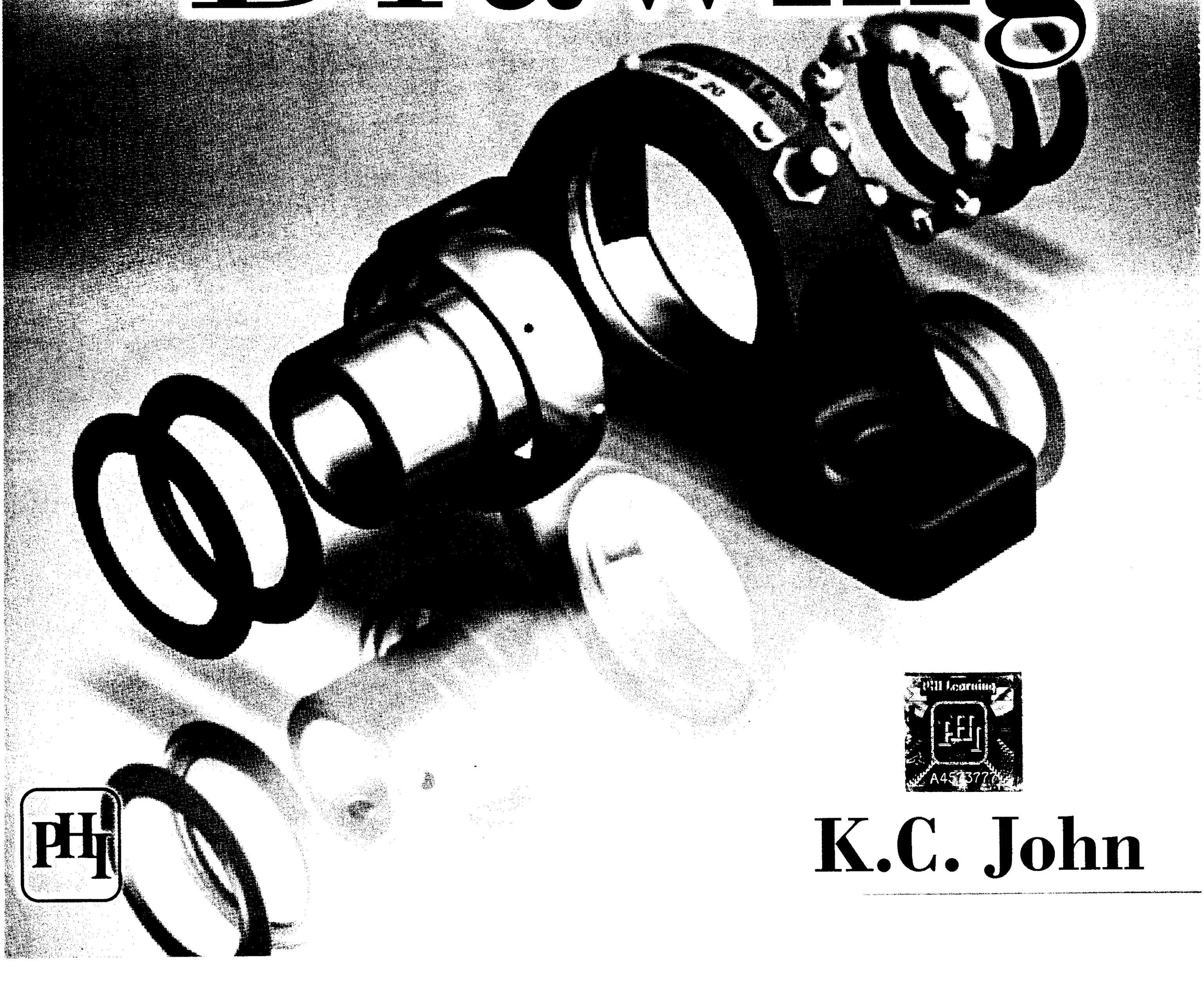
Eastern Economy Edition

Textbook of Machine Drawing



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K.C. John

C H A P T E R 3

Multiview Projection

The multiview projection is an orthographic projection in which the exact shape of an object is represented by two or more views, projected on planes that are usually at right angles to one another. Although the multiview projection is only one of the orthographic projection methods, the term of orthographic projection is generally used to represent a multiview projection because of its wide popularity. Engineers and draftsmen generally prefer this method of drawing to present shapes of objects, due to the limitations of pictorial views.

