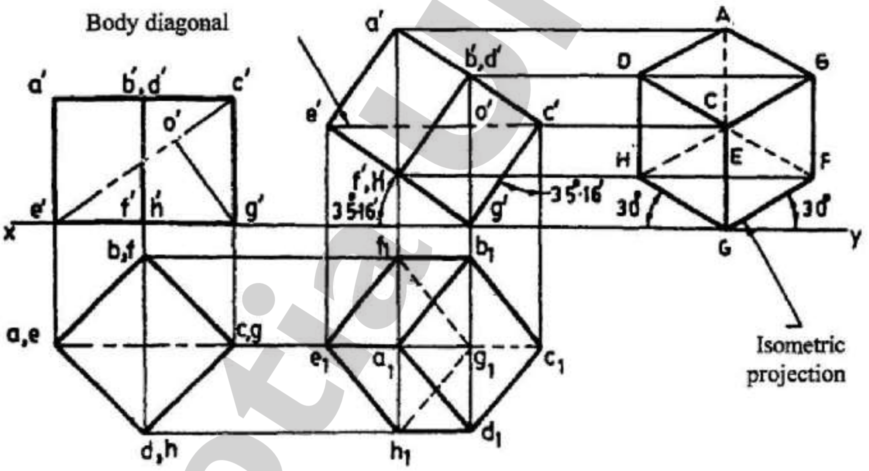
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/08
2. NAME OF THE EXPERIMENT: ISOMETRIC PROJECTION

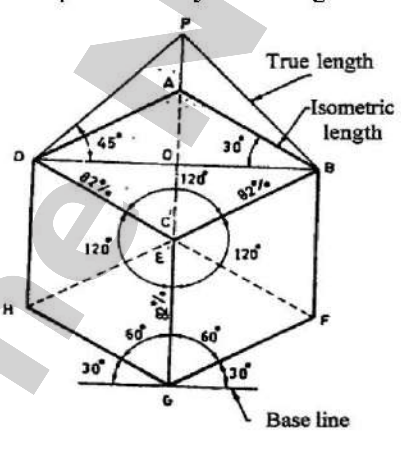
3. OBJECTIVE:
Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings. It is an axonometric **projection** in which the three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees.

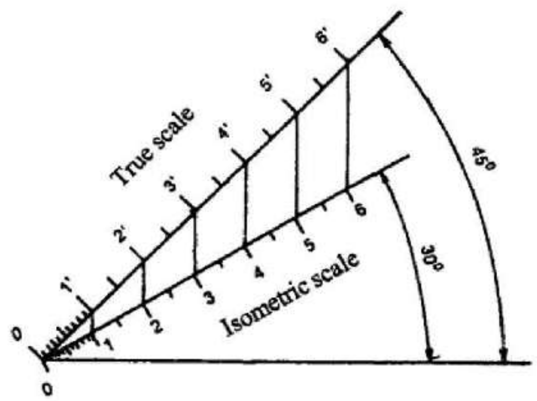
4. TOOLS/ APPARATUS:
Drawing board, T- Square, Set-square (45^0, 30^0-60^0), Geometrical instrument box:
i) Large size bow compass with interchangeable pencil and pen legs, ii) Lengthening bar, iii) Large type divider iv) Small bow compass v) Small bow divider, vi) Small bow ink pen
Diagonal scale, drawing papers, Drawing pencil (Clutch pencil), Sand paper, Eraser, Board clip

5. PRINCIPLE:
It is a pictorial orthographic projection of an object in which a transparent cube containing the object is tilted until one of the solid diagonals of the cube becomes perpendicular to the vertical plane and the three axes are equally inclined to this vertical plane. The steps are shown in figure below. Here ABCDEFGH is the isometric projection of the cube. This is also discussed in solid projection.



Isometric Scale
In the isometric projection of a cube shown in Fig.9.2, the top face ABCD is sloping away from the observer and hence the edges of the top face will appear fore-shortened. The true shape of the triangle DAB is represented by the triangle DPB.





The extent of reduction of an isometric line can be easily found by construction of a diagram called **isometric scale**. For this, reproduce the triangle DPA as shown in Fig.9.3. Mark the divisions of the true length on DP. Through these divisions draw vertical lines to get the corresponding points on DA. The divisions of the line DA give dimensions to isometric scale. From the triangle ADO and PDO in the given above figure, the ratio of the isometric length to the true length, i.e., DA/DP = cos 45°/cos30° = 0.816. The isometric axes are reduced in the ratio 1:0.816 i.e., 82% approximately.

