

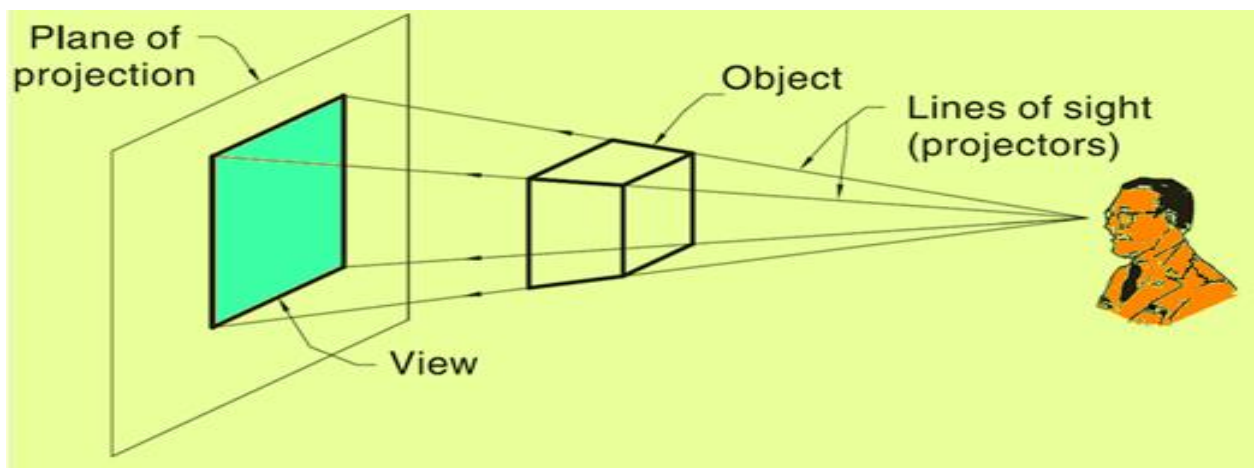
UNIT-3

Introduction to Projection

3.1 Introduction to first and third angle projection

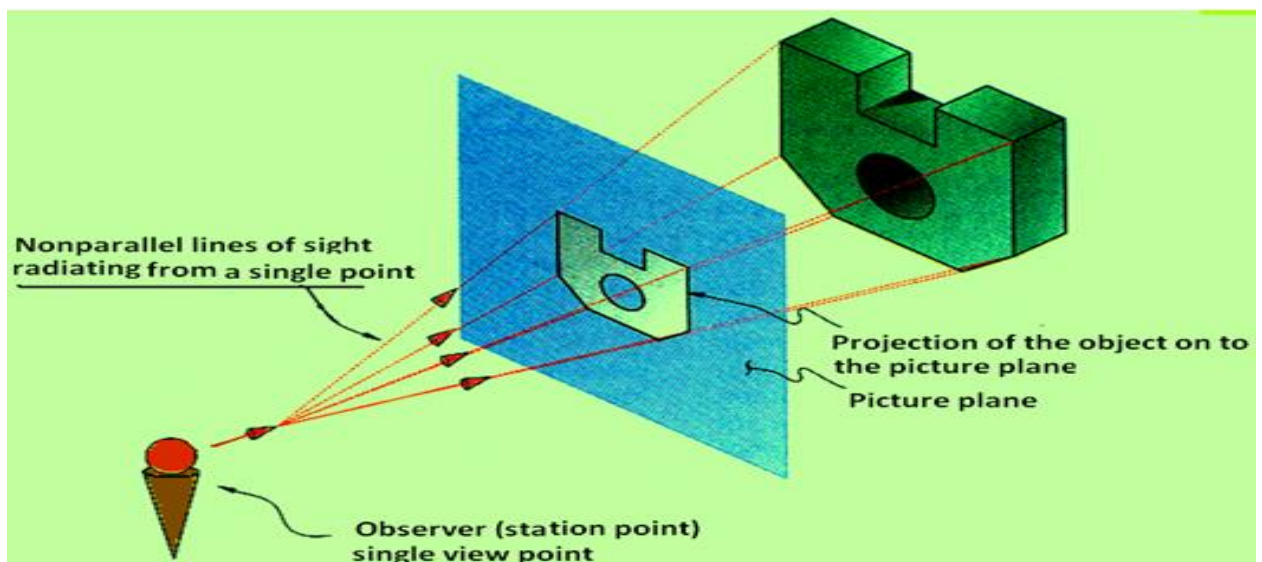
Projection

- In engineering, 3-dimensional objects and structures are represented graphically on a 2-dimensional media. The act of obtaining the image of an object is termed “projection”.
- The image obtained by projection is known as a “view”.

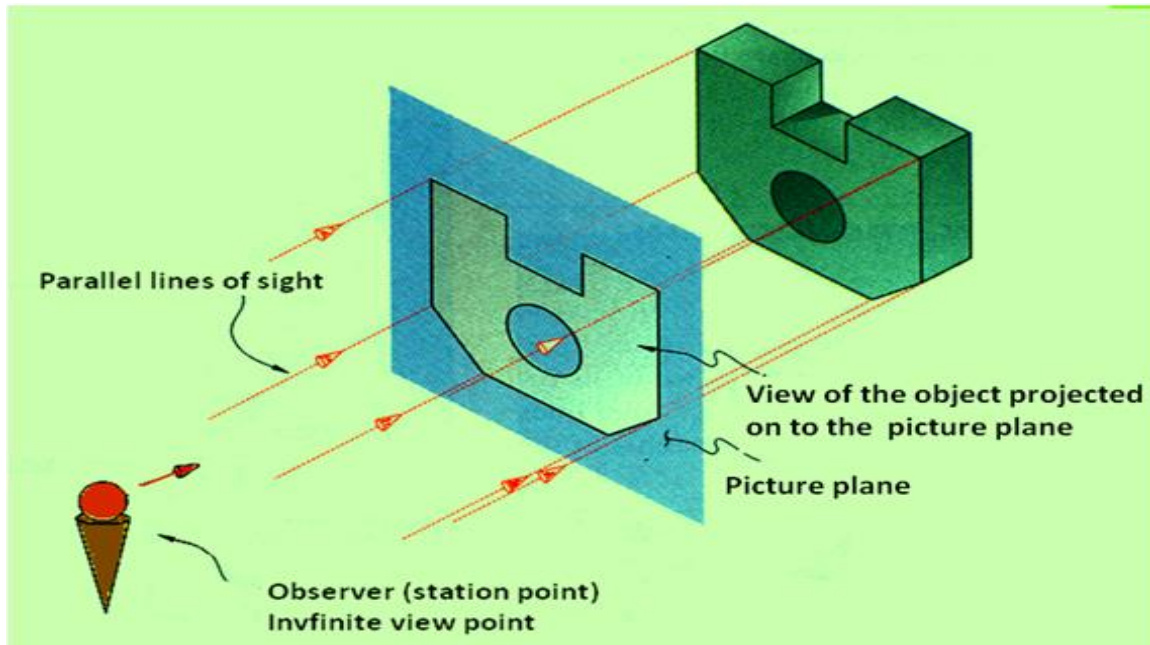


Projection Types

- **Perspective projection:** Observer is assumed to be stationed at finite distance from the object. All lines of sight start at a single point.

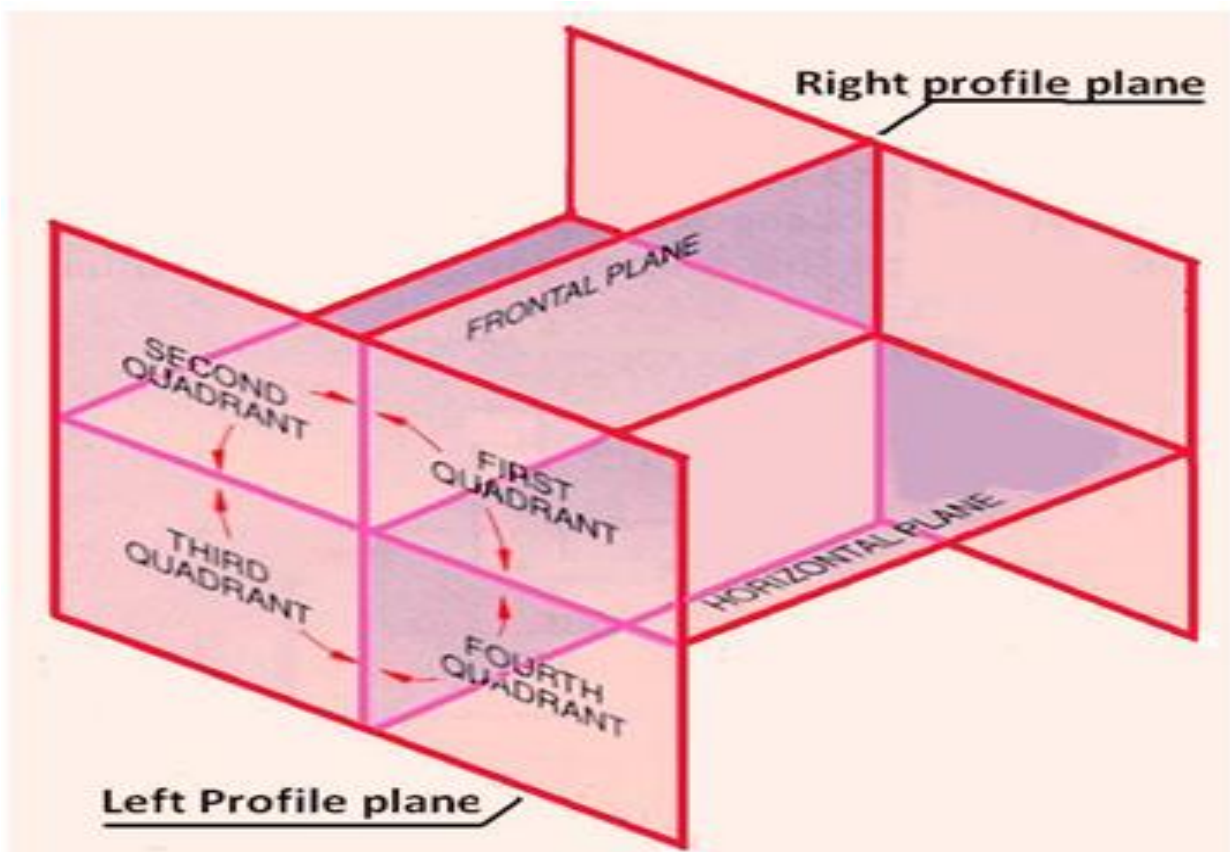


- **Parallel projection:** All lines of sight are parallel . The observer is assumed to be stationed at infinite distance from the object.



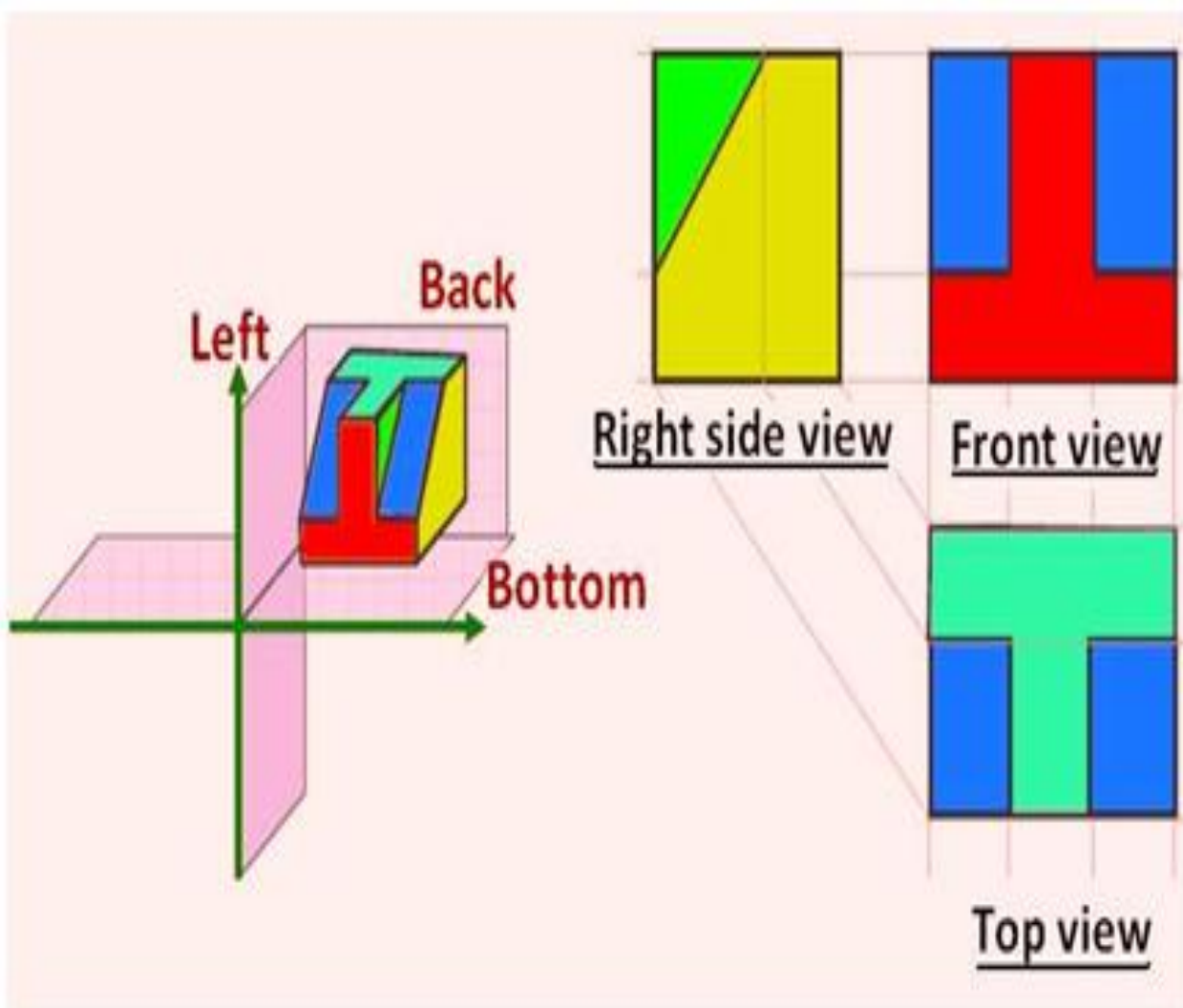
Projection Methods

Universally either the 1st angle projection or the third angle projection methods is followed for obtaining engineering drawings. The principal projection planes and quadrants used to create drawings are shown in figure below . The object can be considered to be in any of the four quadrants.



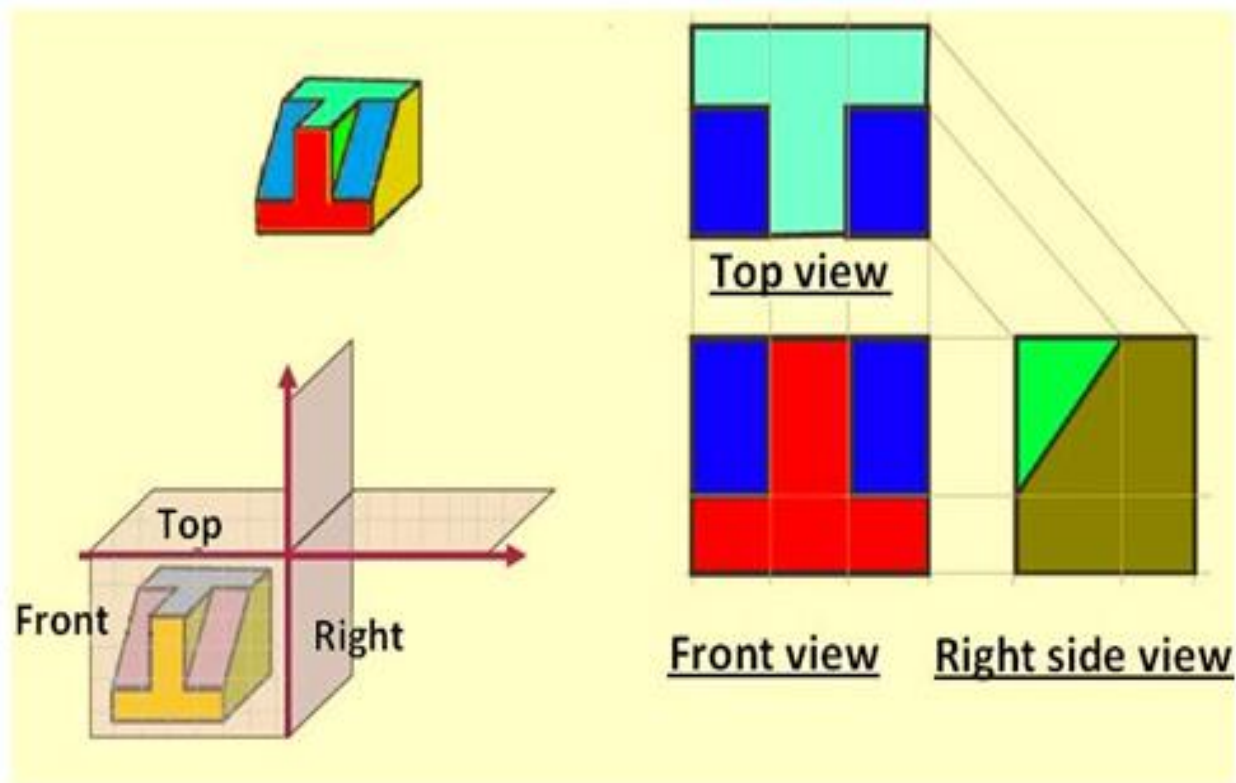
First Angle Projection

In this the object is assumed to be positioned in the first quadrant and is shown in figure. The object is assumed to be positioned in between the projection planes and the observer. The views are obtained by projecting the images on the respective planes. Note that the right hand side view is projected on the plane placed at the left of the object. After projecting on to the respective planes, the bottom plane and left plane is unfolded on to the front view plane. I.e. the left plane is unfolded towards the left side to obtain the Right hand side view on the left side of the Front view and aligned with the Front view. The bottom plane is unfolded towards the bottom to obtain the Top view below the Front view and aligned with the Front View.



