## MAHARAJA AGRASEN INSTITUTE OF TECHNOLOGY ENGINEERING GRAPHICS LAB MANUALS



NAME: - $\qquad$
SUBJECT TEACHER'S NAME: - $\qquad$
ROLL NO: - $\qquad$
CLASS/BRANCH: - $\qquad$

Introduction:- Technical drawing is the language of engineering without the knowledge of engineering drawing, an engineer is now where, and he could not have constructed the various magnificent structures or intricate machines. Evidently anyone connected in anyway, with engineering construction must understand this language of engineers. Technical drawing is therefore indispensable today and shell continue to be so as long as engineering and technology continue to be of use in the activities of man.

The subject engineering graphics will help the students in many ways for making images, describing the shape, size, finish, colour and construction any object. Student will learn the base concept of orthographic projection, projection of point's lines planes, solids, section of solids, and development of surfaces of solids and Isometric projections.

He will be able use the present drafting software
Layout of drawing Sheet: Layout of Drawing sheet is drawn as given in following figure:


## TITLE BLロCK

| NAME | MAIT.RDHINI, NEW DELHI |  |
| :---: | :---: | :---: |
| BRANCH |  |  |
| RロLL ND. | TITLE $\square F$ DRAWING | Angle of drawing |
| Date commencement |  |  |
|  |  | Grade |
|  |  | Checked By: |

## Lists of drawing instruments:-

In the preparation of engineering drawing, the following drawing instruments and materials are required

1. Drawing board
2. Drawing sheet(A-2 Size)
3. Mini Drafter
4. Instrument box containing compass and dividers
5. Set squares $\left(30^{\circ}-60^{\circ}, 45^{\circ}-45^{\circ}\right)$
6. Drawing pin or clips or cello tape
7. Protractor
8. Drawing pencils (HB, H, 2H)
9. Eraser, Sharpener, Scale, French curves, dusting cloth.

## Conventional lines:

Table 3.1 Convention for lines

| LINE | DESCRIPTION | APPLICATION |
| :--- | :--- | :--- |
| A | Continuous thick | Visible outlines <br> Visible outlines |
| B Continuous thin |  |  |
| (straight or curved) |  |  | | Imaginary lines of intersection |
| :--- |
| Dimension lines <br> Projection lines <br> Leader lines <br> Hatching <br> Outlines of revolved sections <br> in place <br> Short centre lines |
| C |



## Dimensioning:

1. Dimensions should be placed outside the views, except when they are cleaner more easily readable inside.
2. Dimension lines should not cross each other
3. As far as possible, dimension should not be shown between the dotted lines.
4. Dimension lines should be placed at about 6 mm from the outlines.
5. Head should be pointed and filled in. they are made in ratio 3 to1 (Length)


Lettering: - Writing titles, dimension, notes and other important particulars on a drawing is called lettering should therefore be done properly in clear, legible and uniform style preferably freehand and speedily.

## Types of letters:-

1. Single stoke letters:- in these letters, the thickness o line of the letter should be such as is obtained in one stoke of the pencil
Single stoke letters of two types:-
(1) Vertical
(2) Inclined

Inclined letters lean to the right at angle of with the horizontal. The ratio of height to width various but in case of most of the letters it is 7:5 (15:696)

These are shown in fig:
Gothic letters: - if stems of single stroke letters, are given more thickness, the letters are known as gothic letters.


## Sheet No.: 2

## PROJECTION OF POINTS

Projection: If straight lines are drawn from various points on the contour of an object, to meet a plane of projection, the object is said to be projected on that plane. The figure formed by joining, in correct sequence, the points at which these lines meet the plane of projection, is called projection of the object. The line from the object to the plane of projection is called projection as shown in following figure:-


Fig 2.1
Orthographic Projection: When projectors are parallel to each other and also perpendicular to the plane of projection the projection is called Orthographic projection.