6. PROCEDURE:

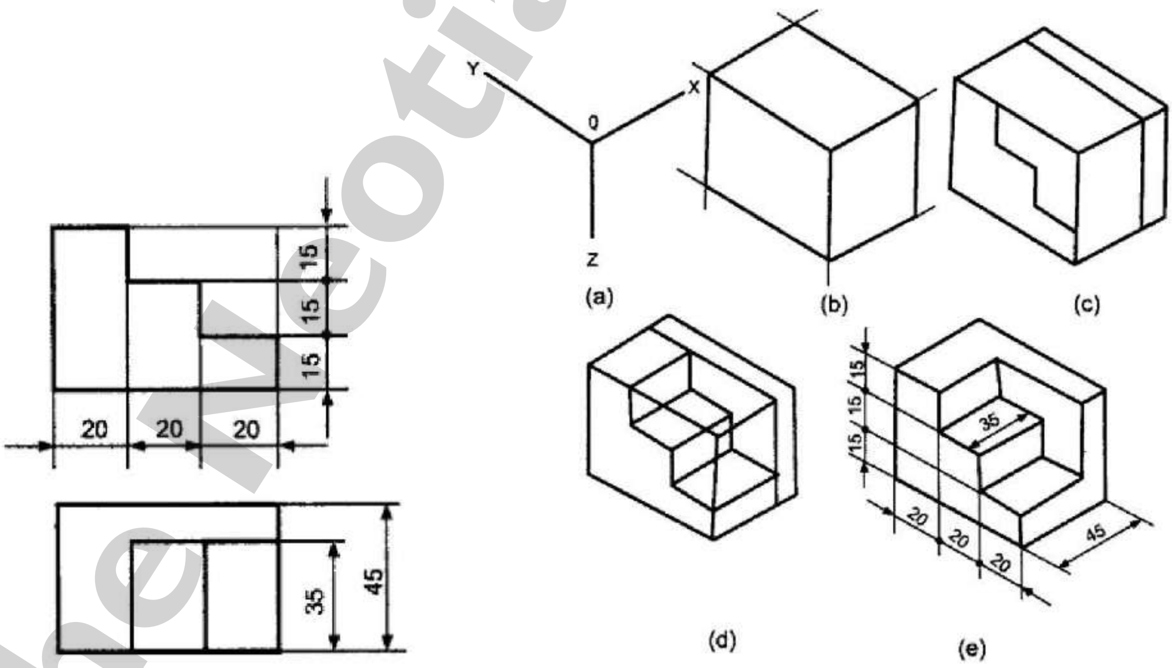
Isometric Projection and Isometric View

When the three-dimensional figure is drawn taking the isometric length then it is called Isometric Projection whereas when the three-dimensional figure is drawn taking the true length then it is called Isometric View.

The isometric view of figure is slightly larger (approximately 22%) than the isometric projection. As the proportions are the same, the increased size does not affect the pictorial value of the representation and at the same time, it may be done quickly. If an object having spherical shape then we have to follow the isometric projection

Steps to be followed to make isometric drawing from orthographic views are given below

(i) Study the given views and note the principal dimensions and other features of the object.
(ii) Draw the isometric axes (a).
(iii) Mark the principal dimensions to-their true values along the isometric axes(b).
(iv) Complete the housing block by drawing lines parallel to the isometric axes and passing through the above markings(c).
(v) Locate the principal corners of all the features of the object on the three faces of the housing block(d).
(vi) Draw lines parallel to the axes and passing through the above points and obtain the isometric drawing of the object by darkening the visible edges(e).



Problem: Draw the isometric projection of a circular plane of diameter 60mm whose surface is (a) Horizontal and (b) Vertical-use Four-centre method

Solution:

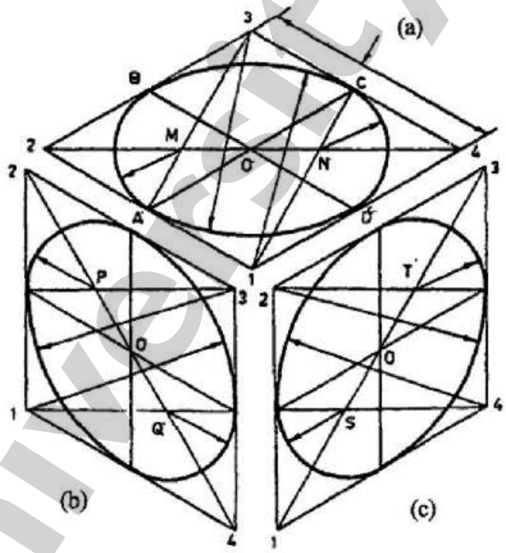
(i) Draw the isometric projection of the square 1-2-3-4 (rhombus) whose length of side is equal to the isometric length of the diameter of the circle = 0.82 x 60.

(ii) Mark the mid points A, B, C and D of the four sides of the rhombus. Join the points 3 and A. This line intersects the line 2-4 joining the point 2 and 4 at M. Similarly obtain the intersecting point N.