Third Angle Projection

In the third angle projection method, the object is assumed to be in the third quadrant. i.e. the object behind vertical plane and below the horizontal plane. In this projection technique, placing the object in the third quadrant puts the projection planes between the viewer and the object and is shown in figure.

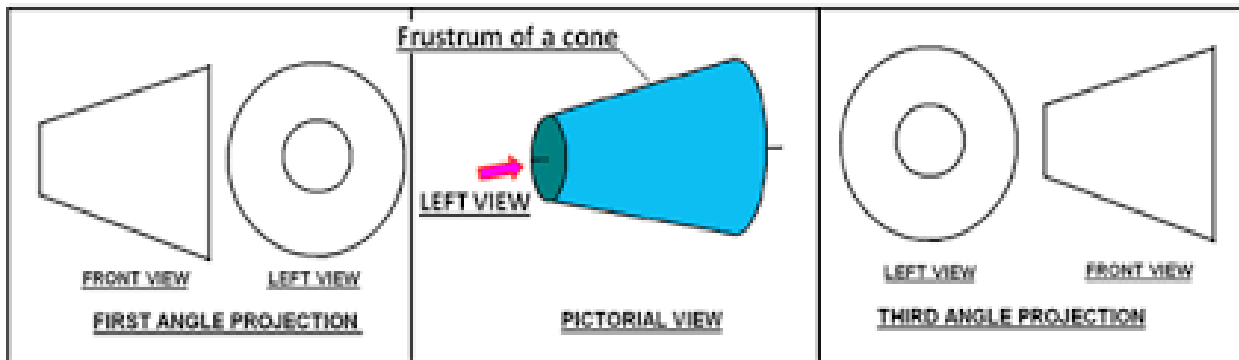


Difference between first- and third-angle projections

First angle projection	Third-angle projection
Object is kept in the first quadrant.	Object is assumed to be kept in the third quadrant.
Object lies between observer and the plane of projection.	Plane of projection lies between the observer and the object.
The plane of projection is assumed to be non-transparent.	The plane of projection is assumed to be transparent.
Front (elevation) view is drawn above the XY line	Front (elevation) view is drawn below the XY line
Top (plan) view is drawn below the XY line	Top (plan) view is drawn above the XY line
Left view is projected on the right plane and vice versa	Left view is projected on the left plane itself.
Followed in India, European countries	Followed in USA

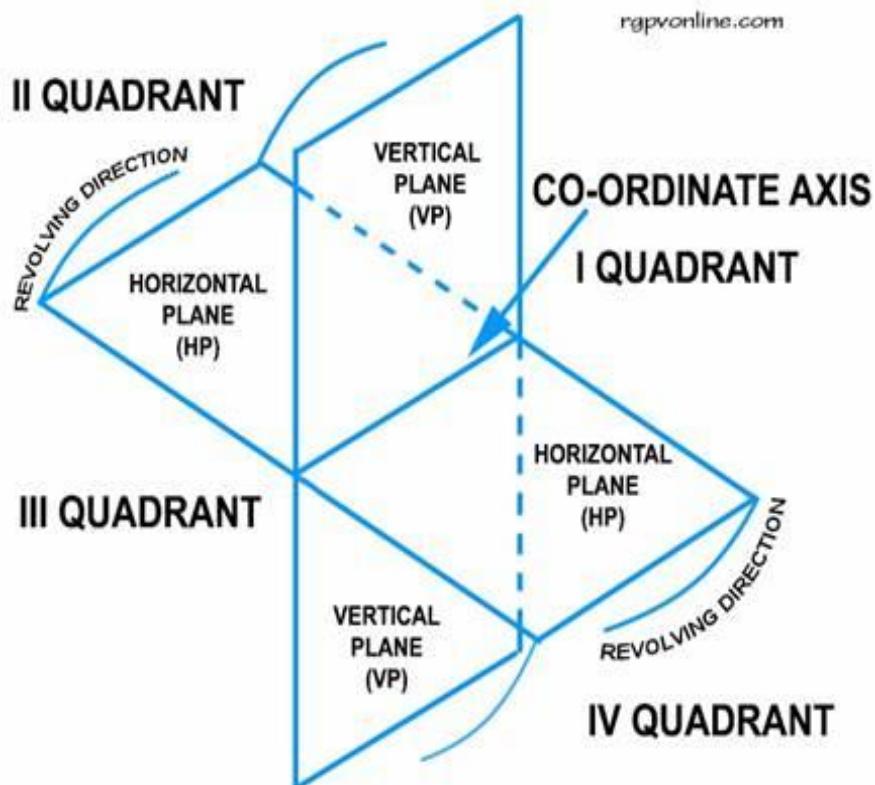
Symbol of projection

- The type of projection obtained should be indicated symbolically in the space provided for the purpose in the title box of the drawing sheet. The symbol recommended by BIS is to draw the two sides of a frustum of a cone placed with its axis horizontal the left view is drawn.



Why 2nd & 4th angle projections are not used?

- In 2nd and 4th angle projection system, the top and front views are overlap to each other. In 2nd angle projection system, the plane is in between object and observer. When we turn the adjacent plane by 90 degree to see the top view, the front and top views are overlap to each other.



3.2. Introduction to projection of point, line and plane

POINT

The position of a point in engineering drawing is defined with respect to its distance from the three principle planes i.e., with respect to the VP, HP, & PP. The point is assumed to be in the respective quadrant shown in figure 3. 1. The point at which the line of sight (line of sight is normal to the respective plane of projection) intersects the three planes are obtained. The horizontal plane and the side planes are rotated so such that they lie on the plane containing the vertical plane. The direction of rotation of the horizontal plane is shown in figure 3.2.

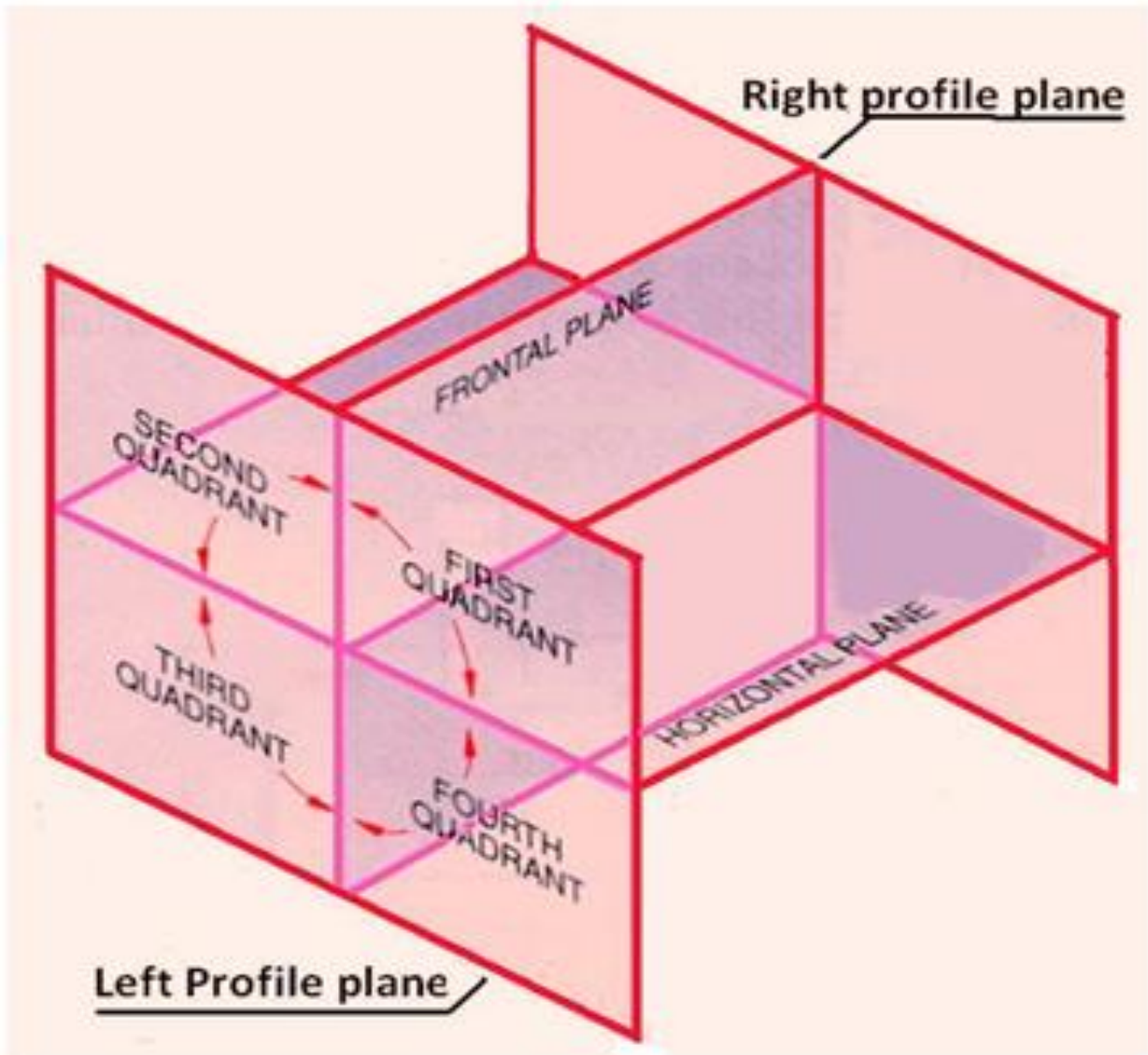


Figure 3.1 The relative positions of projection planes and the quadrants

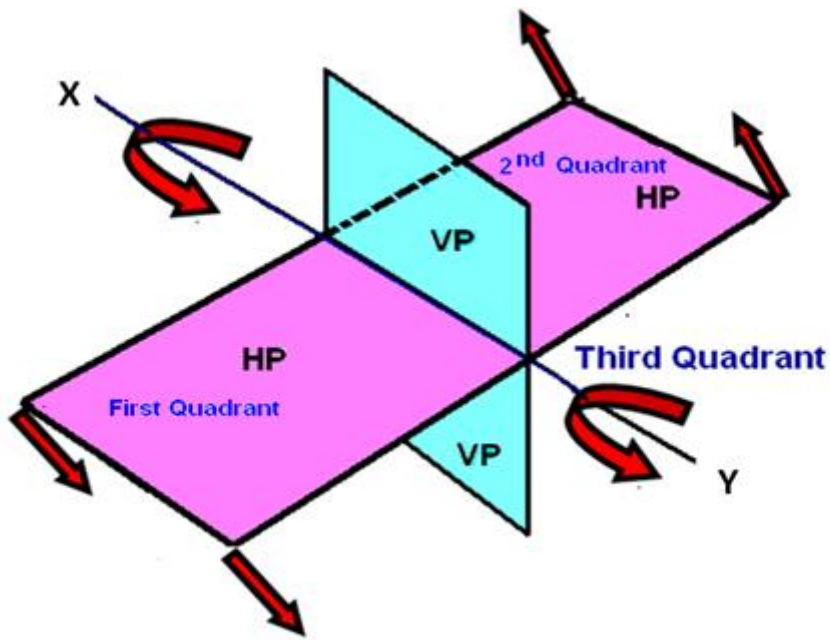


Figure 3.2 The direction of rotation of the Horizontal plane.

Conventions used while drawing the projections of points

With respect to the 1st angle projection of point ‘P’ shown in figure 3.3,

- Top views are represented by only small letters eg. p.
- Their front views are conventionally represented by small letters with dashes eg. p’
- Profile or side views are represented by small letters with double dashes eg. p’’
- Projectors are shown as thin lines.
- The line of intersection of HP and VP is denoted as X-Y.
- The line of intersection of VP and PP is denoted as X1-Y1

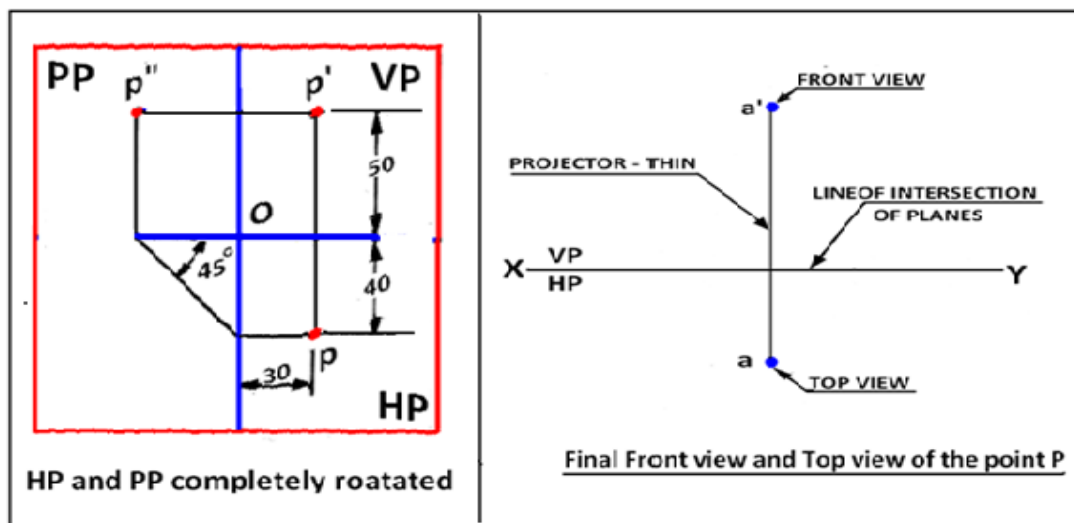
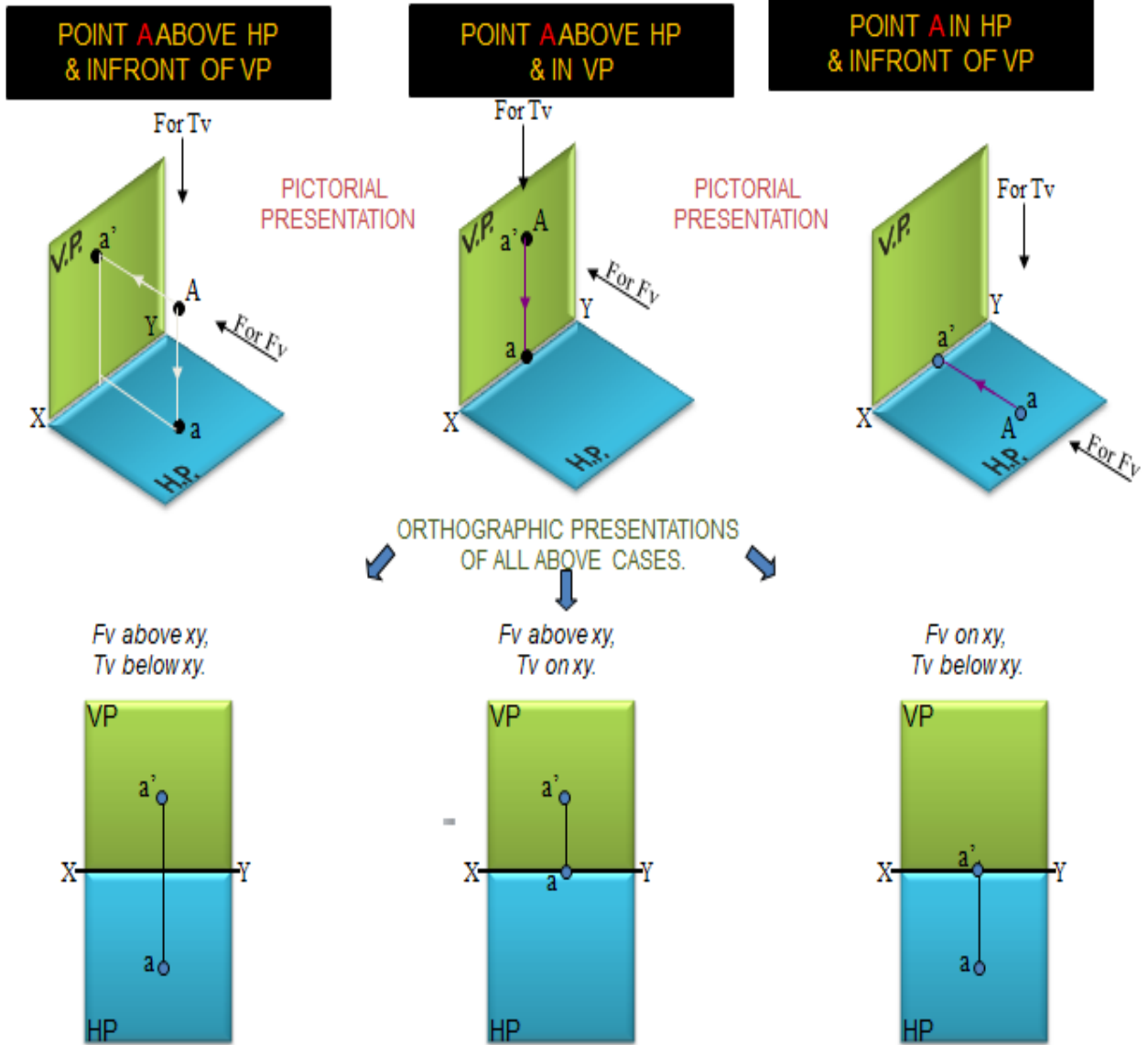


Figure 3.3. Showing the three planes and the projection of the point P after the planes have been rotated on to the vertical plane.