Planes of Projection: Two planes used for the orthographic projection are called reference planes or principal plane of projection. They intersect each other at right angles. They are known as:-
(i) Vertical Plane (VP)
(ii) Horizontal Plane (HP)

The vertical plane is often called the frontal plane and denoted by the letters F.P.

The line of intersection of vertical plane and Horizontal Plane is called reference line and is denoted by letter XY.

Projection on vertical plane (VP) is called front view or elevation. Projection on the HP is called the top view or the plan.

Profile Plane: A plane perpendicular to HP and VP is called profile plane. Projection on profile plane is called side view or end view.

Four Quadrants: When the planes of projection are extended beyond the line of intersection, they form four quadrants or dihedral angles. They are numbered as first, second, third and fourth quadrant. The object may be situated on any one of the quadrants. The position of the object relative to planes is described as above or below HP in front of or behind the VP.

The planes of projections are assumed to be transparent. The projections are obtained by drawing projectors from the object to the planes (VP and HP) by looking from the front or from the above. The quadrants are shown in figure 2.2.


Figure 2.2:
When the object lies in the first quadrant; it means it may lie:

- Above HP and infront of VP
- Or on HP and infront of VP
- Or on VP and above HP

When the object lies in the second quadrant, it means it may be:

- Above HP and behind VP
- Or on HP and behind VP
- Or above HP and on VP

When the object lies in the third quadrant, it means it may be:

- Below HP and behind VP
- On HP and behind VP
- Below HP and on VP

When object lies in the fourth quadrant, it means it may be:

- Below HP and front of VP
- On HP and in front of VP
- Below HP and on VP


First Angle Projection:
(i) When the object is situated in the first quadrant, the method of projection is called first angle projection method.
(ii) The object lies between observer and plane of projection.
(iii) In this method, when views are drawn in their relative position, the top view comes below the front view. In other words, the view seen from above is placed on other side (i.e. below) the front view.
(iv) Similarly left hand and view is drawn on the right side of front view and right hand side view is drawn on the left of front view.

## Convention of first angle projection:



Fig 2.3

## Third Angle Projection:

(i) When the object is situated in the third quadrant, the method of projection is called third angle projection method.
(ii) Plane of Projection is lies between object and observer.
(iii) In this method, when views are drawn in their relative position, the top comes above the front view. In other words, the view seen from above is placed on the same side (i.e. above) of front view.
(iv) Left hand end view is drawn at left hand of front view and right hand end view is drawn at the right side of front view.

Convention of third angle projection


Fig 2.4
Note: Students are required to draw on drawing sheets in $1^{\text {st }}$ Angle Projection.

As per Indian code of practice for general engg. Drawing, published in 1973, the committee responsible for preparation has left the option of selecting first or third angle projection method to users.

## Projection of points in different quadrants

1. Point $A$ is hmm above $H P$ and $g \mathrm{~mm}$ in front of VP. Point $A$ is in first quadrant..



Fig. 2.5
2. Point $B$ is in the hmm above HP and gmm behind VP. Hence $B$ in the second quadrant.


Fig. 2.6
To draw a projection i.e. front view $b^{\prime}$ and top view $b$ on the paper, once the third quadrant is open, HP coincide with VP and both HP \& VP are above the XY line.
3. Point C is hmm below HP and gmm behind VP. Hence point C in the third quadrant.


Fig. 2.7
To draw the projections ( $c^{\prime}$ and $c$ ) on the paper, once the third quadrant is open, HP lies above XY line and VP below the XY line and draw top view above the $X Y$ line and front view below the $X Y$ line.
4. Point $D$ is hmm below HP and gmm infront of VP. Hence point $D$ is in the fourth quadrant. To draw projections (Front view d' and top view d), once the $1^{\text {st }}$ quadrant is opened, HP concedes with VP and both will be below the XY line. Hence front view and top view will be below the XY line.



Note:
(i) Distance of the point above the HP or below the HP indicate the position of front view.
(ii) Distance of the point in front of VP or behind VP indicate the position of top view.

