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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – I – Construction of Plane Curves – SCIA1103

I. Introduction and Construction of Plane Curves

Engineering drawing is a two dimensional representation of three dimensional objects. In general, it provides necessary information about the shape, size, surface quality, material, manufacturing process, etc., of the object. It is the graphic language from which a trained person can visualize objects.

Drawing Instruments and aids:

The Instruments and other aids used in drafting work are listed below:

- Drawing board
- Set squares
- French curves
- Templates
- Mini drafter
- Instrument box
- Protractor
- Set of scales
- Drawing sheets
- Pencils

Drawing Board:

Until recently drawing boards used are made of well seasoned softwood of about 25 mm thick with a working edge for T-square. Nowadays mini-drafters are used instead of T-squares which can be fixed on any board. The standard size of board depends on the size of drawing sheet size required.

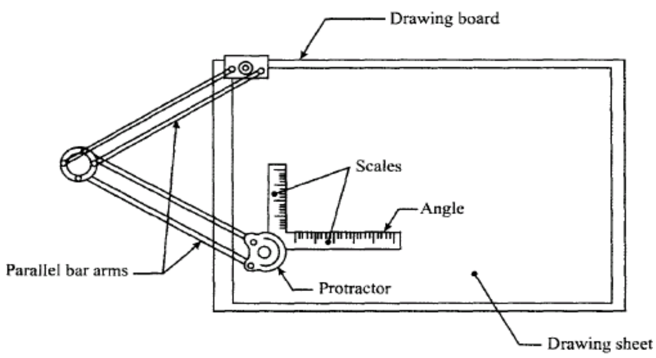


Fig. 1.1 Mini-draughter

Mini-Drafter:

Mini-drafter consists of an angle formed by two arms with scales marked and rigidly hinged to each other .It combines the functions of T-square, set-squares, scales and protractor. It is used for drawing horizontal, vertical and inclined lines, parallel and perpendicular lines and for measuring lines and angles.

Instrument Box

Instrument box contains 1. Compasses, 2. Dividers and 3. Inking pens.
What is important is the position of the pencil lead with respect to the tip of the compass. It should be at least 1 mm above as shown in the fig. because the tip goes into the board for grip by 1 mm.

(a) Sharpening and position of compass lead

(b) Position of the lead leg to draw larger circles

Figure.1.2

Pencils:

Pencils with leads of different degrees of hardness or grades are available in the market. The hardness or softness of the lead is indicated by 3H, 2H, H, HB, B, 2B, 3B, etc. The grade HB denotes medium hardness of lead used for general purpose. The hardness increases as the value of the numeral before the letter H increases. The lead becomes softer, as the value of the numeral before B increases.

- HB Soft grade for Border lines, lettering and free sketching
- H Medium grade for Visible outlines, visible edges and boundary lines
- 2H Hard grade for construction lines, Dimension lines, Leader lines, Extension lines, Centre lines, Hatching lines and Hidden lines.

Drawing Sheet:

The standard drawing sheet sizes are arrived at on the basic Principal of x: y = 1: 2^ (1/2) and xy = 1 where x and y are the sides of the sheet. For example AO, having a surface area of 1 Sq.m; x = 841 mm and y = 1189 mm. The successive sizes are obtained by either by halving along the length or doubling the width, the area being in the ratio 1: 2. Designation of sizes is given in the fig. For class work use of A2 size drawing sheet is preferred.

Designation	Dimension, mm Trimmed size
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

Table.1.1

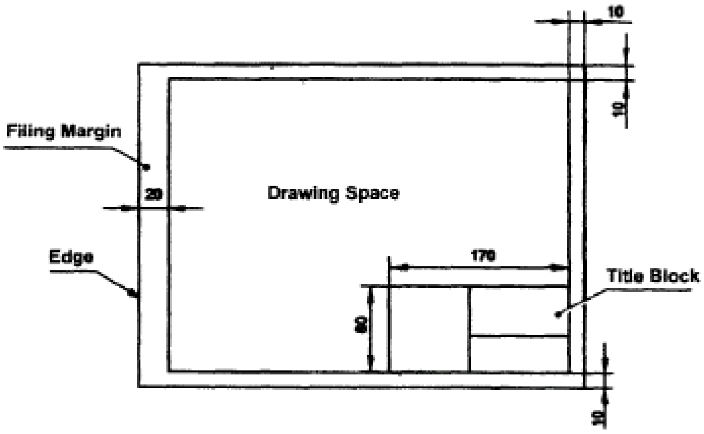


Figure .1.3

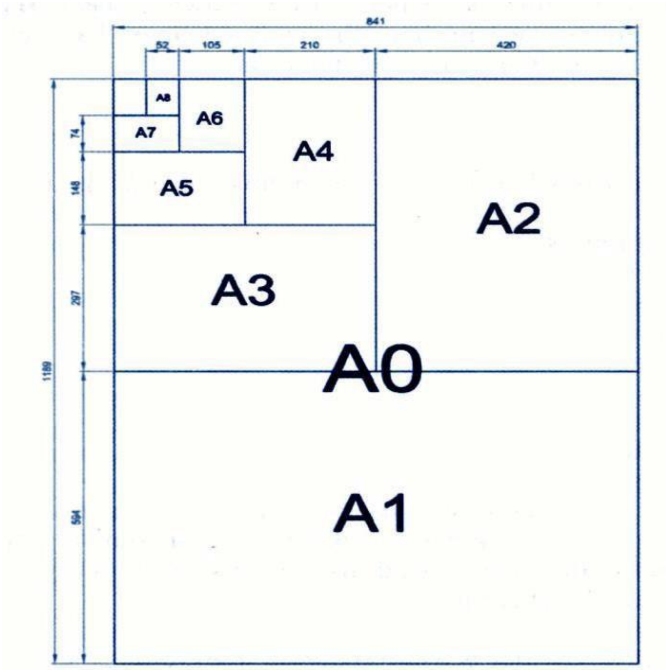


Figure.1.4

Title Block:

The title block should lie within the drawing space at the bottom right hand comer of the sheet. The title block can have a maximum length of 170 mm and width of 65mm providing the following information.

- Title of the drawing.
- Drawing number.
- Scale.
- Symbol denoting the method of projection.
- Name of the firm, and
- Initials of staff, who have designed, checked and approved.

Lines:

Just as in English textbook the correct words are used for making correct sentences; in Engineering Graphics, the details of various objects are drawn by different types of lines. Each line has a definite meaning and sense to convey.

- **Visible Outlines, Visible Edges:** (Continuous wide lines) the lines drawn to represent the visible outlines/ visible edges / surface boundary lines of objects should be outstanding in appearance.
- **Dimension Lines (Continuous narrow Lines):** Dimension Lines are drawn to mark dimension.
- **Extension Lines (Continuous narrow Lines):** There are extended slightly beyond the respective dimension lines.
- **Construction Lines (Continuous narrow Lines):** These are drawn for constructing drawings and should not be erased after completion of the drawing.
- **Hatching / Section Lines (Continuous Narrow Lines):** These are drawn for the sectioned portion of an object. These are drawn inclined at an angle of 45° to the axis or to the main outline of the section.
- **Guide Lines (Continuous Narrow Lines):** These are drawn for lettering and should not be erased after lettering.
- **Break Lines (Continuous Narrow Freehand Lines):**Wavy continuous narrow line drawn freehand is used to represent break of an object.
- **Break Lines (Continuous Narrow Lines With Zigzags):** Straight continuous narrow line with zigzags is used to represent break of an object.
- **Dashed Narrow Lines (Dashed Narrow Lines):**Hidden edges / Hidden outlines of objects are shown by dashed lines of short dashes of equal lengths of about 3 mm, spaced at equal distances of about 1 mm. the points of intersection of these lines with the outlines / another hidden line should be clearly shown.
- **Center Lines (Long-Dashed Dotted Narrow Lines):** These are drawn at the center of the drawings symmetrical about an axis or both the axes. These are extended by a short distance beyond the outline of the drawing.
- **Cutting Plane Lines:** Cutting Plane Line is drawn to show the location of a cutting plane. It is long-dashed dotted narrow line, made wide at the ends, bends and change of direction. The direction of viewing is shown by means of arrows resting on the cutting plane line.
- **Border Lines:** Border Lines are continuous wide lines of minimum thickness 0.7 mm.

No.	Line description and Representation	Applications
01.1	Continuous narrow line B	Dimension lines, Extension lines
		Leader lines, Reference lines
		Short centre lines
		Projection lines
		Hatching
		Construction lines, Guide lines
		Outlines of revolved sections
		Imaginary lines of intersection
01.1	Continuous narrow freehand line C	Preferably manually represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a center line[a].
01.1	Continuous narrow line with zigzags A	Preferably mechanically represented termination of partial or interrupted views, cuts and sections, if the limit is not a line of symmetry or a center line[a].
01.2	Continuous wide line	Visible edges, visible outlines
		Main representations in diagrams, maps, flow charts
02.1	Dashed narrow line D	Hidden edges
		Hidden outlines
04.1	Long-dashed dotted narrow line E	Center lines / Axes, Lines of symmetry
		Cutting planes (Line 04.2 at ends and changes of direction)
04.2	Long-dashed dotted wide line F	Cutting planes at the ends and changes of direction outlines of visible parts situated in front of cutting plane

Table 1.2

CONVENTIONAL REPRESENTATION OF MATERIALS

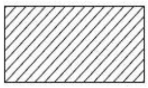
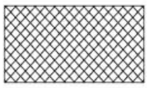
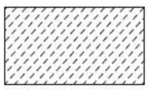
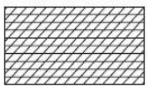
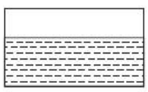
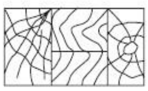
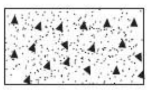
Type	Convention	Material
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its Alloys, etc.
		Lead, Zinc, Tin, White-metal, etc.
Glass		Glass
Packing and Insulating material		Porcelain, Stoneware, Marble, Slate, etc.
		Asbestos, Fibre, Felt, Synthetic resin products, Paper, Cork, Linoleum, Rubber, Leather, Wax, Insulating and Filling materials, etc.
Liquids		Water, Oil, Petrol, Kerosene, etc.
Wood		Wood, Plywood, etc.
Concrete		A mixture of Cement, Sand and Gravel

Table 1.3

LETTERING

Lettering is defined as writing of titles, sub-titles, dimensions, etc., on a drawing.

Importance of Lettering:

To undertake production work of an engineering component as per the drawing, the size and other details are indicated on the drawing. This is done in the form of notes and dimensions. Main Features of Lettering are legibility, uniformity and rapidity of execution. Use of drawing instruments for lettering consumes more time. Lettering should be done freehand with speed. Practice accompanied by continuous efforts would improve the lettering skill and style. Poor lettering mars the appearance of an otherwise good drawing.

Size of Letters:

- Size of Letters is measured by the height h of the CAPITAL letters as well as numerals.
- Standard heights for CAPITAL letters and numerals recommended by BIS are given below: 1.8, 2.5, 3.5, 5, 6, 10, 14 and 20 mm

Note: Size of the letters may be selected based upon the size of drawing.

Guide Lines:

In order to obtain correct and uniform height of letters and numerals, guide lines are drawn, using 2H pencil with light pressure. HB grade conical end pencil is used for lettering.

The following are some of the guide lines for lettering

- Drawing numbers, title block and letters denoting cutting planes, sections are written in 10 mm size.
- Drawing title is written in 7 mm size.
- Hatching, sub-titles, materials, dimensions, notes, etc., are written in 3.5 mm size.
- Space between lines = 3/4 h
- Space between words may be equal to the width of alphabet M or 3/5 h.

Procedure for Lettering:

1. Thin horizontal guide lines are drawn first at a distance ' h' apart.
2. Lettering Technique: Horizontal lines of the letters are drawn from left to right. Vertical, Inclined and curved lines are drawn from top to bottom.
3. After lettering has been completed, the guidelines are not erased.

Specifications	Value	Size						
Capital Letter Height	h	2.5	3.5	5	7	10	14	20
Lowercase Letter Height	a = (5/7) h	-	2.5	3.5	5	7	10	14
Thickness of Lines	b = (1/14) h	0.18	0.25	0.35	0.5	0.7	1	1.4
Spacing between Characters	c = (1/7) h	0.35	0.5	0.7	1	1.4	2	2.8
Min.Spacing between words	d = (3/7) h	1.05	1.5	2.1	3	4.2	6	8.4
Min. Spacing between Base Lines	e = (10/7) h	3.5	5	7	10	14	20	28

Table.1.4

Recommended Size (height h) of Letters / Numerals	
Main Title	5 mm, 7 mm, 10 mm
Sub-Titles	3.5 mm, 5 mm
Dimensions, Notes, etc.	2.5 mm, 3.5 mm, 5 mm

Table.1.5

Dimensioning:

Drawing of a component, in addition to providing complete shape description, must also furnish Information regarding the size description. These are provided through the distances between the Surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these Features on a drawing, using lines, symbols, figures and notes is called dimensioning.

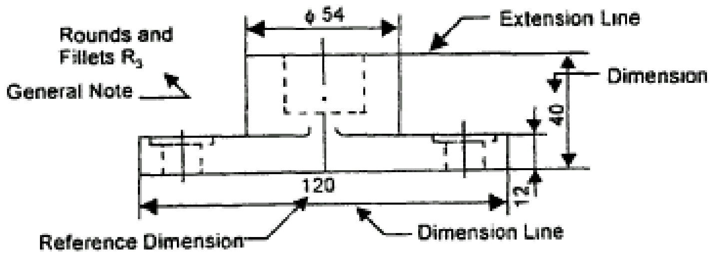


Figure.1.5

GEOMETRICAL CONSTRUCTIONS

Introduction:

Engineering drawing consists of a number of geometrical constructions. A few methods are illustrated here without mathematical proofs.

1. ***a) To divide a straight line into a given number of equal parts say 5.***

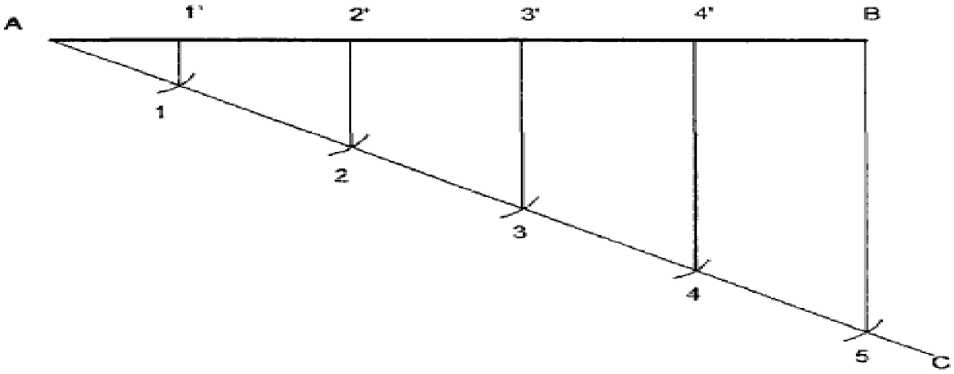


Figure.1.6

Construction:

1. Draw AC at any angle θ to AB
2. Construct the required number of equal parts of convenient length on AC like 1,2,3.
3. Join the last point 5 to B
4. Through 4, 3, 2, 1 draw lines parallel to 5B to intersect AB at 4',3',2' and 1'.

CONIC SECTIONS

Cone is formed when a right angled triangle with an apex and angle is rotated about its altitude as the axis. The length or height of the cone is equal to the altitude of the triangle and the radius of the base of the cone is equal to the base of the triangle. When a cone is cut by a plane, the curve formed along the section is known as a conic.

a) CIRCLE:

When a cone is cut by a section plane A-A making an angle of 90° with the axis, the section obtained is a circle.

b) ELLIPSE:

When a cone is cut by a section plane B-B at an angle more than half of the apex angle less than 90°, the curve of the section is an ellipse. Its size depends on the angle and the distance of the section plane from the apex of the cone.

c) PARABOLA:

If the angle is equal to angle made when the section plane C-C is parallel to the slant side of the cone the curve at the section is a parabola. This is not a closed figure like circle or ellipse. The size of the parabola depends upon the distance of the section plane from the slant side of the cone.

d) HYPERBOLA:

If the angle is less than angle made when the section plane D-D, the curve at the section is hyperbola. The curve of intersection is hyperbola, provided the section plane is not passing through the apex of the cone. However if the section plane passes through the apex, the section produced is an isosceles triangle.

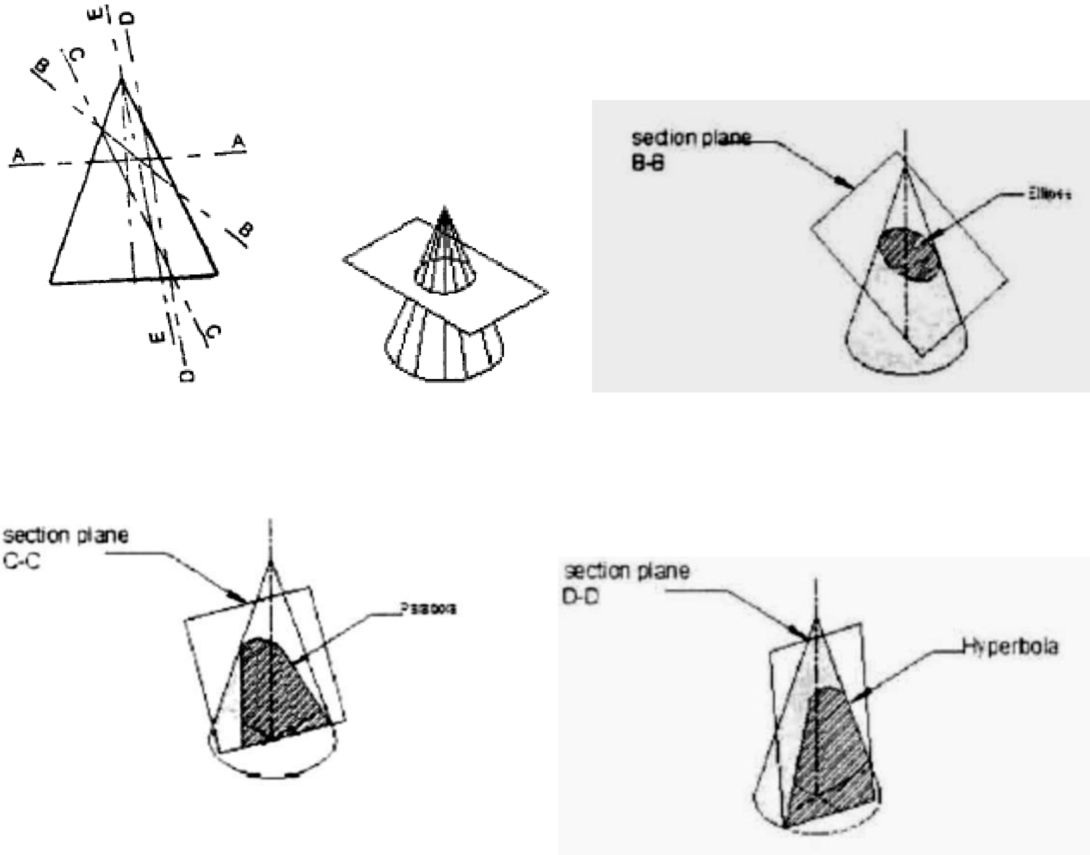


Figure.1.7

Eccentricity(e) :

a. If e=1, it is parabola
b. If e>1, it is hyperbola
c. If e<1, it is an ellipse

Where eccentricity e is the ratio of distance of the point from the focus to the distance of the point from the directrix.

PARABOLA:

In physical world, parabola are found in the main cables on simple suspension bridge, as parabolic reflectors in satellite dish antennas, vertical curves in roads, trajectory of a body, automobile head light, parabolic receivers.

Figure.1.8

To draw a parabola with the distance of the focus from the directrix at 50mm (Eccentricity method)

Construction:

1. Draw the axis AB and the directrix CD at right angles to it:
2. Mark the focus F on the axis at 50mm.
3. Locate the vertex V on AB such that AV = VF
4. Draw a line VE perpendicular to AB such that VE = VF
5. Join A, E and extend. Now, VE/VA = VF/VA = 1, the eccentricity.
6. Locate number of points 1, 2, 3, etc., to the right of V on the axis, which need not be equidistant.
7. Through the points 1, 2, 3, etc., draw lines perpendicular to the axis and to meet the line AE extended at 1',2',3' etc.
8. With centre F and radius 1-1', draw arcs intersecting the line through 1 at P1 and P`1
9. Similarly, locate the points P2, P`2, P3, P`3 etc., on either side of the axis. Join the points by smooth curve, forming the required parabola.

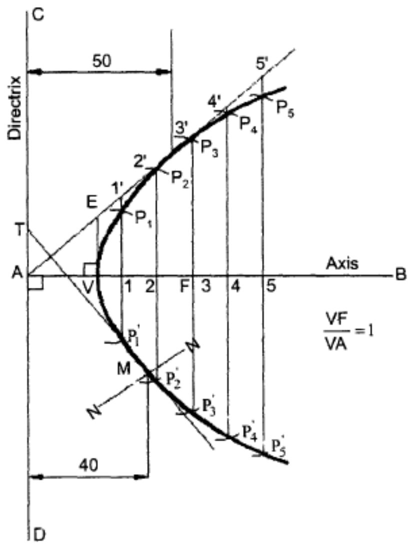


Figure.1.9

To draw a normal and tangent through a point 40mm from the directrix.

To draw a tangent and normal to the parabola. locate the point M which is at 40 mm from the directrix. Then join M to F and draw a line through F, perpendicular to MF to meet the directrix at T. The line joining T and M and extended is the tangent and a line NN, through M and perpendicular to TM is the normal to the curve.

ELLIPSE:

Ellipses are mostly found as harmonic oscillators, phase visualization, elliptical gears, ellipse wings.

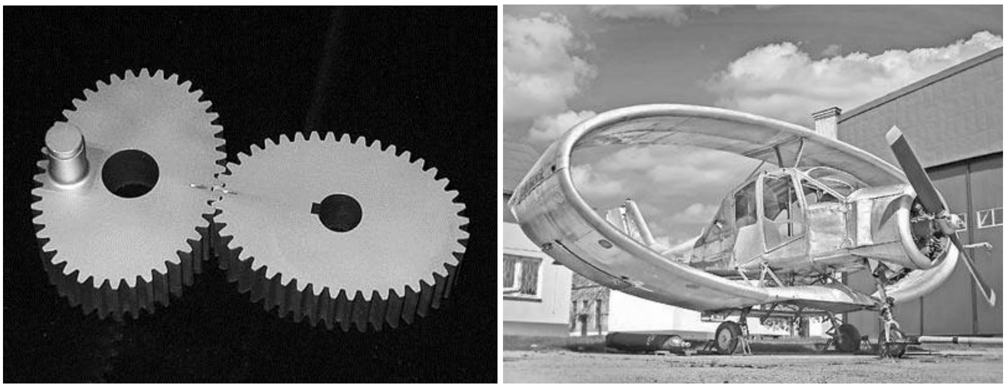


Figure.1.10

To draw an ellipse with the distance of the focus from the directrix at 50mm and eccentricity = 2/3 (Eccentricity method)

Construction:

1. Draw any vertical line CD as directrix.
2. At any point A in it, draw the axis.
3. Mark a focus F on the axis such that AF1=50mm.
4. Divide AF1 in to 5 equal divisions.
5. Mark the vertex V on the third division-point from A.
6. Thus eccentricity e= VF1/VA = 2/3.
7. A scale may now be constructed on the axis which will directly give the distances in the required ratio.
8. At V, draw a perpendicular VE = VF1. Draw a line joining A and E.
9. Mark any point 1 on the axis and through it draw a perpendicular to meet AE produced at 1'.
10. With centre F and radius equal to 1-1', draw arcs to intersect a perpendicular through 1 at points P1 and P'1.
11. Similarly mark points 2, 3 etc. on the axis and obtain points P2 and P'2, P3 and P'3, etc.
12. Draw the ellipse through these points, it is a closed curve two foci and two directrices.

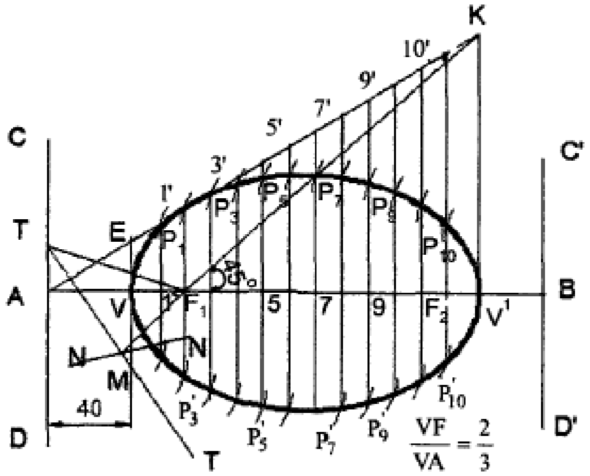


Figure.1.11

HYPERBOLA

Lampshades, gear transmission, cooling towers of nuclear reactors are some of the applications of Hyperbola.

Figure.1.11

To draw a hyperbola with the distance of the focus from the directrix at 50mm and e=3/2 (Eccentricity method)

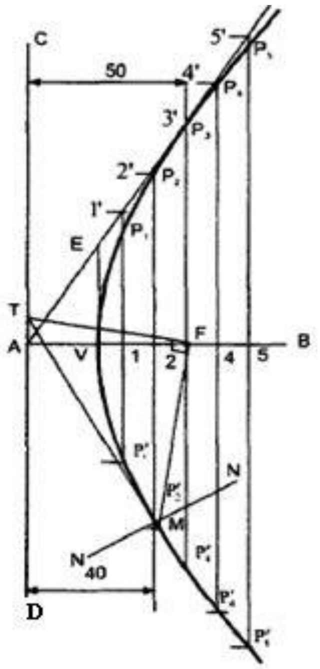


Figure.1.12

Construction:

1. Draw the directrix CD and the axis AB.
2. Mark the focus F on AB and 65mm from A.
3. Divide AF into 5 equal divisions and mark V the vertex, on the second division from A.
4. Draw a line VE perpendicular to AB such that VE=VF. Join A and E.
5. Mark any point 1 on the axis and through it, draw a perpendicular to meet AE produced at 1'.
6. With centre F and radius equal to 1-1', draw arcs intersecting the perpendicular through 1 at P1 and P'1.
7. Similarly mark a number of points 2, 3 etc and obtain points P2 and P'2, etc.

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UNIT – II – Projection of Points, Lines and Solids – SCIA1103

II. Projection of Points, Lines and Solids

Introduction

What is point?

An element which has no dimensions, it can be situated in the following positions with respect to principal planes of the projections.

- Point situated above H.P and in front of V.P.
- Point situated above H.P and behind V.P
- Point situated below H.P and behind V.P.
- Point situated below H.P and in front of V.P.
- Point situated on H.P and in front of V.P.
- Point situated above H.P and on V.P.
- Point situated on H.P and behind V.P.
- Point situated below H.P and on V.P.
- Point situated on both H.P and V.P.

Conventional Representation:

- Actual Position of a point designated by capitals i.e. A, B, C, D …
- Front view of a point is designated by small letters with dashes i.e. a’, b’, c’, d’….
- Top view of a point is designated by only small letters i.e. a, b, c, d ….
- Side view of a point is designated by small letters with double dashes i.e. a”, b”, c”, d”...

The Intersection of reference planes is a line known as reference line denoted by x-y and the line connecting the front and top view is known as projection line; it is always perpendicular to the principal axis (x-y line).