Point in First Quadrant

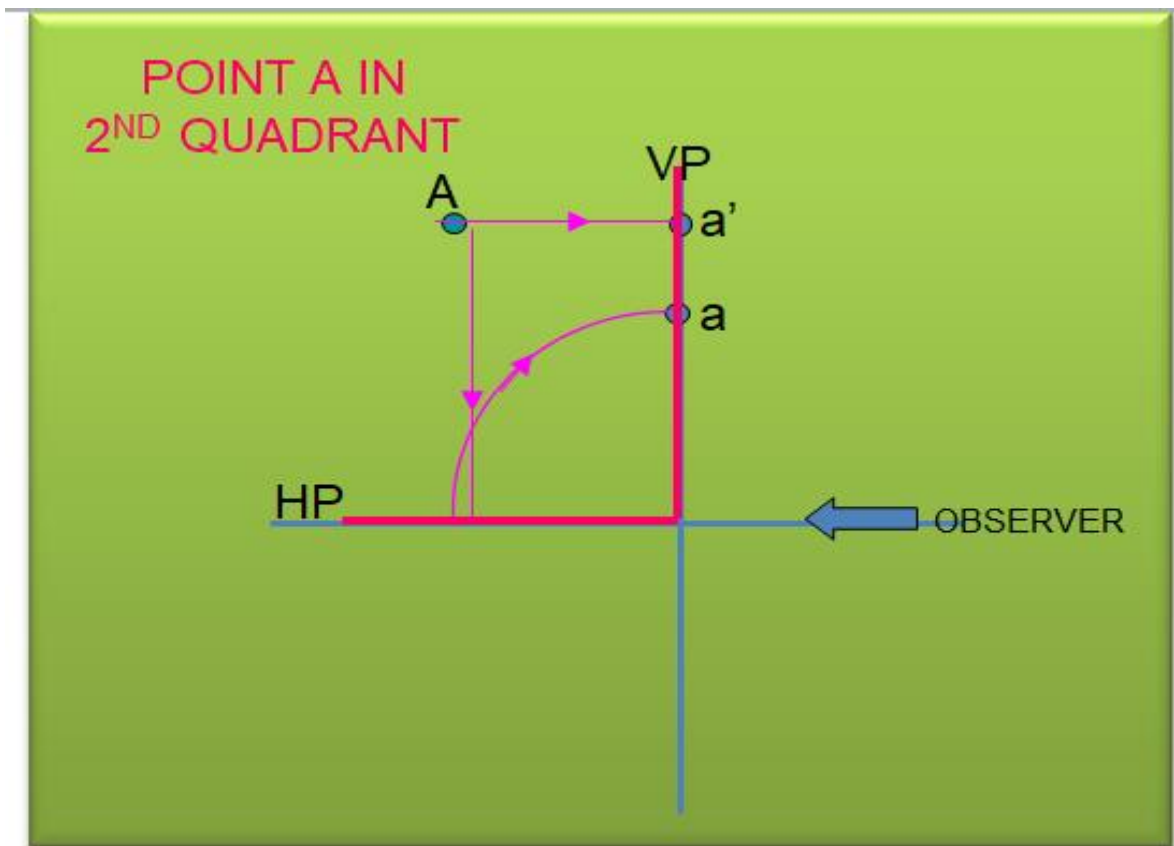


Projections of point in first Quadrant

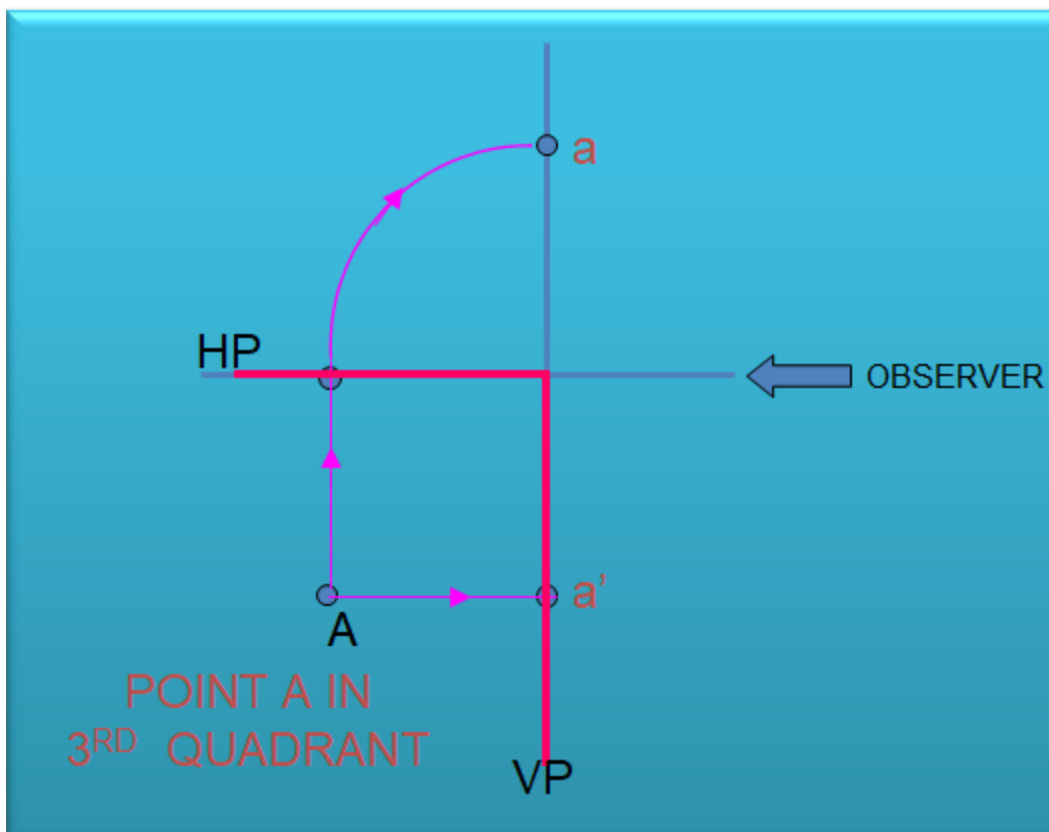
Projection of points in different quadrants

Point A is Placed In different quadrants and it's FV & TV are brought in same plane for Observer to see clearly. FV is visible as it is a view on VP. But as TV is a view on HP, it is rotated downward 90° , In clockwise direction. The In front part of HP comes below XY line and the part behind VP comes above.

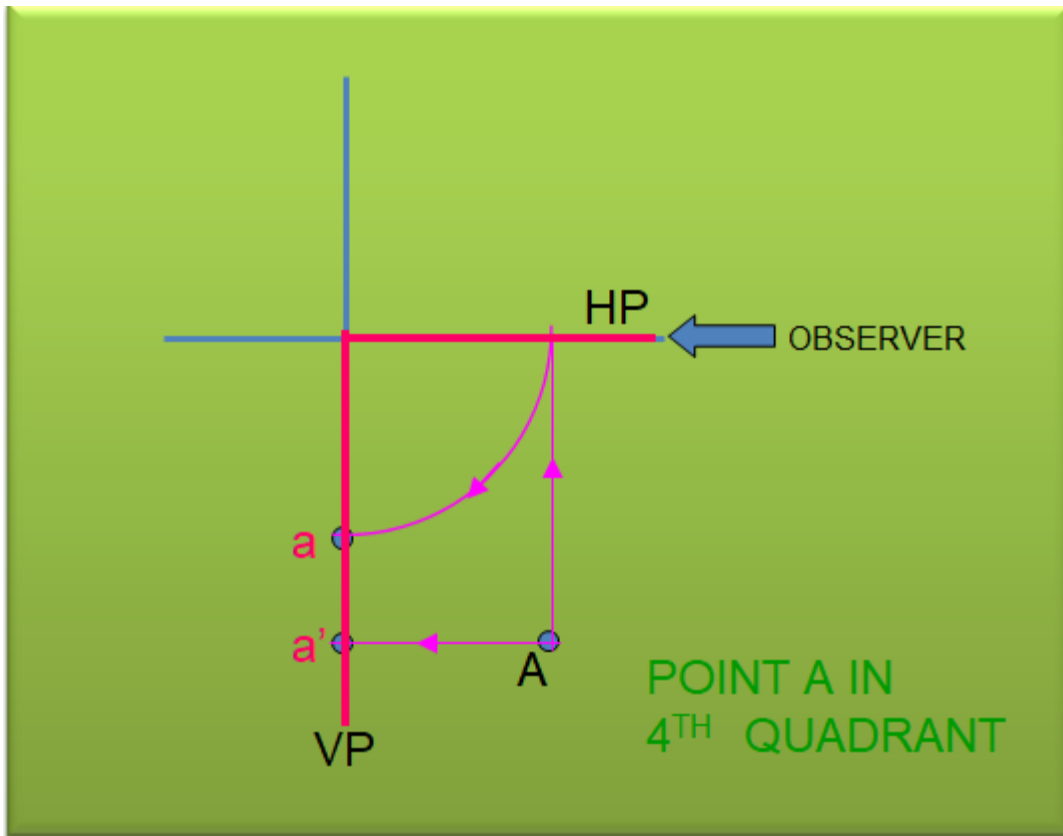
Point is Second Quadrant



Point is Third Quadrant



Point is Fourth Quadrant



PROJECTIONS OF STRAIGHT LINES

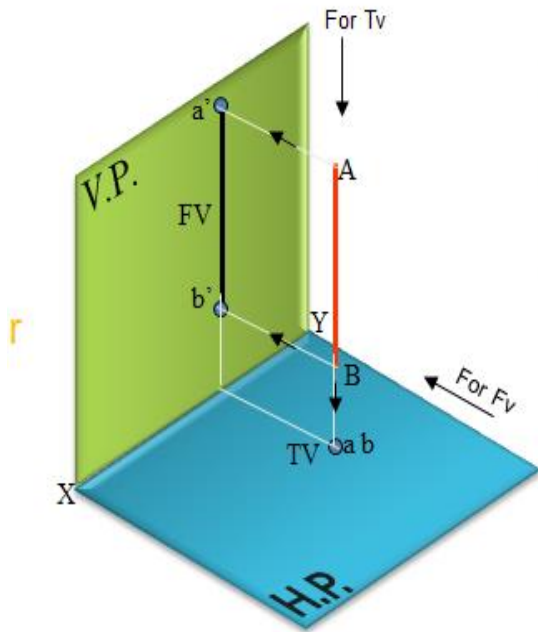
INFORMATION REGARDING A LINE means

- It's Length,
- Position of it's ends with HP & VP .
- It's inclinations with HP & VP will be given.

SIMPLE CASES OF THE LINE

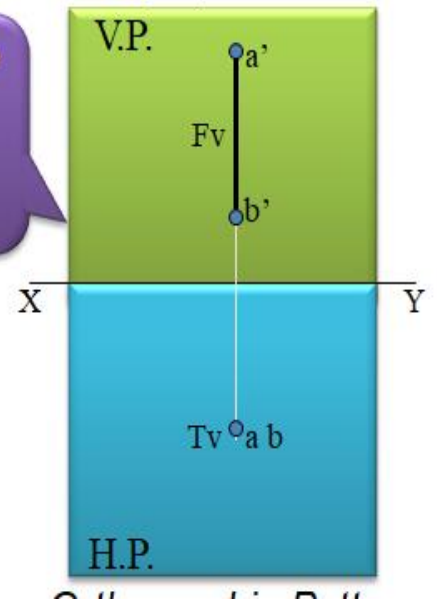
1. A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)
2. LINE PARALLEL TO BOTH HP & VP.
3. LINE INCLINED TO HP & PARALLEL TO VP.
4. LINE INCLINED TO VP & PARALLEL TO HP.
5. LINE INCLINED TO BOTH HP & VP.

Case 1 - A VERTICAL LINE (LINE PERPENDICULAR TO HP & // TO VP)

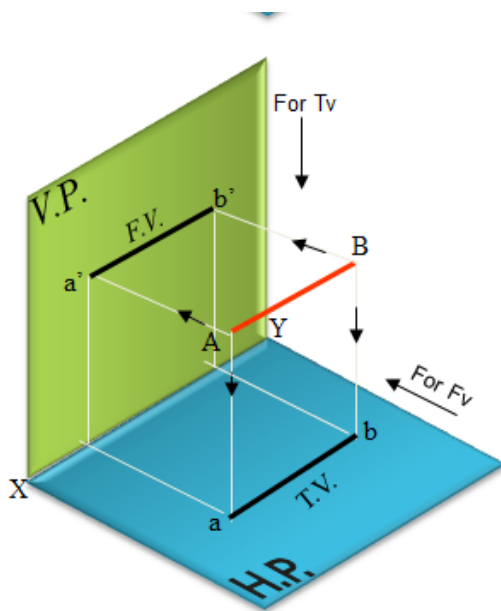


FV is a vertical line
Showing True
Length &
TV is a point.

Orthographic Pattern

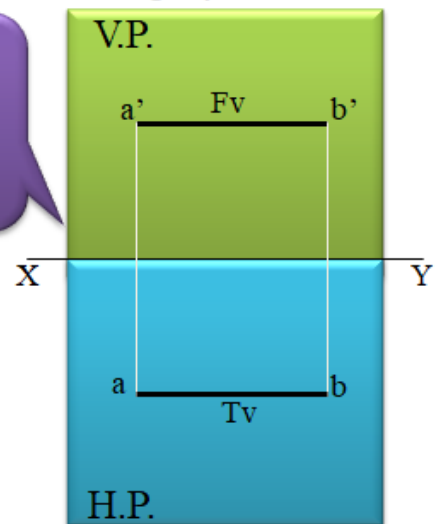


Case – II - LINE PARALLEL TO BOTH HP & VP

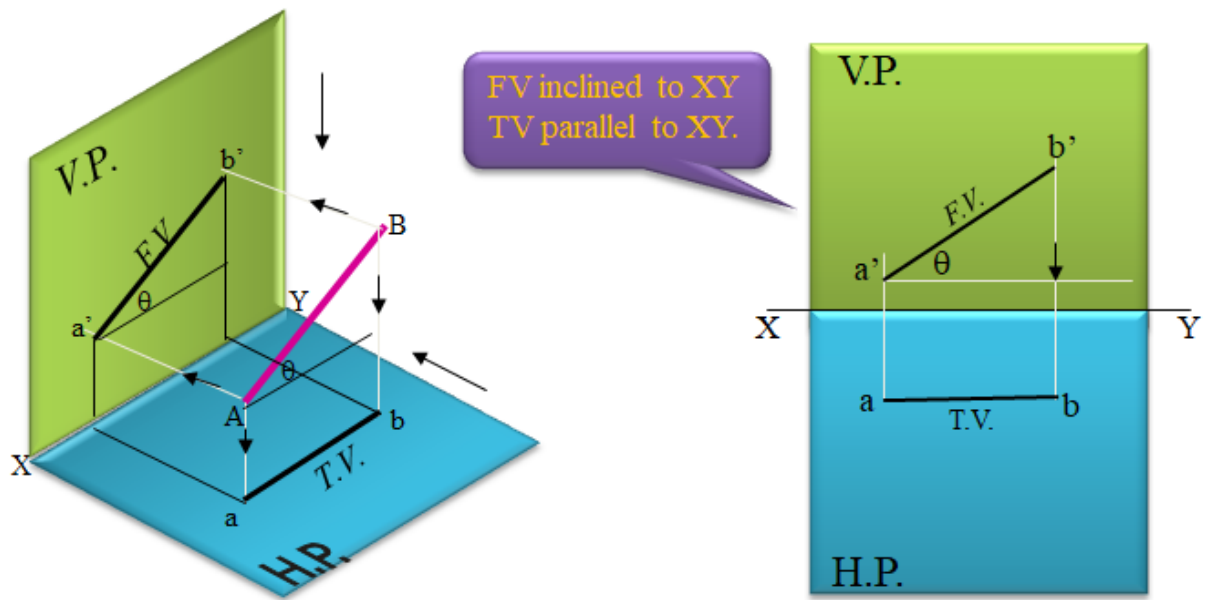


FV & TV both are
// to XY
&
both show T. L.