3.1 PRINCIPLE OF MULTIVIEW (ORTHOGRAPHIC) PROJECTION

The multiview projection system is the most popular system of projection followed by engineers to represent the true shape and size of three-dimensional objects on two-dimensional planes. Usually, two views will be sufficient to describe an object completely. Here, the two views are drawn on two mutually perpendicular planes. These planes are called *principal* or *coordinate planes of projection*. Out of the two planes, one is vertical and the other is horizontal and so they are called *vertical* and *horizontal planes* respectively. The view obtained on the vertical plane is called *front view* or *front elevation* or simply *elevation*. The vertical plane on which the front view is obtained is sometimes called *frontal plane*. The view obtained on the horizontal plane is called *top view* or *plan*.

Sometimes, three views may be required to describe an object completely. Here, the three views have to be drawn on the three mutually perpendicular planes called *principal* or *coordinate planes of projection*. Out of these coordinate planes, the third plane is perpendicular to the first and second planes and it is called *profile plane*. The view obtained on the third plane is called *profile view, side view, end view,* or *side elevation*.

The arrangement of the three mutually perpendicular planes is shown in Figure 3.1. Here, the vertical plane (VP) and the horizontal plane (HP) divide the space into four quadrants, if extended. According to the anticlockwise or left-hand system, these quadrants are marked as I, II, III and IV. The profile plane (PP) divides each quadrant into two parts, one in front of PP and the other behind PP. Thus, the whole space is divided into eight compartments called *octants*.

The projection obtained on the coordinate planes, keeping the object in the first quadrant, is called *first-angle projection*. Similarly, the projection is said to be the *second, third* or *fourth* angle projection depending upon whether the object is situated in the II, III or IV quadrant respectively. However, only two systems of projection, i.e. first angle and third angle projections are followed.