(iii) With centre M and radius = MA draw an arc AB. Also draw an arc CD with centre N.

(iv) With centre 1 and radius = 1C, draw an are BC. Also draw the arc AD.

(v) The ellipse ABCD is the required isometric projection of the horizontal circular plane. Similarly obtain the isometric projection in the vertical plane as shown in the figure.



Problem: A hexagonal prism of base of side 30mm and height 60mm is resting on its base on H.P. Draw the isometric drawing of the prism.

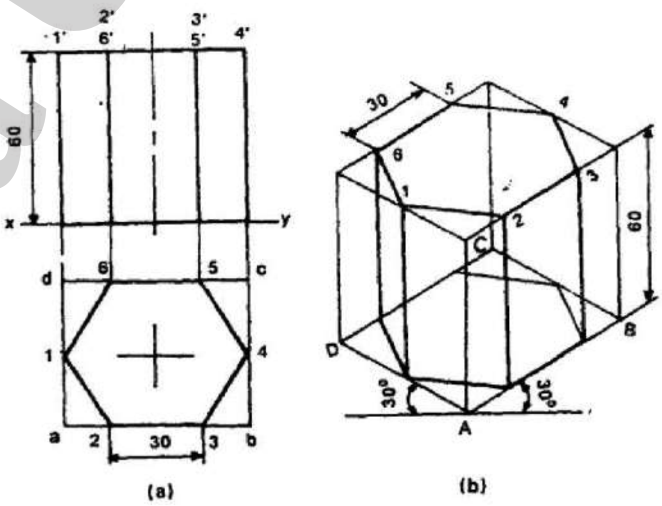
Solution:

(i) Draw the orthographic views of the prism as shown in figure below.

(ii) Enclose the views in a rectangle (i.e. the top view – base - and front views).

(iii) Determine the distances (off-sets) of the corners of the base from the edges of the box.

(iv) Join the points and darken the visible edges to get the isometric view.



7. SAFETY: Not applicable

8. DISPOSAL: Not applicable

9. REPORT/ ASSIGNMENT:
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.

1. EXPERIMENT NO: ES-MEP101/09
2. NAME OF THE EXPERIMENT: LEARNING AutoCAD

3. OBJECTIVE:

Accuracy: The drawings are not useful to the maximum extent if they are not accurate.
Speed: "Convert Time into Money" in industry. There is no place for the slow technician, or engineer. Speed is not attained in a hurry; it should be with intelligent and continuous work. It comes with practice.
Legibility: Drawing is a means of communication to others, and that it should be clear and legible to serve its purpose. Care should be taken especially in dimensioning and lettering.
Neatness: If a drawing is to be acceptable it should be clean and neat because even small dust particle can act as smallest entity as point.

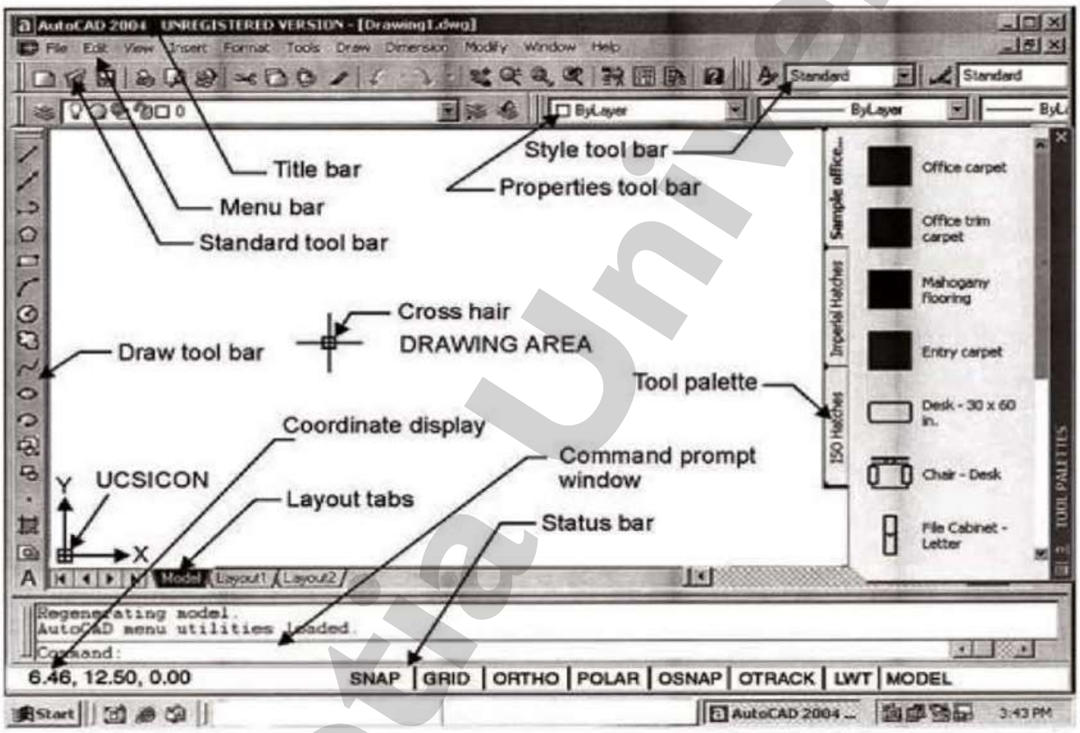
4. TOOLS/ APPARATUS:
Computer, AutoCAD software.