## QUESTION OF SHEET NO. 2

Solve and draw following questions on the sheet:-

1. Draw the projections of the following points taking common reference line, keeping the distance between any two consecutive point as 20 mm .
(i) Point A 30 mm infront of VP and 30 mm above HP.
(ii) Point B is in HP and 25 mm infront of VP
(iii) Point C is 25 mm above HP and 40 mm behind VP.
(iv) Point $D$ is in VP and 40 mm above HP.
(v) Point E is 30 mm below HP and 50 mm behind VP
(vi) Point $F$ is in VP and 40 mm below HP.
(vii) Point G is both HP and the VP.
2. A point A is 20 mm below HP and 30 mm behind VP. Draw as projections.
3. A point $P$ is 15 mm above HP and 20 mm infront of VP. Another part Q is 25 mm behind the VP and 40 mm below HP. Draw the projections of $P$ and $Q$, keeping the distance between their projectors 75 mm , draw straight lines joining their (i) top views (ii) Front views.
4. Two point $A$ and $B$ are in HP. Point $A$ is 30 mm infront of $V P$, while $B$ is behind the VP. The distance between their projectors 75 mm and line joining their top views makes an angle of $45^{\circ}$ with XY. Find the distance of the point $B$ from the VP.
5. Point $A$ is 20 mm above HP and 30 mm infront of $V P$ and $B$ is 25 mm below HP and 40 mm behind VP. The end projectors for these points are 40 mm apart. Draw the projections of points and find the length of front view and top view of the line joining point $A$ and B.

## Sheet No.:3

## PROJECTION OF STRAIGHT LINES-I

A straight line is the shortest distance between the two points. Hence projection of straight line may be drawn by joining the respective position of its ends, which are points.

The position of straight line is described with reference two reference planes. It may be

1. Parallel to HP and VP.
2. Perpendicular to HP and parallel to VP or perpendicular to VP and parallel to HP.
3. Inclined to HP and parallel to VP or Inclined to VP and parallel to HP.
4. Inclined to HP and VP.

## I. A line $A B$ is parallel to $H P$ and VP

Since line AB is parallel to HP and VP. Its front view a`b` and top view ab will show true length of line $A B$ and will be parallel to $X Y$ line


## II. A line $A B$ is perpendicular HP and parallel to VP

Since a line is perpendicular to HP. It will be automatically parallel to VP since it is parallel to VP, front view will show true length of line $A B$ and top view will be a point, where points $a \& b$ will meet.


## III. A line AB is perpendicular to VP and parallel to HP.

Since the line AB is parallel to HP. Top view will show true length of line $A B$ and will be perpendicular to any line. Front view will be point, where both points a and b will meet.


## IV. A line AB is Inclined to HP and parallel to VP.

Since the line AB is parallel to VP. From view will show true length of line and true inclination with HP so knowing the position of point $A$ (as given in question) projection of end $A$ are drawn. From the point $A$, line a`b` is drawn equal to length of line $A B$ at an angle $\Theta$ with HP since the line $A B$ is parallel to VP , top view ab will be parallel to XY .


Figure 3.4:

## V. A line AB included to VP and parallel to HP.

Since the line $A B$ is parallel to HP. Top view ab will show true length of line $A B$ and true inclination with VP $(\phi)$.

Projection of points $A$ as per given in the question drawn as $a^{\prime}$ and $a$.
Draw line ab as top view at angle $\phi$ with VP. Front view a`b` will be parallel to $x y$ line.


Figure 3.5:

## QUESTION OF SHEET NO. 3

Students are required to draw following questions an sheet no.3.