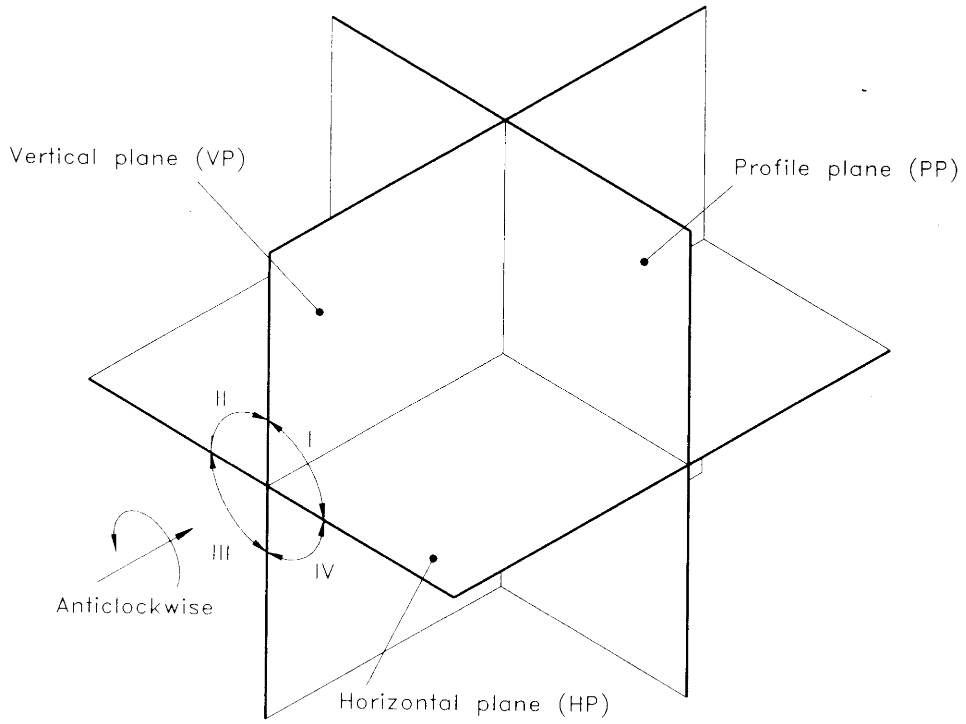


Figure 3.1 Planes of projection showing octants (anticlockwise system).

3.2 FIRST ANGLE PROJECTION AND THE LOCATIONS OF THE THREE VIEWS

In first angle projection, the object is assumed to be positioned in the first quadrant as shown in Figure 3.2. Here, the object is placed in such a way that its main faces are parallel to the principal planes and hence the projections of these faces on the principal planes will have the true shape and size.

The three views formed on the principal planes are described below:

1. Front view: The view of the object formed on the vertical plane (VP) or frontal plane, when looked orthogonally at the object in the direction marked FRONT, is called *front view*. Here, the VP is behind the object. Thus, the object is in between the plane of projection and the eye. This is indicated by

EYE > OBJECT > PLANE

2. Top view: The view of the object formed on the horizontal plane (HP) when looked orthogonally at the object from the top in the direction marked TOP, is called *top view*. Here, the horizontal plane is below the object. Thus, the object is in between the plane of projection and the eye. This is indicated by

EYE > OBJECT > PLANE

3. Left side view: The view of the object formed on the profile plane (PP), when looked orthogonally at the object in the direction marked LEFT-HAND SIDE, is called *left side view*. Here, the profile plane is behind the object. Thus, the object is in between the eye and the plane of projection. This is also indicated by

EYE > OBJECT > PLANE

To bring the three views into a single plane, revolve the coordinate planes through 90°, as indicated by the arrows. The complete layout of the three views of the object, after rabation, will be as shown in Figure 3.3.

3.3 THIRD ANGLE PROJECTION AND THE LOCATIONS OF THE THREE VIEWS

In third angle projection, the object is assumed to be positioned in the third quadrant. Here, the object is placed in such a way that its main faces are parallel to the principal planes and hence the projections of these faces on the principal planes will have the true shape and size.

The complete layout of the three views of an object in third angle projection is as shown in Figure 3.4.