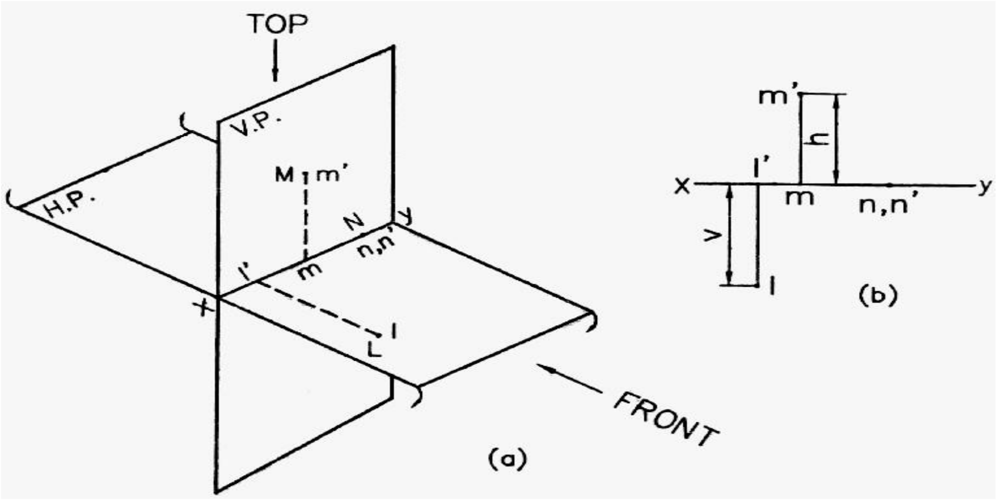

Figure 2.1

Problem:

1. Draw the orthographic projections of the following points?

(a) Point P is 30 mm. above H.P and 40 mm. in front of VP

(b) Point Q is 25 mm. above H.P and 35 mm. behind VP

(c) Point R is 32 mm. below H.P and 45 mm behind VP

(d) Point Sis 35 mm. below H.P and 42 mm in front of VP

(e) Point T is in H.P and 30 mm behind VP

(f) Point U is in V.P and 40 mm. below HP

(g) Point V is in V.P and 35 mm. above H.P

(h) Point W is in H.P and 48 mm. in front of VP

Solution:

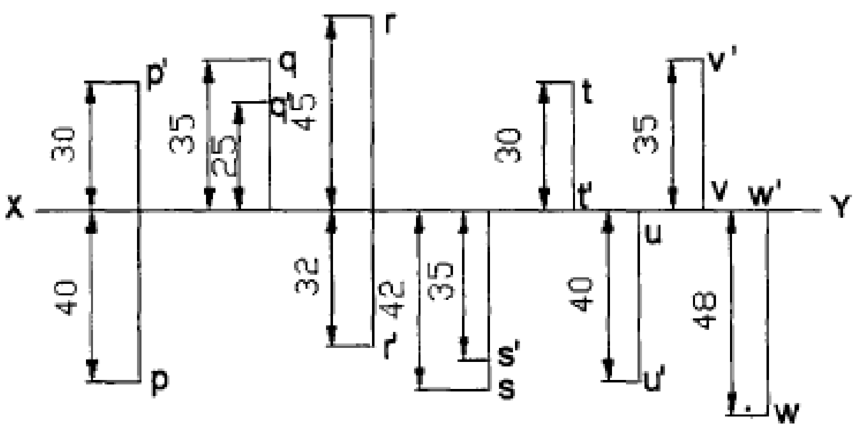

Figure 2.2

PROJECTION OF STRAIGHT LINES

Introduction

What is Line?

A Shortest distance between two points and the actual length of the line is known as True Length denoted by TL.

Orientation of Straight Lines

- Line parallel to both H.P and V.P
- Line perpendicular to H.P and parallel to V.P
- Line perpendicular to V.P and parallel to H.P
- Line inclined to H.P and parallel to V.P
- Line inclined to V.P and parallel to H.P
- Line situated in H.P
- Line situated in V.P
- Line situated in both H.P and V.P
- Line inclined to both the reference planes.
  1. Line inclined to both H.P and V.P front view angle and top view angle = 90 deg
  2. Line inclined to both H.P and V.P front view angle and top view angle = 90 deg

Problems

- **Line parallel to both H.P and V.P**

  A 50mm long line AB is parallel to both H.P and V.P. The line is 25mm in front of V.P and 60mm above H.P, draw the projections of the line.

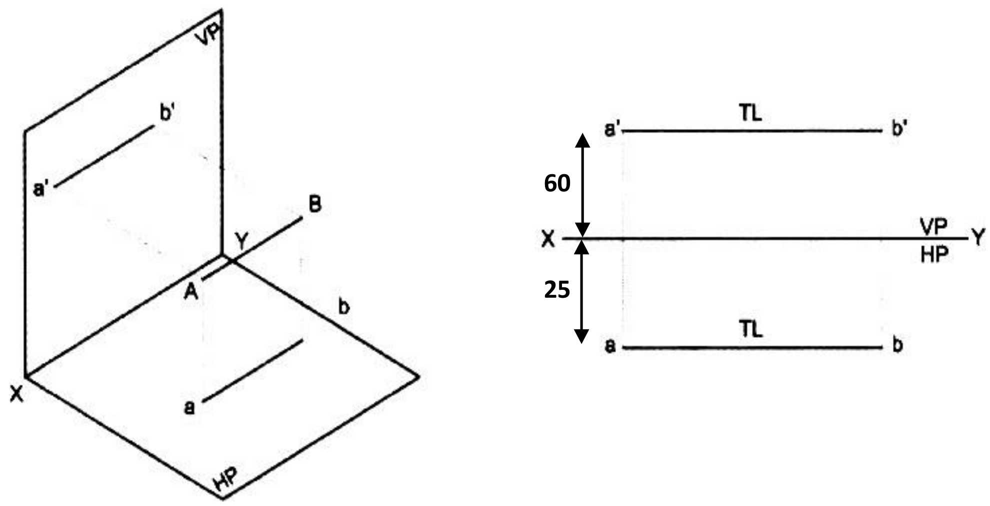

Figure 2.3

- **Line perpendicular to H.P**

A 60mm long line AB has its end A at a distance of 20mm above the H.P. The line is perpendicular to the H.P and 40mm in front of V.P, draw the projections of the line.

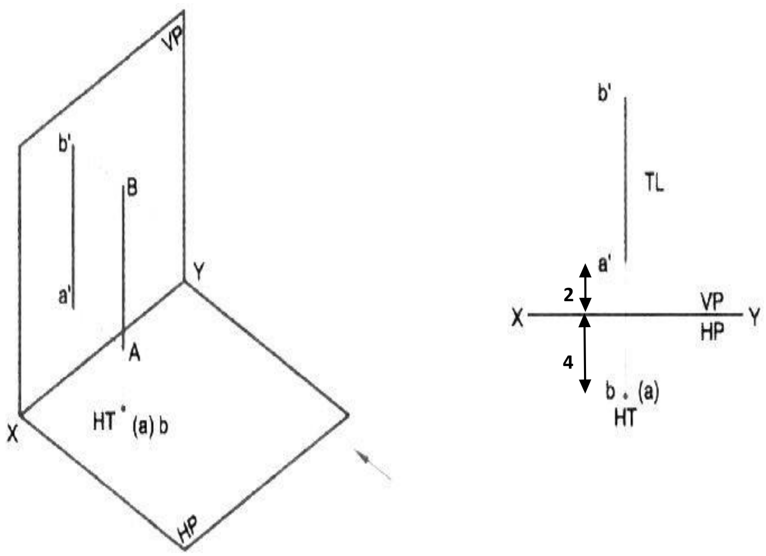

Figure 2.4

- **Line perpendicular to V.P**

  A 60mm long line AB, has its end A at a distance of 20mm in front of the V.P. the line is perpendicular to V.P and 40mm above H.P, draw the projection of the line.

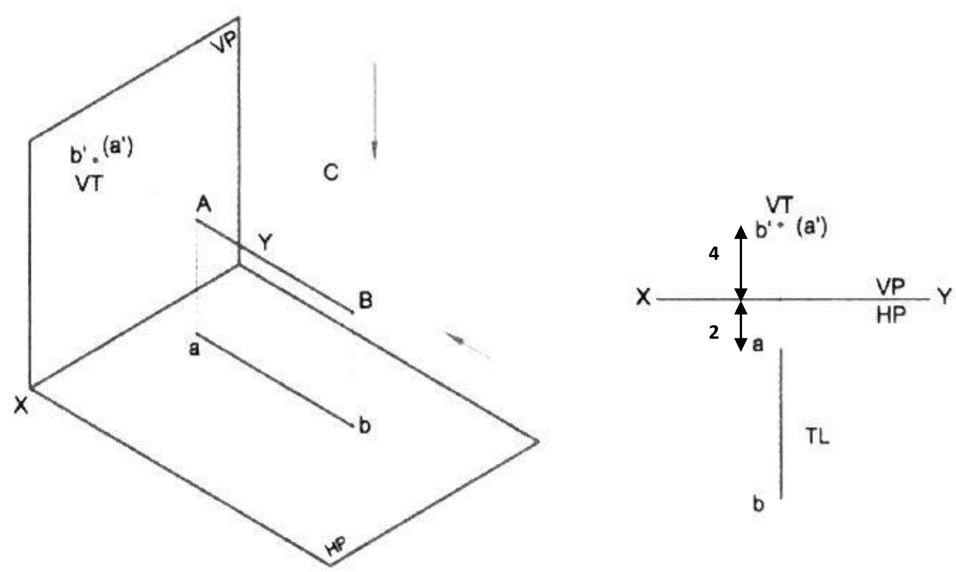

Figure 2.5

- **Line inclined to H.P and parallel to V.P**

  A 80mm long line AB has the end A at a distance of 20mm above HP and 40mm in front of V.P. The line is inclined at 30 deg to H.P and parallel to V.P, draw the projection of the line.

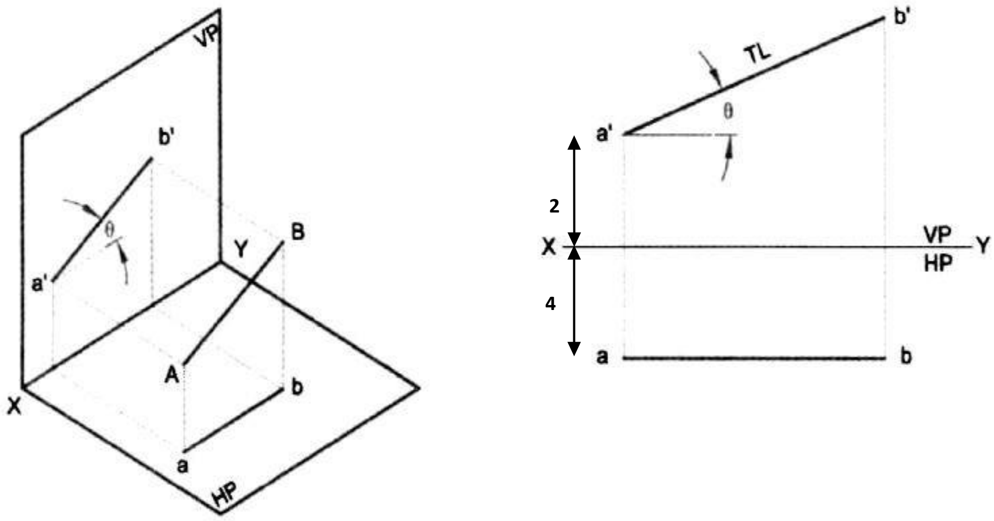

Figure 2.6

- **Line inclined to V.P and parallel to H.P**

  An 80mm long line AB is inclined at 30 deg to V.P and is parallel to H.P. The end A is 20mm above the H.P and 20mm in front of the V.P, draw the projection of the line.

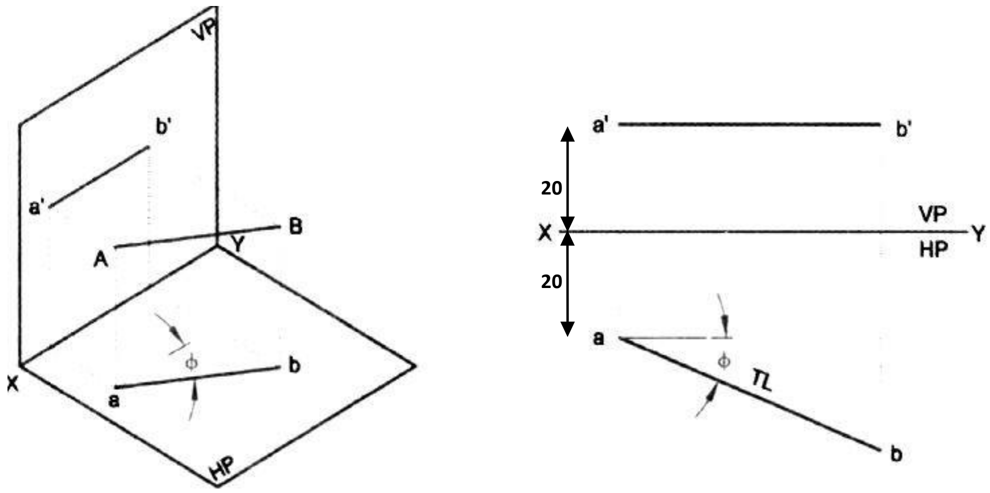

Figure 2.7

- **Line situated in H.P**

  A line AB 60mm long is situated in H.P and inclined to V.P at 30 deg. The end A is 20mm in front of V.P, draw the projection of line.

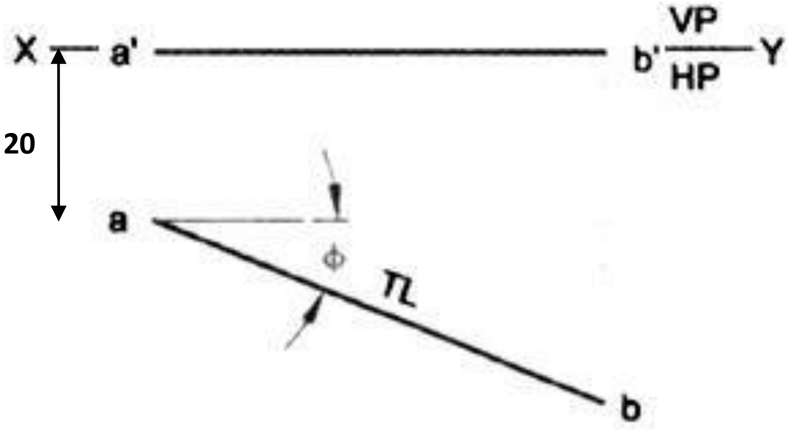

Figure 2.8

- **Line situated in V.P**

  Draw the projections of 70mm long line AB situated in the V.P and inclined at 30 deg to H.P. The end A is 25 mm above H.P.

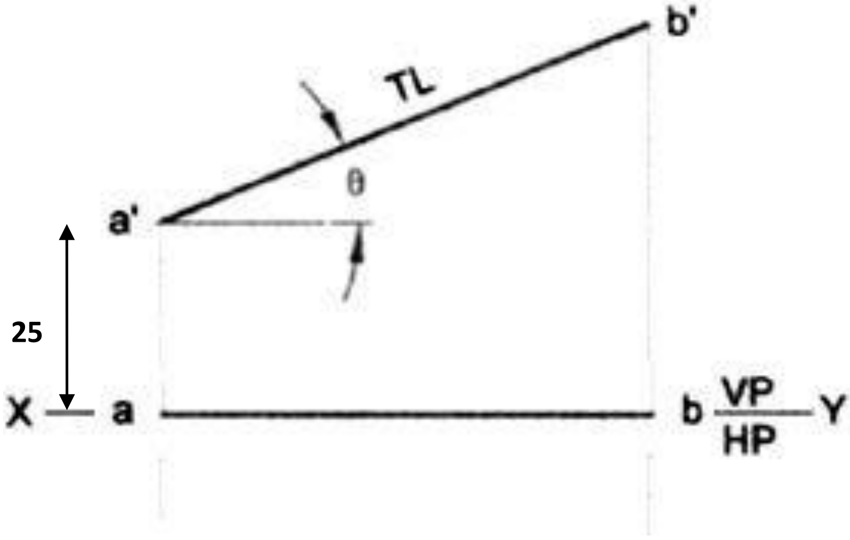

Figure 2.9

- **Lines inclined to both the reference planes.**

A 70mm long line AB has an end A at 20mm above H.P and 30mm in front of V.P. The line is inclined at 45 deg to the H.P and 30 deg to V.P, draw the projections.

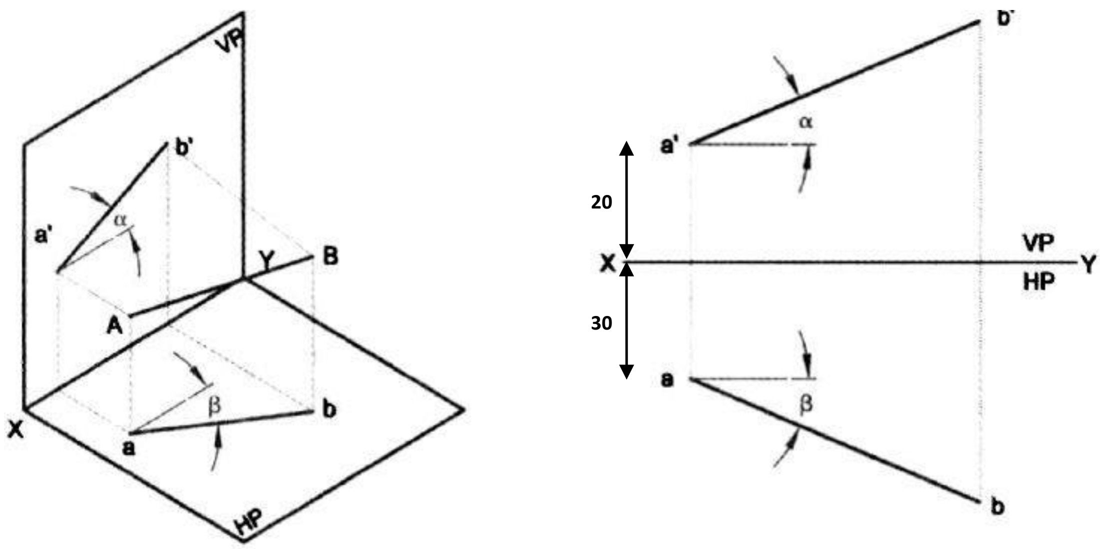

Figure 2.10

Problem:

The top view of a 75mm long line AB measures 65mm, while its front view measures 50mm. Its one end A is in HP and12mm in front of VP. Draw the projections of AB and determine its inclination with HP and VP

Solution:

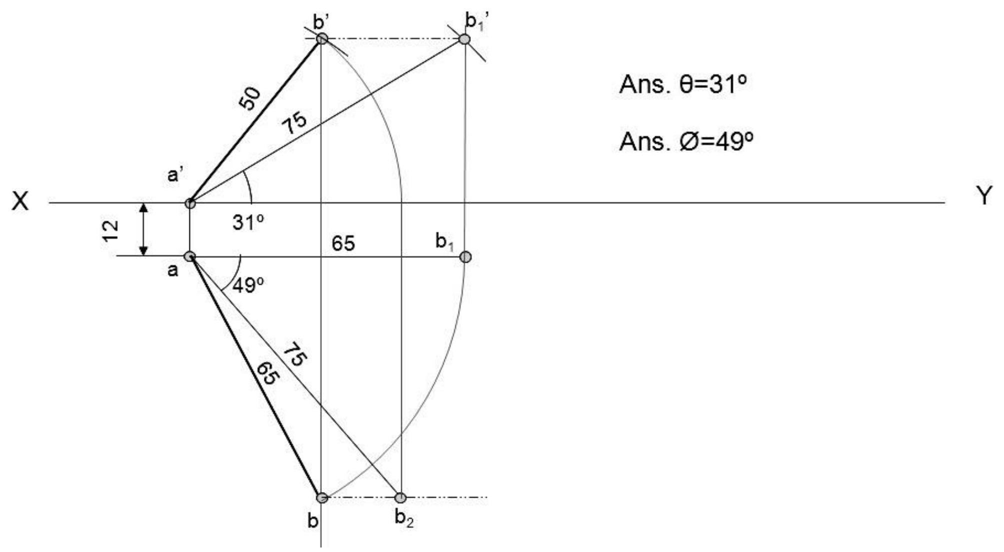

Figure 2.11

PROJECTION OF SOLIDS

Introduction:

A solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the number of which depends on the type of solid and its orientation with respect to the planes of projection. Solids are classified into two major groups.

(i) Polyhedral, and
(ii) Solids of revolution

POLYHEDRAL

A polyhedral is defined as a solid bounded by plane surfaces called faces. They are: (i)Regular polyhedral (ii) Prisms and (iii) Pyramids

Regular Polyhedral

A polyhedron is said to be regular if its surfaces are regular polygons. The following are some of the regular polyhedral.

SOLIDS

Prisms: 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 centers 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 (Fig) The nomenclature of the prism is given in Fig.

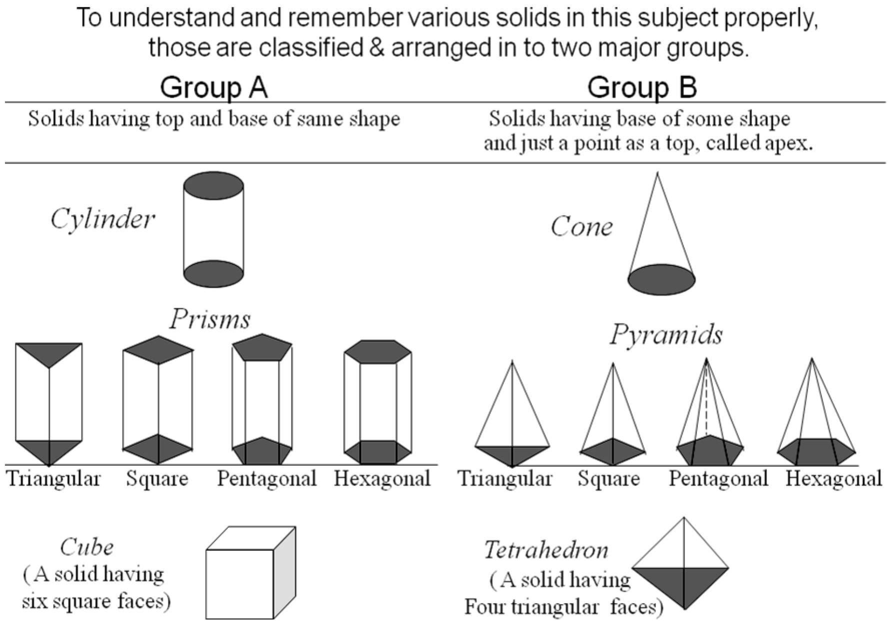

Figure 2.12

(a) **Tetrahedron:** It consists of four equal faces, each one being a equilateral triangle.
(b) **Hexa hedron(cube):** It consists of six equal faces, each a square.
(c) **Octahedron**: It has eight equal faces, each an equilateral triangle.
(d) **Dodecahedron**: It has twelve regular and equal pentagonal faces.
(e) **Icosahedrons**: It has twenty equal, equilateral triangular faces.

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. The nomenclature of a pyramid is shown in Fig.

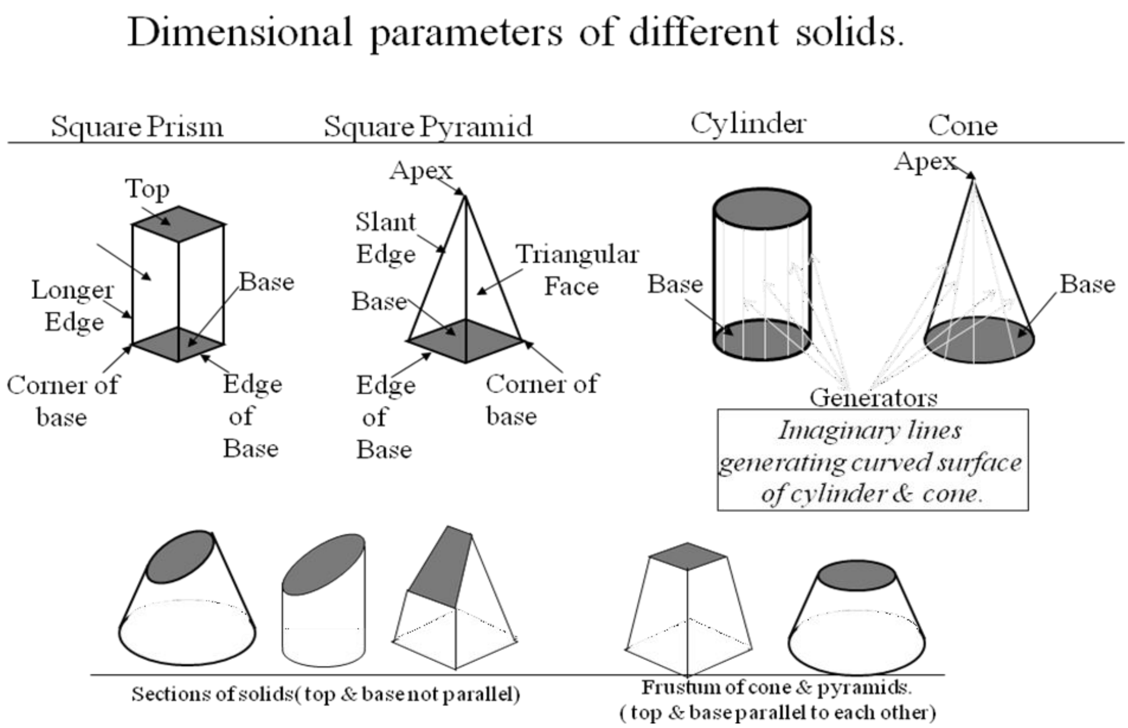

Figure 2.13

Types of Pyramids:

There are many types of Pyramids, and they are named after the shape of their base. These are Triangular Pyramid, Square Pyramid, Pentagonal pyramid, hexagonal pyramid and tetrahedron

Solids of Revolution: 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.

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

Prisms Position of a Solid with Respect to the Reference Planes: The position of solid in space may be specified by the location of either the axis, base, edge, diagonal or face with the principal planes of projection. The following are the positions of a solid considered.

1. **Axis perpendicular to HP**
2. **Axis perpendicular to VP**
3. **Axis parallel to both the HP and VP**
4. **Axis inclined to HP and parallel to VP**
5. **Axis inclined to VP and parallel to HP**
6. **Axis inclined to both the Planes (VP. and HP**)

The position of solid with reference to the principal planes may also be grouped as follows:

1. Solid resting on its base.
2. Solid resting on anyone of its faces, edges of faces, edges of base, generators, slant edges, etc.
3. Solid suspended freely from one of its corners, etc.

1. Axis perpendicular to one of the principal planes:

When the axis of a solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base.

When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from it. Similarly when the axis of the solid is perpendicular to V.P, the front view must be drawn first and then the top view is projected from it.