5. PROCEDURE:

Starting AutoCAD:
Once AutoCAD 2004/05 software is located on to the computer and the operating system is available, one can start using the facility. Soon the computer is turned on, the operating system is automatically loaded. Various application icons appear on the windows screen. AutoCAD can be started by double-clicking on the AutoCAD icon available on the desktop of the computer.
The various components of the initial AutoCAD screen are as shown in figure below consisting of:
Drawing Area: The drawing area covers a major portion of the screen. Various objects can be drawn in this region by the use of AutoCAD commands. The position of the pointing device is represented on the screen by the cursor. On the lower left corner, a coordinate system icon is present. On the top right corner, standard windows buttons are also available.
Command Window: At the bottom of the drawings area, command window is present and commands can be entered by keyboard.
Status Bar At the bottom of the screen, status bar is displayed, which will make it easy to change the status of some AutoCAD functions by proper selection.
Standard Tool Bar: Standard tool bar displays coordinates and they will change only when a point is specified. The absolute coordinates of the cursor will be specified with respect to the origin.
Snap: Snap mode allows the cursor to be moved in specified/fixed increments.
Grid: By choosing this button, grid lines are displayed on the screen and can be used as reference lines to draw AutoCAD objects.
Ortho: By selecting the orthomode, lines can be drawn only at right angles on the screen.
Polar: The movement of the cursor is restricted along a path based on the angle set as the polar angle. One can use either polar mode or orthomode only at a particular time.
Keyboard: Using keyboard, command name can be typed at the command prompt and by pressing ENTER or SPACE BAR, the command can be invoked.
Menu: The menu bar is at the top of the screen which displays the menu bar titles. As the cursor is moved over this, various titles are highlighted and by means of pick button, a desired item can be chosen. Once it is selected, the corresponding menu is displayed directly under the title. A command can be invoked by picking from this.
Draw Toolbar: This is an easy and convenient way to invoke a command. This is displayed on the left extreme of the initial AutoCAD screen and very easy to choose by picking.
Tool Palettes: These are shown on the right side of the monitor screen. An easy and convenient way of placing blocks/patterns of hatching in the present drawing. By default, AutoCAD displays the tool palettes on the right of the drawing area. Various hatching patterns also can be selected from this.

One can also use function keys for quick access to certain commands. Only important functions defined by AutoCAD 2004 are given below:

Function Key	*Function*
F1	Online help
F2	Toggles between command window on and off
F5	Switches among Isoplanes Top, right and left
F6	Toggles between coordinates on and off
F7	Toggles between grid on and off
F8	Toggles between orthomode on and off
F9	Toggles between snap mode on and off
F10	Toggles between Polar tracking on and off



Basic Geometric Command:

Drawing Entity-Point

The point command locates a point in the drawing.

Command: POINT (one has to give the location)

POINT: 25, 45 location of the point. Thus, a point is placed at the given location (25, 45). After setting the limits of the drawing, the following drawing aids/tools may be used to locate specific points on the screen (electronic drawing sheet).

ORTHO Command—this is orthogonal drawing mode. This command constrains the lines drawn in horizontal and vertical direction only.

Command: ORTHO

ON/OFF <current>:

SNAP Command—this command is used to set increments for cursor movement. If the screen is on SNAP mode, the cursor jumps from point to point only. The cursor movement can be effectively controlled using the SNAP command. This is useful for inputting the data through digitizer/mouse.

Command: SNAP

Snap spacing or ON/OFF/Aspect/Locate/Style <current>: 0.1 (default)

GRID Command-working on a plain drawing area is difficult since there is no means for the user to understand or correlate the relative positions or straightness of the various objects made in the drawing. The command enables to draw dotted lines on the screen at pre-defined spacing. These lines will act as graph for reference lines in the drawing. The grid spacing can be changed at will. The grid dots do not become part of the drawing.

Command: GRID

Grid spacing or ON/OFF/Snap/Aspect <0>: 0.5 (default)

Function keys may create drawing aids/tools also. The function keys F7, F8 and F9 act as toggle keys for turning ON or OFF of GRID, ORTHO and SNAP tools respectively.