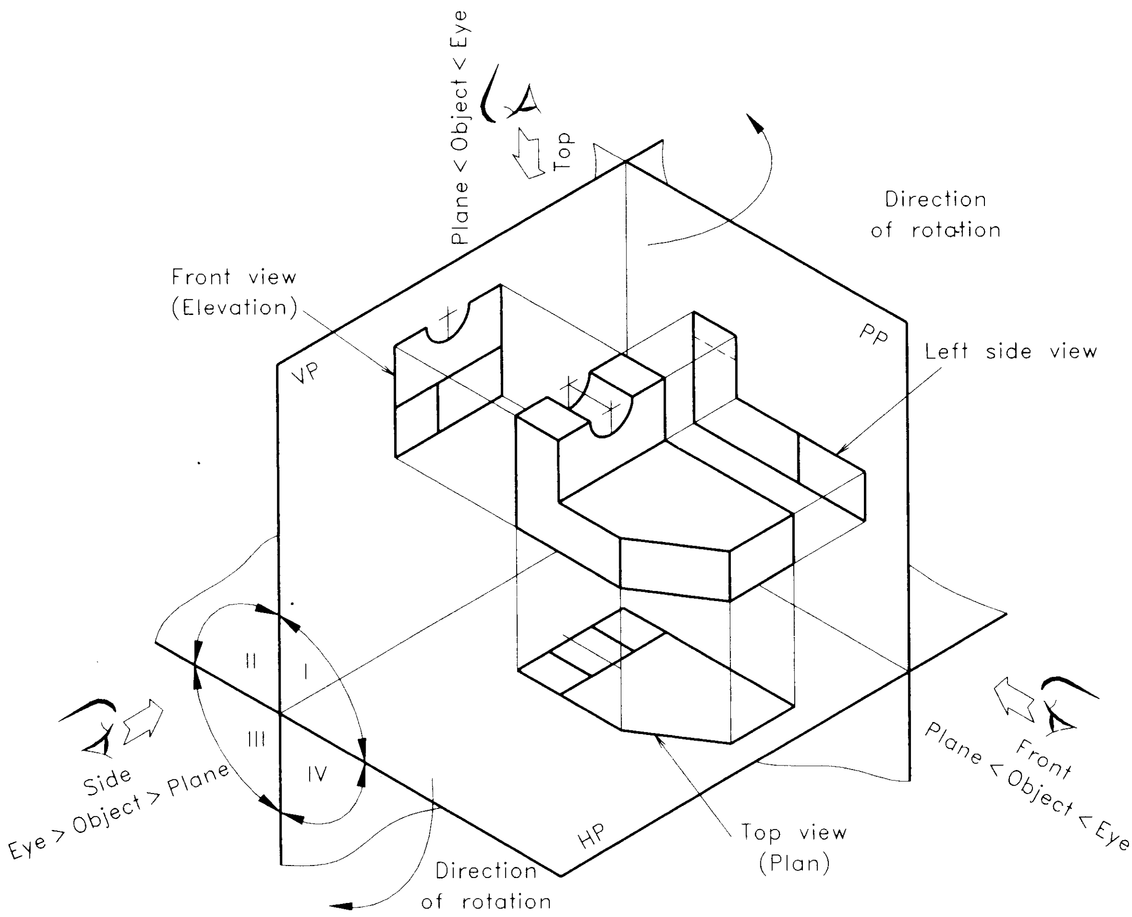


Figure 3.2 First angle projection following anticlockwise system.

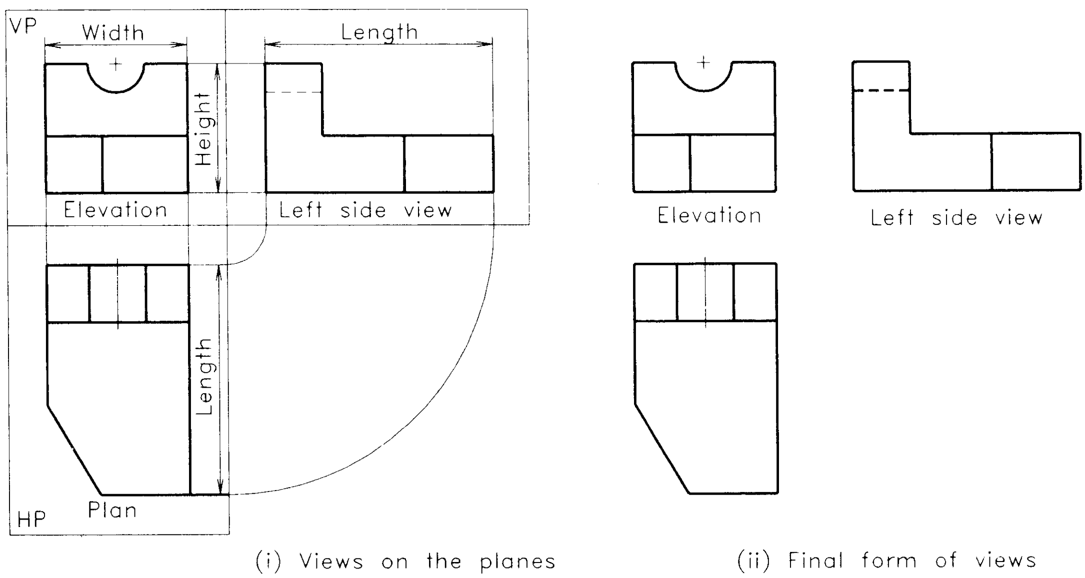


Figure 3.3 Layout of the principal views (first angle projection).