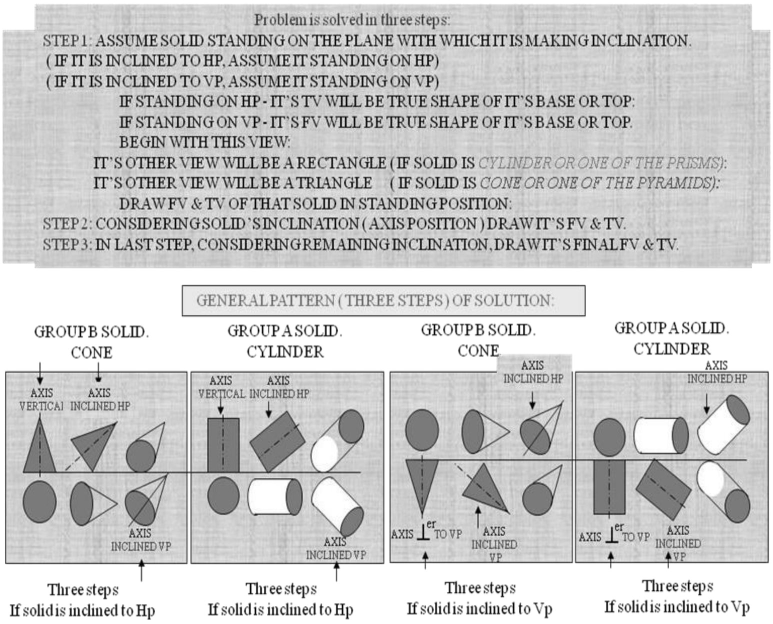

Figure 2.14

Problems:

When the axis of solid is perpendicular to one of the planes, it is parallel to the other. Also, the projection of the solid on that plane will show the true shape of the base. When the axis of a solid is perpendicular to H.P, the top view must be drawn first and then the front view is projected from it. Similarly when the axis of the solid is perpendicular to V.P, the front view must be drawn first and then the top view is projected from it.

1. Axis perpendicular to HP

Problem:

A Square Pyramid, having base with a 40 mm side and 60mm axis is resting on its base on the HP. Draw its Projections when (a) a side of the base is parallel to the VP. (b) A side of the base is inclined at 30^0 to the VP and (c) All the sides of base are equally inclined to the VP.

Solution:

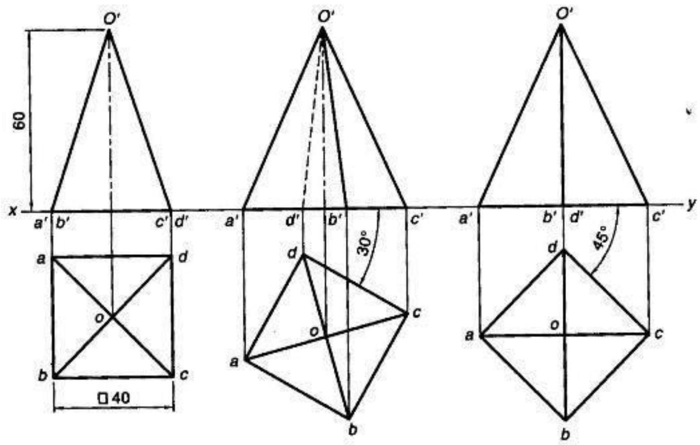

Figure 2.15

2. Axis perpendicular to VP

Problem:

A pentagonal Prism having a base with 30 mm side and 60mm long Axis, has one of It's bases in the VP. Draw Its projections When (a)rectangular face is parallel to and 15 mm above the HP (b) A rectangular face perpendicular to HP and (c) a rectangular face is inclined at 45^0 to the HP Solution:

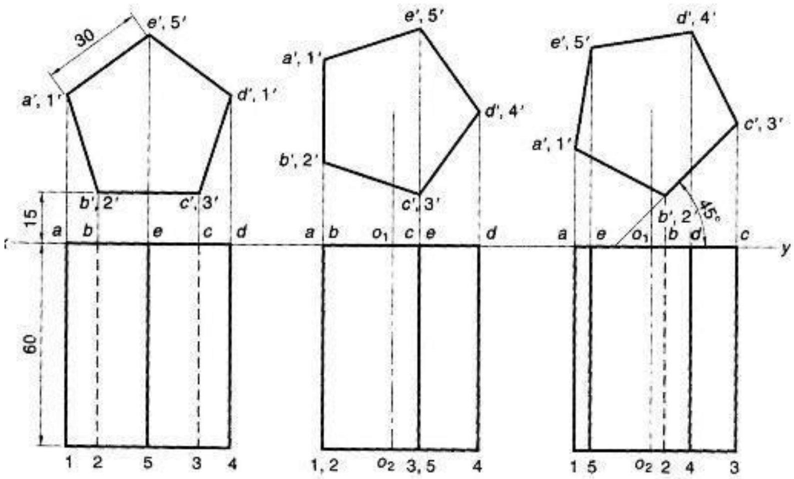

Figure 2.16

3. Axis parallel to both the HP and VP

Problem:

A pentagonal Prism having a base with a 30 mm side and 60mm long axis, is resting on one of its rectangular faces on the HP. with axis parallel to the VP. Draw its projections?

Solution:

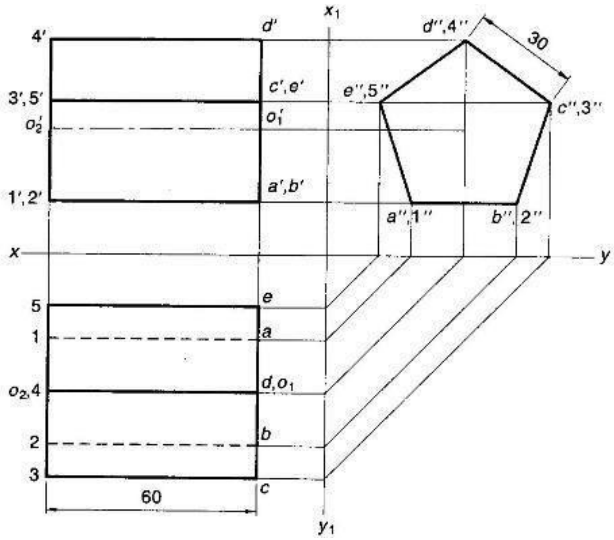

Figure 2.17

4. Axis inclined to HP and parallel to VP

Problem:

A Hexagonal Prism having a base with a30 mm side and 75 mm long axis, has an edge its base on the HP. Its axis is Parallel to the VP and inclined at 45^0 to the HP Draw its projections?

Solution:

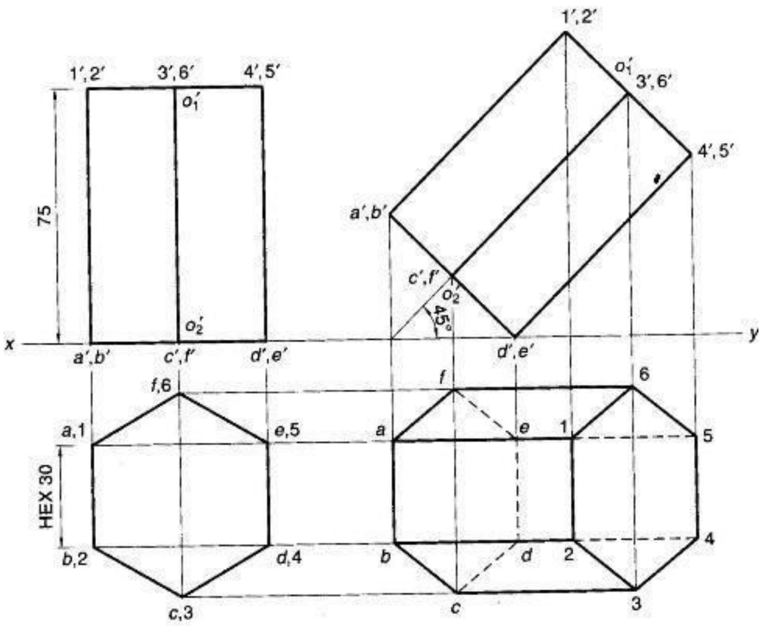

Figure 2.18

5. Axis inclined to VP and parallel to HP

Problem:

An Hexagonal Prism, having a base with a 30 mm side and 65 mm long axis, has an edge it's base in the VP Such that the axis is inclined at 30^0 to the VP and Parallel to the HP. Draw its Projections?

Solution:

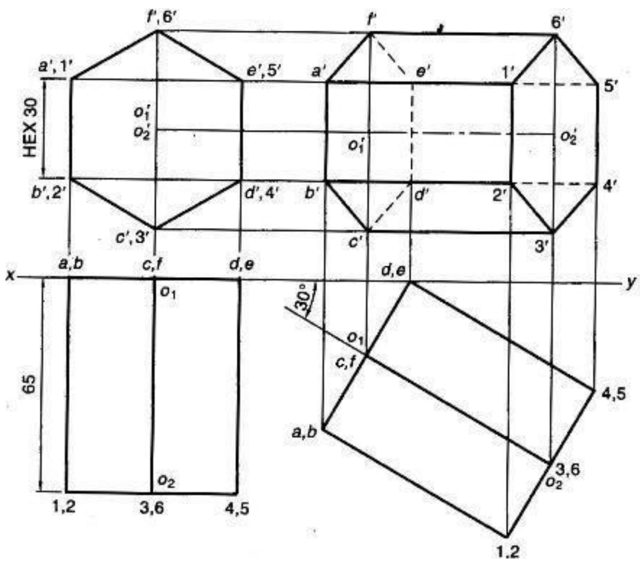

Figure 2.19

6. **Axis inclined to both the principal planes (HP and VP)**

A solid is said to be inclined to both the planes when

(i) the axis is inclined to both the planes,

(ii) the axis is inclined to one plane and an edge of the base is inclined to the other.

In this case the projections are obtained in three stages.

Stage I: Assume that the axis is perpendicular to one of the planes and draw the projections.

Stage II: Rotate one of the projections till the axis is inclined at the given angle and project the other view from it.

Stage III: Rotate one of the projections obtained in Stage II, satisfying the remaining condition and project the other view from it.

Problem:

A cone 40 mm diameter and 50 mm axis is resting on one of its generator on HP which makes 30^0 inclinations with VP. Draw it's projections?

Solution Steps:

Resting on HP on one generator, means lying on HP

1. Assume it standing on HP.
2. It's TV will show True Shape of base(circle)
3. Draw 40mm dia. Circle as TV& taking 50 mm axis project FV. (a triangle)
4. Name all points as shown in illustration.
5. Draw 2^{nd} FV in lying position I.e. o'e' on xy. And project it's TV below xy.
6. Make visible lines dark and hidden dotted, as per the procedure.
7. Then construct remaining inclination with VP (generator o_1e_1 30^0 to xy as shown) & project final FV.

Solution:

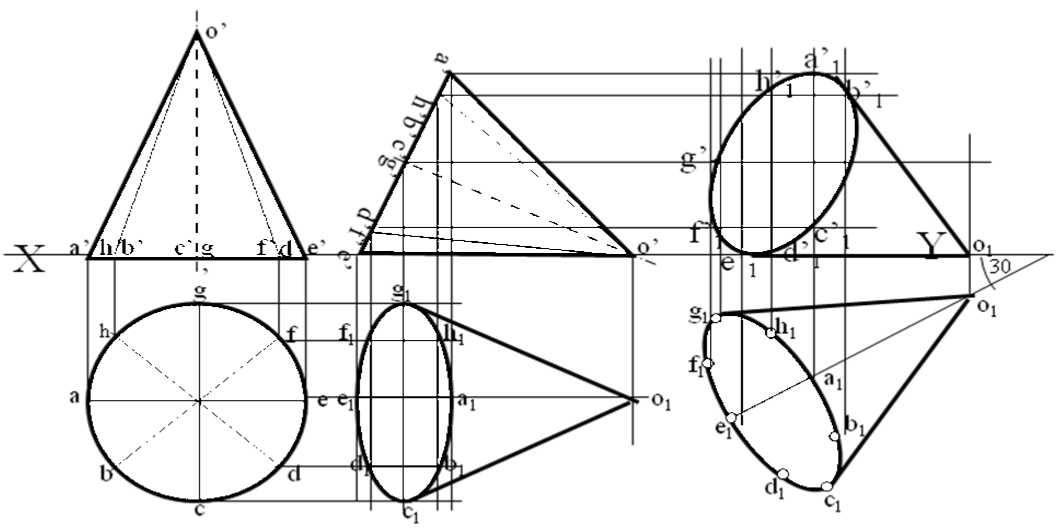

Figure 2.20

Problem:

A circular cone, 40 mm base diameter and 60 mm long axis is resting on HP, on one point of base circle such that it's axis makes 45^0 inclination with HP and 40^0 inclination with VP. Draw it's projections.

Solution:

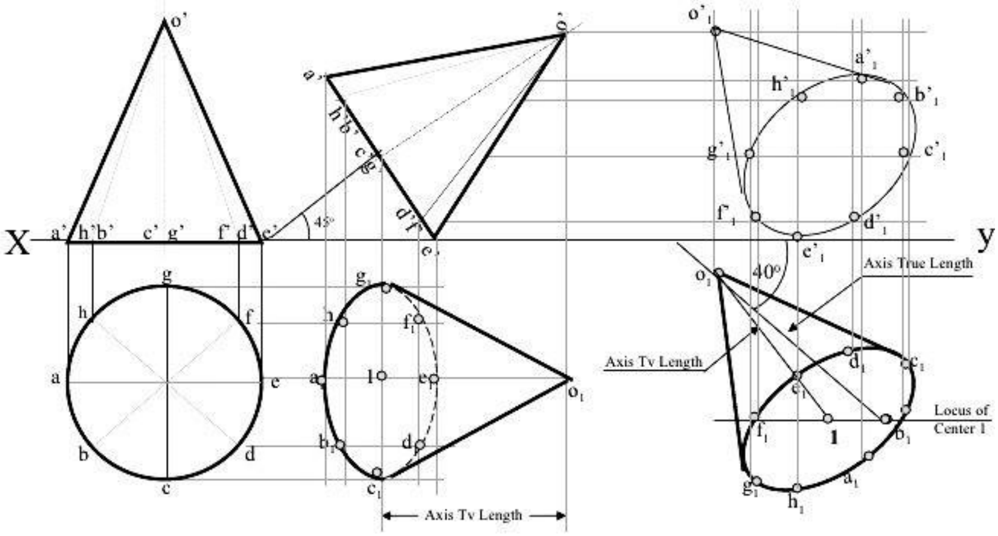

Figure 2.21

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF CIVIL ENGINEERING

UNIT – III – Section of Solids and Development of Surfaces – SCIA1103

III. Section of Solids and Development of Surfaces

Section Views

- The internal hidden details of the object are shown in orthographic views by dashed lines.
- The intensity of dashed lines in orthographic views depends on the complexity of internal structure of the object.
- If there are many hidden lines, it is difficult to visualize the shape of the object
- Therefore, the general practice is to draw sectional views for complex objects in addition to or instead of simple orthographic views.
- A sectional view, as the name suggests, is obtained by taking the section of the object along a particular plane. An imaginary cutting plane is used to obtain the section of the object.

Theory of Solids

- Whenever a section plane cuts a solid, it intersects (and or coincides with) the edges of the solids.
- The point at which the section plane intersects an edge of the solid is called the *point of intersection* (POI).
- In case of the solids having a curved surface, viz., cylinder, cone and sphere, POIs are located between the cutting plane and the lateral lines.

True Shape of the Sections

- A section will show its *true shape* when viewed in normal direction.
- To find the true shape of a section, it must be projected on a plane parallel to the section plane.
- For polyhedra, the true shape of the section depends on the number of POIs. The shape of the section will be a polygon of the sides equal to the number of POIs.
- The true shape of the section of a sphere is always a circle.
- The sections of prisms and pyramids are straight line segmented curves.
- The sections of cylinders and cones will mostly have smooth curves.

Types of Cutting Planes and Their Representation

- A cutting plane is represented by a cutting plane line
- The cutting plane line indicates the line view of the cutting plane.
- The two ends of the cutting plane line are made slightly thicker and provided with arrows.
- The direction of the arrow indicates the direction of viewing of the object.
- In the first-angle method of projection, the direction of the arrows is toward the POP, i.e., toward XY (or $X1Y1$).

Types of section planes

- Vertical Section plane
- Horizontal Section Plane
- Profile Section plane
- Auxiliary Section plane
- Oblique Section plane

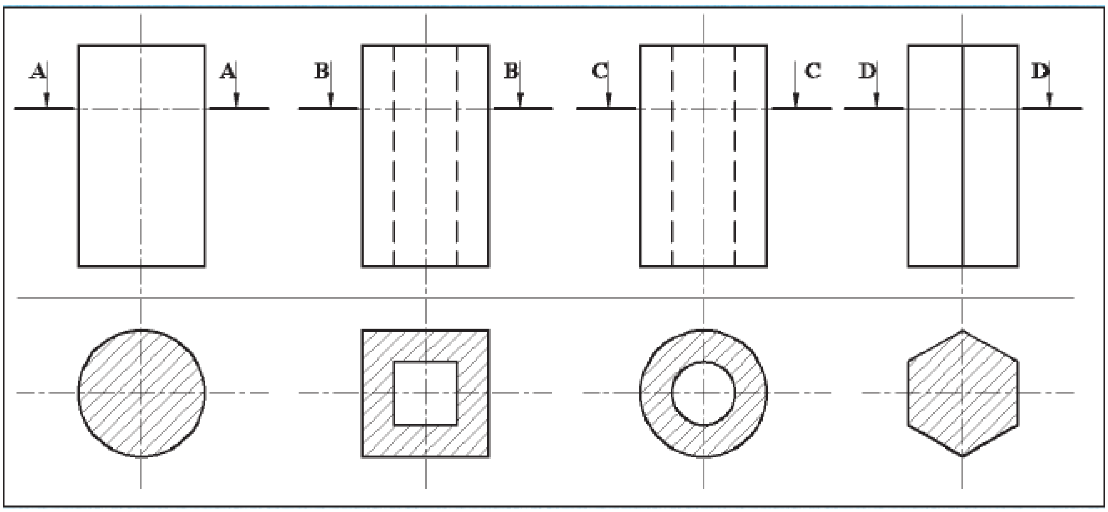

Figure 3.1

Hatching of Sections

- The surface created by cutting the object by a section plane is called as *section*.

- The section is indicated by drawing the hatching lines (section lines) within the sectioned area.
- The hatching lines are drawn at 45° to the principal outlines or the lines of symmetry of the section
- The spacing between hatching lines should be uniform and in proportion to the size of the section.

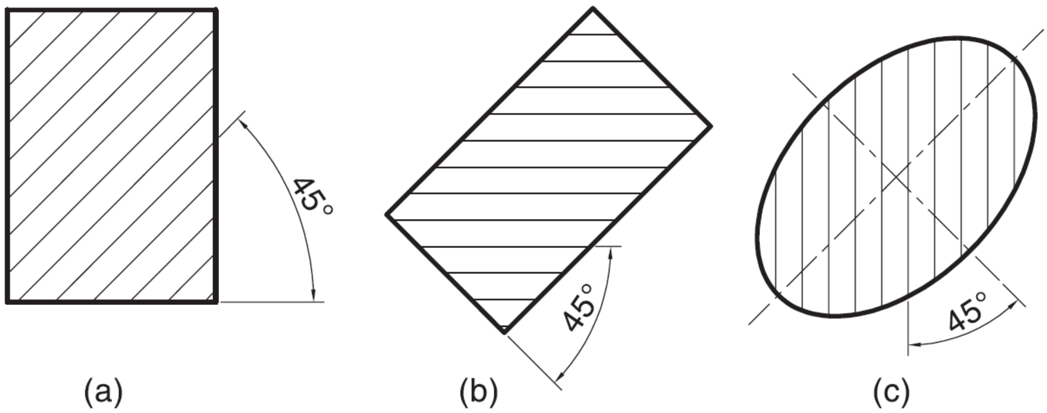

Figure 3.2

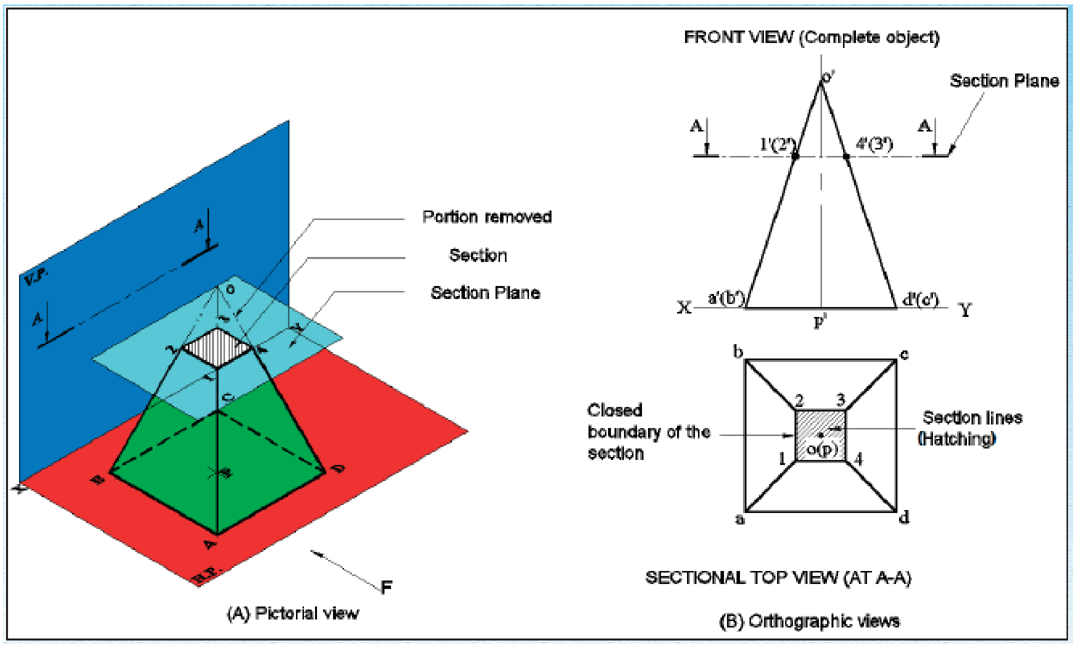

Figure 3.3

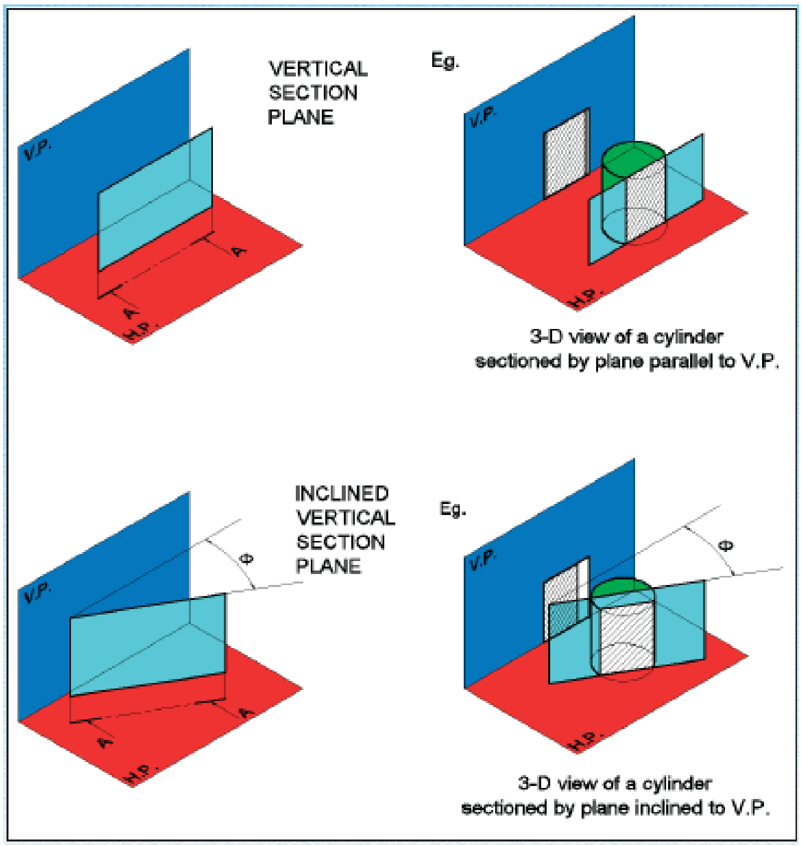

Figure 3.4

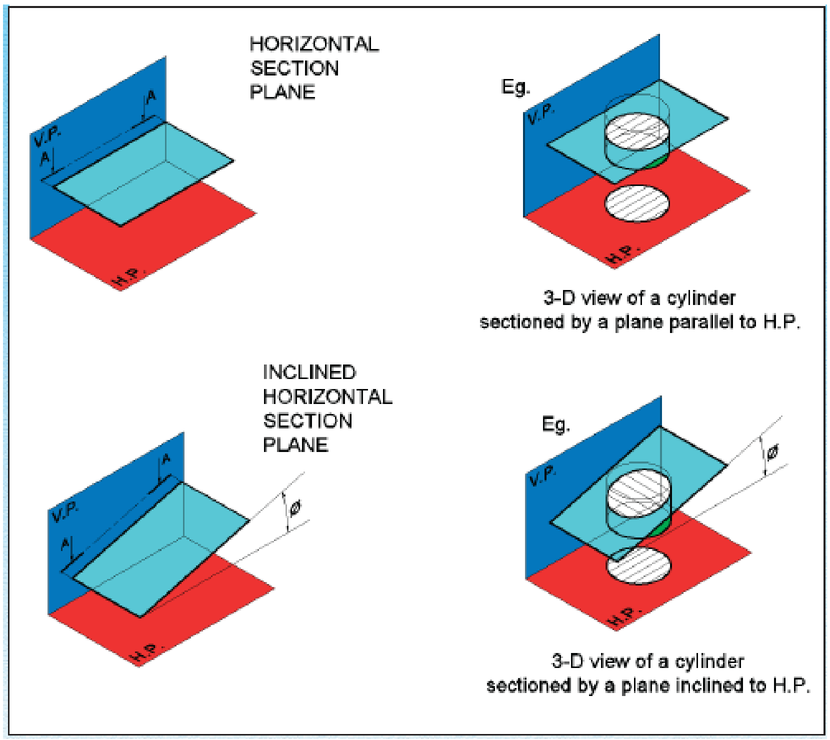

Figure 3.5

SECTIONAL VIEW – PARALLEL TO **H.P** AND **PERPENDICULAR** TO **V.P**

A cube of 40 mm sideis cut by a horizontal section plane, parallel to H.P at a distance of 15 mm from the top end. Draw the sectional top view and front view

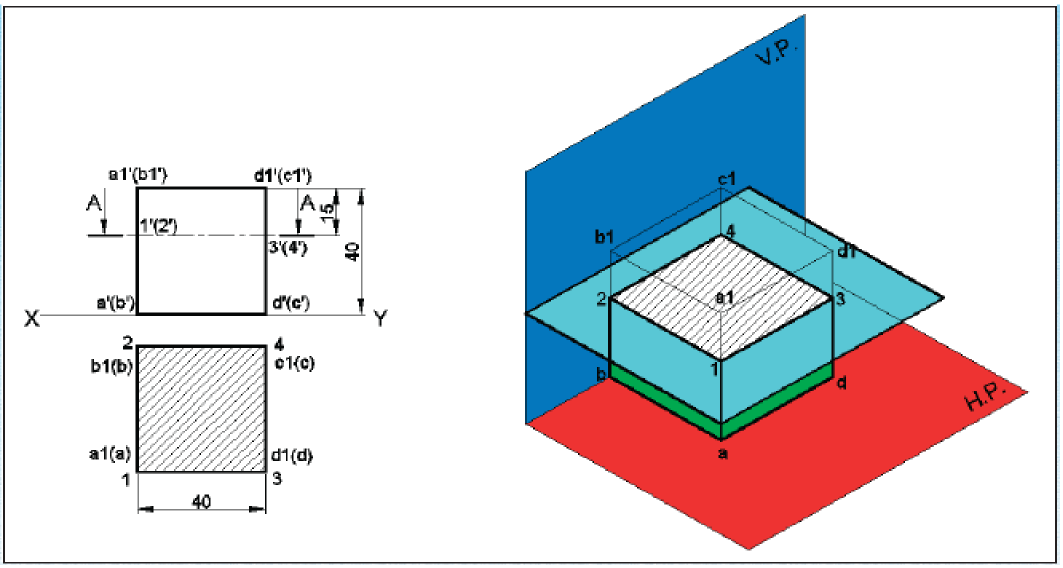

Figure 3.6

SECTIONAL VIEW – INCLINED TO **H.P** AND **PERPENDICULAR** TO **V.P**

A square prism of base side 50 mm and height of axis 80 mm has its base on H.P, it is cut by a section plane perpendicular to V.P and inclined to H.P such that it passes through the two opposite corners of the rectangular face in front. Draw the sectional Top View and Front View. Find the angle of inclination of the section plane