1. A line $A B, 80 \mathrm{~mm}$ long is in HP and makes an angle of 30 with VP. Its end $A$ is 25 mm behind VP draw its projections.
2. The length of top view of a line parallel to the VP and inclined at $45^{\circ}$ to HP is 5 cm . one end of the line is 1.2 cm below HP and 2.5 cm behind VP. Draw the length projections of the line and determine it's true length.
3. The front of 7.5 cm long line measures 5.5 cm . The line is parallel to HP and one of its ends is in the VP and 2.5 cm below the HP. Draw the projections of the line and determine its inclination with VP.
4. A line $A B 55 \mathrm{~mm}$ long has its and $A 25 \mathrm{~mm}$ above $H P$ and in the VP. The line is inclined at angle $45^{\circ}$ to HP draw it's projections.
5. A line $A B 70 \mathrm{~mm}$ long has its and $A$ is 15 mm above $H P$ and 25 mm in front of VP. It's top view has a length of 40mm. Draw it's projections and find the inclination of the line with HP.

## Sheet No.:4

## PROJECTION OF STRAIGHT LINES-II

A given line may be inclined to both the reference planes i.e. HP and VP. In such cases, length of line and its inclination with HP and VP may be given; it may be required to draw its projections. In another case, projections of line may be given, and it may required to determine its true length and its inclinations with HP an VP.

Case: Length of line $A B$ and its inclination and with HP and with VP are given. Position of point $A$ is also given. Projections are to be drawn.


Fig. 4.1
$\mathrm{a}^{\prime} \mathrm{b}^{\prime}{ }_{1}=$ Front view of Line $A B$
$a b_{1}=$ Top view of Line $A B$

## Procedure:

- Draw the front view a' and top view a of the point A as per given question:-
- From a' draw line a'b' equal to true length of line $A B$ and at angle $\Theta$ with the HP.
- From the point $a$, draw a line ab equal true length of line $A B$ and at angle $\phi$ with VP.
- Draw locus ef, rs, pq and cd from the $b^{\prime}, a^{\prime}, a$ and $b$ respectively, parallel to XY line. For example ef is locus of point $b^{\prime}$.
- If $a^{\prime} b^{\prime}$ is true length of line $A B a^{\prime} b^{\prime}{ }_{2}$ projected length of $a^{\prime} b^{\prime}$ and is equal to length of top view of line $A B$.
- Further project the point $b^{\prime}{ }_{2}$ on locusline pq such that $a^{\prime} b 2=a b 2=$ length of top view.
- Now bring the point b2 on the locus of point b i.e. line cd. Take a as centre and radius equal to ab2, draw arc b2b1. Join a to b1. ab1 is the length of top view.
- Similarly of $a b$ is true length of line $A B, a b 3=a ` b ` 3=$ length of front view.
- Take a' as centre and radius equal to a`b`3, and draw arc $b 3^{\prime} b 1^{\prime}$ to bring point $b 3^{\prime}$ on locus of point $b^{\prime}$ i.e. ef Join $a^{\prime}$ to $b^{\prime}{ }_{1}$

Hence $a b 3=a^{\prime} b 3^{\prime}=a^{\prime} b^{\prime}{ }_{1}=$ length of front view .
Note: Point b1 and b1' projections of point b should lie on the same vertical line.

II Case: Determination true length of a line and its inclination with HP and VP when projections are given.

Front view $a^{\prime} b^{\prime}$ and top view $a b$ of line $A B$ are given.

Determine true length of line AB and inclination $\Theta$ with HP and $\phi$ with VP. Problem can be solved by two method.
(i) Method of rotation.
(ii) Trapezoid Method.


Fig. 4.2

## (i) Method of Rotation:

Principle: Now if front view $a^{\prime} b^{\prime}$ is made parallel to $X Y$, the line $A B$ becomes parallel to HP and its projection $\mathrm{ab}_{1}$ on HP shows its true length and true inclination with VP.

Similarly if top view ab of line $A B$ is made parallel to $V P$, the line $A B$ becomes parallel to VP and its projection on VP show its true length and true inclination with HP

## Procedure:

Draw locus of point $\mathrm{b}^{\prime}, \mathrm{a}^{\prime}$, a and b i.e. lines ef, $\mathrm{rs}, \mathrm{pq}$ and cd respectively parallel to XY .