HELP Command—AutoCAD provides with complete help at any point of working in the program. HELP can be obtained for any of the individual commands. Most of the information required by the user is generally provided by the help which is always instantaneous.

SAVE Command—AutoCAD provides the following commands to save the work/drawing on the hard disk/floppy diskette:

SAVE SAVEAS QSAVE

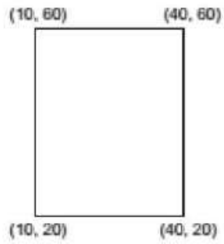
Command: SAVE

Save drawing as <current name>: KLNI

Drawing Entity-Line

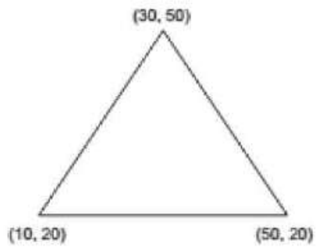
Lines can be constrained to horizontal/ vertical by the ORTHO commands. CLOSE option uses the starting point of the first line segment in the current LINE command as the next point.

1. Lines can be drawn using co-ordinate system (rectangular cartesian co-ordinates). To draw a rectangle:



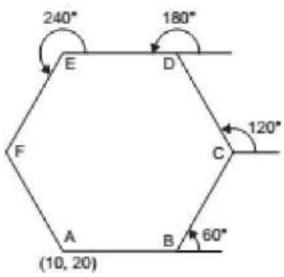
Command: LINE
From point: 10, 20 ↵
To point: 40, 20 ↵
To point: 40, 60 ↵
To point: 10, 60 ↵
To point: ↵

2. It is also possible to specify the co-ordinates in the incremental format as the distances from the current cursor position in the drawing area. The distance is specified by using the @ parameter before the actual value. To construct a triangle of given altitude (30) and base (40):



Command: LINE
From Point: 10, 20 ↵
To point: @ 40, 0 ↵
To point: @ – 20, 30 ↵
To point: ↵

3. It is also possible to specify the point co-ordinate using the ploar co-ordinate format. To construct a hexagon of side 30:



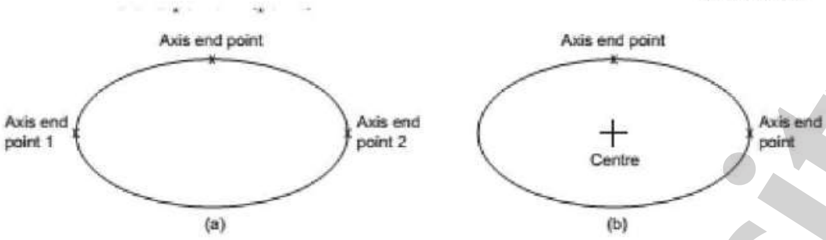
Command: LINE
From point: 10, 20 ↵(A)
To point: @ 30<0 ↵ (B)
To point: @ 30<60 ↵ (C)
To point: @ 30<120 ↵ (D)
To point: @ 30<180 ↵ (E)
To point: @ 30<240 ↵(F)
To point: close

Drawing Entity-Ellipse

This command allows one to draw ellipses or egg shaped objects. From Release 13 onwards, ellipse is treated as a separate entity. The methods available for making ellipses are:

1. By means of axis end points: (Fig.a)

Command: ELLIPSE <axis end point 1>/ center: point ↵
Axis end point 2: (point)



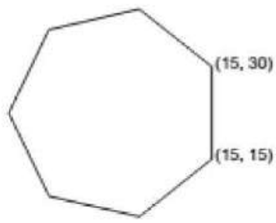
<other axis distance>/ Rotation:
Now, if the distance is entered, AutoCAD interprets it as half the length of the other axis.
2. By means of centre, axis end points (Fig.b)
Command: ELLIPSE <axis end point 1>/ centre: C ↵
Centre point and one end point of each axis should be provided for the response of the AutoCAD.

Drawing Entity-Polygon

This option permits to make/draw polygons from 3 to 24 sides in a number of ways:
1. For making inscribed/circumscribed polygon with a side parallel to x-axis: (Fig.a, b)

(a) Inscribed (b) Circumscribed

Command: POLYGON
Number of sides: 8
Edge/ <centre of polygon>: 100, 200 ↵
Inscribed / circumscribed about a circle (I/C): I or C ↵
Radius of circle: 80
2. With edge option, specifying the size of the edge and orientation:



Command: POLYGON
Number of sides: 7
Edge/<center of polygon>: E ↵
First end point of edge: 15, 15 ↵
Second end point of edge: 15, 30 ↵
The above and various other entities that can be used for making an AutoCAD drawing may also be selected from the tool bar.