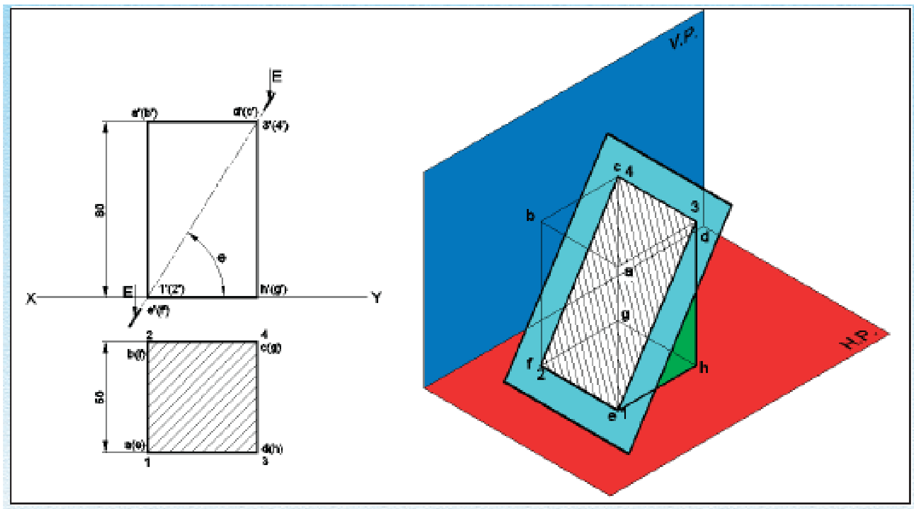

Figure 3.7

SECTIONAL VIEW – PERPENDICULAR TO H.P AND INCLINED TO V.P

A square prism of base side 40 mm and height 70 mm is resting on its rectangular face on the ground such that its axis is parallel to H.P &V.P, it is cut by a section plane perpendicular to H.P &incllined to V.P at an angle of 45° and passing through a point 10 mm from one of its ends. Draw the sectional Front View and Top View

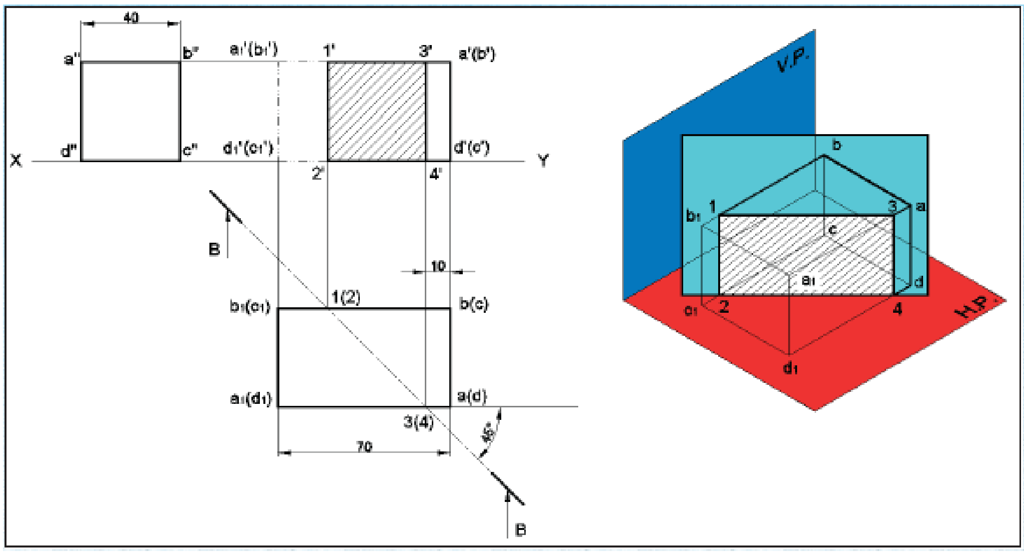

Figure 3.8

TRUE SHAPE OF A SECTION

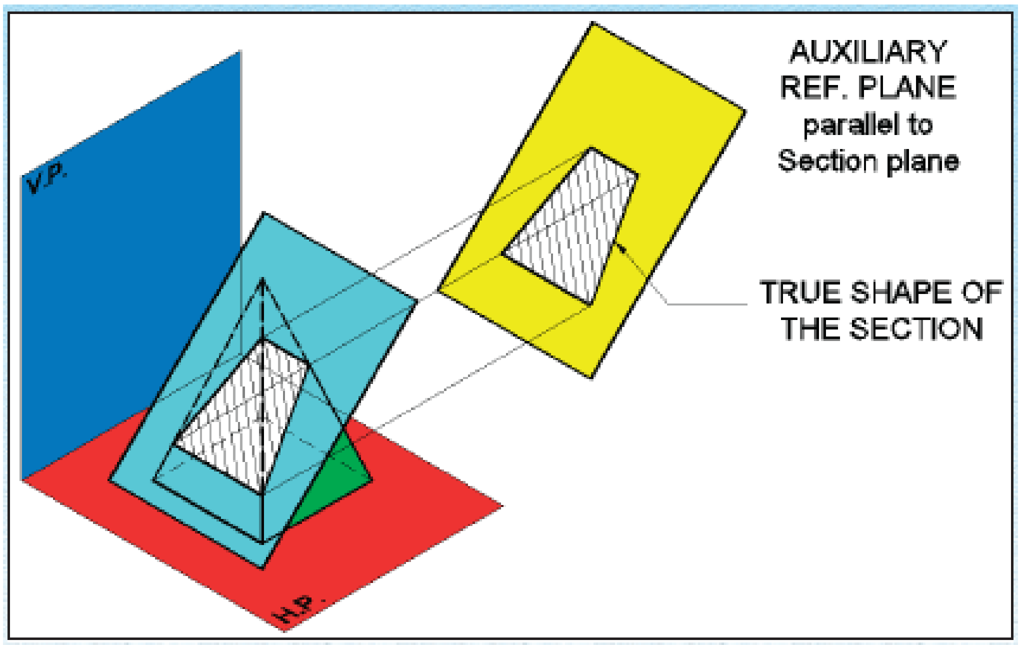

Figure 3.9

PROCEDURE FOR TRUE SHAPE

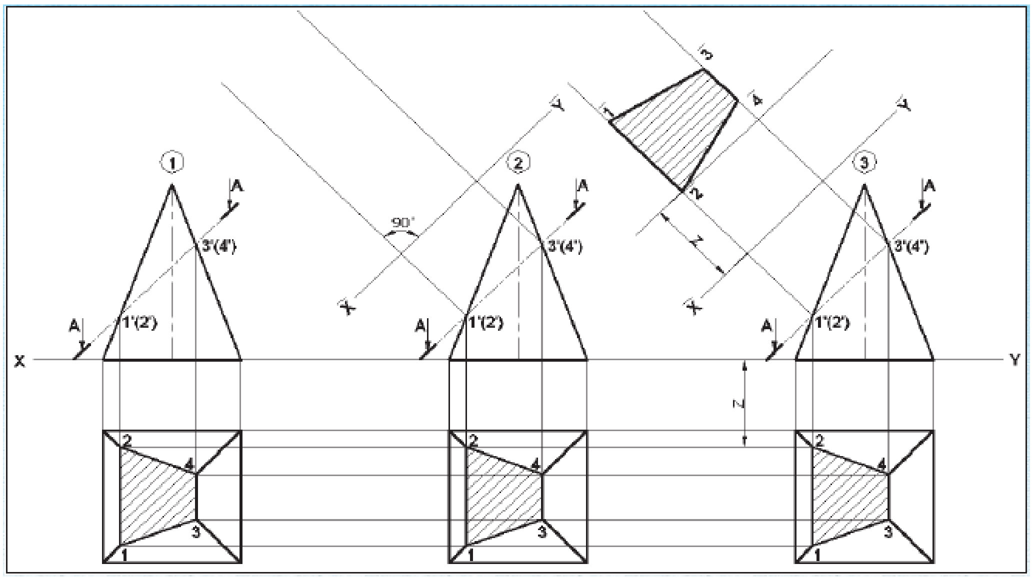

Figure 3.10

EXAMPLE: TRUE SHAPE PROBLEM

A square prism of base side 50 mm and height of axis 80 mm has its base on H.P, it is cut by a section plane perpendicular to V.P and inclined to H.P such that it passes through the two opposite corners of the rectangular face in front. Draw the sectional Top View and Front View and true shape of the section

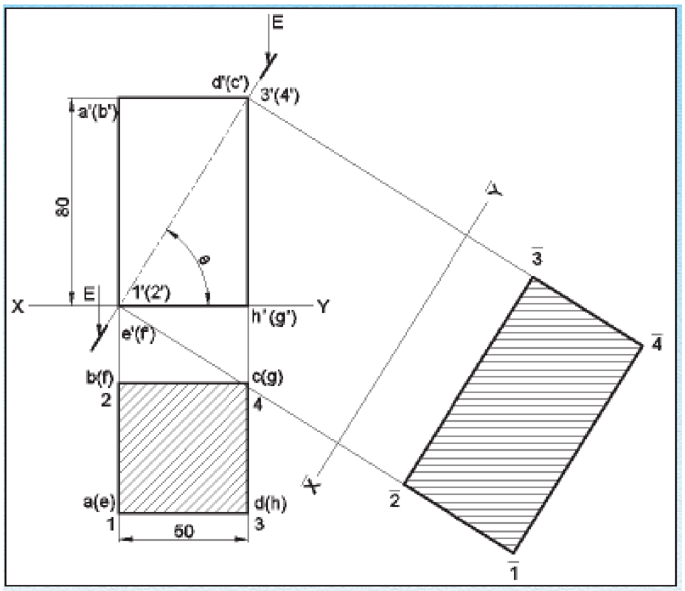

Figure 3.11

Problem: -A cone of diameter 60 mm and height 60 mm is resting on HP on one of its generators. A section plane whose VT is parallel to HP and 15 mm above HP, cuts the solid removing the top portion. Draw the front view and sectional top view of the solid.

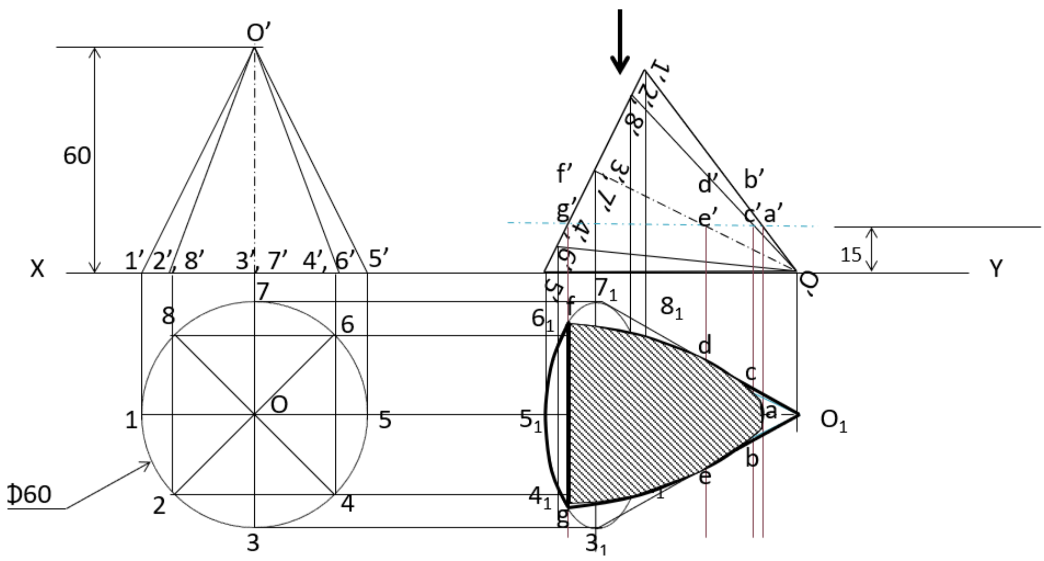

Figure 3.12

Problem: A pentagonal prism , 30 mm base side & 50 mm axis is standing on Hp on it's base whose one side is perpendicular to Vp.It is cut by a section plane 45^0 inclined to Hp, through mid point of axis.Draw Fv, sec.Tv & sec. Side view. Also draw true shape of section

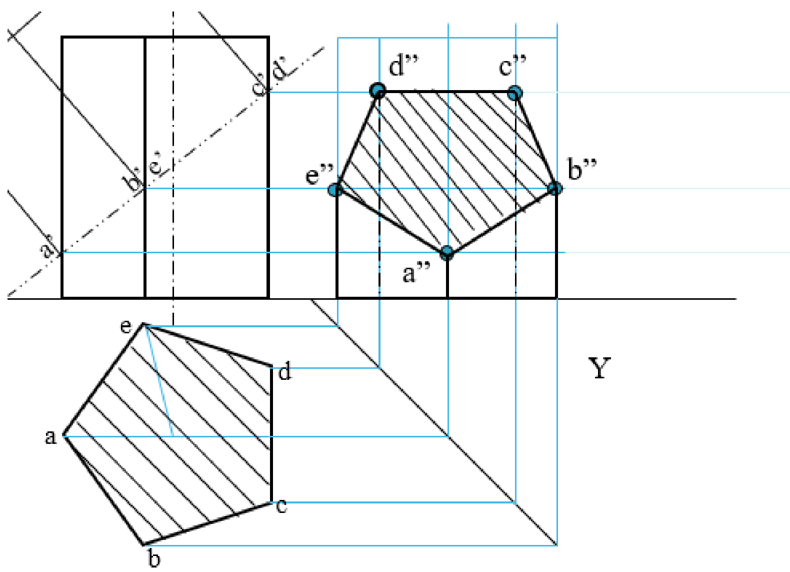

Figure 3.13

Problem: A square prism of base side 50 mm and height of axis 80 mm has its base on H.P, it is cut by a section plane perpendicular to V.P and inclined to H.P such that it passes through the two opposite corners of the rectangular face in front. Draw the sectional Top View and Front View and true shape of the section

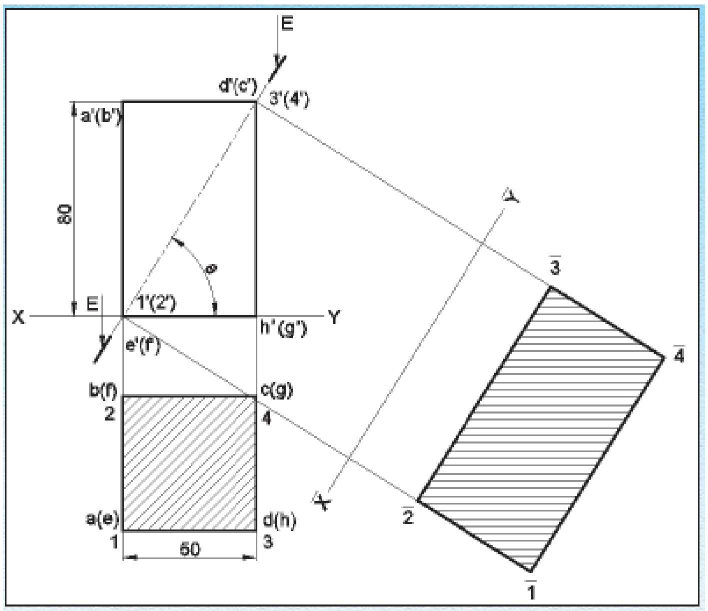

Figure 3.14

DEVELOPMENT OF LATERAL SURFACES OF SIMPLE AND SECTIONED SOLIDS

Development of Surfaces of the solid :

1. Suppose an object like a square prism is wrapped around by using paper.
2. When the wrapper is opened and spread out on a plane surface, the resulting figure is called the development of the surfaces of the solid.

The development of any solid shows the true shape of all the surfaces of the solid.

Methods of Development

1. Parallel line method
2. Radial line method
3. Approximate method

1. The development of the lateral surfaces of the objects only are shown.
2. The base and top are cut to the required geometrical shape and fastened suitably.

PRISMS & CYLINDERS –

Parallel Line Development Method

Development of Prism

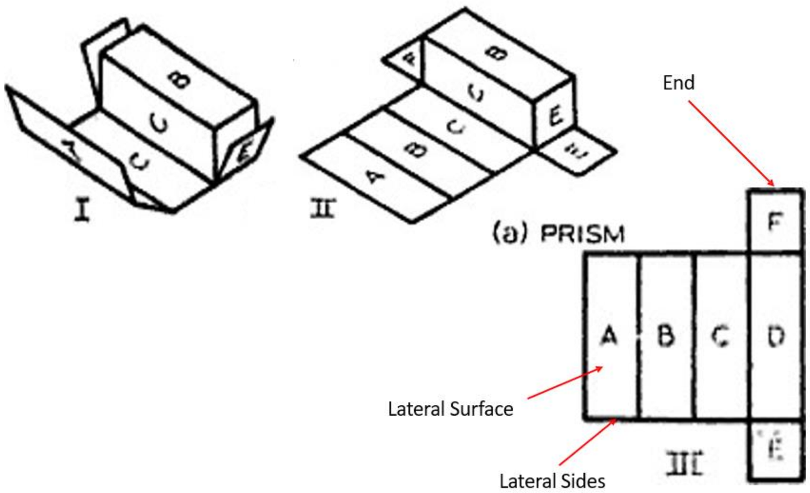

Figure 3.15

Draw the development of the lateral surfaces of a right square prism of edge of base 30 mm and axis 50 mm long.

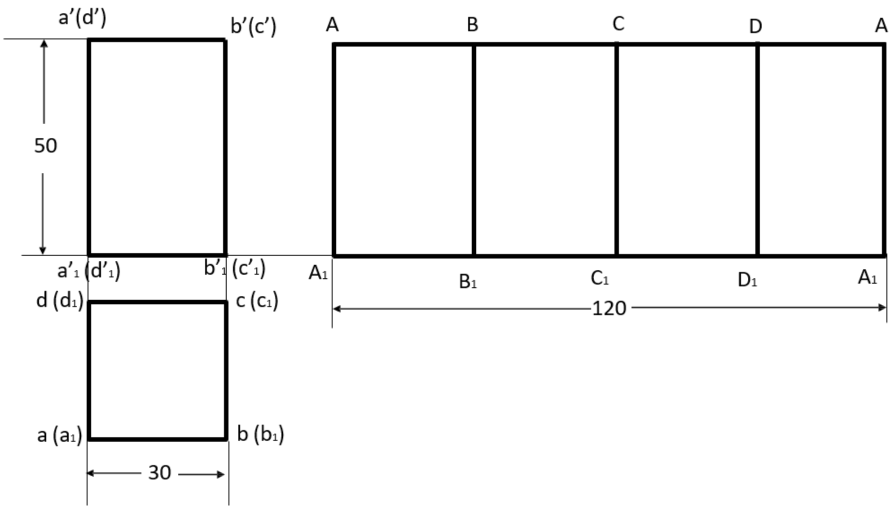

Figure 3.16

Development of Cylinder

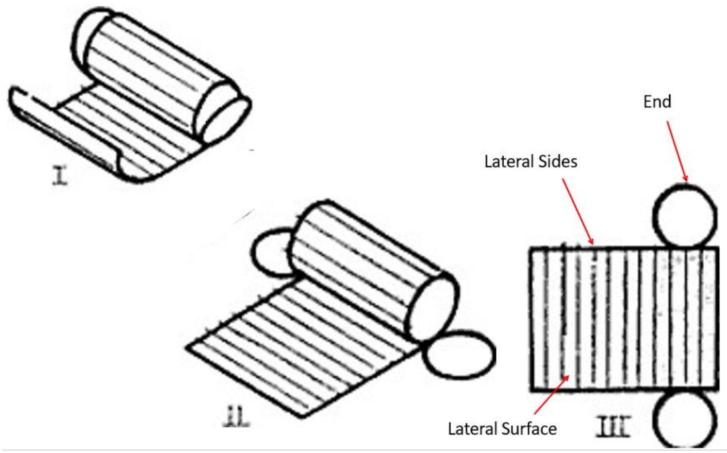

Figure 3.17

Draw the development of the complete surface of a cylindrical drum. Diameter is 40 mm and height 60 mm.

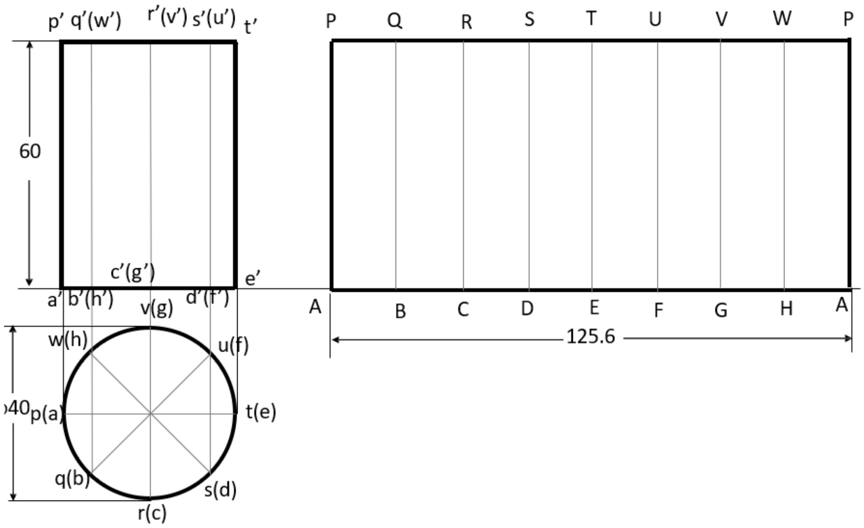

Figure 3.18

A hexagonal prism, edge of base 20 mm and axis 50 mm long, rests with its base on HP such that one of its rectangular faces is parallel to VP. It is cut by a plane perpendicular to VP, inclined at 45° to HP and passing through the right corner of the top face of the prism.

(i) **Draw the sectional top view.**

(ii) **Develop the lateral surfaces of the truncated prism.**

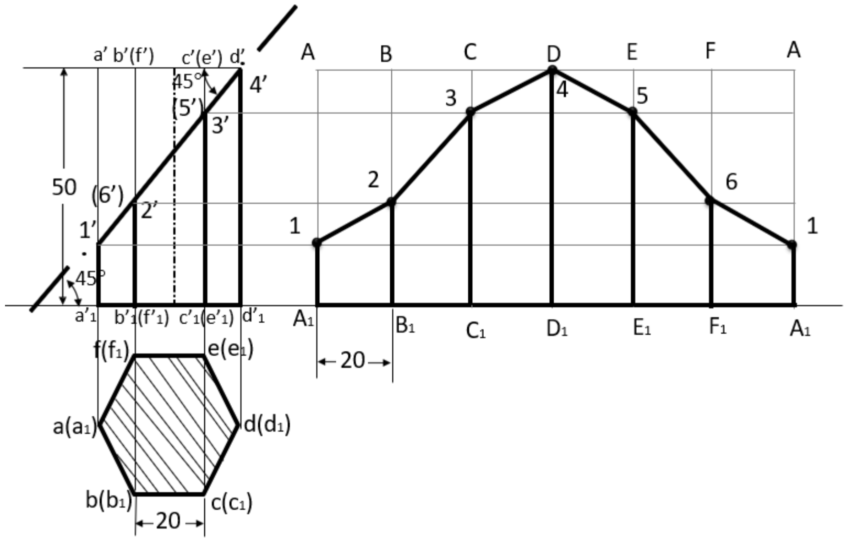

Figure 3.19

A hexagonal prism of base side 20 mm and height 45 mm is resting on one of its ends on the HP with two of its lateral faces parallel to the VP. It is cut by a plane perpendicular to the VP and inclined at 30° to the HP. The plane meets the axis at a distance of 20 mm above the base. Draw the development of the lateral surfaces of the lower portion of the prism.

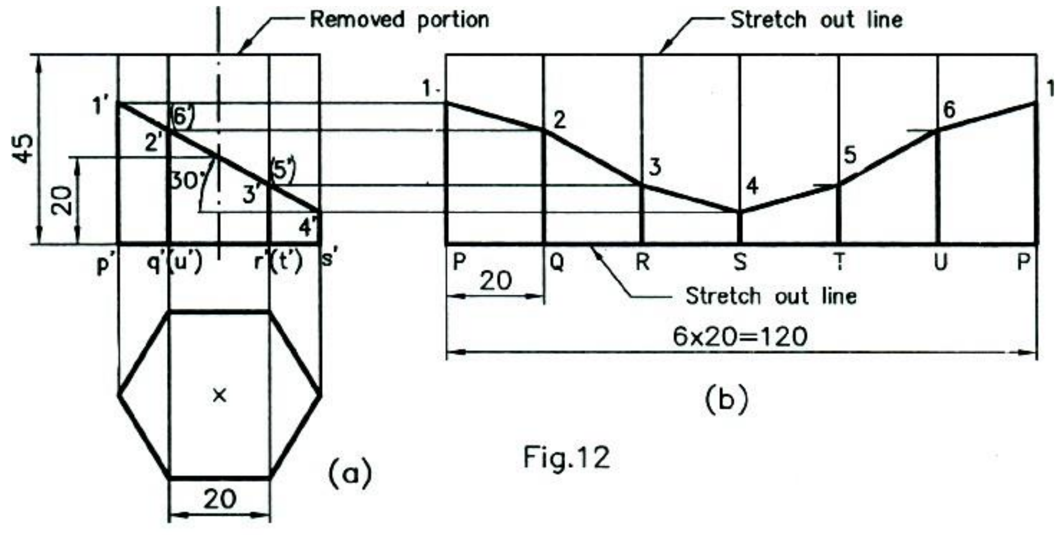

Figure 3.20

Draw the development of the lateral surface of the lower portion of a cylinder of diameter 50 mm and axis 70 mm when sectioned by a plane inclined at 40° to HP and perpendicular to VP and bisecting axis.

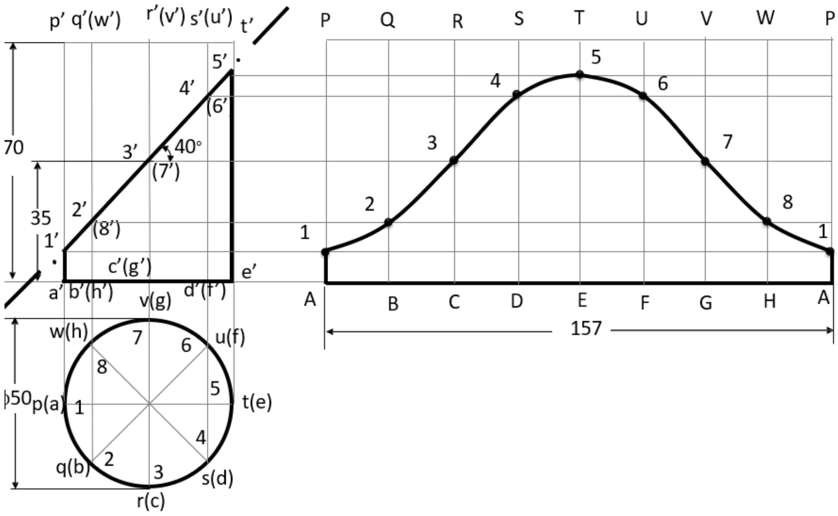

Figure 3.21

PYRAMIDS & CONES –

Radial Line Development Method

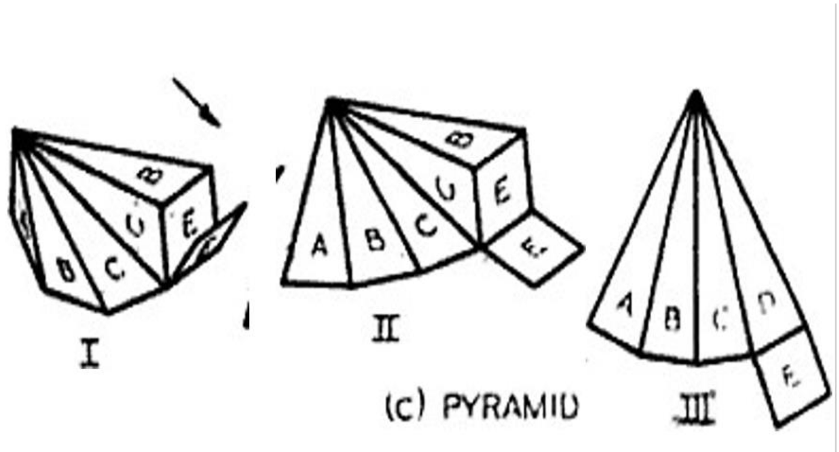

Figure 3.22

Draw the development of the lateral surfaces of a square pyramid, side of base 25 mm and height 50 mm, resting with its base on HP and an edge of the base parallel to VP.