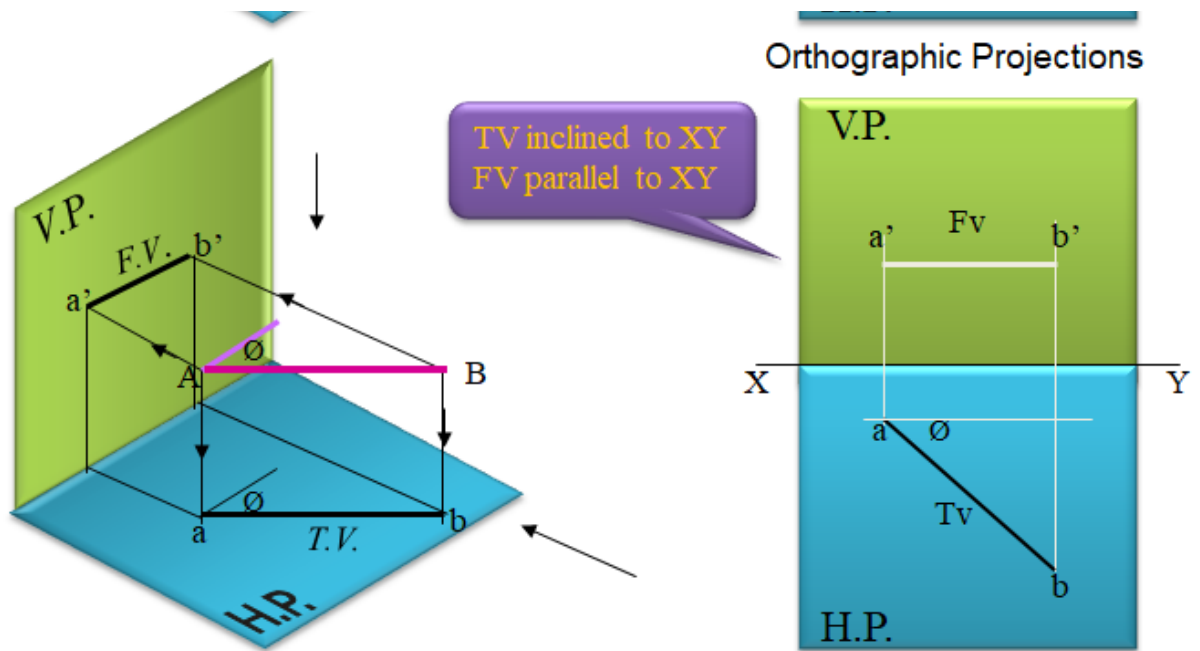
Orthographic Pattern



Case – III LINE INCLINED TO HP & PARALLEL TO VP

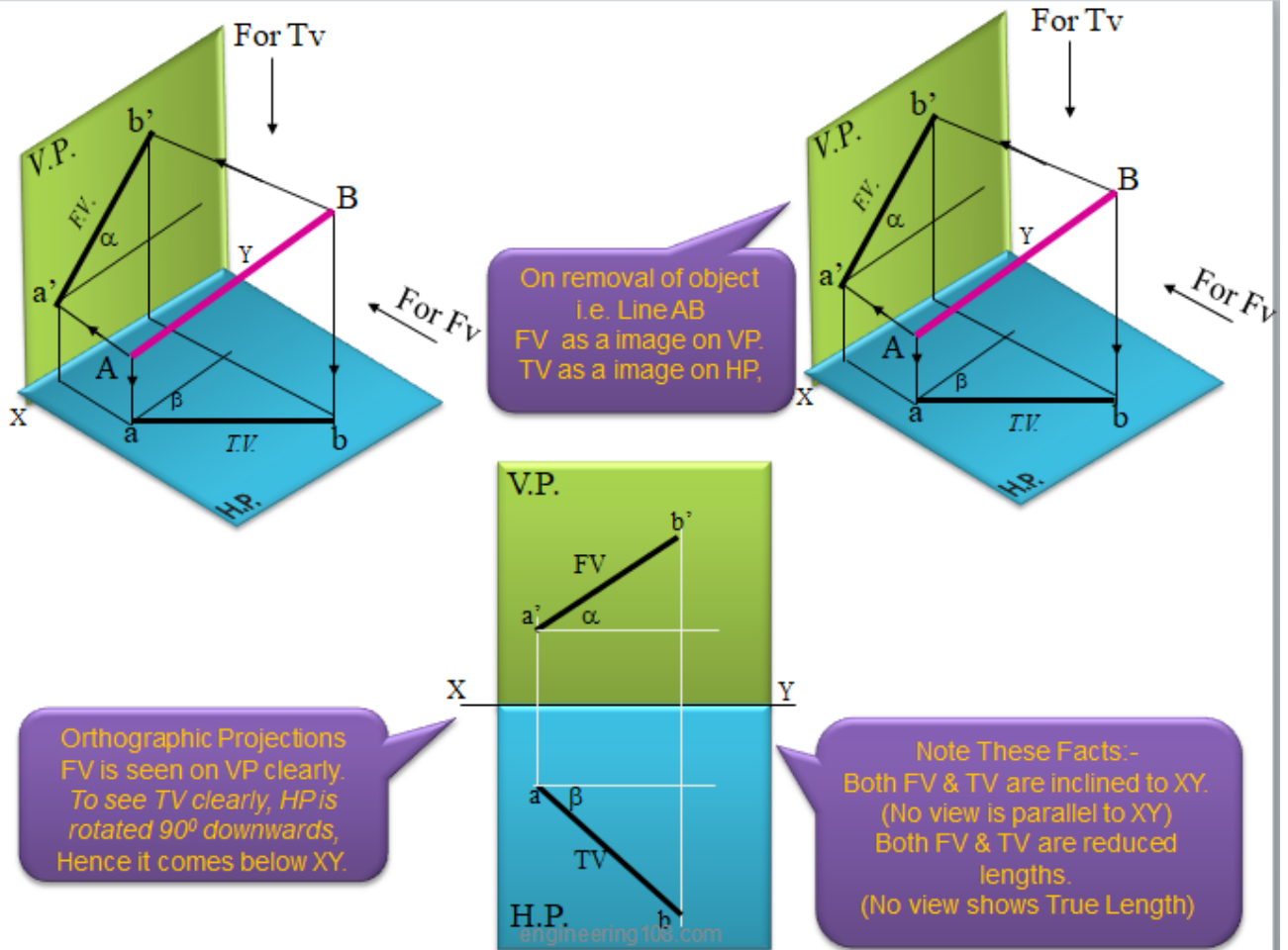


Case – IV LINE INCLINED TO VP & PARALLEL TO HP



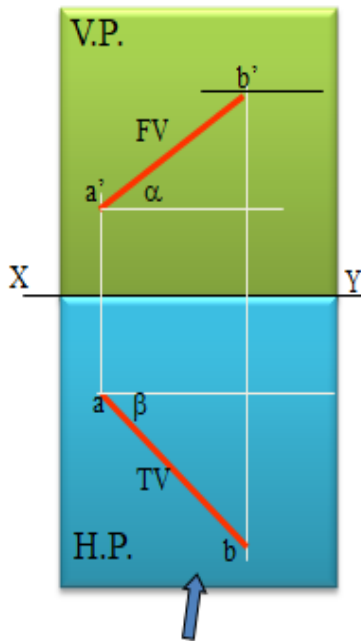
Case- V LINE INCLINED TO BOTH HP & VP

Wrong method of determining the projections



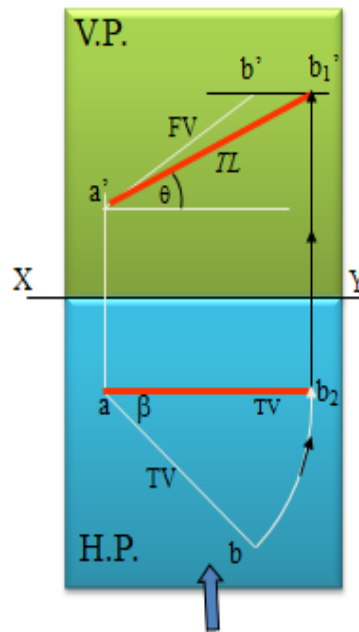
Right method for finding the True Length (T.L.) and Drawing the Projections

Orthographic Projections
Means FV & TV of Line AB
are shown below,
with their apparent Inclinations
 α & β



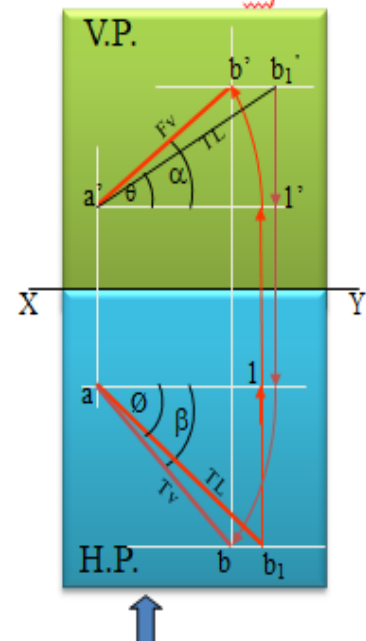
Here TV (ab) is not // to XY line
Hence its corresponding FV
 $a' b'$ is not showing
True Length &
True Inclination with HP.

Note the procedure
When FV & TV known,
How to find True Length.
(Views are rotated to determine
True Length & its inclinations
with HP & VP).



In this sketch, TV is rotated
and made // to XY line.
Hence its corresponding
FV $a' b_1'$ is showing
True Length &
True Inclination with HP.

Note the procedure
When True Length is known,
How to locate FV & TV.
(Component $a-1$ of TL is drawn
which is further rotated
to determine F_v)



Here $a-1$ is component
of TL ab_1' gives length of F_v .
Hence it is brought Up to
Locus of a' and further rotated
to get point b' . $a' b'$ will be F_v .
Similarly drawing component
of other TL ($a' b_1'$) TV can be drawn.

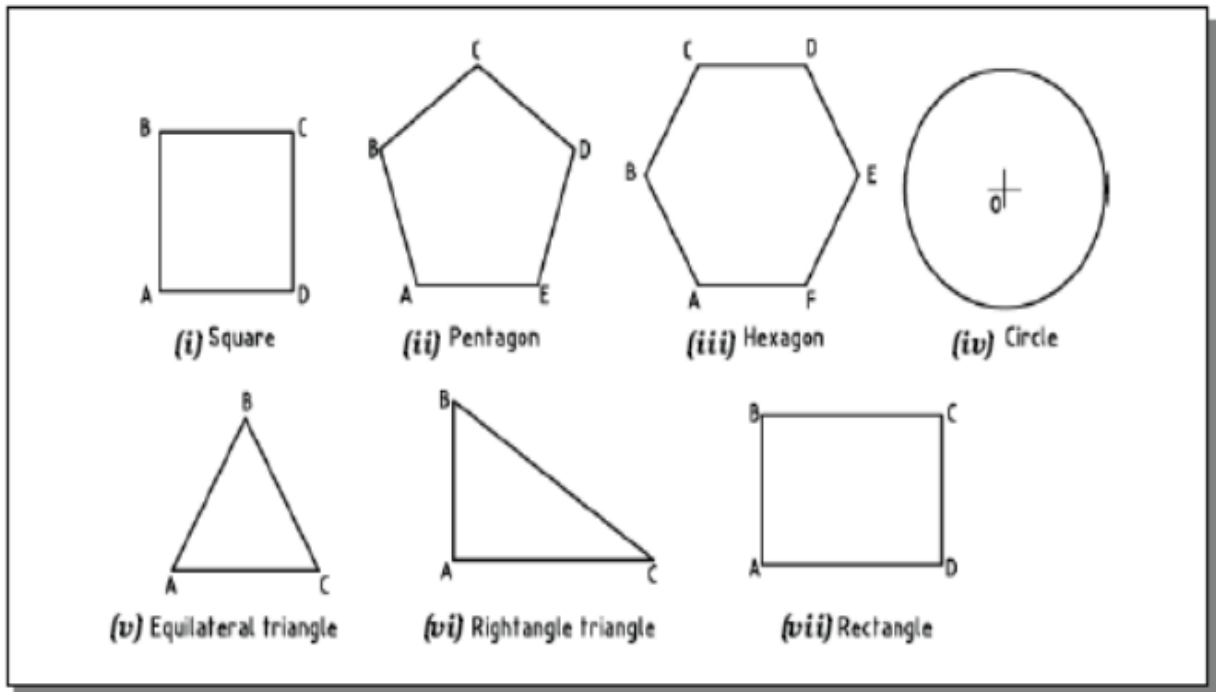
Projection of Planes

A plane is a two dimensional object having length and breadth only. Thickness is negligible.

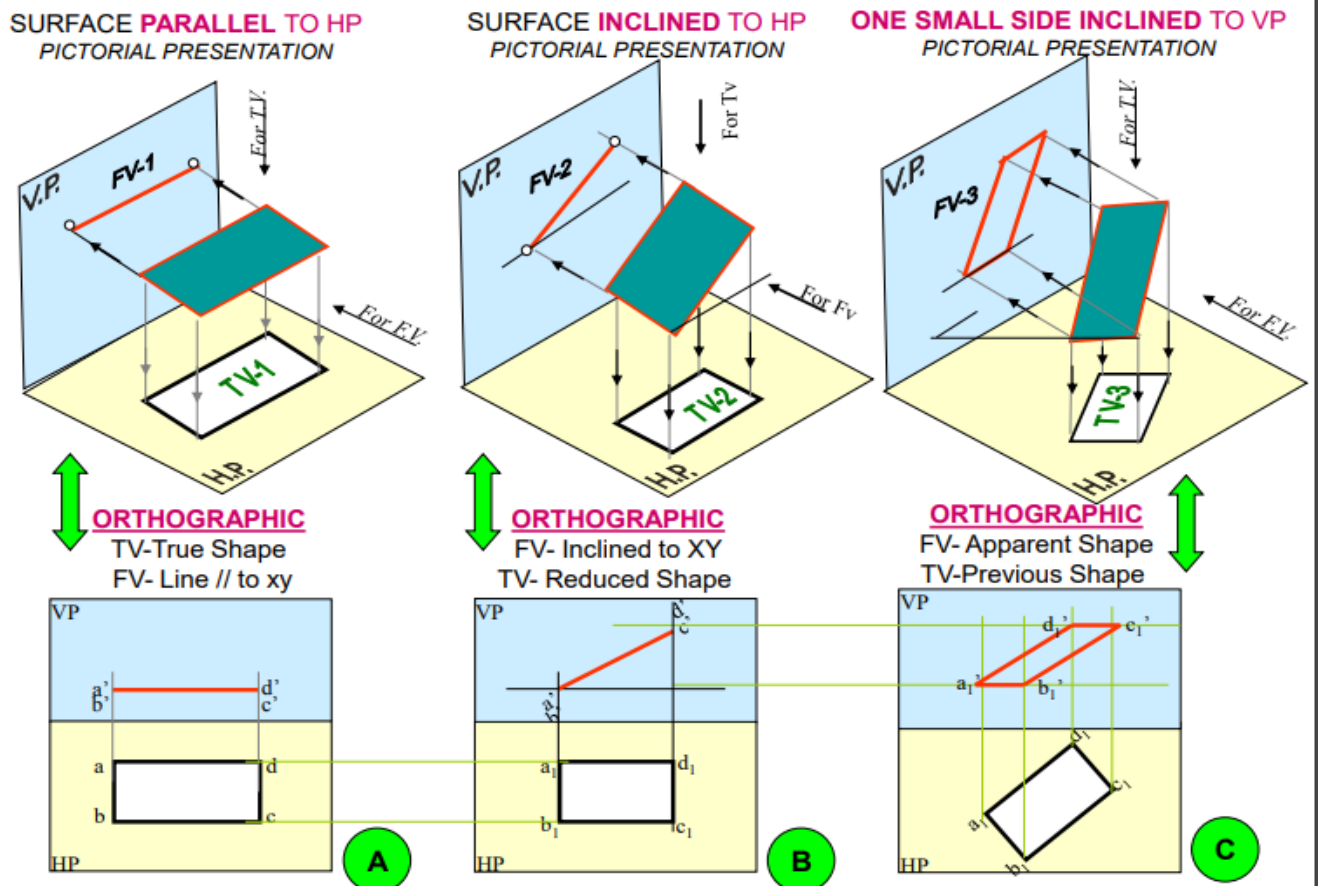
Various shapes of plane figures are considered such as square, rectangle, circle, pentagon, hexagon, etc.