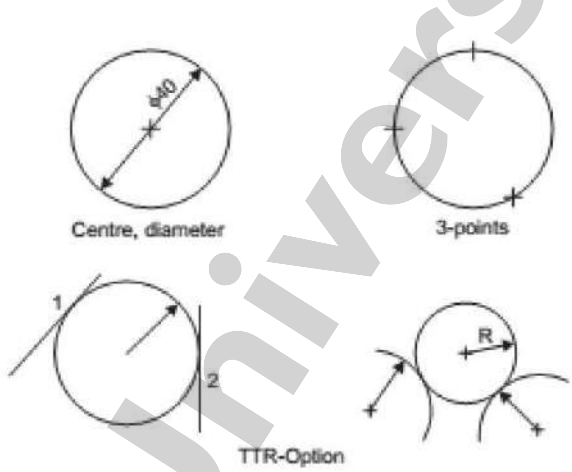
Drawing Entity-Rectangle

A rectangle is a polygon based on two opposite corner points, known as diagonal points.
Command: RECTANGLE
First corner: 10, 15 ↵
Second corner: 60, 50 ↵
Or from the tool bar menu icon, the pointing device can drag the rectangle and therectangle can be completed.

Drawing Entity-Circle

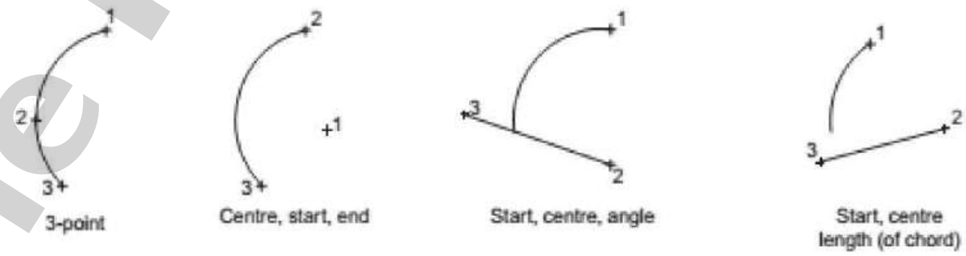
Circle command offers several methods for drawing circles, the default being to choose a centre point and enter or pick a diameter or radius.
Command: CIRCLE
1. 3P/ 2P/ TTR/ <centre point>:
Pick a centre point or enter an option
2. Diameter/ <Radius><current default>: select D or R

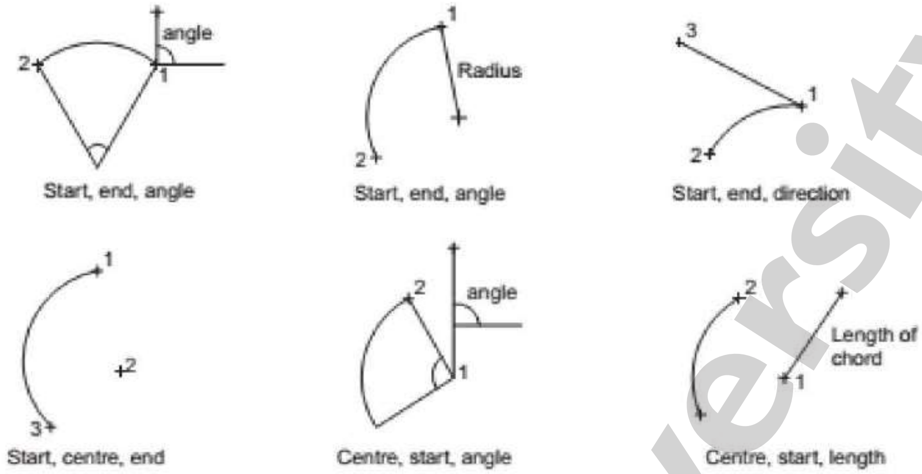
3. 3P (3 point) option: one is prompted for a first, second and third point. The circle willmbe drawn to pass through these points.
4. 2p (2 point) option: one is prompted for the selection of two points which form them opposite ends of the diameter.
5. TTR option: allows one to define a circle based on two tangent points and a radius. The tangent points can be on lines, arcs or circles.