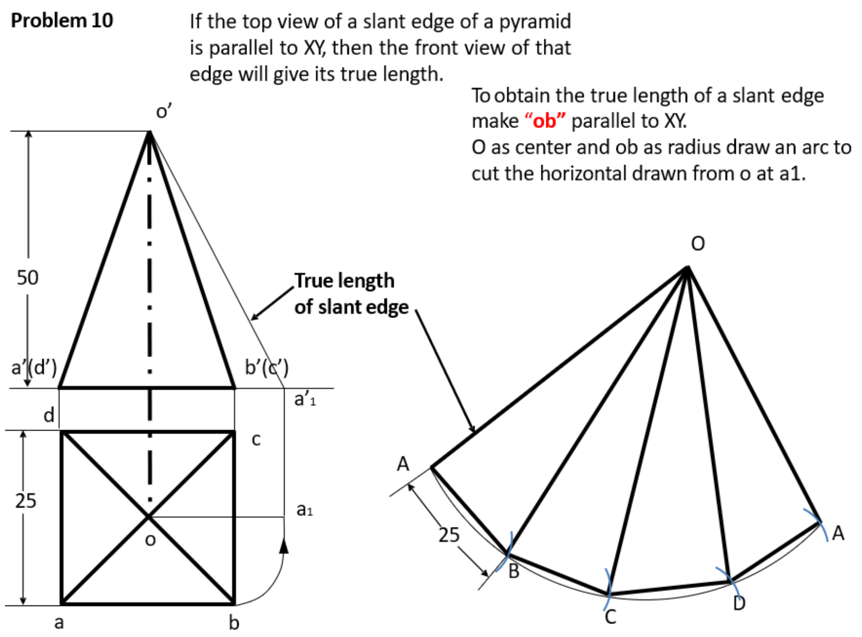

Figure 3.23

Development of Cone

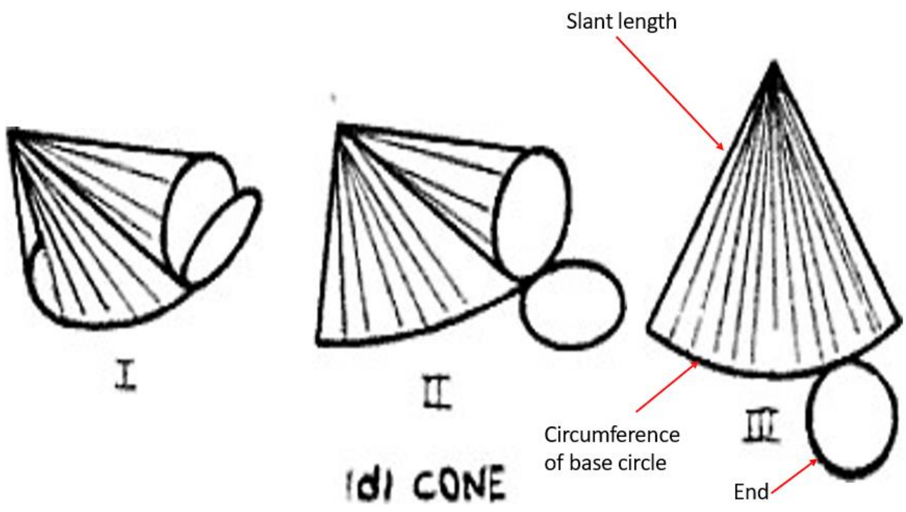

Figure 3.24

Draw the development of the lateral surface of a cone of base diameter 48 mm and altitude 55 mm.

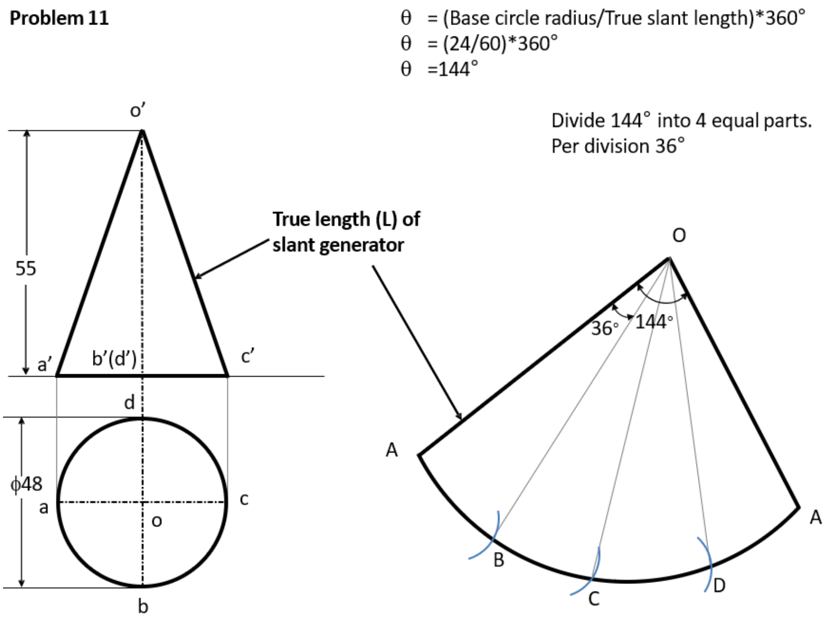

Figure 3.25

A pentagonal pyramid side of base 30 mm and height 52 mm stands with its base on HP and an edge of the base is parallel to VP and nearer to it. It is cut by a plane perpendicular to VP, inclined at 40° to HP and passing through a point on the axis 32 mm above the base. Draw the sectional top view. Develop the lateral surface of the truncated pyramid

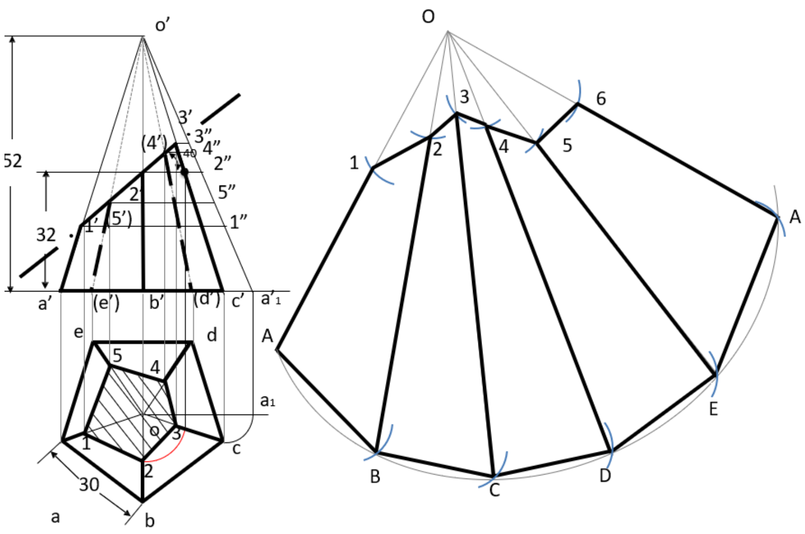

Figure 3.26

A Cone of base diameter 60 mm and height 70 mm is resting on its base on HP. It is cut by a plane perpendicular to VP and inclined at 30° to HP. The plane bisects the axis of the cone. Draw the development of its lateral surface.

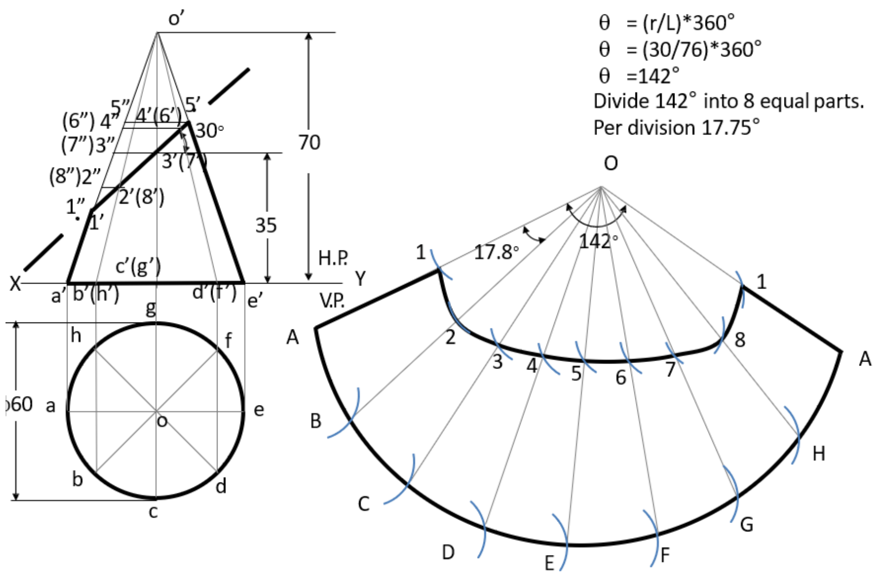

Figure 3.27

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SCHOOL OF BUILDING AND ENVIRONMENT
DEPARTMENT OF CIVIL ENGINEERING

UNIT – IV – Isometric Projections and Perspective Projections – SCIA1103

IV. Isometric Projections and Perspective Projections

Isometric projection:

Isometric projection is a type of pictorial projection in which the three dimensions of a solid are not only shown in one view but their actual sizes can be measured directly from it. The three lines AL, AD and AH, meeting at point A and making 120^0 angles with each other are termed Isometric Axes. The lines parallel to these axes are called Isometric Lines. The planes representing the faces of the cube as well as other planes parallel to these planes are called Isometric Planes.

Isometric scale:

When one holds the object in such a way that all three dimensions are visible then in the process all dimensions become proportionally inclined to observer's eye sight and hence appear apparent in lengths. This reduction is 0.815 or 9/11 (approx.). It forms a reducing scale which is used to draw isometric drawings and is called Isometric scale. In practice, while drawing isometric projection, it is necessary to convert true lengths into isometric lengths for measuring and marking the sizes.

Construction of isometric scale:

From point A, with line AB draw 30^0 and 45^0 inclined lines AC & AD respective on AD. Mark divisions of true length and from each division-point draw vertical lines up to AC line. The divisions thus obtained on AC give lengths on isometric scale.

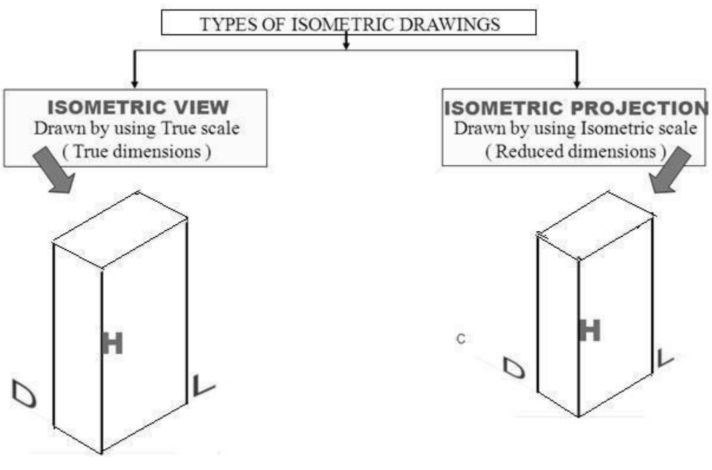


Figure 4.1

Isometric scale [Line AC] required for Isometric Projection:

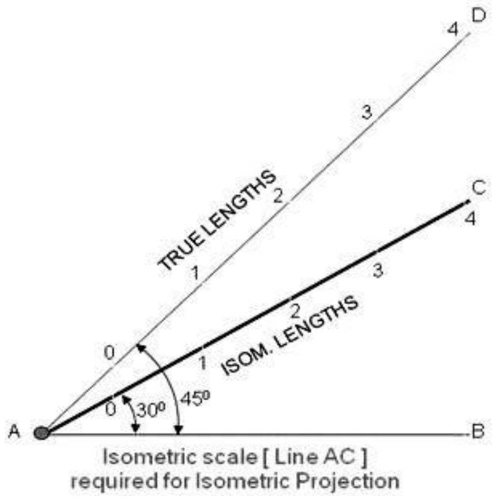


Figure 4.2

Terminology:

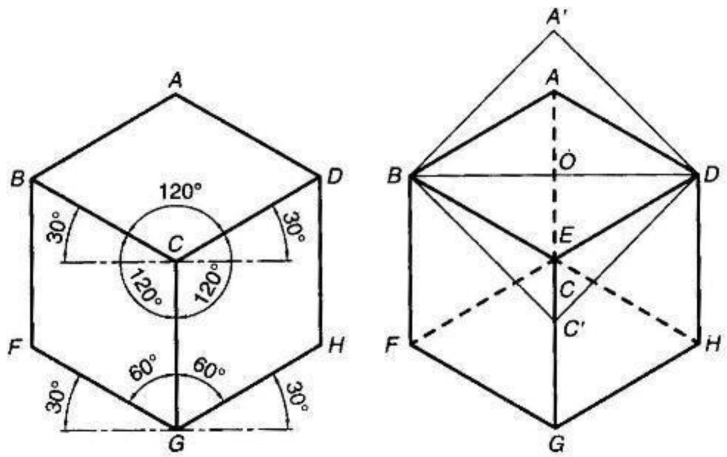


Figure 4.3

Isometric axes: The Three Lines CB, CD, CG meeting at a point C and making an angle of 120^0 with each other are called Isometric axes.

Isometric Lines: The Lines parallel to the Isometric Axis are termed as Isometric lines. Example from above fig. AB, AD, GF, GH, BF, DH are Isometric Lines.

Non-Isometric Lines*:* The lines which are not parallel to the isometric axes are known as Non- Isometric Lines Example from above fig. BD, AC, CF, BG are Non-Isometric Lines.

Isometric Planes: The planes representing the faces of the cube as well as other planes parallel to these planes are termed as Isometric Planes Example from above fig. ABCD, BCGF, CGHD are Isometric Planes

Isometric Scale: It is the scale which is used to convert the true length in to Isometric Length

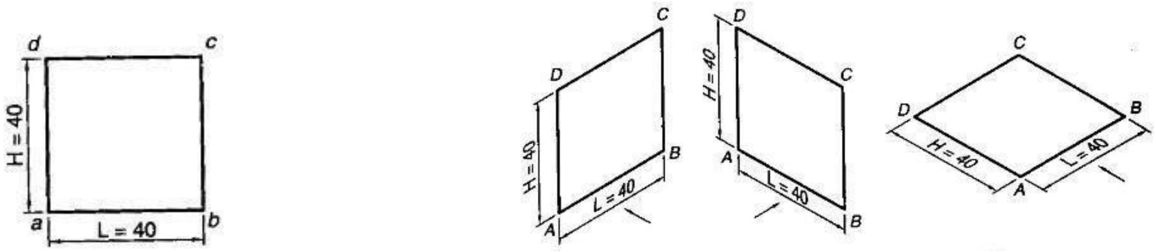
Isometric views of planes:

Simple Problems:

Problem:

Draw the isometric view of a square with 40mm side?

Solution:



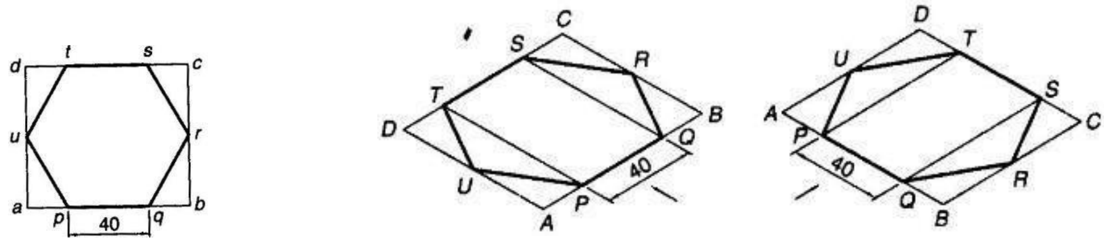
(a) *(b)* *(c)*

Figure 4.4

Problem:

Draw the isometric view of a Hexagon with 40mm side such that its surface is Parallel to the HP and a side Parallel to the VP?

Solution:



(a) *(b)*

Figure 4.5

Problem:

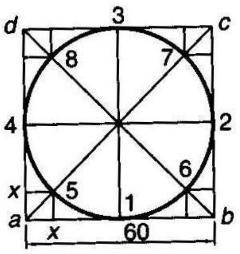
Draw the isometric view of a Circle with a 60mm Diameter on all three Principle Planes Using Co- ordinate methods?

Solution:

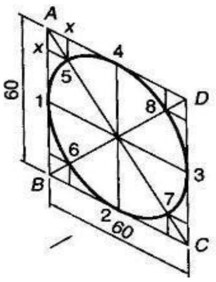
Construction Procedure:

1. **Draw a circle with 60mm Diameter and enclose it in a square abcd.**
2. Mark midpoints of the sides 1, 2, 3 and 4, where the square touches the circle tangentially
3. Draw the Diagonals of the square which cut in the circle at points 5, 6, 7 and 8 as shown in fig (a).

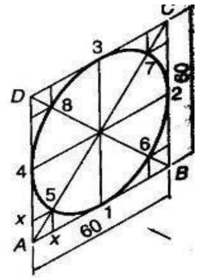
4. Draw a Rhombus ABCD to represent Isometric view of a square abcd.
5. Mark points 1, 2, 3 and 4 on it as the midpoint of the sides.
6. Mark points 5, 6, 7 and 8 on it, such that they are at a distance equal to Ax from the side of the square .join points to obtain isometric view as shown in figures(b)(c)(d)



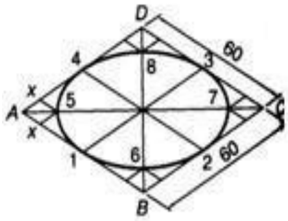
(a)



(b)



(c)



(d)

Figure 4.6

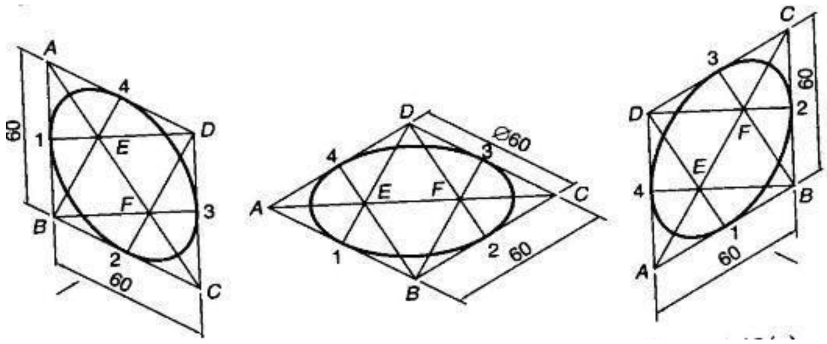
Problem:

Draw the isometric view of a Circle lamina with a 60mm Diameter on all three Principle Planes using for center methods?

Solution:

Construction:

1. **Draw a Rhombus ABCD of 60mm side to represent isometric view of a square**
2. Mark 1,2,3 and 4 as a midpoints of the sides AB,BC,CD and DA respectively join (the ends of the minor diagonals) B to meet points 3 & 4 and D to meet points 1 & 2. Let B4 and D1 intersect at point E and B3 and D2 intersect at a point F. then B,E,D and F are the Four centers for drawing the ellipse
3. With center B and radius B3 draw Arc 3-4. With center D and Radius D1 draw Arc 1-2. With center E and radius E1 draw Arc 1-4. With centre F and radius F2 draw Arc 2-3.
4. These Arcs join in the form of an Ellipse which represents the required isometric as shown in figure (a)(b)(c)



(a) *(b)* *(c)*

Figure 4.7

Isometric views of solids

Problem:

Draw an isometric view of a square prism having a base with 40mm side and a 60mm long axis, resting on the HP when (a) On its base with axis Perpendicular to the HP (b) On its rectangular faces with axis perpendicular to the VP and (c) on its rectangular face with axis parallel to VP.

Solution:

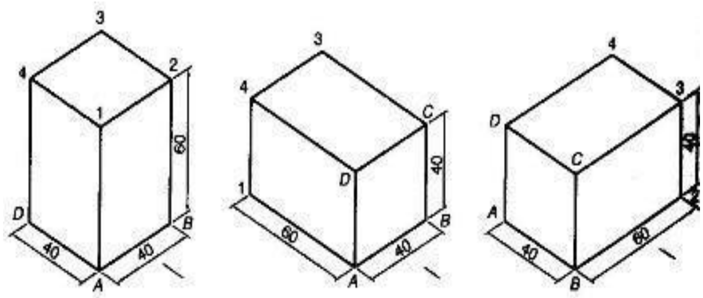


Figure 4.8

ISOMETRIC VIEW OF SOLIDS CONATINING- NON ISOMETRIC LINES

The inclined lines of an object are represented non isometric lines in isometric projections. These are drawn by one of the following methods

1. Box Method:

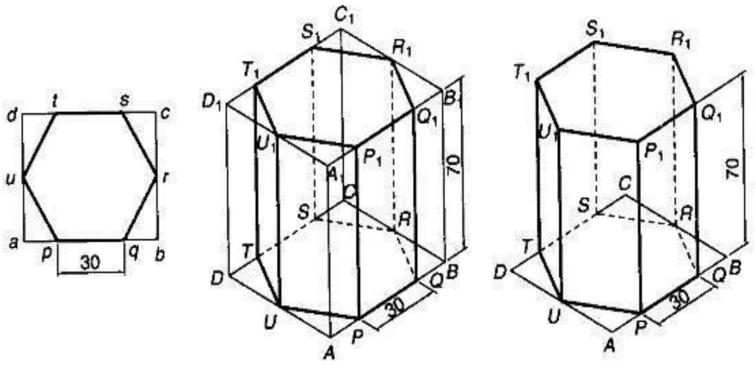
In this box method, the object is assumed to be enclosed in a rectangular box and both the isometric and non-isometric lines are drawn by locating the corresponding points of contact with the surfaces and edge of the box.

2. Off-Set Method:

In this Off-set Method the lines parallel to isometric axes are drawn from every corner or reference of an end to obtain the corner or the reference point at the other end.

The Box Method is generally convenient for solving most of the problems* Problem:

Draw isometric view of a hexagonal prism having a base with 30 mm side and a 70mm long axis resting on its base on the HP. With an edge of the base parallel to the VP when (a) using Box Methods (b) using Off-set Method?



(a) *Box Method* *(b) Off-set Method*

Figure 4.9

Problem:

Draw an isometric view of a cylinder, with a 50mm base diameter and a 70mm long axis when (a) The base is on the HP (b) when one of the generators is on the HP?

Solution:

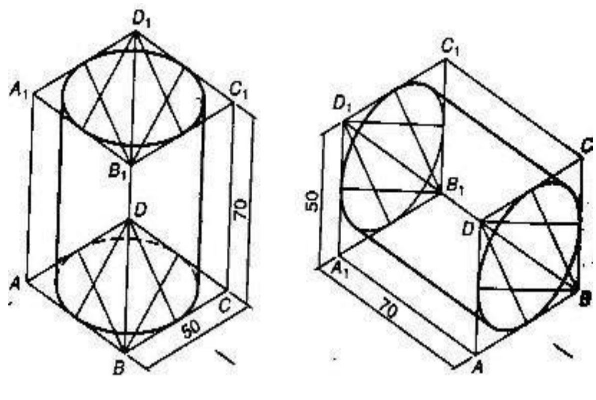
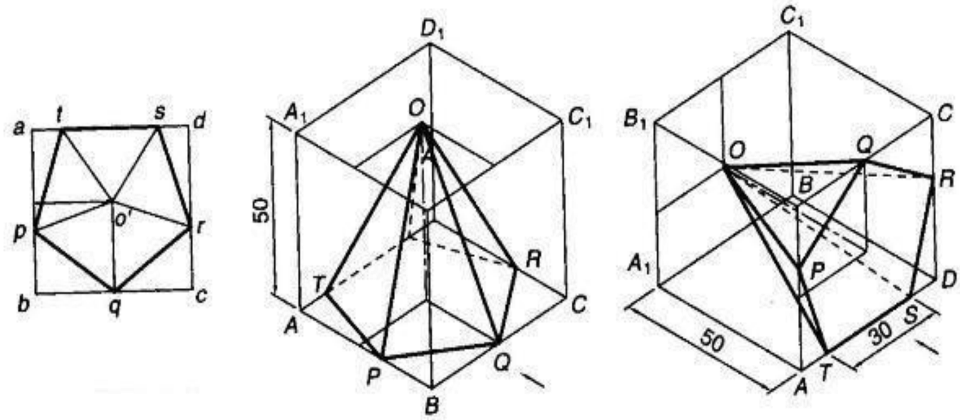


Figure 4.10

Problem:

Draw an isometric view of a pentagonal pyramid having a base , with a 30 mm side and 50mm long axis (a) when the its axis is vertical (b) when the its axis is horizontal?

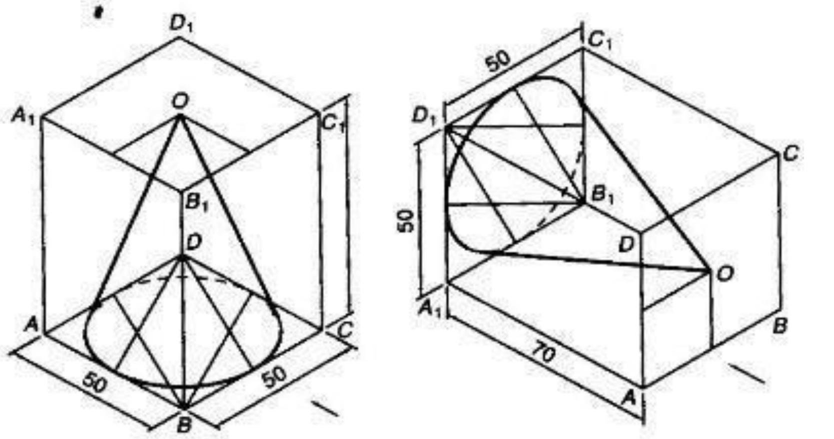


(a) Axis is Vertical (b)Axis is horizontal

Figure 4.11

Problem:

Draw an isometric view of Cone with a base diameter is 50 mm side and 70mm long axis (a) when the base is on the HP (b) when the base is on the VP?



(a)Base is on the HP (b) Base is on the VP

Figure 4.12

ISOMETRIC VIEW OF FRUSTUMS

Problem:

Draw an isometric view of Frustum of Hexagonal Pyramid having 35 mm base side 20 mm top side and 80mm long axis, resting on its base on the HP with an Edge of the base parallel to the VP?