POSITIONS OF A PLANE

- Surface of the plane kept perpendicular to HP and parallel to VP
- Surface of the plane kept perpendicular to VP and parallel to HP
- Surface of the plane kept perpendicular to both HP and VP
- Surface of the plane kept inclined to HP and perpendicular to VP
- Surface of the plane kept inclined to VP and perpendicular to HP
- Surface of the plane kept inclined to both HP & VP



The concept can be understood with the help of examples given in the figure for a rectangle with different positions.



PLANE SURFACES INCLINED TO BOTH HP AND VP

Change of position method:-

Orthographic projections of a plane surface inclined to one reference plane are drawn by changing the position of the plane surface from simple position to the required position in two stages known as the change of position method.

Three stages are given below: 1. Simple position 2. Second position 3. Final position

SIMPLE POSITION

Rule:-

When a plane surface is parallel to HP, top view shows its true shape & size. Therefore, draw the top view first. Project the front view from it.

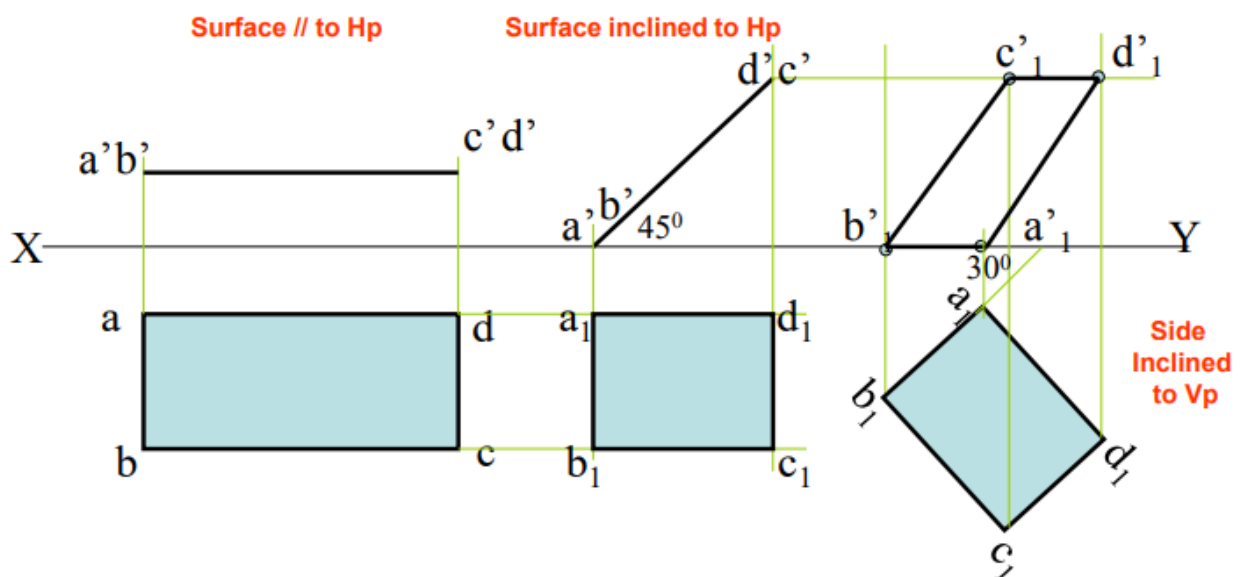
When a plane surface is parallel to VP, front view shows its true shape & size. Therefore, draw the front view first. Project the top view from it.

Problem 1: Rectangle 30mm and 50mm sides is resting on HP on one small side which is 30 degree inclined to VP, while the surface of the plane makes 45 degree inclination with HP. Draw its projections.

Solution : Steps Read problem and answer following questions

1. Surface inclined to which plane? ----- HP
2. Assumption for initial position? -----// to HP
3. So which view will show True shape? --- TV
4. Which side will be vertical? ---One small side.

Hence begin with TV, draw rectangle below X-Y drawing one small side vertical.

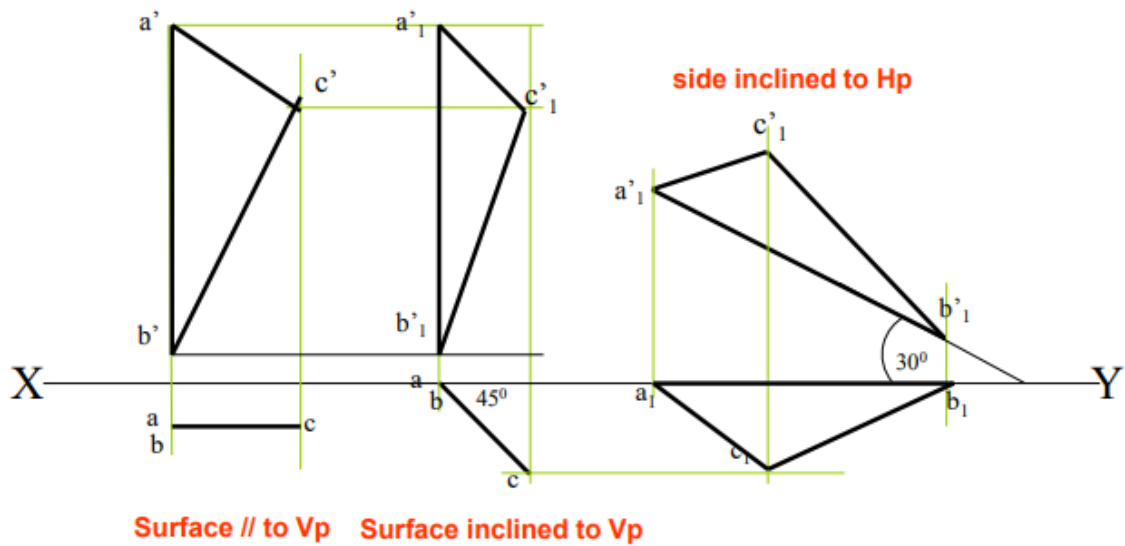


Problem 2: A 300 – 600 set square of longest side 100 mm long, is in VP and 30 degree inclined to HP while it's surface is 45 degree inclined to VP. Draw it's projections

Solution : Read problem and answer following questions

1. Surface inclined to which plane? ----- VP
2. Assumption for initial position? -----// to VP
3. So which view will show True shape? --- FV
4. Which side will be vertical? ----- Longest side.

Hence begin with FV, draw triangle above X-Y keeping longest side vertical.



3.3 Sectioning of Solids

Introduction

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

Sectional drawings are multi-view technical drawings that contain special views of a part or parts that reveal interior features. A primary reason for creating a section view is the elimination of hidden lines, so that a drawing can be more easily understood or visualized. Traditional section views are based on the use of an imaginary cutting plane that cuts through the object to reveal interior features. This imaginary cutting plane is controlled by the designer and are generally represented by any of the following:

- (a) **Full section view**, where the section plane goes completely through the object. Example shown in figure 1.
- (b) **Half section view**, where the section plane goes half-way through the object. Example shown in figure 2.
- (c) **Offset section**, where the sectional plane bent through the features that are not aligned. Example shown in figure 3.
- (d) **Broken-out section** where the section goes through part of the object. Example shown in figure 4

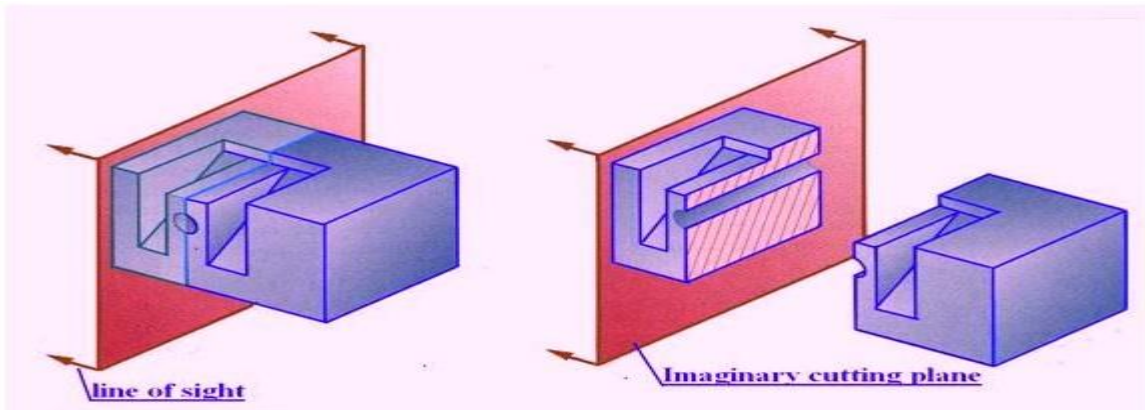


Figure 1. Illustrates a full Section view

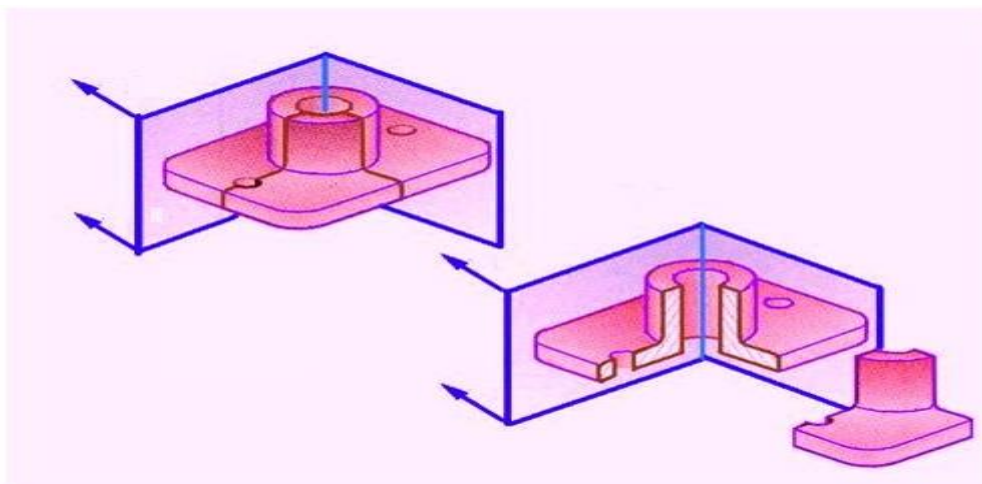


Figure 2. Illustrating a half section view

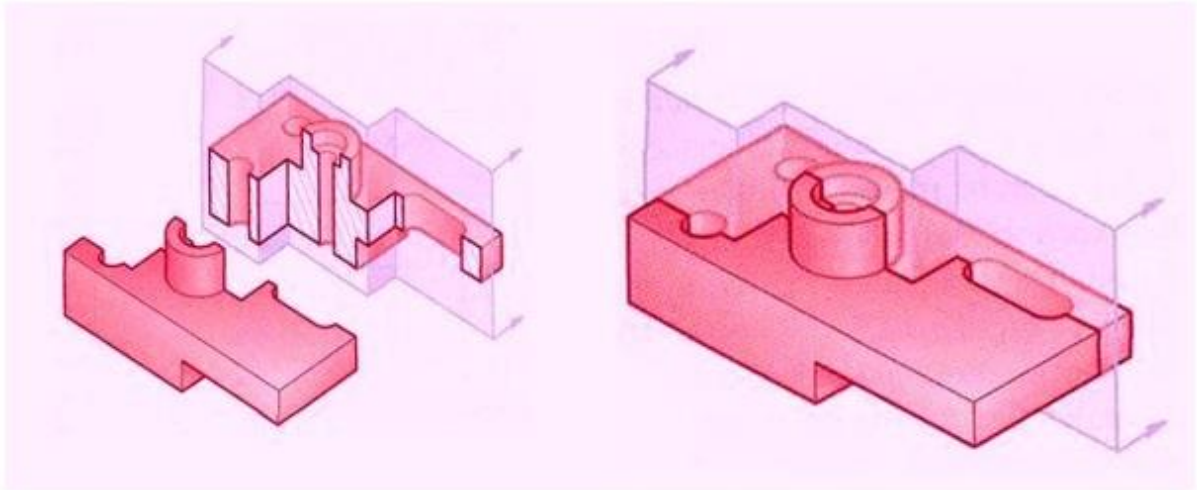


Figure 3. Illustrating an offset section

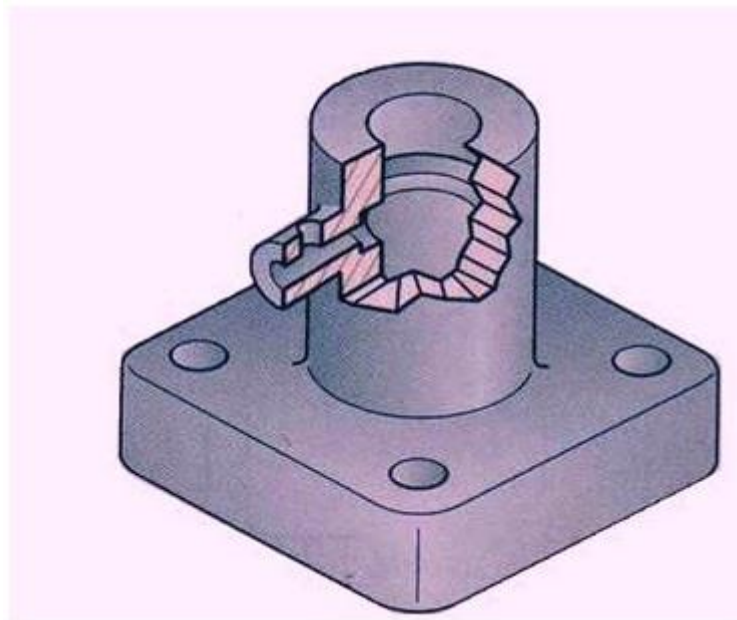


Figure 4. Illustrating a Broken-out Section

- An important reason for using section views is to reduce the number of hidden lines in a drawing.
- A section view reveals hidden features without the use of hidden lines. Adding hidden lines to a section view complicates the drawing defeating the purpose of clarifying with a section.
- As illustrated in figure 5, there are times, when a minimum number of hidden lines are needed to represent features other than the primary one shown by the section. In the figure, the through and through cavity may not be represented properly since it could be mistaken with a circular hole.

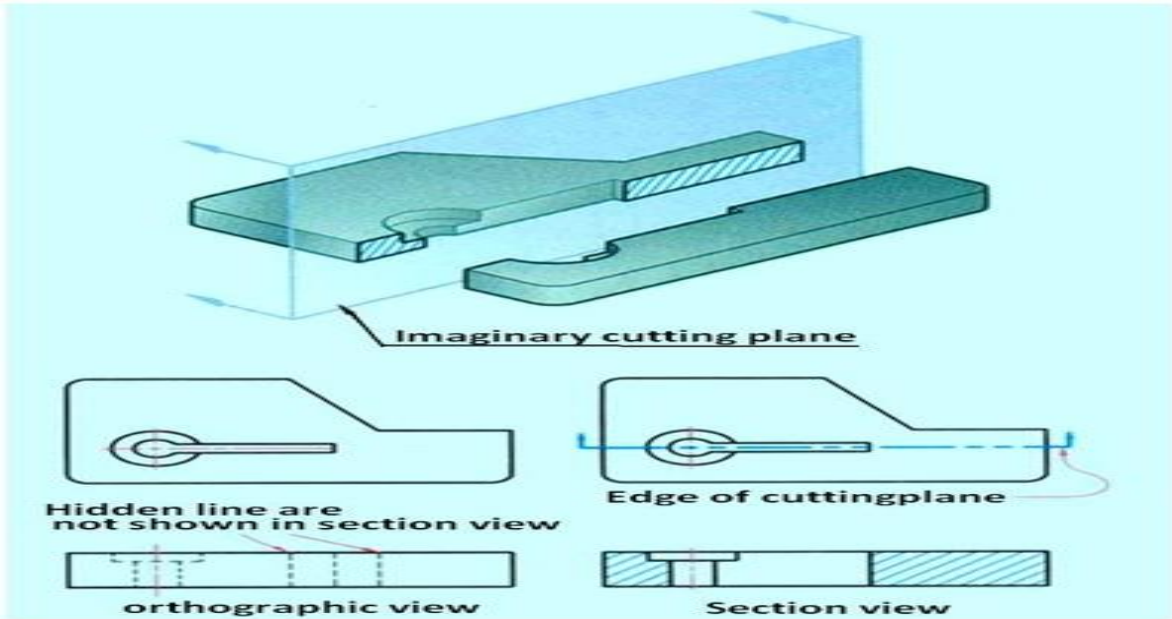


Figure 5 Illustration of the need of section view.