Take $a^{\prime}$ as centre and radius equl to $a^{\prime} b^{\prime}$ and draw arc $b^{\prime} b 2^{\prime}$ to make front view $a^{\prime} b^{\prime}$ parallel to $X Y$ and line $A B$ becomes parallel to $H P$. Project point b2' on the locus of point $b$. Join $a$ to $b 1$. ab1 is true length of line $A B$ and show true inclination $\phi$ with VP.

Similarly take a as centre and radius equal to ab, draw an arc bb2, to make top view ab parallel to XY. Now line AB becomes parallel to VP and its projection on VP shows its true length and true angle of inclination with HP.
(ii) Trapezoid Method:


Fig. 4.3

## Procedure:

Draw the projections i.e. front view and top view of line $A B$ as per question. A the point a' draw perpendicular $a^{\prime} A^{\prime}$ equal to distance of point $A$ from $X Y$. Further draw perpendicular $b^{\prime} B 1$ equal to distance of $b$ from $X Y$ line. Join $A 1$ to B1. A1B1 shows true length of line AB.

Line A1B1 and a'b' will make angle $\phi$, inclination with VP if extended back.
Similarly draw perpendicular aA2 at a equal to distance to distance of $a^{\prime}$ from XY. Further draw perpendicular bB2 at $b$ equal distance of $b^{\prime}$ from $X Y$ join $A 2$ to $B 2$. A2B2 shows the true length of line $A b$. Line $a b$ and A2B2 will make angle $\Theta$, inclination with HP if extended back.

Traces of a Line: When a line is inclined to a plane, it will meet that plane produced if necessary. The point of intersection of line and plane is called trace.

Horizontal Trace (HT): If a line is inclined to HP, it will meet Horizontal plane then the point of intersection of line and HP is called horizontal trace (HT).

Vertical Trace (VT): If a line inclined to VP; it will meet the vertical plane. The point of intersection of line (produced back if necessary) with the VP plane is called vertical trace.

Note 1: If a line is inclined to HP and VP. A will have both HT and VT.
Note 2: If a line is parallel to any reference plane it will have not trace with that plane.

## Determination traces of a line:

## (1) A line $A B$ is inclined to HP and parallel to VP

Draw the front view $a^{\prime} b^{\prime}$ and top view ab of line. Angle of inclination $\Theta$ with HP is shown by front view.

Produced back front view a'b' till it intersect XY line at point C. From C draw perpendicular on top view ab (produced back) at a point called HT.


Fig. 4.4
(2) A line $A B$ is inclined to VP and parallel to HP

Draw the projections (Front view $\mathbf{a}^{\prime} \mathrm{b}^{\prime}$ and top view ab ) of line AB... Angle of inclination $\phi$ with VP is shown by its top view. Produce back top view ab till it cuts the XY line at $D$. From $D$ draw perpendicular on the extended front view $a^{\prime} b^{\prime}$. Point of intersection of front view and perpendicular from $D$ is the vertical trace.


Fig. 4.5
(3) A line $A B$ is inclined to HP and VP:


Fig. 4.6
Draw the projections (front view $a^{\prime} b^{\prime}$ and top view $a b$ ) of line $A B$.
Produce back front view $a^{\prime} b^{\prime}$ till it cut the $X Y$ line at $C$. From $C$ draw perpendicular on extended top view to get HT.

Produce back top view ab. It cuts the XY line at D. From D draw perpendicular on the extended front view to get VT.