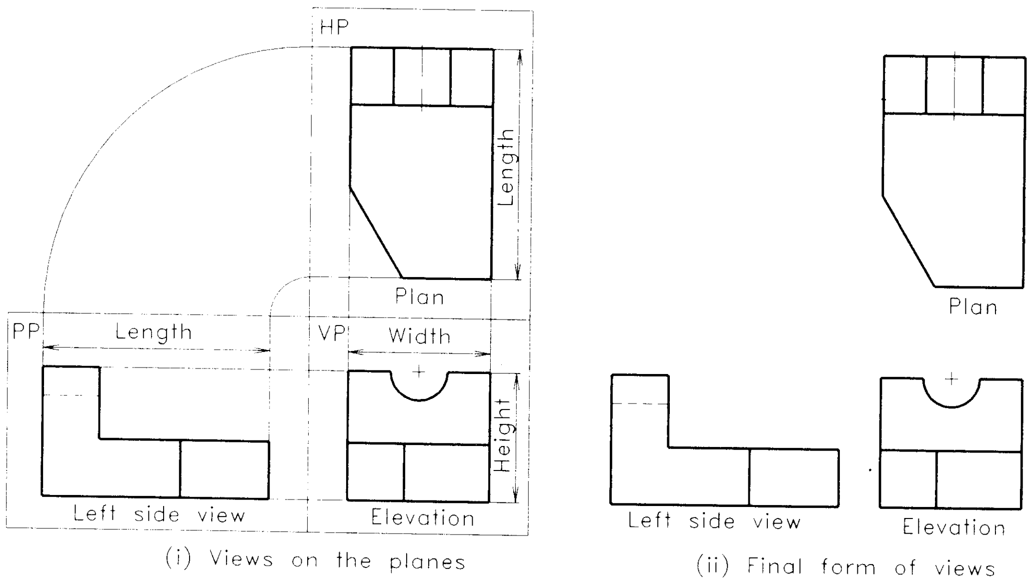


Figure 3.4 Layout of the principal views (third angle projection).

3.4 TRANSPARENT BOX AND THE SIX ORTHOGRAPHIC VIEWS

To describe the shape and size of a complicated object completely on a sheet of paper, sometimes more than three views are required. In such cases, transparent box method can be used to get six different views of the object. Here, the object is assumed to be placed inside a transparent box, keeping its important face parallel to the front side of the box (see Figure 3.5). The six sides of the box are assumed to be six planes of projection. The observer views the enclosed object from outside. Six views are obtained on the six planes by drawing projectors from various points on the object to these planes. These views are called *front, top, right side, left side, bottom* and *rear views*. To transfer these six views, the box is opened to one plane, the plane of the drawing sheet. The six views can be developed by applying the principle of first and third angle projection methods.

In first angle projection method, the object is placed between the eye and the plane of projection. Hence, we follow the *EYE > OBJECT > PLANE* principle.

Consider a transparent box ABCDEFGH containing an object inside it, as shown in Figure 3.5. The following are the views obtained on the six sides of the transparent box.

1. *Front view:* The view of the object formed on the rear side ABCD of the box, when looked in the direction of the arrow marked by FRONT, is called *front view*.

2. *Top view:* The view of the object formed on the bottom side DCGH of the box, when looked in the direction of the arrow marked by TOP, is called *top view*.

3. *Left side view:* The view of the object formed on the right side BFGC of the box when looked in the direction of the arrow marked by LEFT SIDE, is called *left side view*.

4. *Right side view:* The view of the object formed on the left side AEHD of the box, when looked in the direction of the arrow marked by RIGHT SIDE, is called *right side view*.

5. *Bottom view:* The view of the object formed on the top side ABFE of the box, when looked in the direction of the arrow marked by BOTTOM, is called *bottom view*.