- Figure 6 illustrates a full section view of an object.
- As shown in the correct drawing, the section lined areas are bounded by visible lines, never by hidden lines, because the bounding lines are visible in the section view .
- Visible surfaces and edges that represent a change of planes behind the cutting plane are drawn as lines in a section view.
- Figure 6 shows a section view for which the cutting plane passes through the center of a counter bored hole. A line represents the change of planes between the drilled and counter bored holes and is an example of a visible feature that is behind the cutting plane.

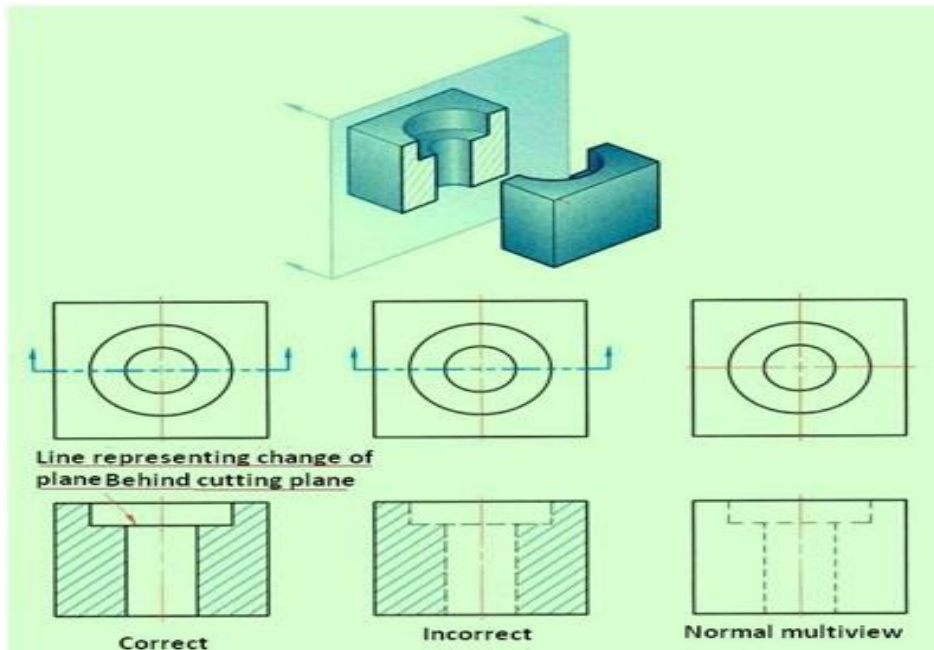


Figure 6 Correct and incorrect representation along with the multiview drawing

Visualization of Section Views

- Figure 7 is multi-view drawing of a part that may be difficult to visualize in its 3-D form, because of the many hidden lines.

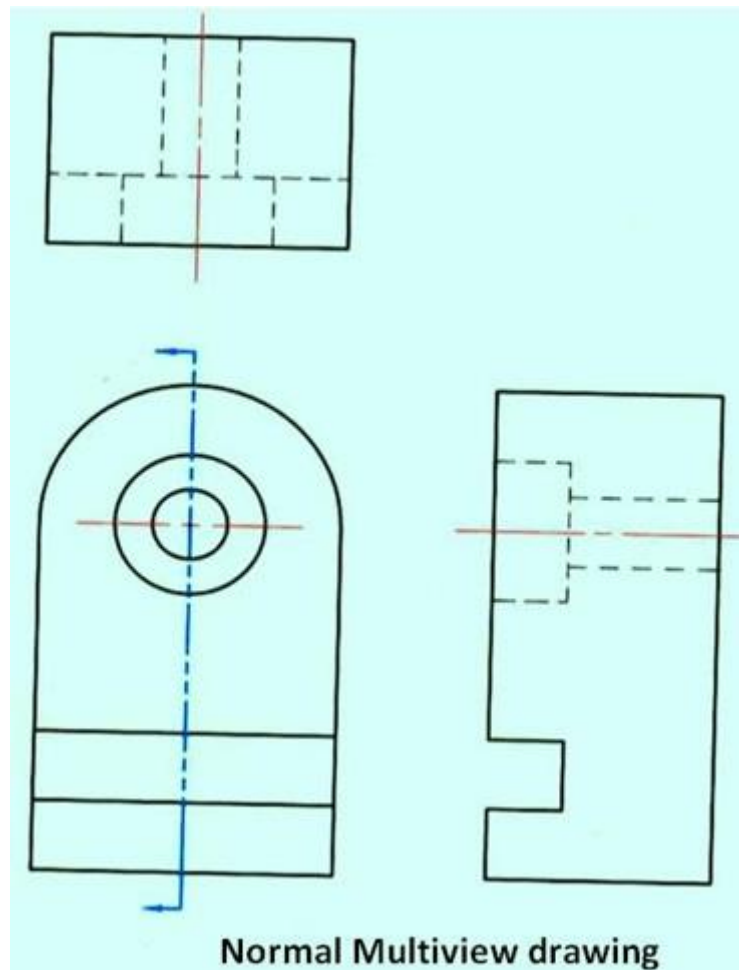


Figure 7 A multiview drawing of an object

- A section view is created by passing an imaginary cutting plane vertically through the center of the part.
- Figure 8 is a 3D representation of the part after it is sectioned.
- The section view more clearly shows the interior features of the part.
- In the left corner of the figure, the cutting plane arrows, in the front view, point to the left, to represent the direction of sight for producing a right side view in full section.
- The direction of the arrow can also be thought of as pointing toward the half of the object being kept.
- The right half of the object is "removed" to reveal the interior features of the part.
- The line of sight for the section view is perpendicular to the cut surfaces, which means they are drawn true size and shape in the section view.
- Also, no hidden lines are drawn and all visible surfaces and edges behind the cutting plane are drawn as object lines.
- The corners of the section view are numbered as shown in the right hand figure so that they can be compared with the orthographic section view.

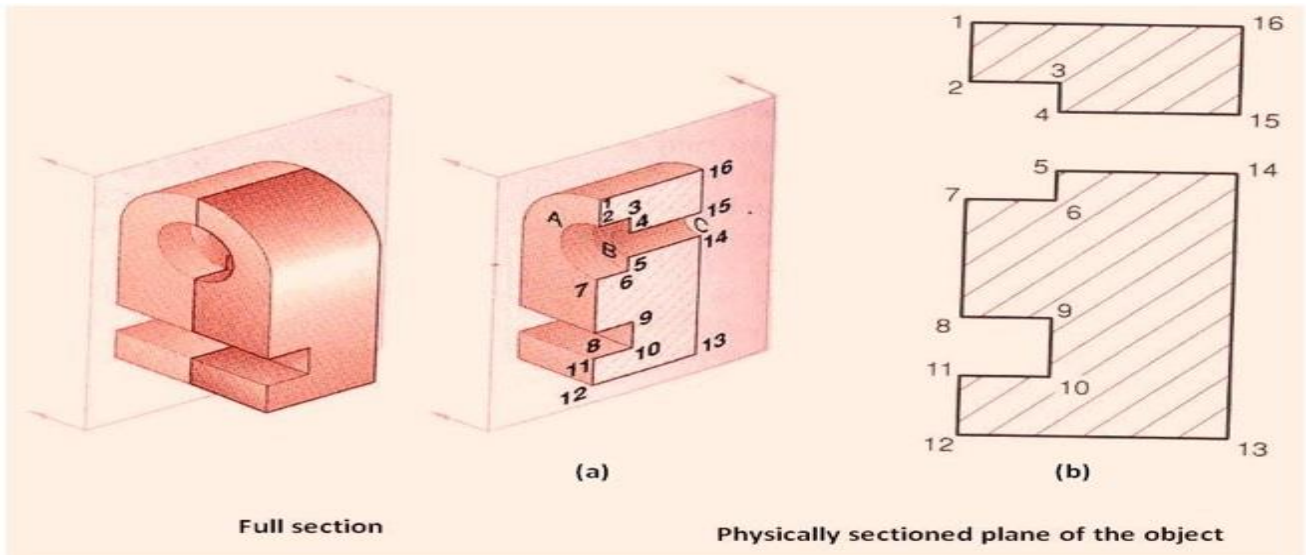


Figure 9 showing a full section and the physically sectioned plane of the object

- The representation of the section view of the object shown in figure 9 is shown as (b) in figure 10. The section view in figure (a) shows only those surfaces touched by the cutting plane.
- Since conventional practice requires that features behind the cutting plane be represented, the change of planes between the two holes in the counter bored hole are shown in figure (b).
- If the section is viewed along the line of sight identified by the arrows in figure (c), arcs A, B, and C will be visible and should be represented as lines. In figure (b), the lines are 2-7,4-5,15-14.
- The counter bore and through holes are represented as rectangular features 2-7-6-3, and 4-5-14-15.
- All the surfaces touched by the cutting plane are marked with section lines. Because all the surfaces are the same part, the section lines are identical and are drawn in the same direction. The center line is added to the counter bored hole to complete the section view.

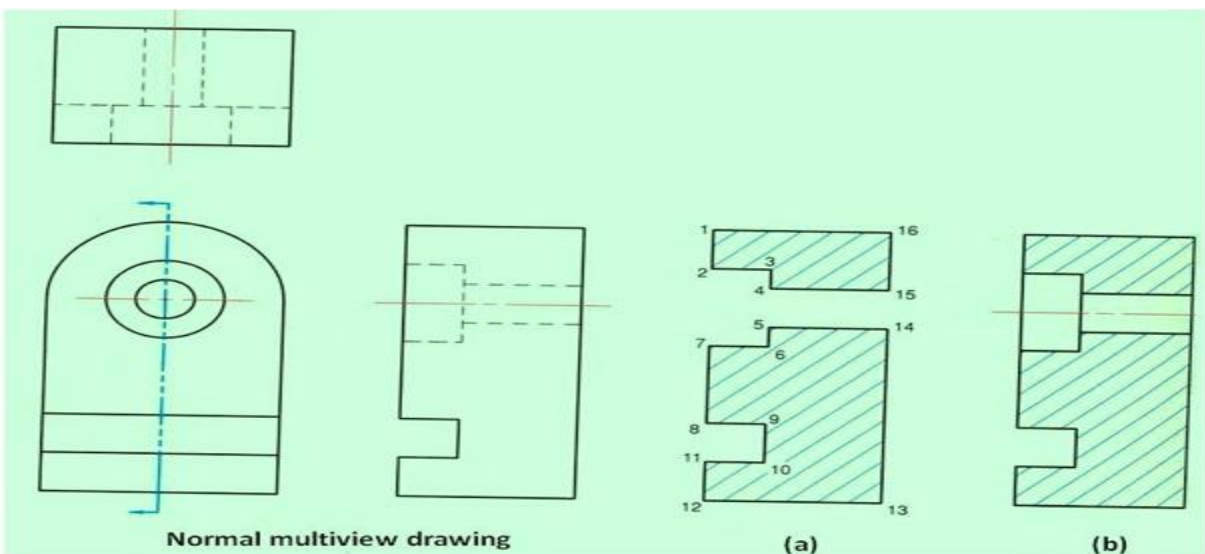


Figure 10. showing the object, orthographic view, sectioned surface and sectional view.

CUTTING PLANE LINES:

- The cutting plane line show the exact line along which the cutting plane passes through the object.
- This represent the *edge view* of the cutting plane and are drawn in the view(s) adjacent to the section view. This is represented in figure 11. In the figure the cutting plane line is drawn in the top view, which is adjacent to the sectioned front view.

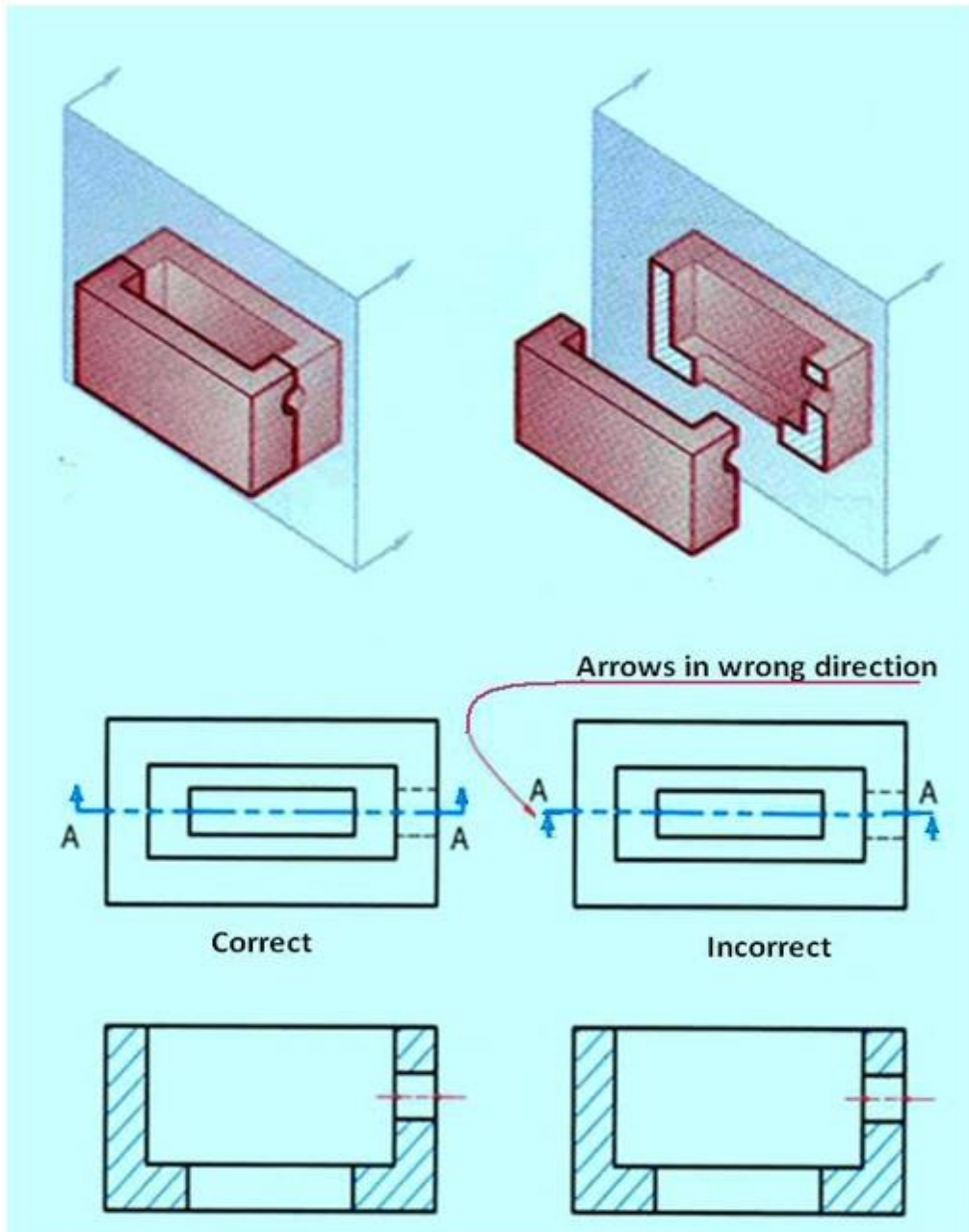


Figure 11 showing the representation of a cutting plane line

- Cutting plane lines are *thick* (0.7 mm) dashed lines, that extend past the edge of the object 6 mm and have line segments at each end drawn at 90 degrees and terminated with arrows.
- The arrows represent the direction of the line of sight for the section view and they point away from the sectioned view.
- Two types of lines are acceptable for cutting plane lines in multi-view drawings.
- The normal representation of cutting plane lines are shown in figure 12. Line B-B is composed of alternating long and two short dashes, which is one of the two standard methods.
- The length of the long dashes varies according to the size of the drawing, and is approximately 20 to 40 mm.
- For a very large section view drawing, the long dashes are made very long to save drawing time. The short dashes are approximately 3 mm long. The open space between the lines is approximately 1.5 mm.
- Capital letters are placed at each end of the cutting plane line, for clarity or when more than one cutting plane is used on a drawing.
- The second method used for cutting plane lines is shown by line C-C, which is composed of equal-length dashed lines. Each dash is approximately 6 mm long, with a 1.5 mm space between.