Drawing Entity-Arc

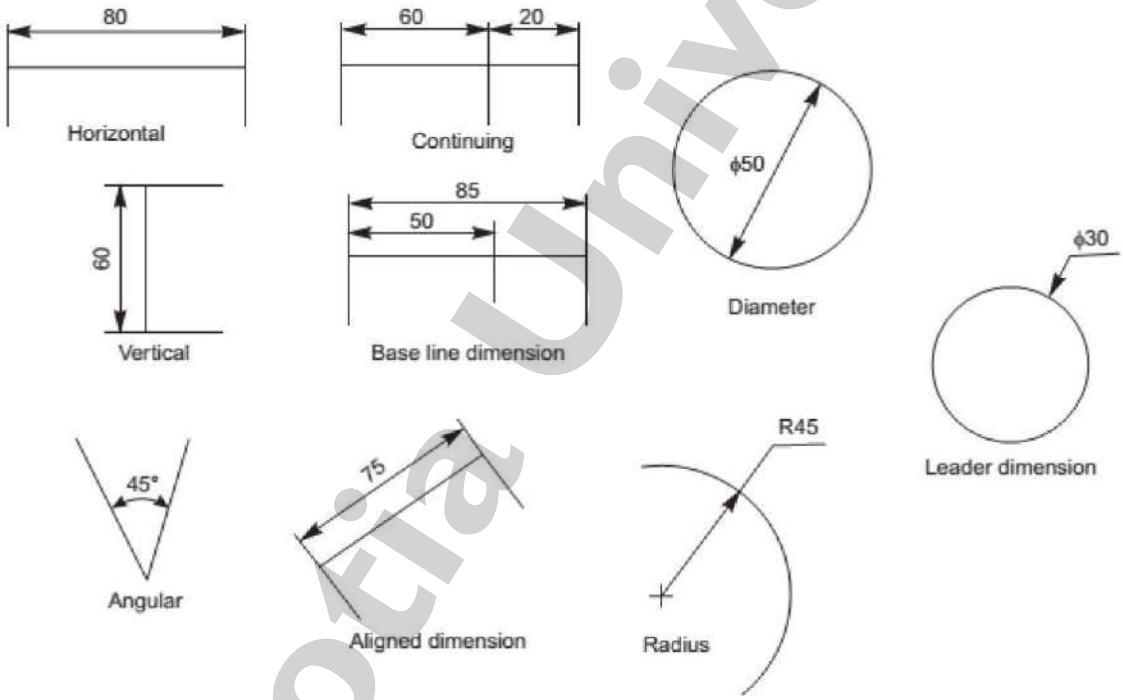
Arc command permits to draw an arc, using a variety of methods.
Command: ARC
1. Centre/ <start point>: pick a start point using mouse or select C for more options.
2. Centre/End/ <second point>: pick a second point of the arc or select C, if option is C.
3. Angle/length of chord/end point: pick end point of the arc, if option is E.
4. Angle/Direction/Radius/ <centre point>: pick end point of the arc or specify the option.
Angle —"included angle" prompt appears, to enter the value.
Centre — enter the location of an arc's centre point-at the prompt centre-pick a point,
Direction —enter a tangent direction from the starting point of an arc. At this prompt, pick a point with cursor.
End — at this prompt, pick the end point of the arc.
Length — enter the length of a arc's chord. At this prompt, enter a length or drag and pick a length with cursor.
Radius — at the prompt "radius", enter a radius value.
Start point — enter the beginning point of an arc.





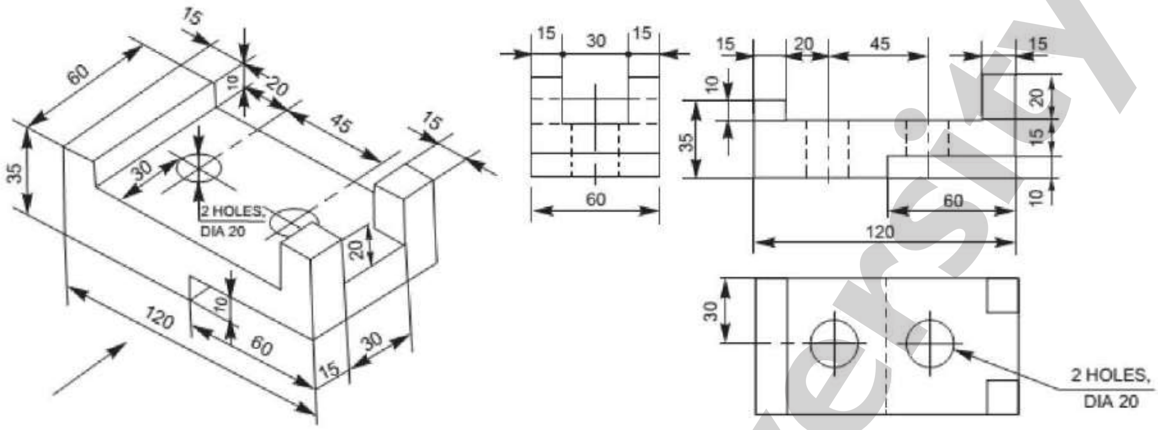
Edit Commands:
The commands used for modifying the drawings fall under this category. Using these commands, the objects may be erased, retrieved, moved to another location, made into multiple copies, rotated, enlarged, mirror imaged, part of a drawing may be moved and the above effects can also be reversed (undo).
ERASE Command—this lets the entities to be permanently removed from the drawing.
The command format is
Command: ERASE
Select objects: (desired objects) once it is entered, the objects/portion of the object is erased/ deleted.
OOPS Command—this restores the entities that have been inadvertently ERASED. Whenever ERASE command is used, a list of entities erased is retrieved by this command.
Command: OOPS
Once it is entered, it restores all the entities erased by the recent ERASE command. Once another ERASE is done, the list of entities erased by the previous ERASE command is discarded. OOPS cannot be used to restore them.
AutoCAD allows backup step by step to an earlier point in an editing session, using the UNDO command. This stores all the sequences made by the user in the current drawing session.
UNDO Command—this command allows to undo several commands at once. This command is used for correcting any errors made in the editing process. When a SAVE option is used, then the UNDO cannot do anything before that.
Command: UNDO
If the response contains a number, that many number of preceding operations will be undone.
REDO Command—if REDO is entered immediately after a command that undoes something, it will undo the UNDO.
Command: REDO
An UNDO after REDO will redo the original UNDO.
OFFSET Command—this constructs an entity parallel to another entity at either a specified distance or through a specified point.
MIRROR Command—this allows to mirror the selected entities in the drawing. The original objects can be deleted (like a move)/retained (like a copy).
MOVE Command—the move command is used to move one/more existing drawing entities from one location in the drawing to another.
COPY Command—this is used to duplicate one or more existing drawing elements at another location without erasing the original.