6. *Rear view:* The view of the object formed on the front side EFGH of the box, when looked in the direction of the arrow marked by REAR, is called *rear view*.

Assume that the transparent box is formed by hinging the sides of the box onto the edges of these sides. It may be noted that all the sides of the transparent box except the front side EFGH, are hinged to the four edges AB, BC, CD and DA of the rear side ABCD. The front side EFGH is hinged to the edge FC. There are two hinges on each side. Now to open the box, rotate the sides of the box outwards about the respective hinges as shown in Figure 3.6. All the sides of the box are opened out in such a way that the front view occupies the central position. Continue the process of the rotation until all sides of the box lie in a single plane, the plane of the drawing sheet.

The layout of the six views in first angle projection method is shown in Figure 3.7. The rear view may also be placed to the left-hand side of the right side view.

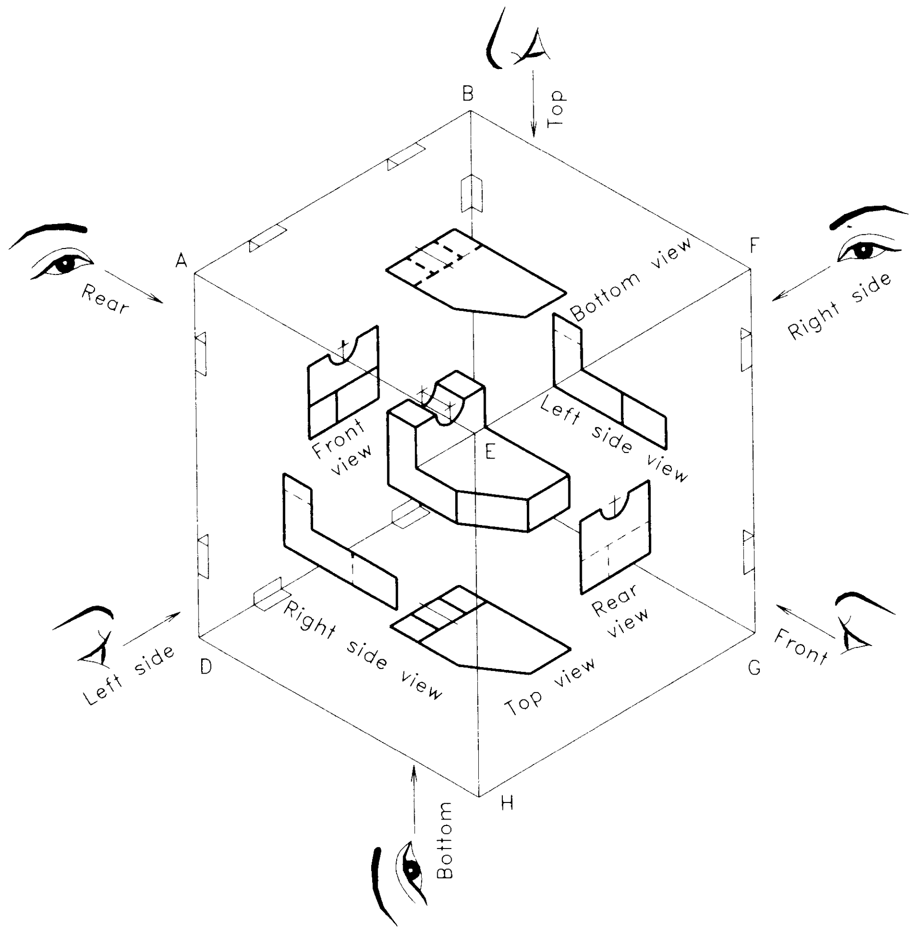


Figure 3.5 Transparent box containing an object (first angle projection).