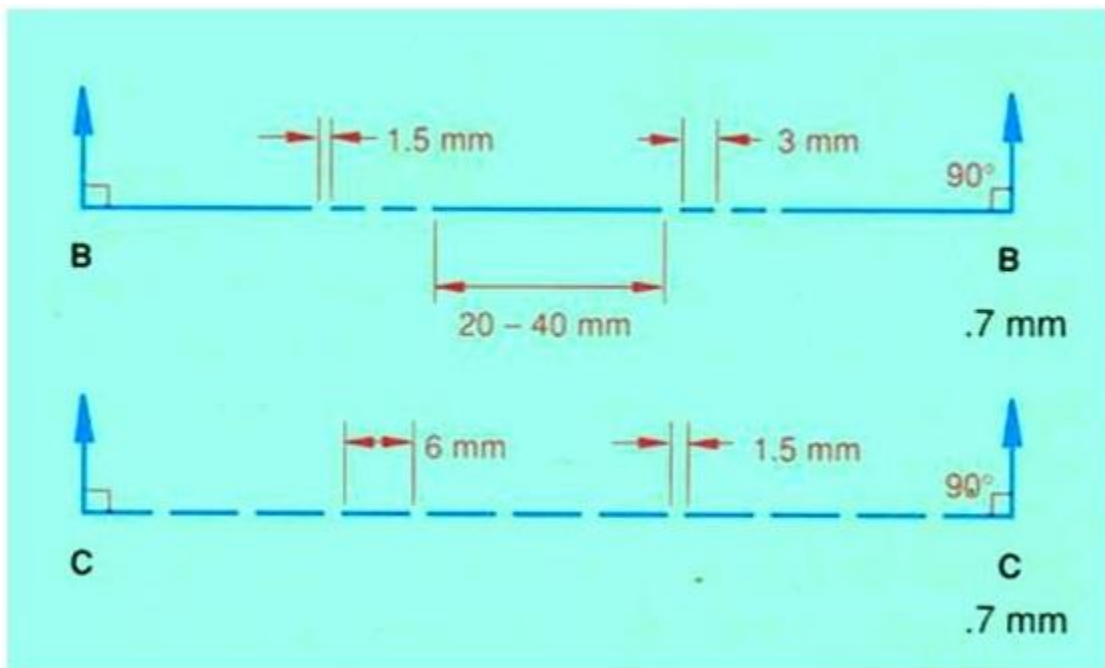


Figure 12 Normal representation of cutting plane lines.

Placement of Cutting Plane Lines

- Cutting plane lines are only added to a drawing for clarity. If the position of the cutting plane is obvious, the line need not be drawn.
- Also, if the cutting plane line is in the same position as a center line, the cutting plane line has precedence.
- In figure 10, the cutting plane appears as an edge in the top view and is normal in the front view; therefore, it is a **frontal cutting plane**.
- The front half of the object is "removed" and the front view is drawn in section.

- If the cutting plane appears as an edge in the front view and is normal in the top view, it is a horizontal cutting plane. The top half of the object is "removed" and the top view is drawn in section. Figure 13 shows a horizontal cutting plane.

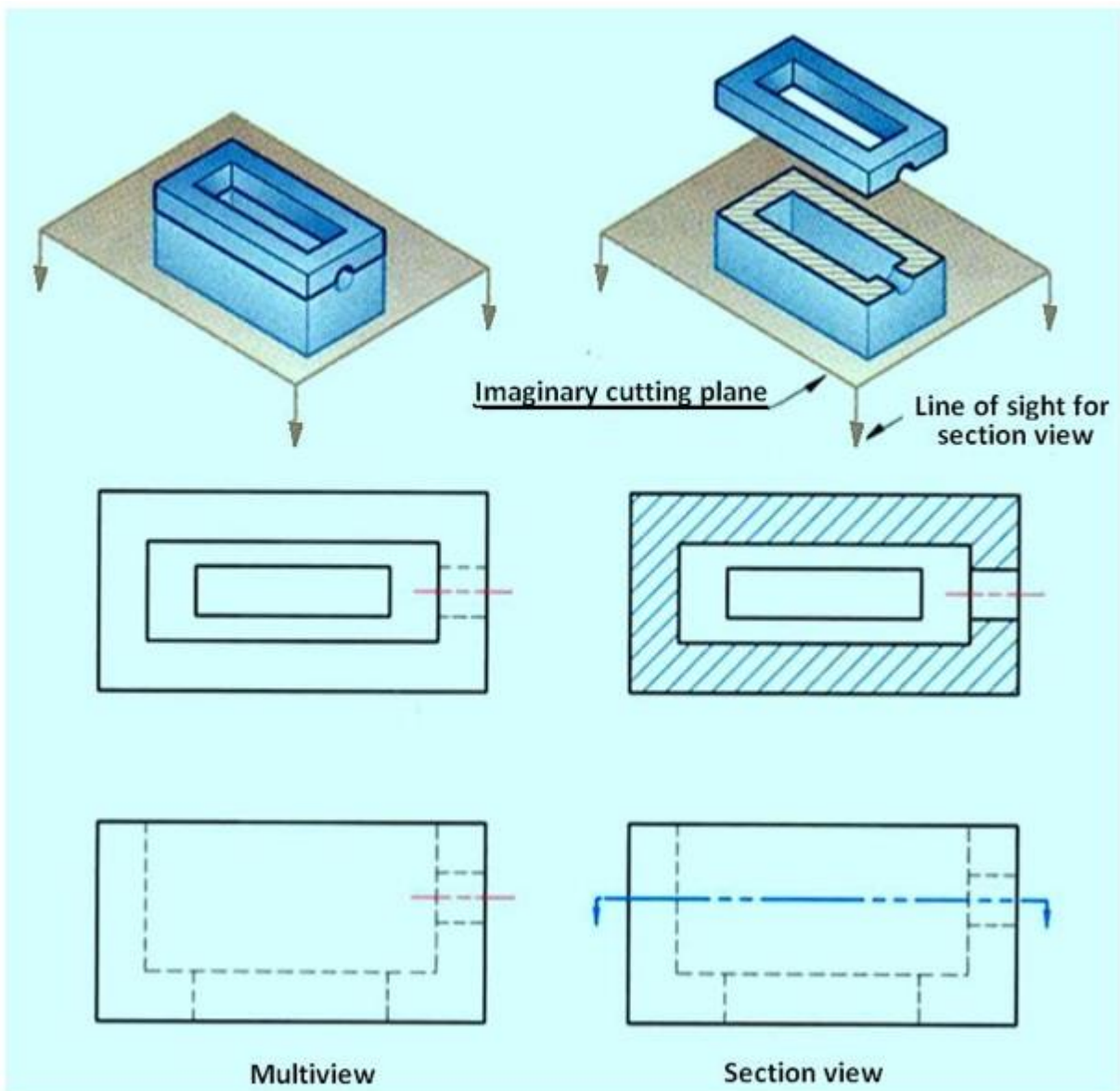


Figure 13. A horizontal cutting plane.

- If the cutting plane appears as an edge in the top and front views and is normal in the profile view, it is a profile cutting plane.
- The left (or right) half of the object is "removed" and the left (or right) side view is drawn in section.
- A profile cutting plane is shown by BB in figure 14. Multiple sections can be done on a single object, as shown in the figure 14.
- In this example, two cutting planes are used: one a horizontal and the other a profile cutting plane.
- Both cutting planes appear on edge in the front view, and are represented by cutting plane lines A-A and B-B, respectively.

- Each cutting plane will create a section view, and each section view is drawn as if the other cutting plane did not exist.

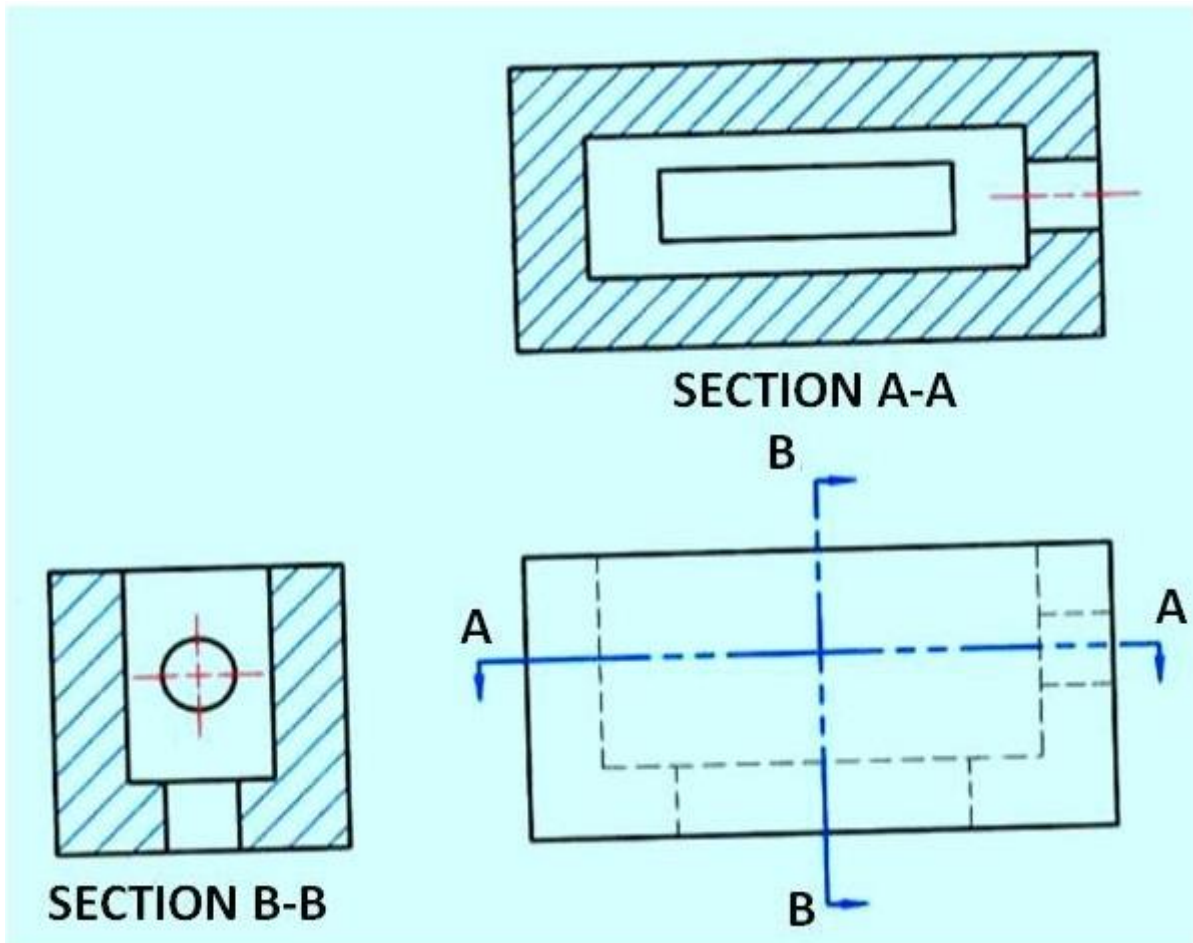


Figure 14. shows a profile cutting plane.

Section Line Practices

- Section lines or cross-hatch lines are added to a section view to indicate the surfaces that are cut by the imaginary cutting plane.
- Different section line symbols can be used to represent various types of materials.
- However, there are so many different materials used in engineering design that the general symbol (i.e., the one used for cast iron) may be used for most purposes on engineering drawings.
- The actual type of material required is then noted in the title block or parts list or as a note on the drawing.
- The angle at which lines are drawn is usually 45° degrees to the horizontal, but this can be changed for adjacent parts shown in the same section. Also the spacing between section lines is uniform on a section view.

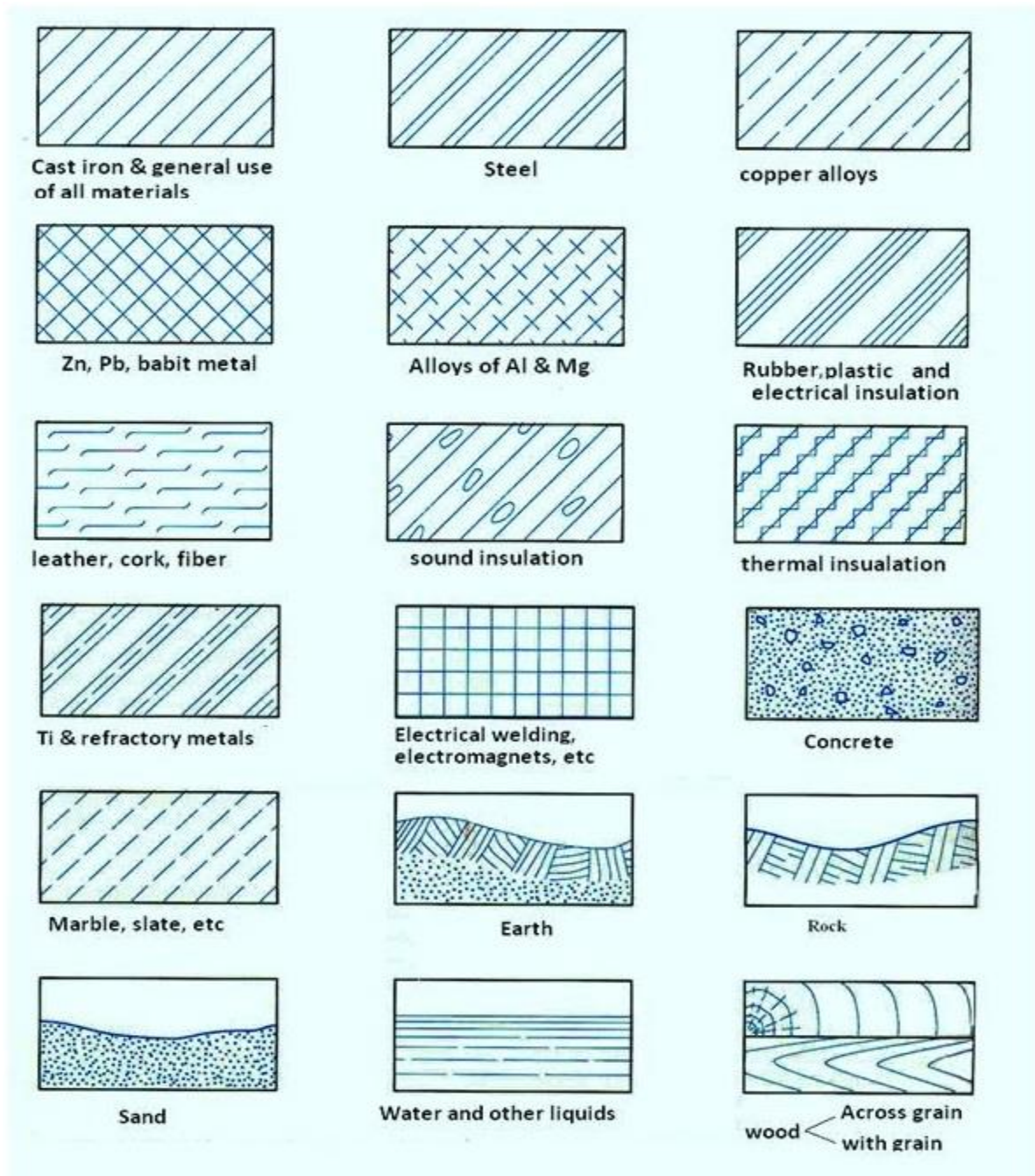


Figure 15. General symbols used to represent various materials in section view.

- The general purpose cast iron section line is drawn at a 45° and spaced 1.5 mm to 3 mm or more, depending on the size of the drawing.
- As a general rule, use 3mm spacing.
- Section lines are drawn as thin (.35 mm) black lines.
- The section lines should be evenly spaced and of equal thickness, and should be thinner than visible lines .
- Also, do not run *section* lines beyond the visible outlines or stop them too short. The correct and incorrect method of drawing section lines are shown in figure 16.

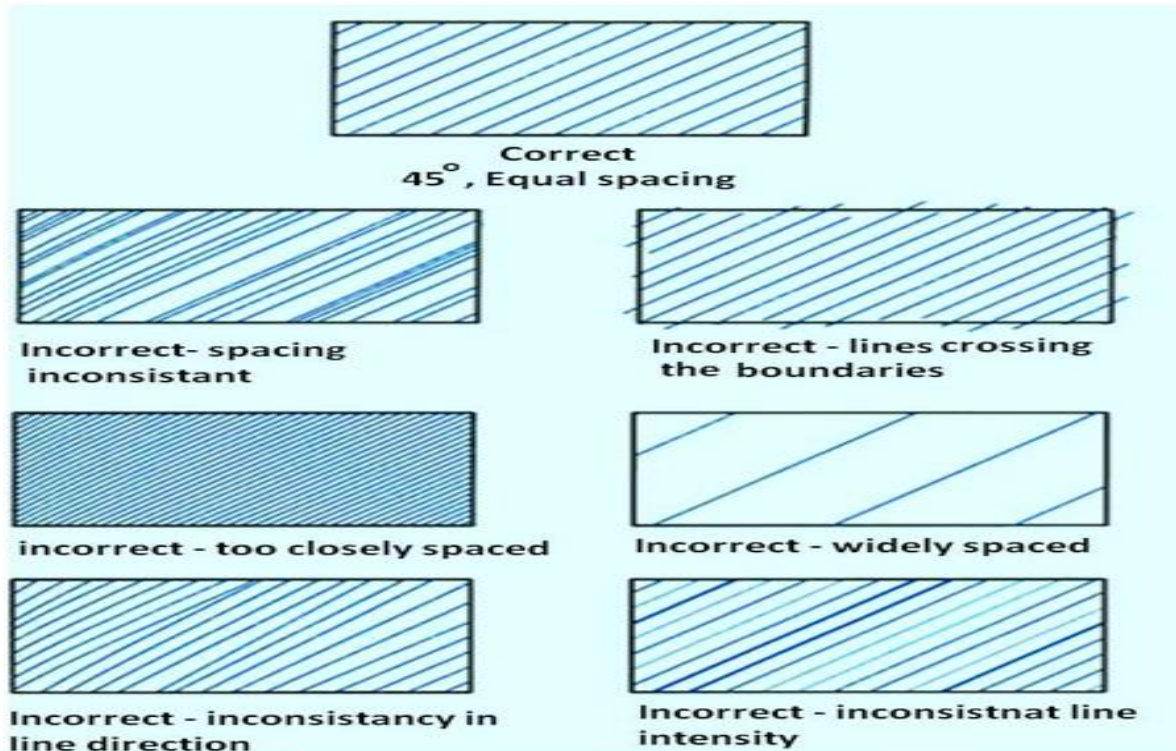


Figure 16. Representation of section line.