## QUESTION OF SHEET NO. 4

## Projections of Lines - II

1. A line $A B$ is 50 mm long, has its end $A$ in both $H P$ and $V P$. It is inclined at $30^{\circ}$ to HP and $45^{\circ}$ to the VP. Draw its projections show its HT and VT.
2. A line $A B, 65 \mathrm{~mm}$ long, has its end $A 20 \mathrm{~mm}$ above $H P$ and 25 in front of $V P$. The end $B$ is 50 mm above HP and 65 mm in front of VP. Draw the projections of line $A B$ and show its inclination with HP \& VP.
3. A line $A B, 90 \mathrm{~mm}$ long, is inclined at $45^{\circ}$ to HP top view makes an angle of $60^{\circ}$ with the VP. The end $A$ is in HP and 12 mm in front of VP. Draw the front view and find its inclination with VP.
4. The end $A$ of line $A B$ is in the $H P$ and 25 mm behind $V P$. The end $B$ is in the VP and 50 mm above the HP. The distance between the projectors is 75 mm . Draw the projections of line $A B$, and determine its true length, traces, inclination with HP \& VP. Use Trapezoid Method.
5. The projectors of end $A \& B$ of a line $A B$ are 100 mm apart. $A$ is 55 mm below HP and 55 mm behind VP. B is 100 mm above HP and 20 mm in front of VP. Determine true length, traces and inclinations with HP and VP.

## Sheet No.: 5

## PROJECTION OF PLANES

## Plane Surfaces:

Plane surfaces have only two dimensions i.e. length and breadth. They do not have thickness. A plane surface may have triangular, rectangular, square, pentagonal or hexagonal shape.

Types of Planes: Plain may be divided in two main types:-
(i) Perpendicular planes
(ii) Oblique planes

Perpendicular planes can be sub divided into following sub types:
(a) Perpendicular to both the reference planes
(b) Perpendicular to one reference plane and parallel to other
(c) Perpendicular to one reference plane and inclined to other

Oblique Planes: Planes which are inclined to both the reference planes are called oblique planes.

Traces of Planes: If a plane is perpendicular or inclined to a reference plane, the line in which plane surface meet with reference plane is the trace of plane.

The line in which, the plane meet the HP, is called Horizontal Trace (HT). The line in which it meets with VP is called vertical trace (VT).

## Perpendicular Planes:

(i) A square plane is perpendicular to HP and VP:

Projection are shown in fig. 5.1


Fig. 5.1
(ii) A square plane perpendicular to HP and parallel to VP. Since the plane is parallel to VP front view a'b'c'd' will show its true shape and top view will be a straight line parallel to XY as shown in fig. 5.2


Fig. 5.2

Since the plane is perpendicular to HP, it has HT and no VT, since it is parallel to VP.
(iii) A square plane perpendicular to VP and parallel to HP. Since the plane is parallel to HP, top view abcd will show its shape but no HT. Front view will be straight line parallel to XY and it also represent VT as in fig. 5.3


Figure 5.3:
(iv) A square plane perpendicular to HP and inclined to VP. First assume, the plane is parallel to VO. Draw front view a'b'c'd' first and project top view from the front view. In the second stage, rotate top view adbc at angle $\phi$, inclination with VP. New top view will be ad $-b_{1} c_{1}$ Project points $b_{1} c_{1}$ to get point $\mathrm{b}^{\prime}{ }_{1}$ and $\mathrm{c}^{\prime}{ }_{1}$ in the front view to get final front view $\mathrm{a}^{\prime} \mathrm{b}^{\prime}{ }_{1} \mathrm{c}^{\prime}{ }_{1} \mathrm{~d}^{\prime}$.


Figure 5.4:
(v) A square plane perpendicular to VP and inclined to HP

First assume parallel to HP and perpendicular to VP top view abcd will show the true shape of square plane. Project front view a'd'-b'c' from top view.


Figure 5.5:

In the second stage rotate front view $a^{\prime} d^{\prime}-b^{\prime} c^{\prime}$ by an angle $\Theta$, inclination with HP to get new front view $\mathrm{a}^{\prime} \mathrm{d}^{\prime}-\mathrm{b}^{\prime}{ }_{1} \mathrm{c}^{\prime}{ }_{1}$. Project the point $\mathrm{b}^{\prime}{ }_{1} \mathrm{c}^{\prime}{ }_{1}$ on top view to get point b1 and c1 and to get new top view ab1c1d.
(vi) Oblique Planes: The projection of planes, inclined to both the reference planes is drawn in three stages as per the conditions given in the question.