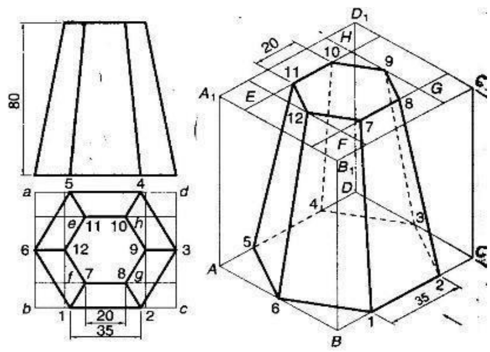


Figure 4.13

Problem

Draw an isometric view of Frustum of Cone with a 60 mm base diameter, 40 mm Top diameter and 70mm long axis, resting on its base on the HP?

Solution:

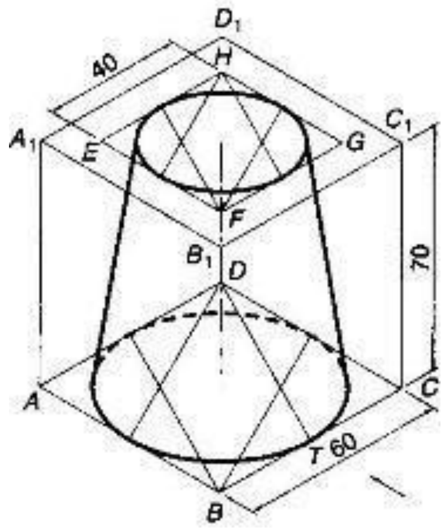


Figure 4.14

Orthographic Projection: Projection is defined as an Image or drawing of the object made on a plane. The lines form the object to the Plane are called projectors.

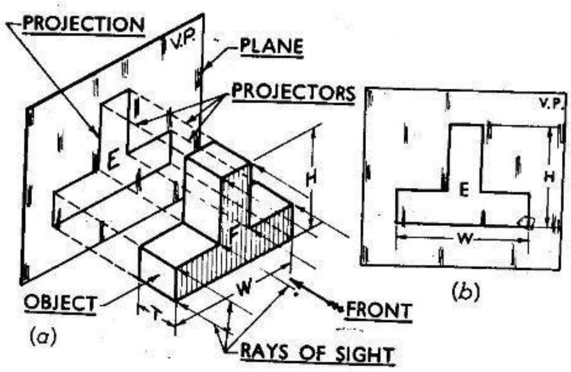


Figure 4.15

Methods of Projections: In Engineering drawing the following four methods of Projection are commonly used they are

(1) Orthographic Projection

(2) Isometric projection

(3) Oblique projection

(4) Perspective Projection

In orthographic projection an object is represented by two are three views on the mutual perpendicular projection planes each projection view represents two dimensions of an object. In iso, oblique and perspective projections represents the object by a pictorial view as eyes see it. In these methods of projects in three dimensional object is represented on a projection plane by one view only.

Orthographic Projection

When the Projectors are parallel to each other and also perpendicular to the plane the projection is called orthographic Projection

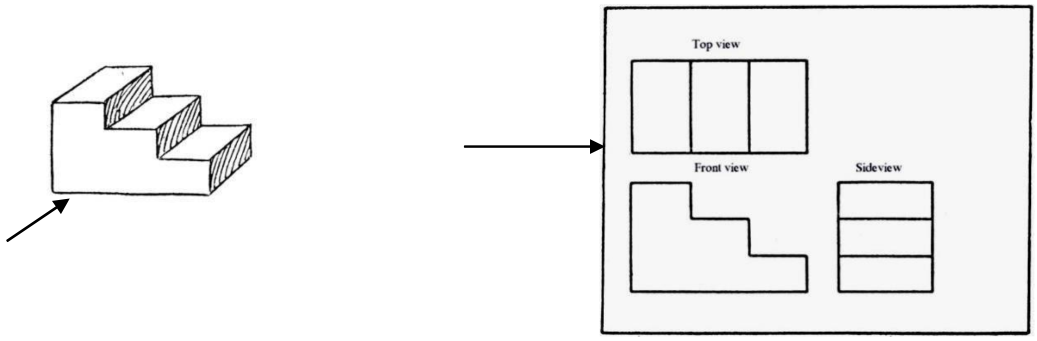


Figure 4.16

Orthographic Projection is a way of drawing an 3D object from different directions. Usually a front, side and plan view is drawn so that a person looking at the drawing can see all the important sides. Orthographic drawings are useful especially when a design has been developed to a stage whereby it is almost ready to manufacture.

Plane of projection: Two planes employed for the purpose of orthographic projections are called reference planes or planes of projection. they are intersect each other at right angle to each other the vertical plane of projection is usually denoted by the letters **VP** and the other Plane is horizontal plane of Projection is denoted by **HP** . The line in which they intersect is termed as the reference line and is denoted by the letters **xy.**

Four quadrants:

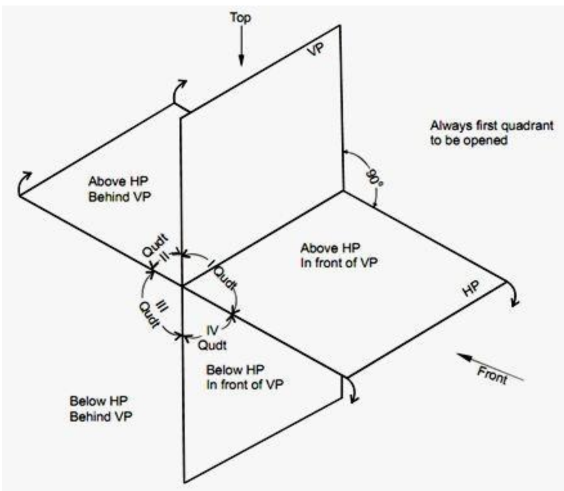


Figure 4.17

The intersection of mutual perpendicular Planes i.e Vertical Plane and Horizontal Plane Form Four quadrants as shown above figure 5.5. Here planes to be assumed transparent here the object may be situated any one of four quadrants. The projections are obtained by drawing perpendiculars from the object to the planes, i.e by looking from the Front and Top. It should be remembered that the first and third quadrants always opened out while rotating the planes. The position of views with respect to the reference line will change according to quadrant in which object may be situated as shown in below figures.

First angle Projection:

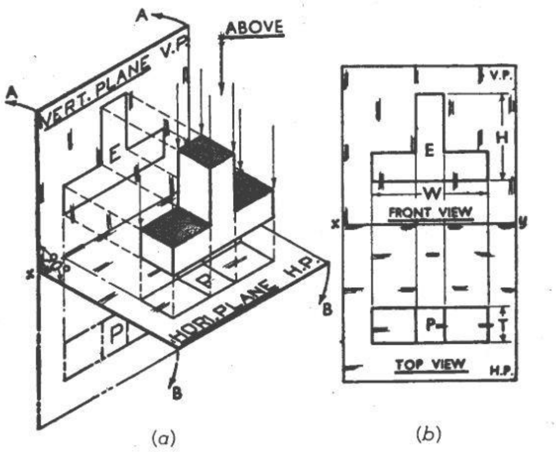


Figure 4.18

We have assumed the object to be situated in front of the VP and above the HP i.e First quadrant and then projected it on these planes, the method of projection is known as **First angle projection method.**

Here object lies between observer and plane of projection. In this method when the views are drawn in their relative positions the Top view comes below the front view.

Third angle Projection:

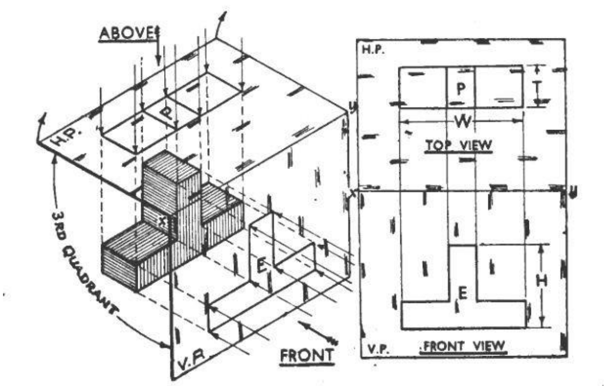


Figure 4.19

Here the object is assumed to be situated in third quadrant, here Plane of projection assumed to be transparent. It lies between Object and the observer. In this method when the views are drawn in their relative positions the Top view comes below the front view.

Reference Line:

While representing Projections it can be seen that while considering the front view which is seen from front the HP coincides with the line xy in their words xy represents HP.
Similarly while considering Top view which view obtained by looking from above, the same line xy represents the VP hence, when the projections are drawn in correct relationship with each other xy represents both the HP and VP this is called as Reference line.

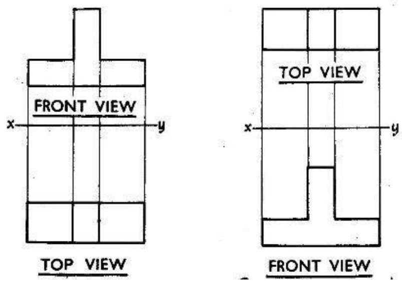


Figure 4.20

Note: There are two ways of drawing in orthographic - First Angle and Third Angle. They differ only in the position of the plan, front and side views.

Problems:

Draw the front view, Top view and Side view of the given figure?

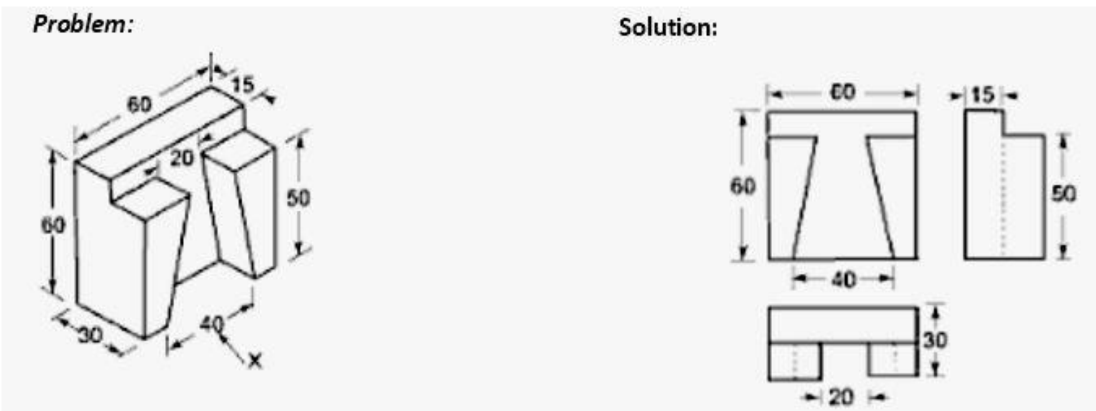
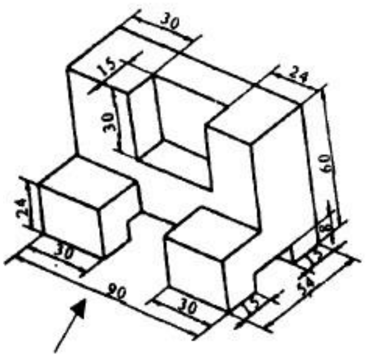


Figure 4.21

Problem:



Solution:

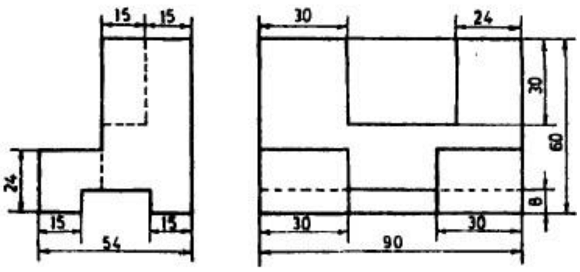
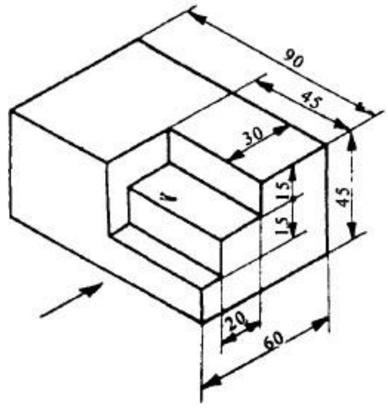


Figure 4.22

Problem:



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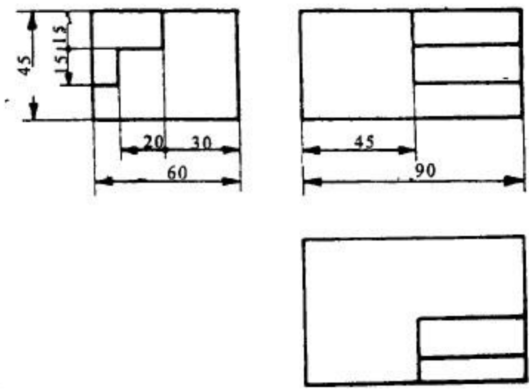
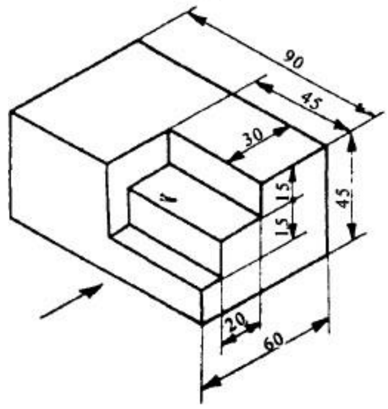


Figure 4.23

Problem:



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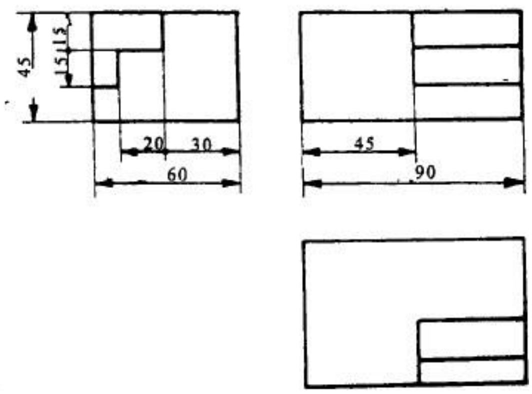
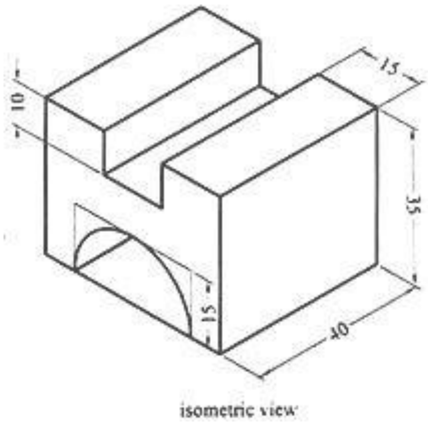


Figure 4.24

Problem



Solution

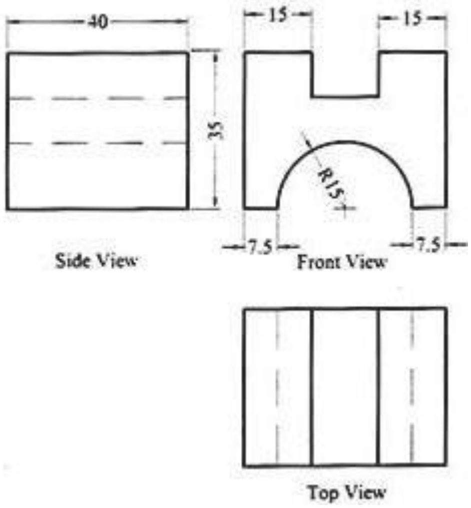
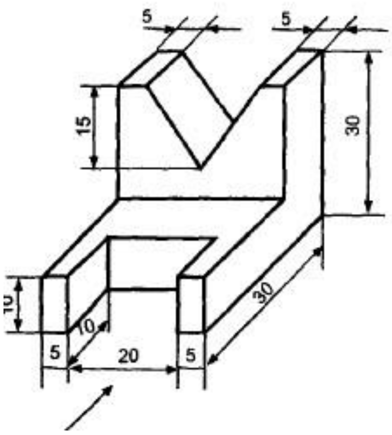


Figure 4.24

Problem:



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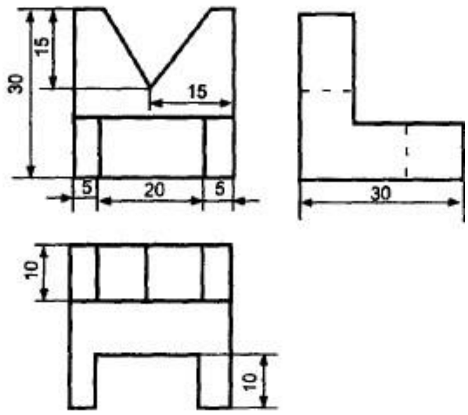
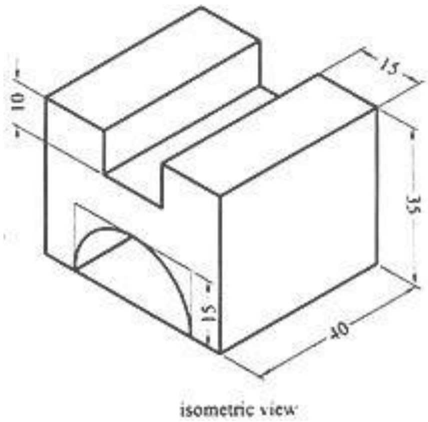


Figure 4.25

Problem



Solution

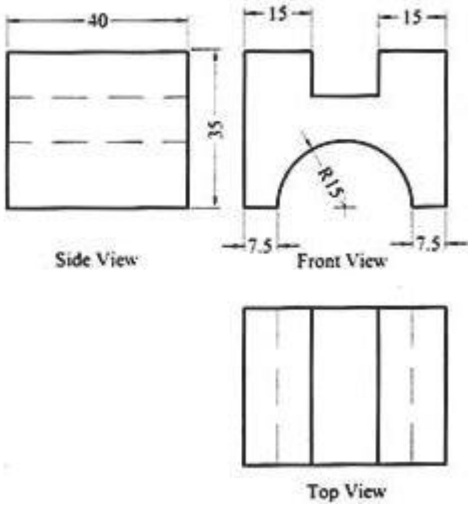
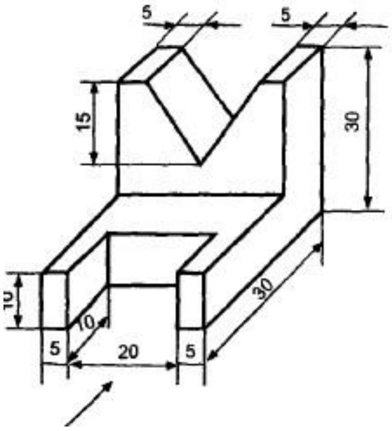


Figure 4.26

Problem:



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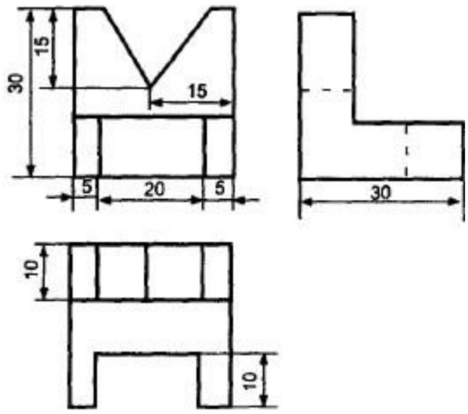
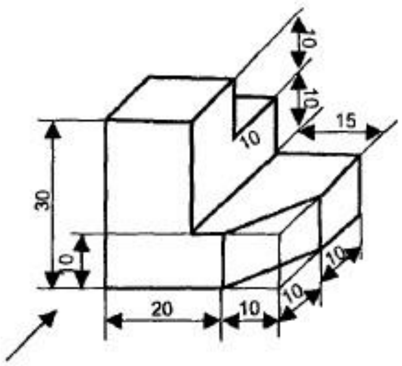


Figure 4.27

Problem:



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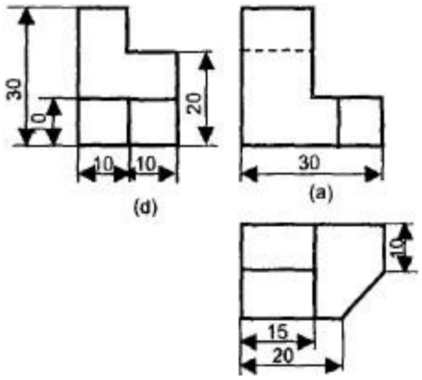
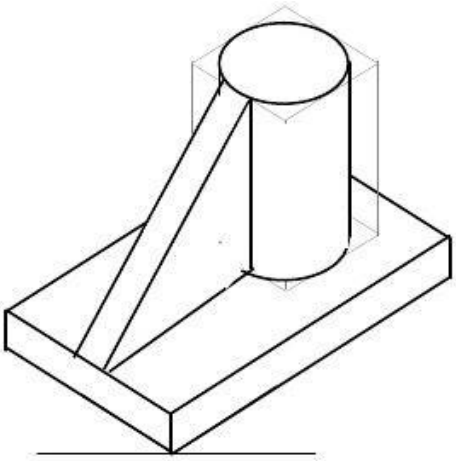


Problem:



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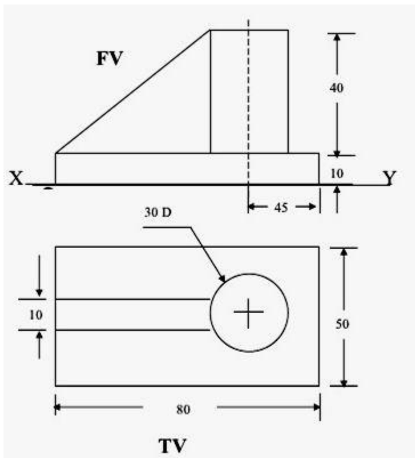

Figure 4.29

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SCHOOL OF BUILDING AND ENVIRONMENT
DEPARTMENT OF CIVIL ENGINEERING

UNIT – V – Computer Aided Drawing using AUTOCAD – SCIA1103

V. Computer Aided Drawing using AUTOCAD

Introduction to AUTOCAD

AutoCAD is a drafting package for use in CAD. There are several drafting packages like Cad key, DIAD, CADAM, Draftsman Delight etc. AutoCAD is a one of the popular CAD packages. It is a computer aided design (CAD) and drafting software package for desktop computers and workstations. AutoCAD's, features are easy to use pull down menus, dialog boxes and icon menus to guide the construction process. Using a mouse, we can draw geometrical entities of any complexity and then layer, rotate, copy, mirror, fillet, chamfer, move, stretch, scale, firm them.

AutoCAD can be used to create a drawing using two modes.

I. Command mode.
II. Menu mode

In **Command mode**, the user has to type various commands on keyboard. The software responds with appropriate prompts to help the user to input the necessary information.

In **Menu mode**, the use of software is through a menu which is located on the right side of the screen or top of the screen. The menu can be selected using the cursor control key on keyboard or mouse. Use of mouse may be found easy. Menu selection can be performed through icons. AutoCAD provides icons for a limited number of commands. Icons enable quick selection of menu.

BENEFITS OF AUTOCAD

The following are the advantages of using CAD.

- Improved engineering productivity
- Reduced engineering personnel requirement
- Drawing modifications are easier to make
- Improved accuracy of design
- Better communication

Entire Selection

The above are the different activities in using AutoCAD and each is selected by typing the number noted on the left against each of them. For example: Type 4 for plotting a drawing. Since we are starting a new drawing, choose option, by pressing 1 key and then press ENTER. A drawing has to assign a name. AutoCAD asks for the NAME with a prompt

Enter the name of the drawing:

Let us cal the drawing as DRG 1.

Type DRG 1 and press ENTER.

The editor screen is shown in the fig 1

AutoCAD drawing or screen editor

AutoCAD screen editor has four areas

1. Drawing area
2. Menu area
3. Command area
4. Status area

The **Drawing area** is the area where you will create drawings. If you move your mouse, you will see two crossed lines across the screen. This is the drawing editor **cursor**. The cursor is used to select positions on the screen when creating drawings

The **Menu area** is on the right side of the screen. Commands can be selected from this menu.

The **Command area** is at the bottom of the screen. Here AutoCAD commands are typed. In this area, AutoCAD prompts you for information that is needed to complete the command.

The **Status area** is at the top the screen. It gives information on the current status of the drawing

Auto cad cursor

The AutoCAD cursor is a pair of two crossed lines across the screen. When we are selecting an object, the drawing cursor changes into a small square. The square is called selection box or selection cursor.

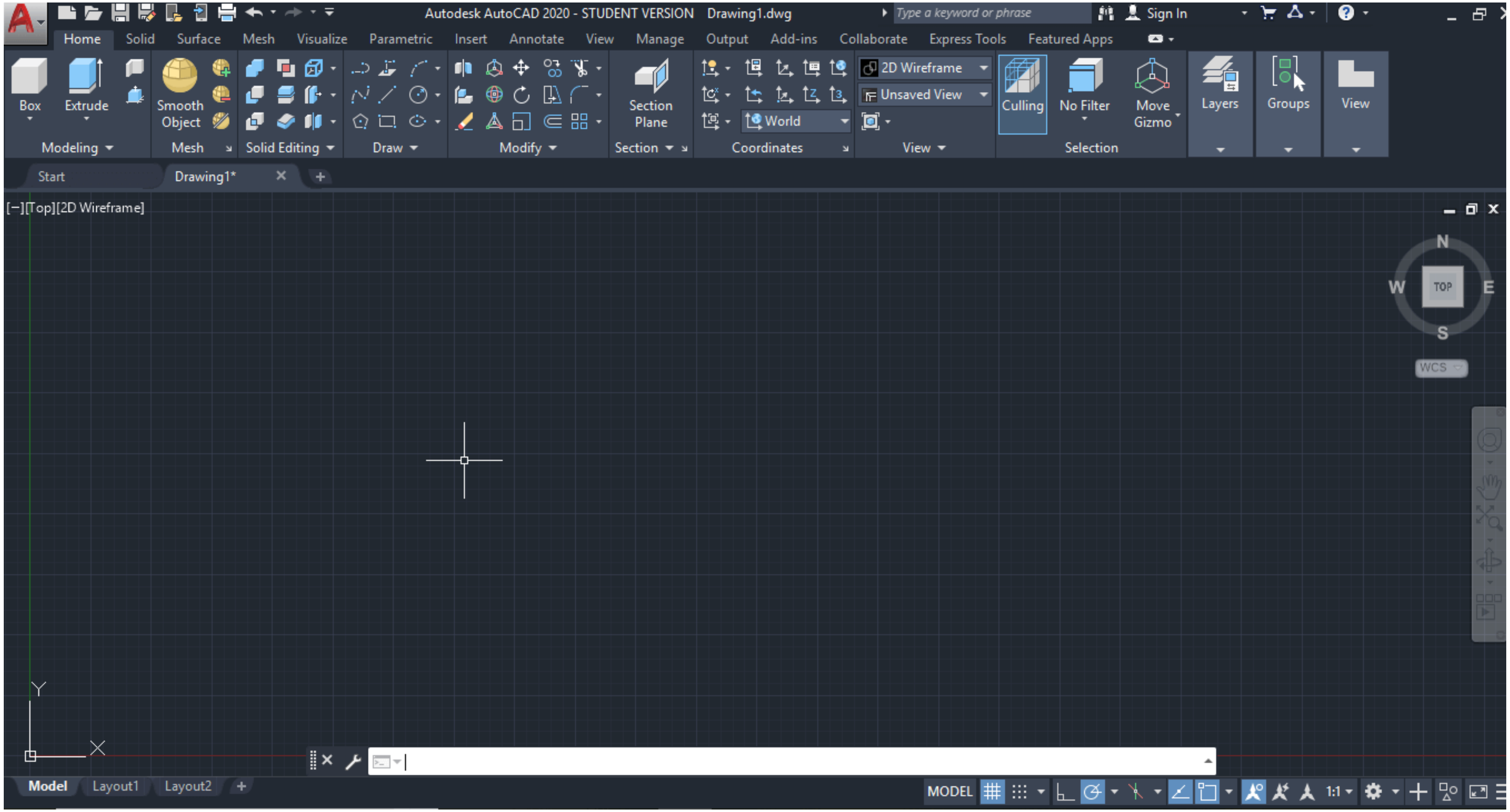


Figure 5.1 CADD SCREEN

LIST OF COMMANDS

DRAW COMMANDS

DRAW COMMANDS	SHORTCUT	USE
Line	L	To draw straight line
Circle	C	To draw circle
Ellipse	El	To draw ellipse
Arc	a	To draw a portion of a circle
Rectangle	Rec	To draw a rectangle
Polygon	Pol	To draw a regular polygon of no. of sides
Polyline	Pl	To draw continuous line
Donut	Do	To draw solid circle
Mline	Ml	To draw no. of parallel lines
Xline	Xl	To draw straight line of infinite length
Ray		To draw straight line of infinite length
Hatch	H	To section the object
Boundary Hatch	bh	To section the object
Text		To write text in single line
Mtext	t	To write text in a paragraph

EDIT COMMANDS

EDIT COMMANDS	SHORTCUT	USE
Erase	E	Erase a single entity or a group of
Oops		Retrieve objects erased inadvertently
Move	M	Move objects to a new location
Copy	Co	Makes no. of copies of an entity to a new location
Array	ar	Make multiple copies of an object
Change	Ch	Changes the properties of the object
Break	br	Break an existing object into pieces
Mirror	mi	Create mirror images of existing
Explode	X	Explode a polyline into its component entities
Rotate	ro	Rotate an existing object through a specified angle
Chamfer	c	Chamfer corners of objects
Fillet	f	Provide radius on corners of objects

Stretch	s	Move parts by stretching the objects
Offset	o	To draw parallel lines or curves
Undo	u	Undo a specified number of commands
Trim	tr	Trim portions of entities

DIMENSIONING COMMANDS

DIMENSIONING COMMANDS	SHORTCUT	USE
Dimlinear	dimlin	To create linear dimensions, i.e vertical, horizontal and inclined dimensions
Dimaligned	dimali	To create an aligned linear dimension
Dimradius	dimrad	To create radial dimensions for circles and arcs
Dimdiameter	dimdia	To create diameter dimensions for circles and arcs
Dimangular	dimang	To create angular dimensions
Dimbaseline	dimbase	To create parallel dimensioning
Dimcontinue	dimcont	To create progressive dimensioning
Dimordinate	dimord	To create superimposed running, dimensioning i.e ordinate point dimensioning
Leader	lead	To create a leader line to connect it with any object so that the required annotation can be added.