- Section lines should not run parallel or perpendicular to the visible outline. If the visible outline to be sectioned is drawn at 45°, the section lines are drawn at a different angle, such as 30° as shown in figure 17.

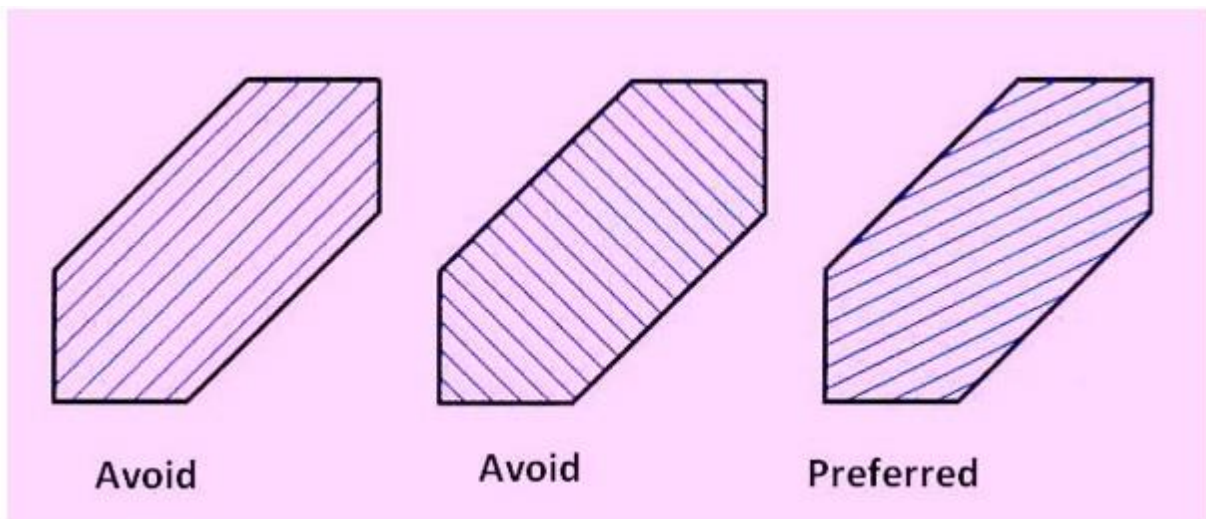


Figure 17 showing the direction of section lines with respect to the visible outline of the object.

- Avoid placing dimensions or notes within the section lined areas. If the dimension or note must be placed within the sectioned area, omit the section lines in the area of the note as shown in figure 17.



Figure 18 Placement of dimensions or notes within the section lines.

- An outline section view is created by drawing partial section outlines adjacent to all object lines in the section view as shown in figure 19. For large parts, outline sectioning may be used to save time.

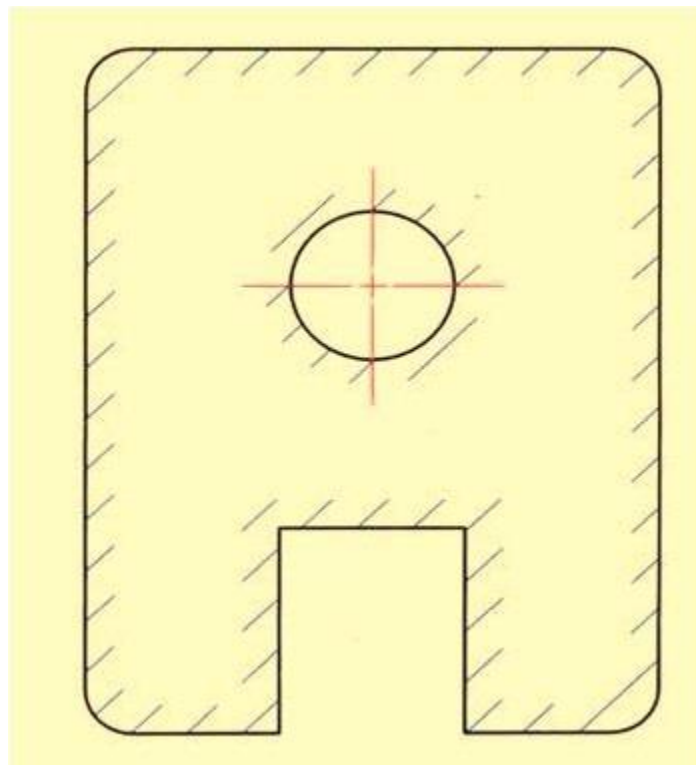


Figure 19. shows an outline section view.

- Very thin parts such as washers and gaskets are not easily represented with section lines, so conventional practice calls for representing the thin part in solid black. Figure 20 shows the section of a gasket drawn as solid black.

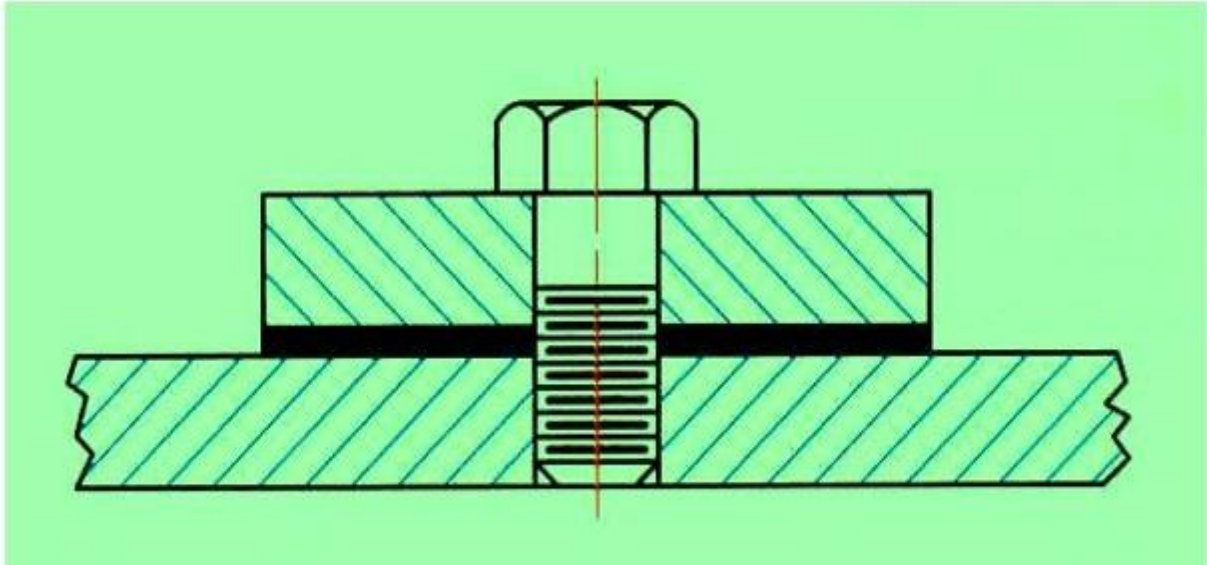


Figure 20. Representation of section view of a very thin part (e.g. gasket)

Full Section View

- A full section view is made by passing the imaginary cutting plane completely through the object.
- As shown in figure 21, all the hidden features intersected by the cutting plane are represented by visible lines in the section view.
- Surfaces touched by the cutting plane have section lines drawn at a 45-degree angle to the horizontal.
- Hidden lines are omitted in all section views unless they must be used to provide a clear understanding of the object.
- The top view of the section drawing shows the cutting plane line, with arrows pointing in the direction of line of sight to view the sectioned half of the object.
- In a multi-view drawing, a full-sectioned view is placed in the same position that an un-sectioned view would normally occupy, I.e., a front section view would replace the traditional front view.

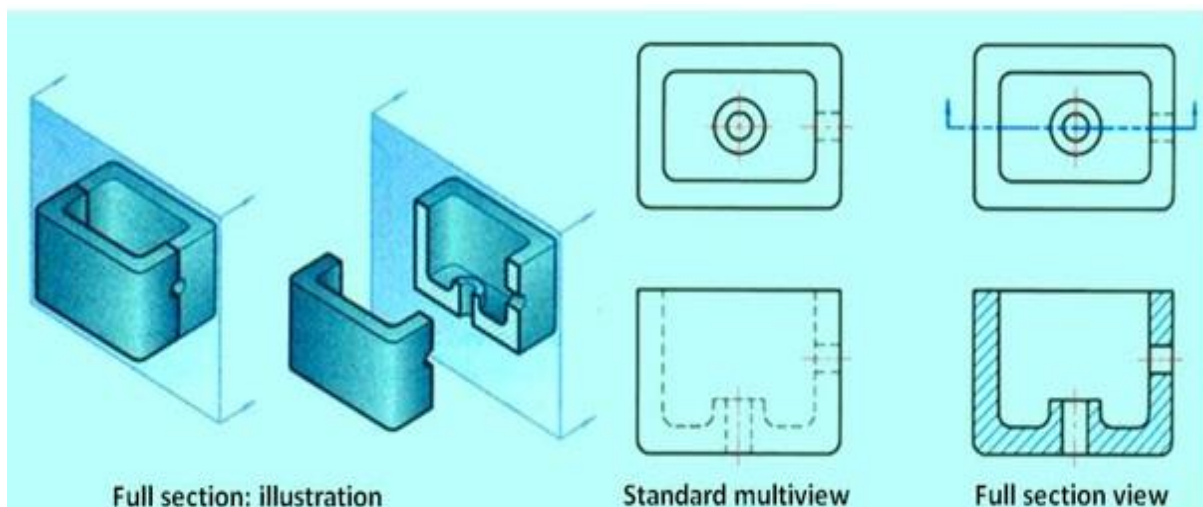


Figure 21 shows a full section view of an object.

Half Section view

- Half sections are created by passing an imaginary cutting plane only halfway through an object.
- Hidden lines are omitted on both halves of the section view.
- Hidden lines may be added to the un-sectioned half, for dimensioning or for clarity.
- External features of the part are drawn on the un-sectioned half of the view. A center line, not an object line, is used to separate the sectioned half from the un-sectioned half of the view.
- The cutting plane line shown in the top view.
- The cutting plane line in the top view is bent at 90° and one arrow is drawn to represent the line of sight needed to create the front view in section. Half section views are used most often on parts that are symmetrical, such as cylinders.
- Also, half sections are commonly used in assembly drawings when external features are also to be shown. Figure 22 shows a half section view of an object.

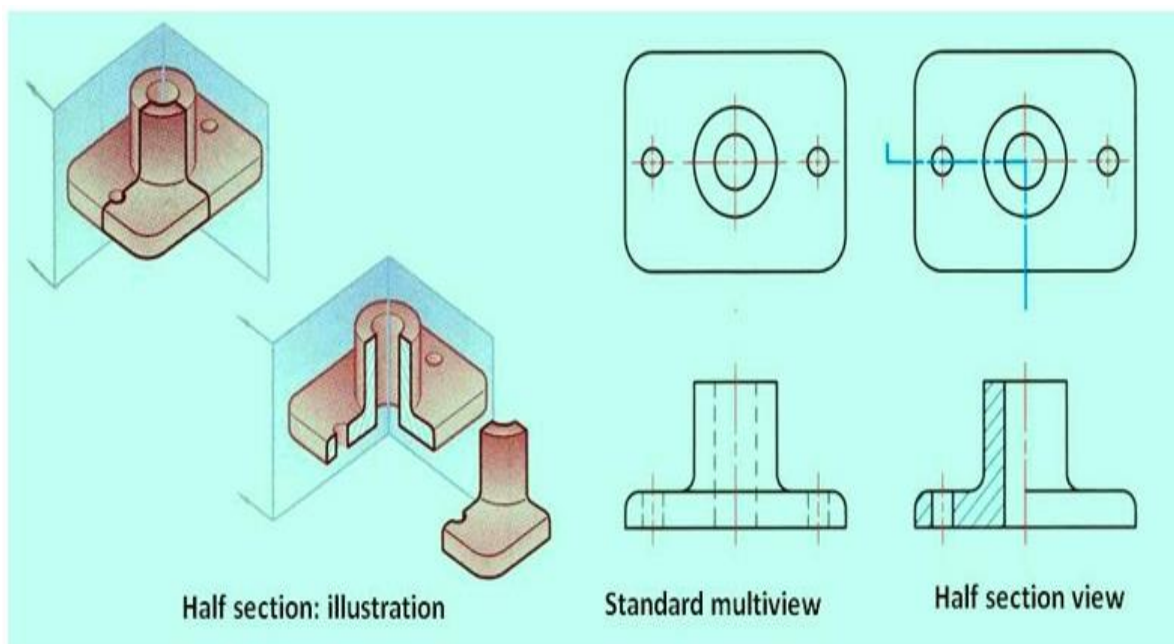


Figure 22 shows the cutting plane passing halfway through an object and one quarter of the object being removed

Broken-Out Sections

- A broken-out section is used when only a portion of the object needs to be sectioned. A broken-out section view of an object is shown in figure 23.
- A break line separates the sectioned portion from the un-sectioned portion of the view.
- A break line is drawn freehand to represent the jagged edge of the break. No cutting plane line is drawn.
- Hidden lines may be omitted from the un-sectioned part of the view, unless necessary for clarity.
- A broken-out section is also used instead of a half or full section view to save time.

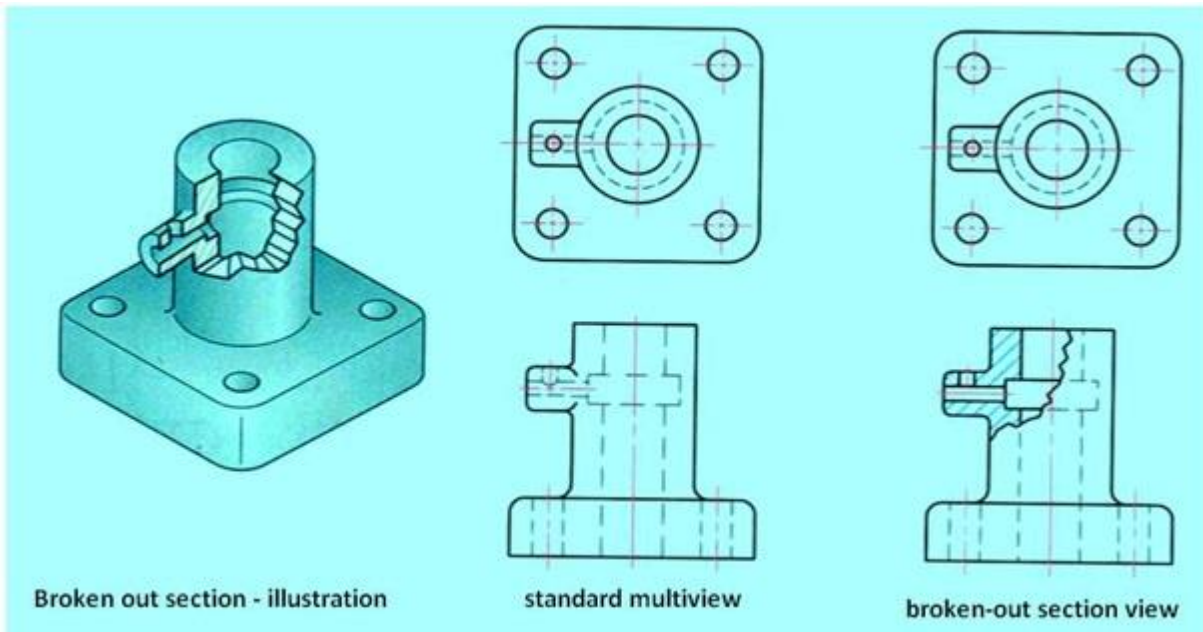


Figure 22 shows the broken out section of an object. Majority of the technical details are also shown.

References

1. www.nptel.com

2. You tube videos helpful for the course

<https://www.youtube.com/watch?v=jzdUdQBk4Vo>

<https://www.youtube.com/watch?v=ehyznirva8M&list=PLUqOKW86QrMa0sHyo0RuDrDgHyoAn2Cev&index=>

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