## QUESTION OF SHEET NO. 5

1. A regular pentagon of 25 mm side has one its side in the HP. Its plane is inclined at $45^{\circ}$ to HP and perpendicular to VP. Draw its projections.
2. Draw the projections of a circular plane of 5 cm diameter having its plane vertical and inclined at $30^{\circ}$ to $V P$. Its centre is 3 cm above the ground and 2 cm in front of VP.
3. A regular hexagonal lamina of side 20 mm rest on one its sides on $H P$, such that its surface is perpendicular to VP and inclined at $45^{\circ}$ to HP. Its nearest corner is 15 mm in front of VP. Draw the projections.
4. A square $A B C D$ of 40 mm side has a corner on the HP and 20 mm in front of VP. All the sides of square are equally inclined to HP and parallel as VP. Draw its projections and show its traces.
5. A square $A B C D$ of 50 mm side has its corner $A$ on the HP. Its diagonal AC is inclined at $30^{\circ}$ to HP and its diagonal BD is inclined at $45^{\circ}$ to $V P$ and parallel to HP, Draw its projections.

## Sheet No.: 6

## PROJECTION OF SOLIDS

A solid has three dimensions, viz. length, breadth and thickness. To represent a solid on flat surface having only length and breadth, at least two orthographic views are necessary. Sometimes, additional views is projected on Auxiliary planes, if necessary to make the description of a solid complete.

Solids may be divided into two main groups:-
(i) Polyhedra
(ii) Solids of revolutions

## Polyhedra:

Polyhedra are defined as solid bounded by planes called faces. When all the faces are equal and regular, the polyhedron is said to be regular.

There are five regular 34olyhedral which may defined as stated below:-
(i) Tetrahedron: It has four equal faces, each one is equilateral triangle.
(ii) Cube or hexahedron: It has six faces, each face is square.
(iii) Octahedron: It has eight faces. Each face is an equilateral triangle.
(iv) Dodecahedron: It has twelve equal faces and each face is regular pentagon.
(v) Icosahedrons: It has twenty faces. Each face is an equilateral triangle.

## Prism:

Prism is a polyhedron having two equal and similar faces called its ends or bases, parallel to each other and joined by other faces, which are parallelograms. The imaginary line joining the centre of the bases is called axis.

A right regular prism its axis perpendicular to the bases. The bases may be triangular, square, pentagonal or hexagonal in shape. Accordingly they called as triangular, square, pentagonal hexagonal prism.


## PRISMS:

## Pyramid:

Pyramid is a polyhedron having a plane figure as base and number of triangular faces meting at a point called the vertex or apex. The imaginary line joining the apex with the centre of base is its axis.

A right and regular pyramid has its axis perpendicular to base which is a regular plane figure. Its faces are equal isosedes triangle. As per shape of the base, they are called as Triangular, square, pentagonal and hexagonal pyramid.


## Solid of revolutions:

A right circular cylinder is a solid generated by the revolution of a rectangle about one of its sides which remain fixed. It has two circular bases. The joining the center of the bases is the axis. It is perpendicular to the bases.

A right circular cone is a solid generated by the revolution of a right angled triangle about one of its perpendicular sides which is fixed. It has one circular base. Its axis join the apex with the centre of the base to which it is perpendicular. Straight lines drawn from the apex to the circumference of the base circle are all equal and are called generators of the cone. The length of generator is the slant height of the cone.


CYLINDER


CONE


Figure 6.1:

A sphere is a solid generated by the revolution of a semicircle about its diameter as the axis. The midpoint of diameter is the centre of sphere.

## Frustum of a solid:

When a pyramid or a cone is cut by a plane parallel to its base, thus removing the top portion, the remaining portion is called its frustum.

## Truncated Solid:

When a solid is cut by a plane inclined to the base, it said to be truncated.
A solid may be inclined to one or both the reference planes. Accordingly projections are drawn in two and three stages respectively.