Basic Dimensioning:
In many applications, a drawing should contain annotations showing lengths or distances or angles between objects to convey the desired information. Dimensioning is the process of adding these annotations to a drawing. AutoCAD provides four basic types of dimensioning; linear, angular, diameter and radius.
DIM and DIMI Commands—DIMI command allows executing one dimensioning command and then returns to the normal command mode. If several dimensioning commands are to be executed, DIM command should be used. In this mode, the normal set of AutoCAD commands is replaced by a special set of dimensioning commands. To end the process of dimensioning, EXIT command has to be used.
The dimensioning commands can be grouped into six categories:
1. Linear — is done with a horizontal, vertical, aligned and rotated command. However, rotated command requires specifying the dimension line angle explicitly.

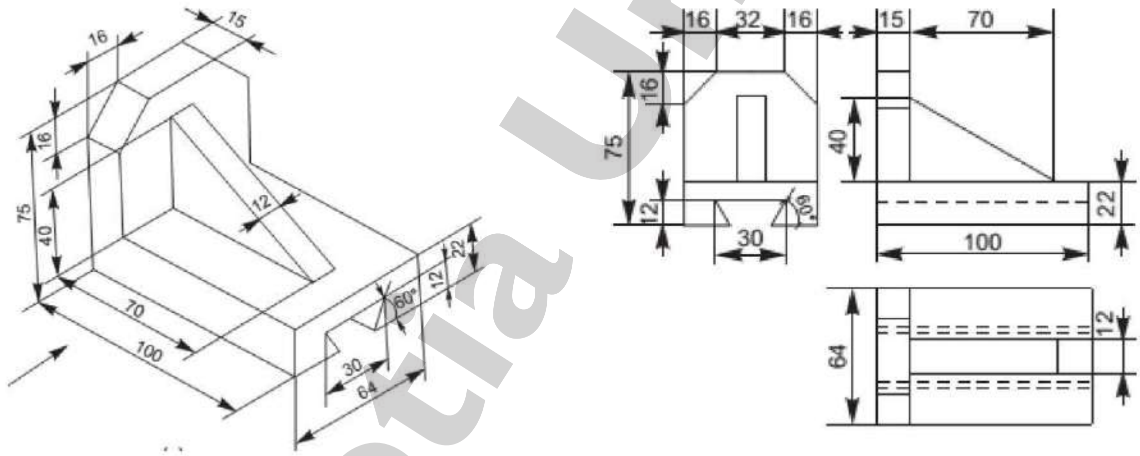


2. Angular — is used to dimension angles. Here, one has to select two non-parallel lines to introduce the angular dimension.
3. Diameter — this can be invoked for dimensioning arcs and circles.
4. Radius — it is almost identical to diameter dimensioning, except that only a radius line is drawn. This line has only one arrow.
5. Associative — used to make various changes to associative dimension entities.
6. Dimensioning utility commands — to draw a centre line or centre mark for a circle/arc, this command is used. AutoCAD generally uses same type of dimensions and dimension label components as standard draughting. Figure 21.19 gives examples of types of dimensions possible: linear, angular, diametric, radial and aligned. A number of variables such as extension lines, text location, tolerance specifications, arrow styles and sizes, etc., actually control the way in which the dimensions may appear in the drawings.

Problem 1:



Problem 2:



6. SAFETY: Not applicable

7. DISPOSAL: Not applicable

8. REPORT/ ASSIGNMENT:
Make a title block leaving 20mm distances from every corner of your drawing sheet (565mm X 765mm). Student will have to draw and submit the given home assignment on the said format to the next class.