HATCHING COMMANDS

HATCHING COMMANDS	USE
Hatching	To hatch a region enclosed within a boundary by picking a point inside the boundary
Hatch	To fill the specified hatch boundary with a non associative hatch
Block	To create a block from selected objects to use it only in the current drawing
Insert	To place a named Block on drawing into the current drawing

CREATING TEXT

Command	Use
Text	The TEXT command lets you write test on a drawing. AutoCAD provides a number of fonts, by applying a style to the font, you may stretch, compress or mirror the text.
Text alignment	The main text alignment modes are left, center and right. You can align a text using a combination of modes; eg. Top / Middle / Base line / Bottom.
Mtext	To create multiple line of text width varying height, Rotation, Justification and fonts.

CO-ORDINATE SYSTEMS

Lines can be drawn by using three different methods.

A. ABSOLUTE CO-ORDINATE SYSTEM (X,Y)

The points are located from origin (0, 0) of X and Y axis. The X and Y coordinates shall be separated by a comma.

Syntax: X- coordinate, Y- coordinate

X- coordinate - Horizontal distance from the origin

Y- Coordinate - Vertical distance from the origin

Command: line

Specify first point: 3,3 ↵

Specify next point or [Undo]: 7, 3 ↵

Specify next point or [Undo]: 5, 5 ↵

Specify next point or [Close/Undo]: C↵

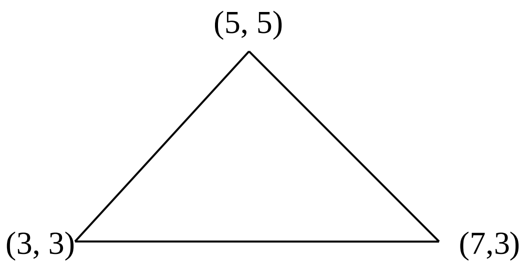


Figure 5.2

B. RELATIVE RECTANGULAR CO-ORDINATE SYSTEM

(@ X distance , y distance)

Distances of the points along X and Y axis are measured with reference to previous point.

Syntax: @ X- coordinate , Y- coordinate

In X- axis all measurements towards right is positive and towards left is negative.

In Y- axis all measurement upwards is positive and downward is negative.

Command: line

Specify first point: 1, 1 ↵

Specify next point or [Undo]: @5, 0 ↵

Specify next point or [Undo]: @0, 5 ↵

Specify next point or [Close/Undo]: @ - 1, 0 ↵

Specify next point or [Close/Undo]: @ 0,-1 ↵

Specify next point or [Close/Undo]: @ -1, 0 ↵

Specify next point or [Close/Undo]: C ↵

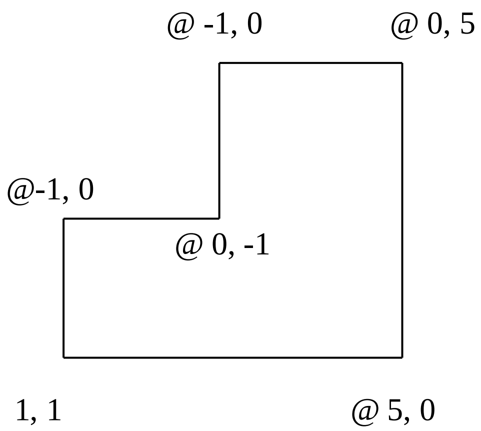


Figure 5.3

Mostly, an absolute co-ordinate is given at the *specify first point*: Distance is measured +ve towards right and up and it is measured –ve towards left and down.

C. RELATIVE POLAR CO-ORDINATE SYSTEM (@ distance < angle)

The point is located by the distance of the point from the current point and the angle that the line between the two points makes with the X – axis.

Syntax : @ distance<angle

Command: line

Specify first point: 4, 6 ↵

Specify next point or [Undo]: @8<0 ↵

Specify next point or [Undo]: @8<90 ↵

Specify next point or [Close/Undo]: @ 8<180

Specify next point or [Close/Undo]: C

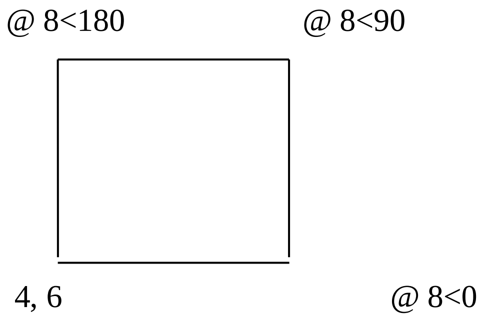


Figure 5.4

DIMENSIONING

DIMENSIONING

Dimensioning is the process of adding measurements to a drawing. The dimensioning system variables control the appearance of dimensions. These variables can be set on the command line or through the Dimension style manager.

Dimensioning Concepts

Dimensions shows the measurements of objects, the distances or angles between objects. AutoCAD provides three basic types of dimensioning.

- ❖ Linear
- ❖ Radial
- ❖ Angular

Dimensions can be

- ❖ Horizontal
- ❖ Vertical
- ❖ Aligned
- ❖ Rotated
- ❖ Ordinate
- ❖ Baseline
- ❖ Continued

Dimensioning can be done for objects like lines, arcs, circles and polyline objects or between point locations.

Parts of a Dimension or Components of a dimension

- ❖ **Dimension text** – Indicates the measurement value
- ❖ **Dimension line** – Indicates the direction and extent of a dimension
  *In angular dimensioning, the dimension line is a arc.
- ❖ **Arrowheads** - Symbols of termination
- ❖ **Extension lines** – Projection lines which extend from the drawing entity to the dimension line.

- ❖ **Leader lines** – Line that stretches from the dimension text to the object being dimensioned.
- ❖ **Center mark and Center lines** – It is a crossmark that identifies the center point of a circle or an arc.

Creating dimensions

Dimensions can be created by selecting an object to dimension and specifying the dimension line location. As dimensions are created, we can modify the dimension text content and its angle relative to the dimension line.

1. CREATION OF SIMPLE FIGURES AND MULTILINE FIGURES VIEW OF OBJECTS FORM THE GIVEN PICTORIAL VIEWS WITH DIMENSIONING

List of commands to be used

Draw command:

Draw Command: LINE, CIRCLE, RECTANGLE, HEXAGON, CIRCLE, ARC, ETC.,

Command: LINE (Press Enter)
From point: (Select a point in the screen using mouse)
To point: (Press Enter)
Draw a line from point to end point as like above for horizontal, Vertical and inclined lines.

Command: RECTANGLE
Specify first corner point or [Chamfer/Elevation/Fillet/Thickness/Width]:
Specify other corner point or [Dimensions]: DIMENSIONS
Specify length for rectangles <0.0000>:
Specify width for rectangles <0.0000>:
Specify other corner point or [Dimensions]:

Command: **CIRCLE** (Press Enter)
3P/2P/TTR/<Center point>: (Pick a point in the screen using mouse)
Diameter/Radius: (Type numeric value) (Press Enter)

For TEXT matters:

Command: **DTEXT** (Press Enter)
Justify/Style/<Start point>: (Select a start point in the screen using mouse).
Height: (Type a required height of the text in the numeric value) (Press Enter)
Rotation angle: (Type a required angle in the numeric value) (Press Enter)
Text: (Type the required text) (Press Enter)

Edit commands OFFSET, TRIM, COPY, MOVE ETC.,

Command: **OFFSET** (Press Enter)
Offset Distance or through: (Type the value of distance) (Press Enter)

Select objects to offset: (Select line or circle to be offsetted) (Press Enter)
Side to offset: (Pick a required side to offset using mouse)

Command: **TRIM** (Press Enter)
Select cutting edges:
Select objects: (Select a perpendicular line to the trim line) (Press Enter)
Select object to trim: (Select by mouse)

For Editing Text

Command: DDEDIT (Press Enter)
Select an annotation object: (Select the text to be edited)

Command: **COPY** (Press Enter)
Select objects: (Select objects to be copied by using mouse) (Press Enter)
Base point or Displacement/Multiple: (Pick any point in the object using mouse) (Press Enter)
Second point of Displacement: (Pick a point where to be copied)

Command: **MOVE** (Press Enter)
Select objects: (Select objects to be moved by using mouse) (Press Enter)
Base point of Displacement: (Pick any point in the object using the mouse)
Second point of Displacement: (Pick a point where to be moved)

Command: **ERASE** (Press Enter)
Select objects: Use any of the object selection method to select the objects. AutoCAD deletes the selected group of entities from the screen.

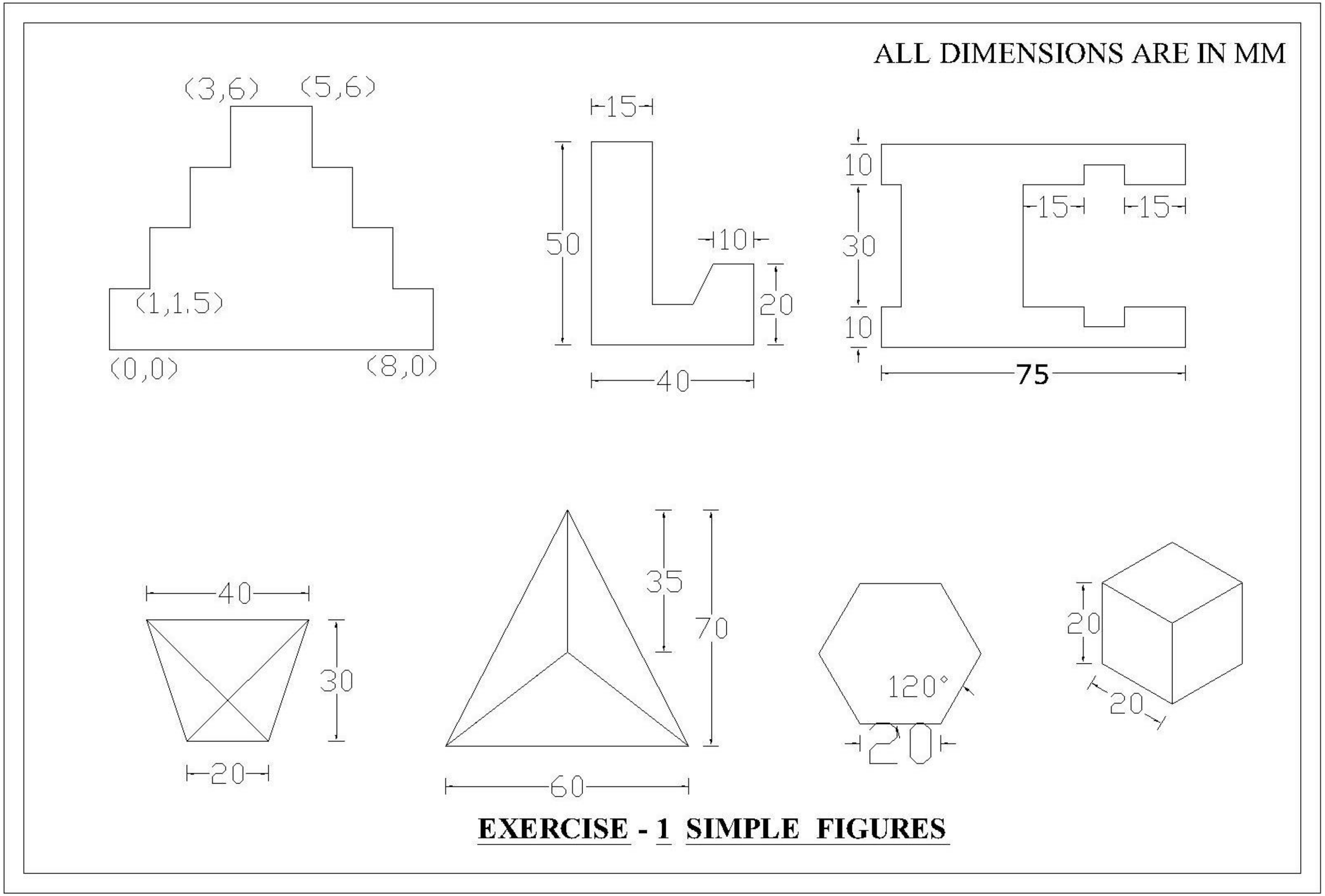

ALL DIMENSIONS ARE IN MM
(3,6)
(5,6)
(1,1.5)
(0,0)
(8,0)
15
50
10
20
40
10
30
10
15
15
75
40
30
20
35
70
60
120°
20
20
20
EXERCISE - 1 SIMPLE FIGURES

Figure 5.5

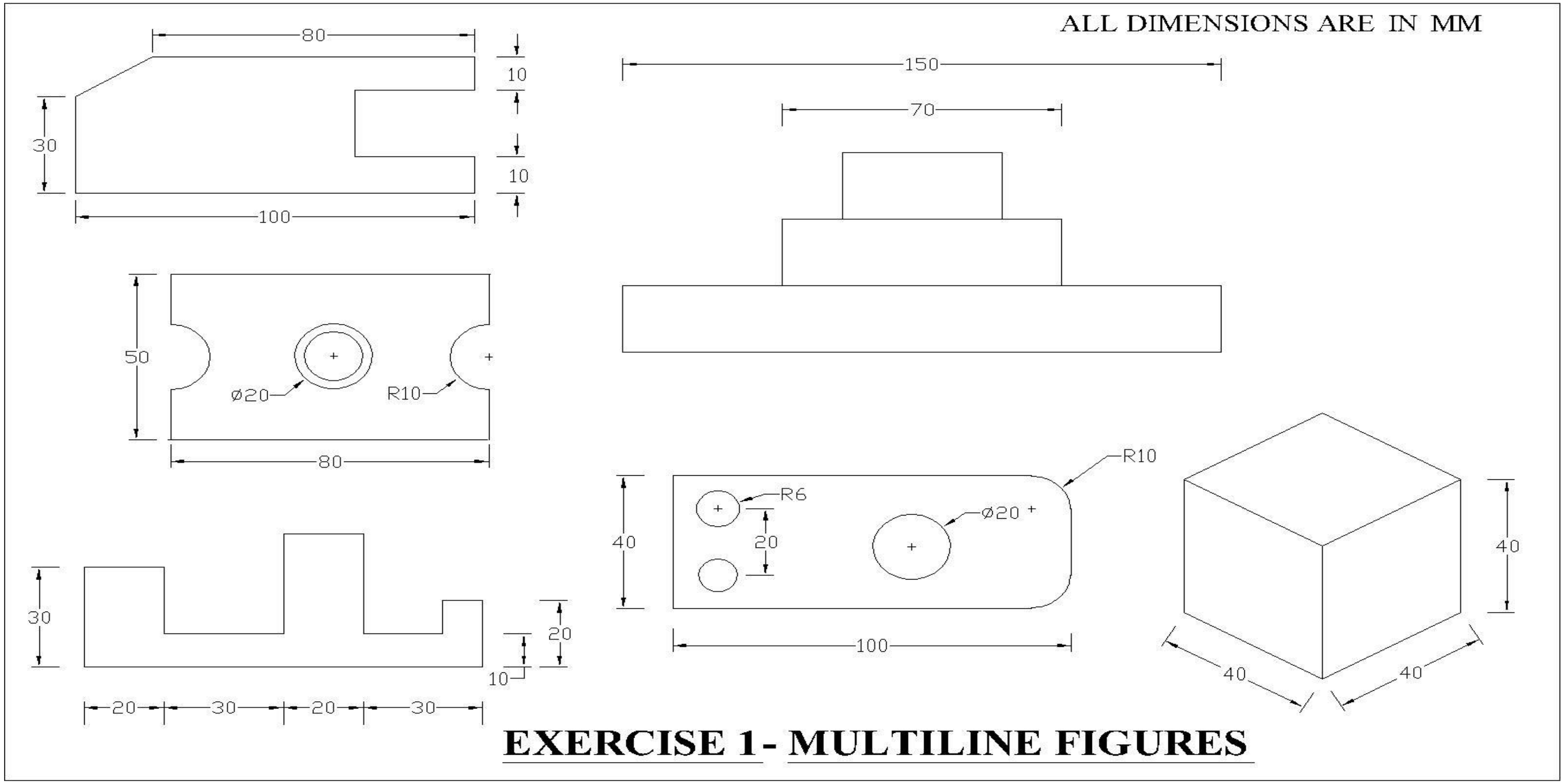

ALL DIMENSIONS ARE IN MM
80
10
30
10
100
150
70
50
Ø20
R10
80
R10
R6
Ø20
40
20
100
40
40
40
30
20
10
20
30
20
30
EXERCISE 1- MULTILINE FIGURES

Figure 5.6

2. TITLE BLOCK

DRAWING OF TITLE BLOCK WITH NECESSARY TEXT AND PROJECTION SYMBOL

<u>List of commands to be used</u>

<u>Draw command: , CIRCLE, RECTANGLE, CIRCLE, ETC.,</u>

Command: LINE (Press Enter)
From point: (Select a point in the screen using mouse)
To point: (Press Enter)
Draw a line from point to end point as like above for horizontal, Vertical and inclined lines.

<u>For making rectangles for borders, title blocks etc.</u>

Command: RECTANGLE
Specify first corner point or [Chamfer/Elevation/Fillet/Thickness/Width]:
Specify other corner point or [Dimensions]: DIMENSIONS
Specify length for rectangles <0.0000>:
Specify width for rectangles <0.0000>:
Specify other corner point or [Dimensions]:

Command: **CIRCLE** (Press Enter)
3P/2P/TTR/<Center point>: (Pick a point in the screen using mouse)
Diameter/Radius: (Type numeric value) (Press Enter)

<u>For TEXT matters</u>*<u>:</u>*

Command: **DTEXT** (Press Enter)
Justify/Style/<Start point>: (Select a start point in the screen using mouse).
Height: (Type a required height of the text in the numeric value) (Press Enter)
Rotation angle: (Type a required angle in the numeric value) (Press Enter)
Text: (Type the required text) (Press Enter)
<u>Edit commands</u>

Command: **OFFSET** (Press Enter)
Offset Distance or through: (Type the value of distance) (Press Enter)
Select objects to offset: (Select line or circle to be offsetted) (Press Enter)
Side to offset: (Pick a required side to offset using mouse)

Command: **TRIM** (Press Enter)
Select cutting edges:
Select objects: (Select a perpendicular line to the trim line) (Press Enter)
Select object to trim: (Select by mouse)

<u>For Editing Text</u>

Command: DDEDIT (Press Enter)
Select an annotation object: (Select the text to be edited)

Command: **COPY** (Press Enter)
Select objects: (Select objects to be copied by using mouse) (Press Enter)
Base point or Displacement/Multiple: (Pick any point in the object using mouse) (Press Enter)
Second point of Displacement: (Pick a point where to be copied)

Command: **MOVE** (Press Enter)
Select objects: (Select objects to be moved by using mouse) (Press Enter)
Base point of Displacement: (Pick any point in the object using the mouse)
Second point of Displacement: (Pick a point where to be moved)

Command: **ERASE** (Press Enter)
Select objects: Use any of the object selection method to select the objects. AutoCAD deletes the selected group of entities from the screen.

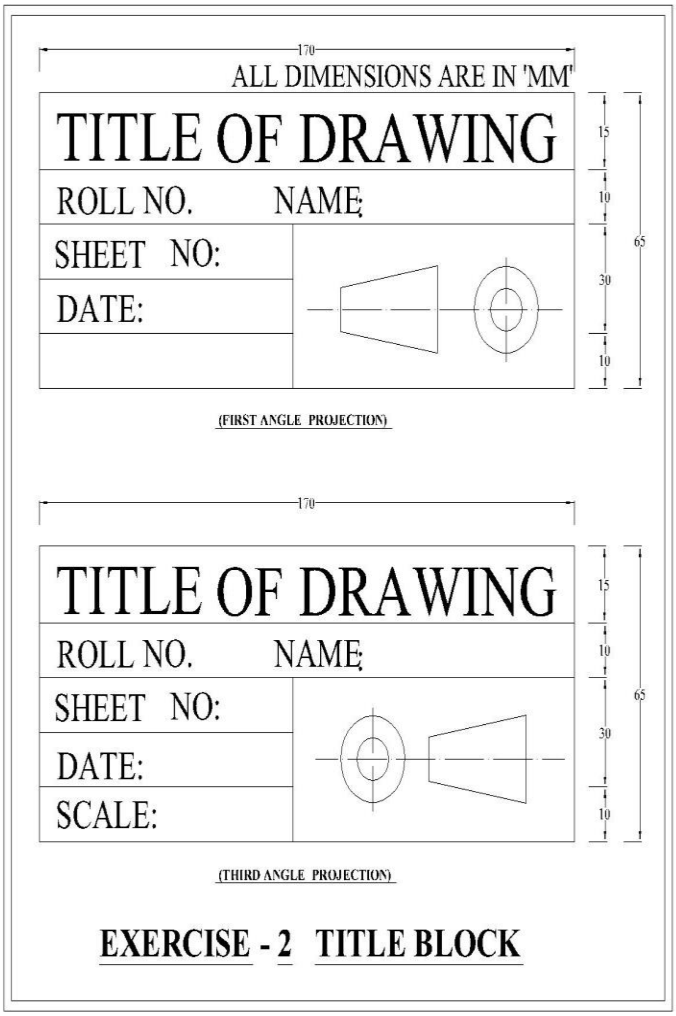


Figure 5.7

PARABOLA

Methods to construct the parabola are given below:

1. Rectangle methods
2. Parallelogram method
3. Tangent method

SPIRAL

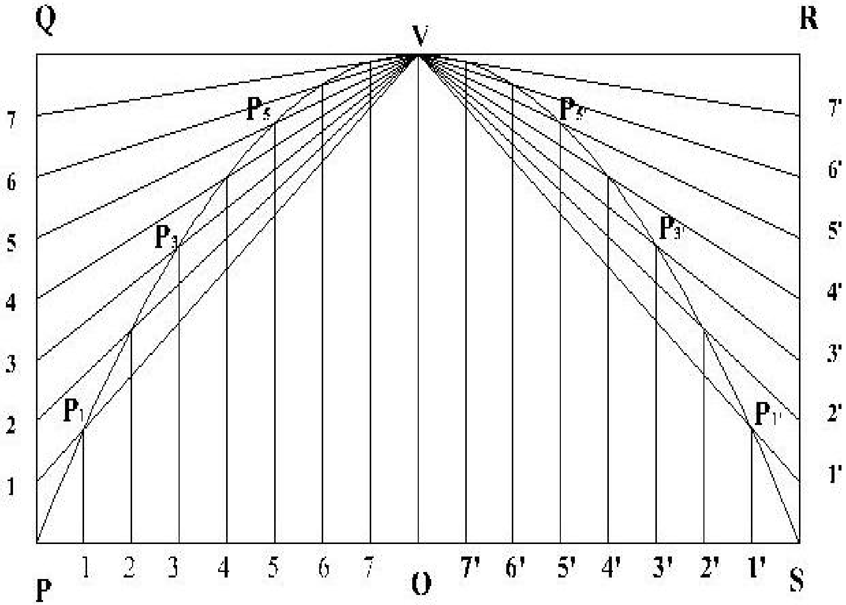
Spiral is a curve formed by the locus of a point which moves around a centre, while moving away from the centre. The centre is called a pole. The point will move along a line called radius vector while the line itself rotates about one of its end points. The locus of the point for one complete revolution of the radius vector is called spiral for one convolution.

There are two types of spirals namely,

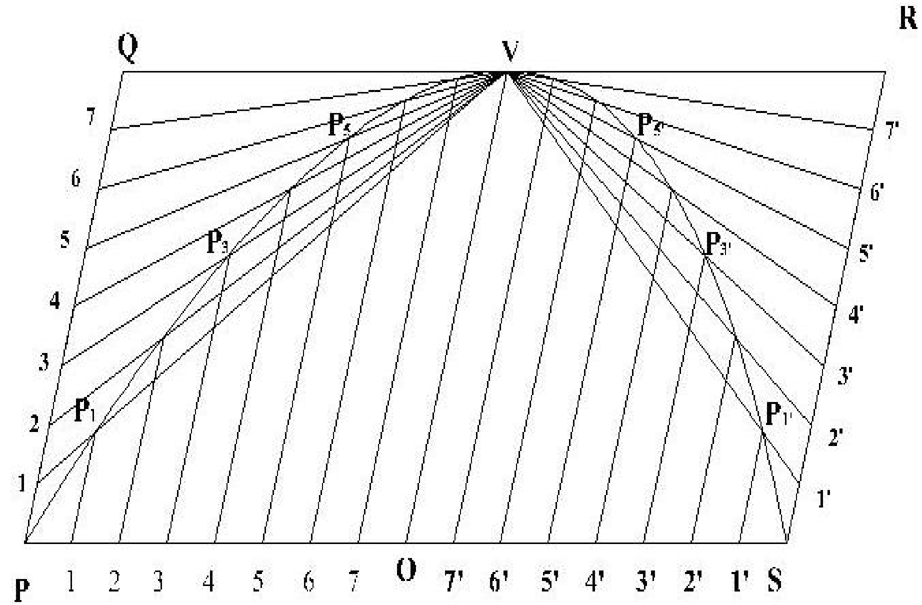
(i) Archimedean spiral
(ii) Logarithmic or Equiangular spiral.