## QUESTION OF SHEET NO. 6

1. Draw the projections of a pentagonal prism, base 25 mm side and 50 mm long, resting on one of its rectangular faces on HP with its axis inclined at $45^{\circ}$ to VP.
2. Draw the projections of a cylinder 75 mm diameter 100 mm long, lying on the HP with its axis inclined $30^{\circ}$ to VP and parallel to HP.
3. A hexagonal pyramid, base 25 mm side and axis 50 mm long, has an edge of its base on the HP. Its axis is inclined at $30^{\circ}$ to HP and parallel to VP. Draw the projections.
4. Draw the projections of a cone, base 75 mm diameter and axis 100 mm long, lying on the HP on one of its generator, with the axis parallel to VP.
5. Draw the projection of cone, base 50 mm diameter and axis 55 long, when it is resting on the HP on its base circle with the axis making an angle of $30^{\circ}$ with HP and its top view making $45^{\circ}$ with the VP.

## Sheet No.: 7

## SECTION OF SOLIDS

In the projected views of an object, invisible features are shown by dotted lines. But when such features are too many, these lines make the view more complicated and difficult to interpret.

In such cases, it is customary to imagine the object as being cut through or sectioned by planes. This imaginary plane is called the sectioned plane or the cutting plane. The part of the object between cutting plane and observer is assumed to be remove and the view is than shown in sections

The projection of the section along with remaining portion of the object is called sectional view. The surface produced by cutting the object by the section plane is called the section. It is indicated by thin section line uniformly spaced and inclined at $45^{\circ}$.

Section planes:- section planes or cutting planes are generally perpendicular planes. They may be perpendicular to one of the reference planes and either perpendicular parallel or inclined to other reference plane. They are usually described by their traces.

It is important to note that projection of the section plane, on the plane to which it is perpendicular, is a straight line, this line will be parallel, perpendicular or inclined to XY , depending upon the section plane being parallel, perpendicular, or inclined respectively to other reference plane. This straight line coincides with the trace of section plane.

## True shape of the section:-

The projection of the section on a reference plane, parallel to the section plane, will show the true shape of the section. Thus when, section plane is parallel to HP, the true shape of the section will be seen in sectional top
view. When it is parallel to VP, the true shape will be visible in the sectional front view.

But when the section plane is inclined the section has to be projected on an auxiliary plane, parallel to the section plane, to get the true shape. When the section plane is perpendicular to both the reference planes, the sectional side view will show the true shape of the section.

## QUESTION OF SHEET NO. 7

1) A right regular pentagonal pyramid side of base 40 mm and ht .60 mm rest on its base in HP with one of its base edge perpendicular to VP. A section plane parallel to the HP cuts the axis of the pyramid at a distance of 25 mm from its base draw its front view and sectional top view.
2) A right regular hexagonal pyramid, side of base 40 mm and ht .70 mm , rest on its base in HP, with one of its base edge parallel to VP. An auxiliary horizontal plane parallel to the HP and perpendicular to the VP cuts the pyramid at a ht. Of 35 mm from the base. Draw its front view and sectional top view.
3) A right regular pentagonal prism, base edge 40 mm and ht .70 mm is held on HP one of its base edge such that its axis is parallel to the VP and inclined to HP at $30^{\circ}$. An auxiliary horizontal plane cuts the prism, intersecting its axis at a distance of 17 mm from its top end. Draw its front view and sectional top view.
4) A right regular pentagonal pyramid, side of base 40 mm and ht .70 mm , rest on its base on HP, such that one its base edges perpendicular to the VP. A section plane parallel to VP cuts the pyramid and is at a distance of 8 mm from the axis. Draw its top view and sectional front view.
5) A right circular cone diameter of base 60 mm and ht .70 mm , rest on its base on HP. A section planes perpendicular to VP and inclined to HP at $45^{\circ}$, cuts the cone meeting its axis at the distance 36 mm from its base. Draw its front view, sectional top view and true shape of section.