INVOLUTE

Involute is a curve traced , a point on a taut cord unwinding from a polygon or circle. The involute of a circle is the curve for gear teeth and gear cutting tools. It is used in the development of tooth profiles.



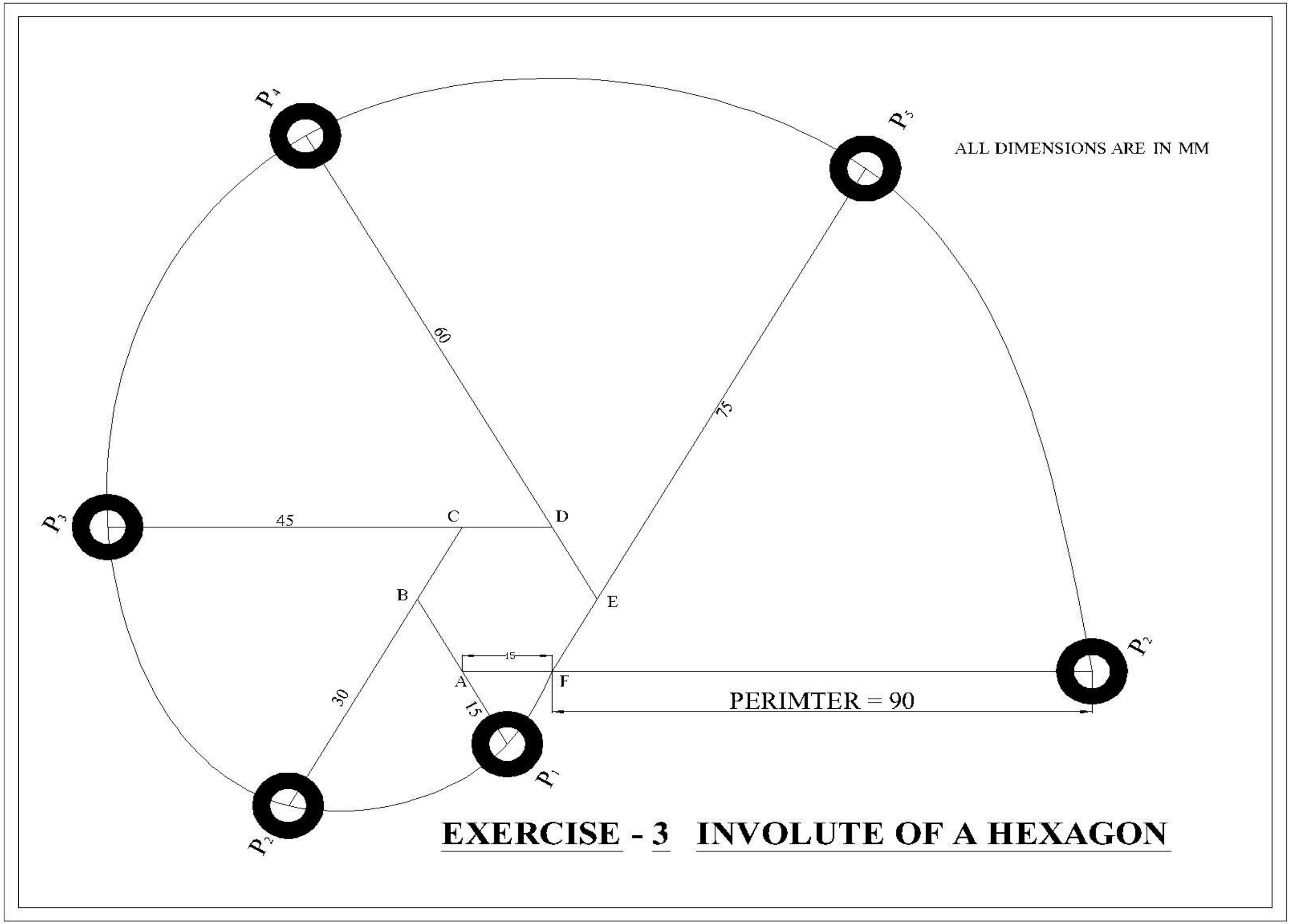
PARABOLA - RECTANGULAR METHOD



PARABOLA - PARALLELOGRAM METHOD

EXERCISE - 3

Figure 5.8



ALL DIMENSIONS ARE IN MM
P4
P5
60
75
P3
45
C
D
B
E
P2
15
A
F
PERIMTER = 90
30
15
P1
P2
EXERCISE - 3 INVOLUTE OF A HEXAGON

Figure 5.9

4. PROJECTION OF SOLIDS

List of commands to be used.
Draw command

Command: LINE (Press Enter)
From point: (Select a point in the screen using mouse)
To point: (Press Enter)
Draw a line from point to end point as like above for horizontal, vertical and inclined lines.

Command: BLOCK (Press Enter)
Block Name: (Type a typical name) (Press Enter)
Insertion point: (Pick a point in the head frame drawing)
Select objects: (Select the Head frame) (Press Enter)
Now the head frame drawing disappears from the screen. To insert the above block,

Command: INSERT (Press Enter)
Block name to insert: (Pick a point in drawing where to be inserted) (Press Enter for all further questions)
As above draw the Top rail, Bottom rail, Tower bolt, Sash bar etc**.**

Command: **CIRCLE** (Press Enter)
3P/2P/TTR/<Center point>: (Pick a point in the screen using mouse)
Diameter/Radius: (Type numeric value) (Press Enter)
To draw section symbols use **PLINE** command or **LINE** and **HATCH** commands
To draw cut lines use **PLINE** command and curve options (Spline/Fit).

Command: **BH** (Press Enter)
Boundary hatching dialog displays, pick selected hatch pattern by using mouse and place the hatch pattern inside the required boundaries.
(Double click to select the hatch pattern)

Command: **CHPROP** (Press Enter)
Select Objects: (Select the continuous line to be changed as hidden lines) (Press Enter)
Change what property: (Type **LT**) (Press Enter)
New line type: (Type **Hidden**) Press Double Enter)
Command: **DIM** (Press Enter)
Dim: (Type required variable like **hor, ver,** etc...) (Press Enter)
For Arrow marks use **Leader option** in Dim command
For Dot marks use variable commands

For TEXT matters:
Command: **DTEXT** (Press Enter)
Justify/Style/<Start point>: (Select a start point in the screen using mouse).
Height: (Type a required height of the text in the numeric value) (Press Enter)
Rotation angle: (Type a required angle in the numeric value) (Press Enter)
Text: (Type the required text) (Press Enter)
For making rectangles for borders, title blocks etc.

Command: **REC** (Press Enter)

<First Corner>: (Select a point in the screen using mouse)
Other corner: @297,210 (Press Enter)

Edit commands

Command: **OFFSET** (Press Enter)
Offset Distance or through: (Type the value of distance) (Press Enter)
Select objects to offset: (Select line or circle to be offsetted) (Press Enter)
Side to offset: (Pick a required side to offset using mouse)

Command: **TRIM** (Press Enter)
Select cutting edges.
Select objects: (Select a perpendicular line to the trim line) (Press Enter)
Select object to trim: (Select by mouse)

Command: **EXTEND** (Press Enter)
Select boundary edges:
Select objects: (Select a perpendicular boundary line to the extending line)
Select object to extend: (Select by mouse)

For Editing Text
Command: DDEDIT (Press Enter)
Select an annotation object: (Select the text to be edited)

Command: **COPY** (Press Enter)
Select objects: (Select objects to be copied by using mouse) (Press Enter)
Base point or Displacement/Multiple: (Pick any point in the object using mouse) (Press Enter)
Second point of Displacement: (Pick a point where to be copied)

Command: **MOVE** (Press Enter)
Select objects: (Select objects to be moved by using mouse) (Press Enter)
Base point of Displacement: (Pick any point in the object using the mouse)
Second point of Displacement: (Pick a point where to be moved)

Command: **LINETYPE** (or) **LT** (Press Enter)
The layer and line type properties dialog box will appear. You can choose any option related to line type and layer from the dialog box.
Command: **STRETCH** (Press Enter)
Select objects to stretch by crossing window or polygon:
Select objects:
AutoCAD stretches lines, arcs and polyline segments that cross the selection window. The end points that lie inside the window are stretched leaving the others unchanged. Any entity that is fully inside the window is moved like the move command.
Base point of Displacement:
Second point of Displacement:
When a point is specified AutoCAD uses this as a base point and prompts for the second point.
Command: **ERASE** (Press Enter)
Select objects: Use any of the object selection method to select the objects. AutoCAD deletes the selected group of entities from the screen.

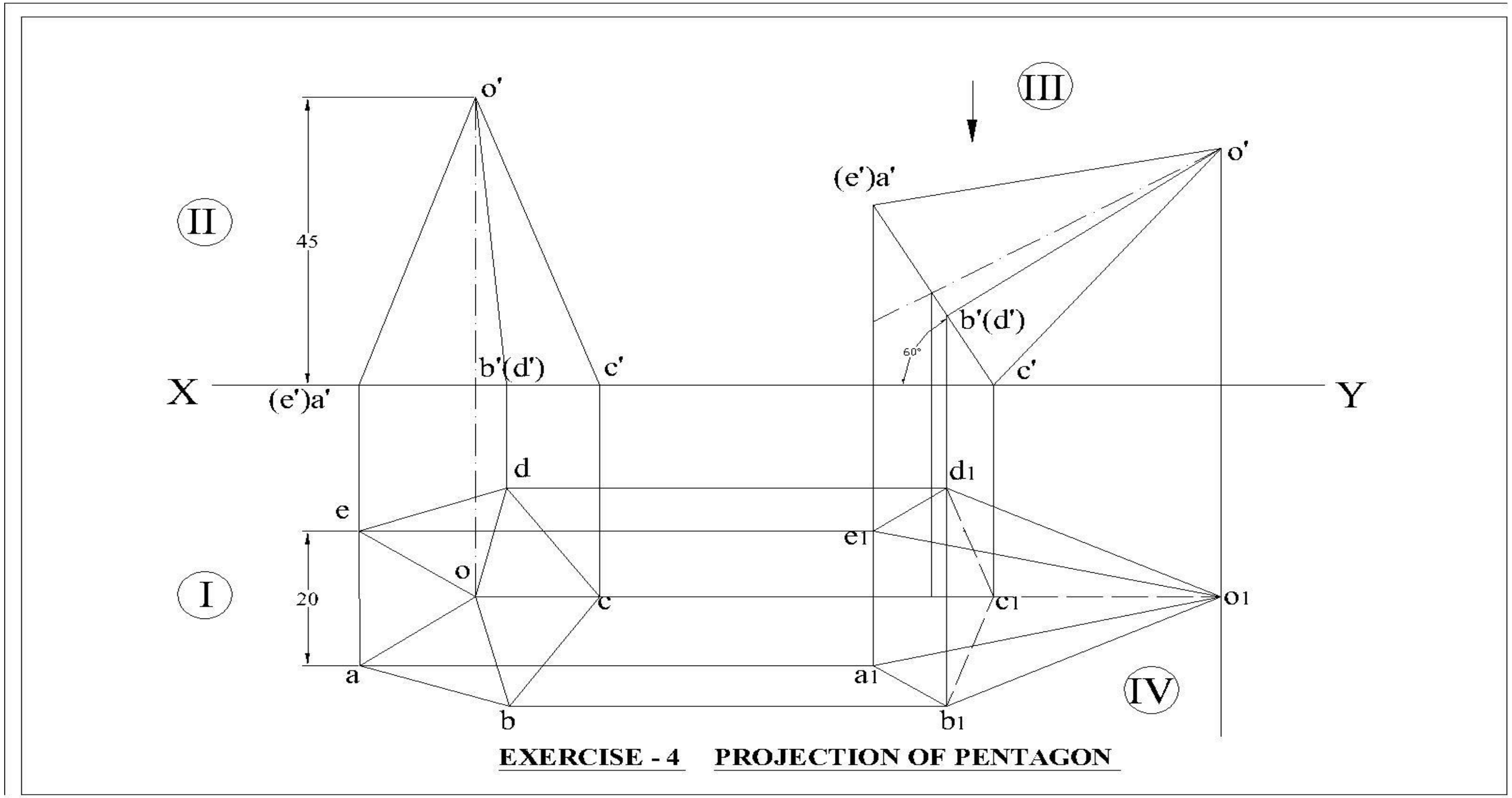

o'
III
(e')a'
o'
II
45
b'(d')
60°
X
(e')a'
b'(d')
c'
c'
Y
d
d1
e
e1
o
I
20
c
c1
o1
a
a1
IV
b
b1
EXERCISE - 4
PROJECTION OF PENTAGON

Figure 5.10

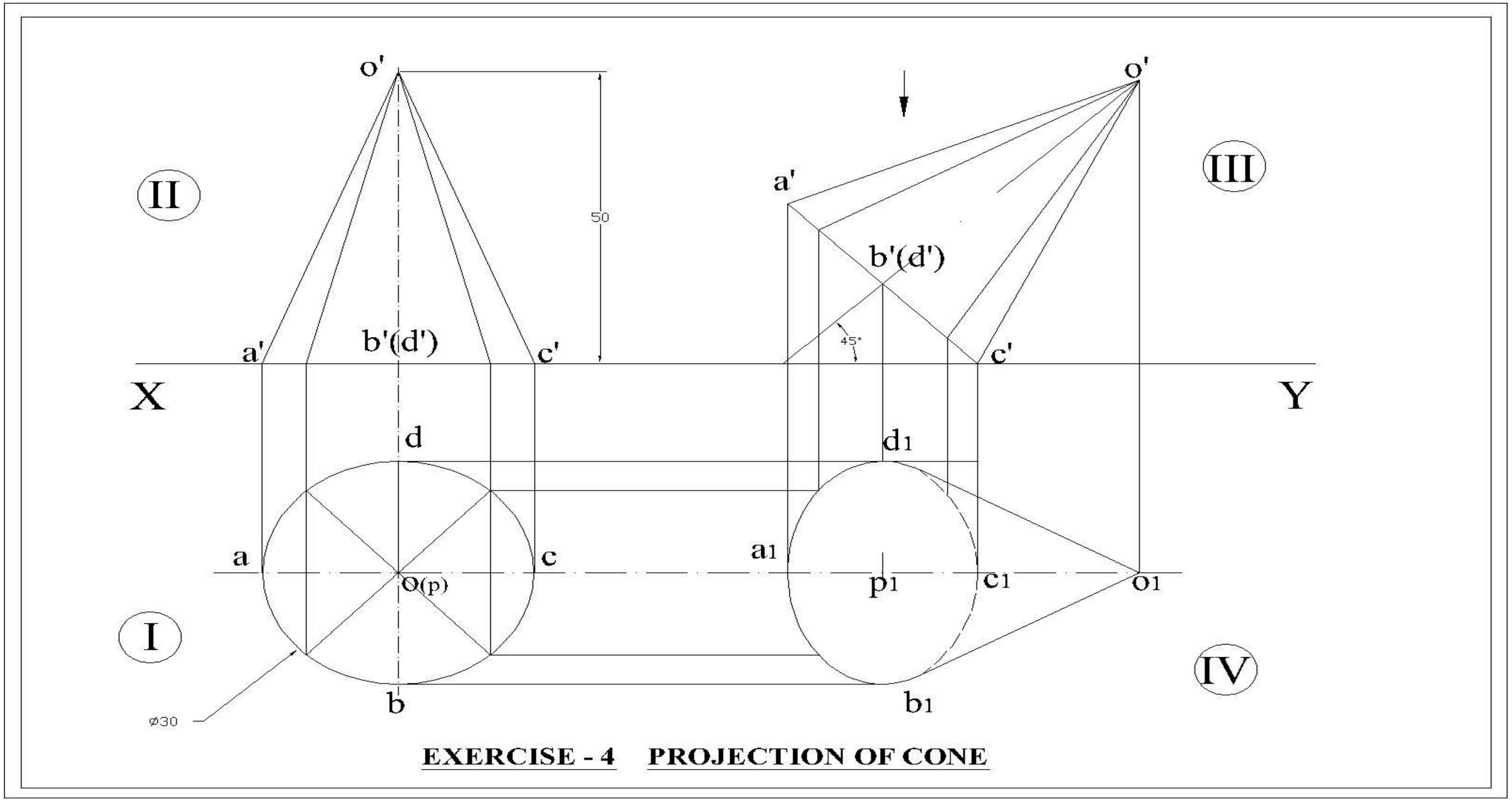

o'
o'
II
III
50
a'
b'(d')
a'
b'(d')
c'
45°
c'
X
Y
d
d1
a
c
a1
c1
o(p)
p1
o1
I
IV
b
b1
ø30
EXERCISE - 4 PROJECTION OF CONE

Figure 5.11

5.SECTIONAL VIEWS OF PRISM, PYRAMID, CYLINDER AND CONE

List of commands to be used.

- **LINE**
- **CIRCLE**
- **MIRROR**
- **DIM**
- **MTEXT**
- **OFFSET**
- **TRIM**
- **EXTEND**
- **DDEDIT**
- **COPY**
- **MOVE**
- **STRETCH**
- **ERASE**

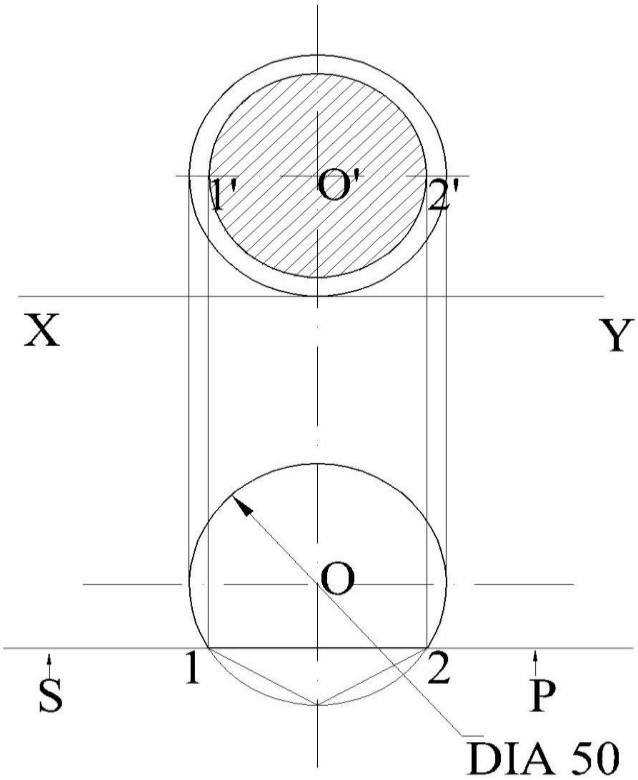


Figure 5.12

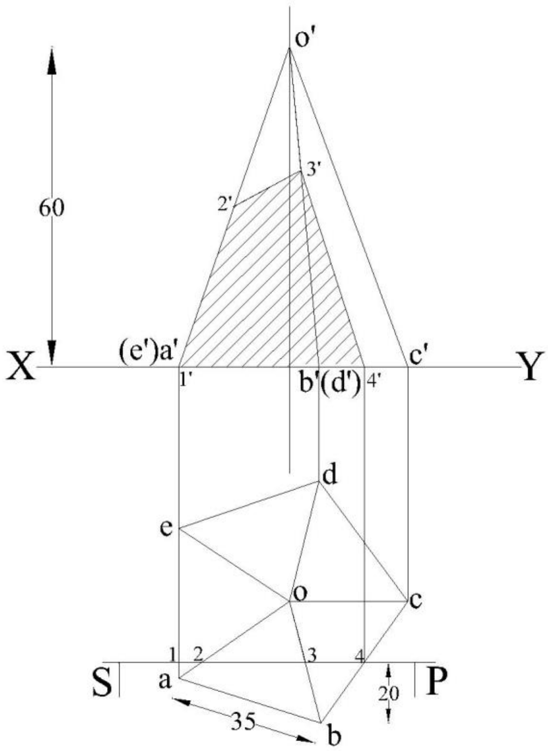


Figure 5.13

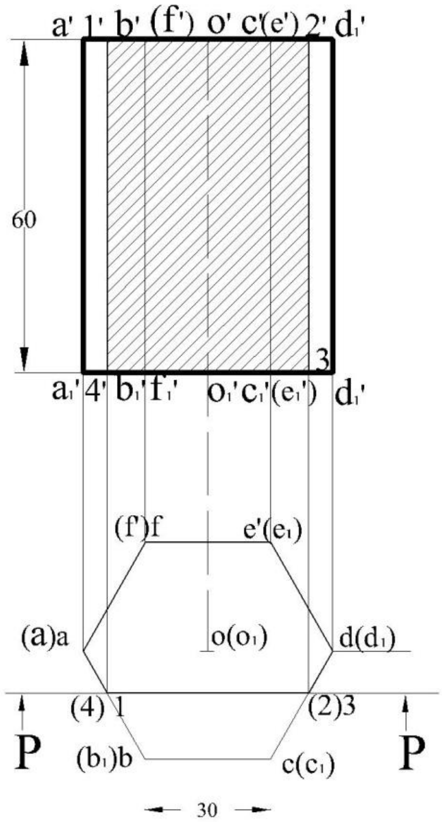


Figure 5.14

6. ISOMETRIC PROJECTION OF SIMPLE OBJECTS

List of commands to be used.

- **LINE**
- **CIRCLE**
- **DIM**
- **DTEXT**
- **OFFSET**
- **TRIM**
- **EXTEND**
- **DDEDIT**
- **COPY**
- **MOVE**
- **STRETCH**
- **ERASE**

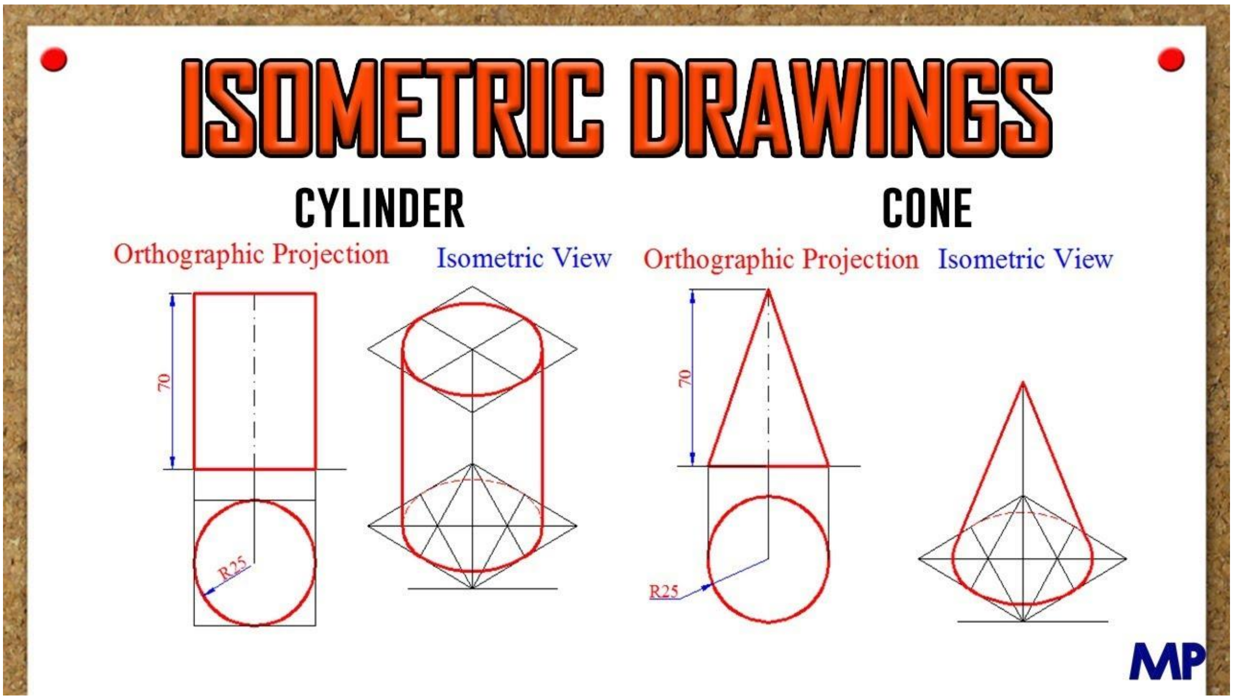
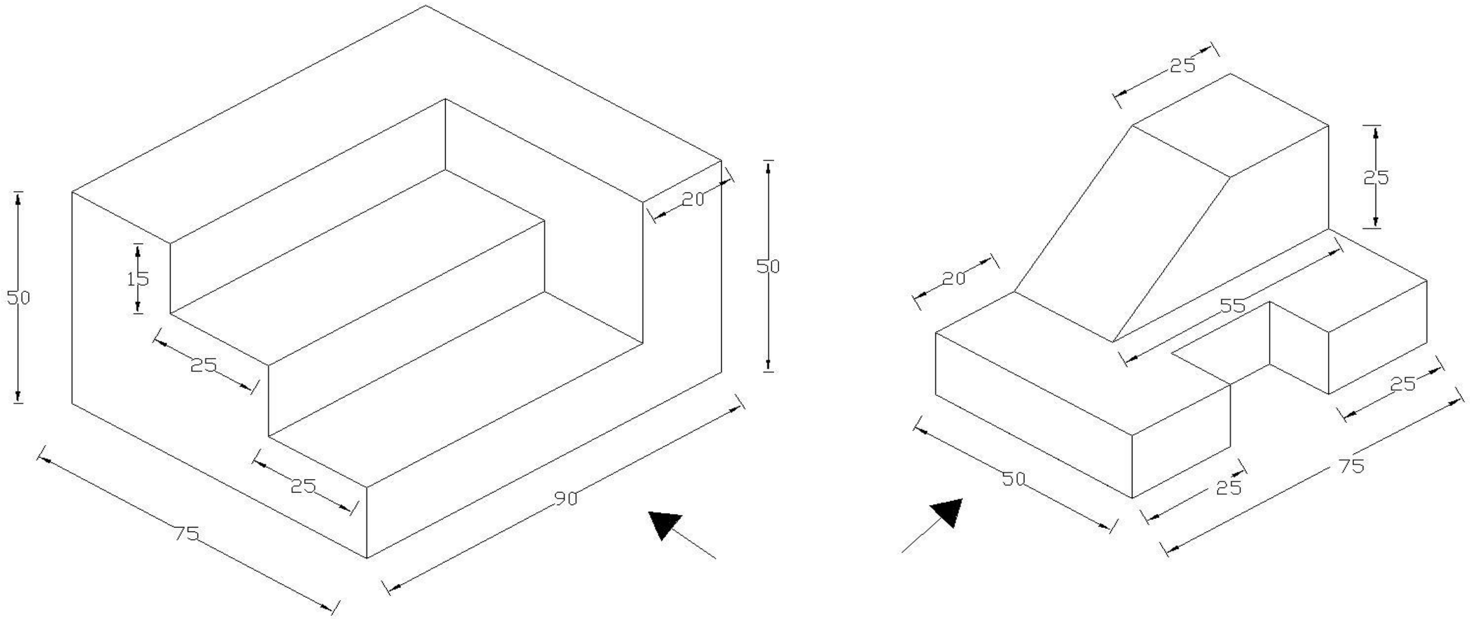


Figure 5.15

7. CREATION OF 3D MODELS OF SIMPLE PERSPECTIVE PROJECTION

List of commands to be used.

- **LINE**
- **CIRCLE**
- **OSNAP**
- **DIM**
- **DTEXT**
- **OFFSET**
- **TRIM**
- **EXTEND**
- **DDEDIT**
- **COPY**
- **MOVE**
- **STRETCH**
- **ERASE**



EXERCISE - 5 3 D MODELS OF SIMPLE PERSPECTIVE PROJECTION

Figure 5.16