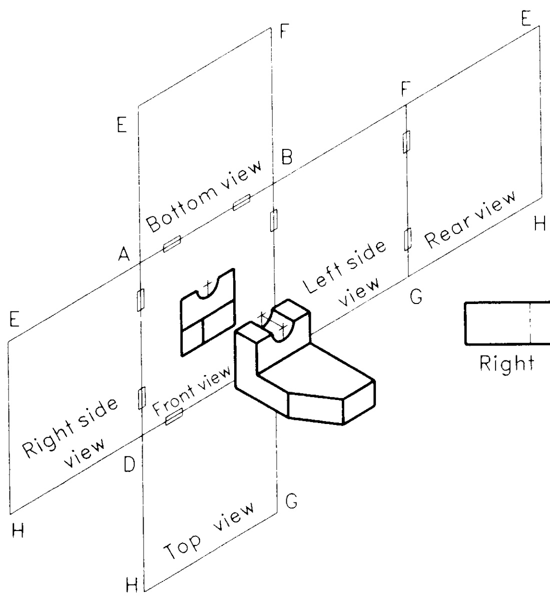


Figure 3.6 Opening of the transparent box (first angle projection).

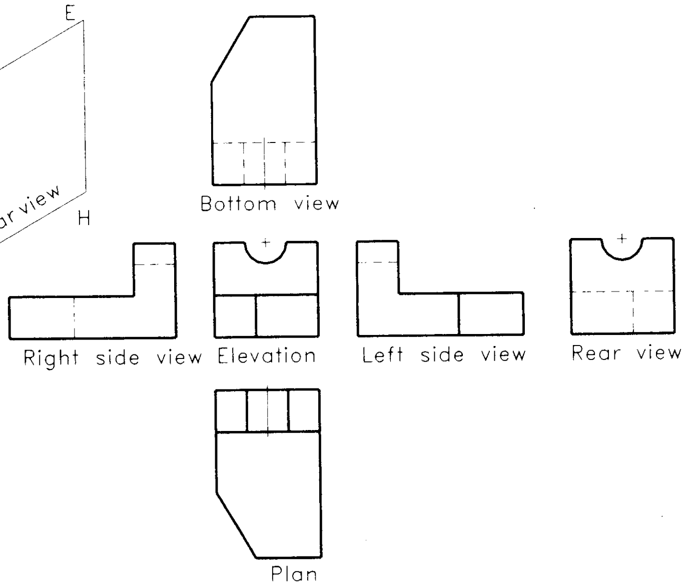


Figure 3.7 Layout of the six views (first angle projection).

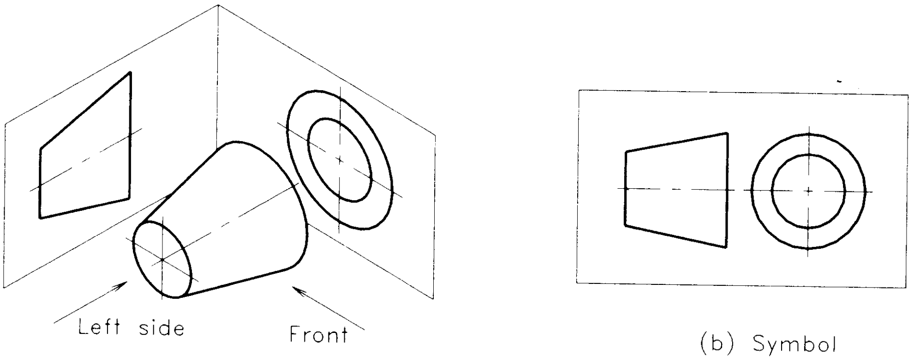


Figure 3.8 Symbol for first angle poojection.

3.5 INDICATION OF FIRST ANGLE PROJECTION

The method of projection used must be indicated inside the space provided in the title block of the drawing sheet. A distinguishing symbol is recommended by the Bureau of Indian Standards for this purpose. The front and left side views of a frustum of a cone lying with its axis horizontal, is used for this. The symbol for first angle projection is shown in Figure 3.8.

3.6 SELECTION OF MINIMUM NUMBER OF VIEWS

For describing the shape of an object completely by its orthographic views, it is necessary to select the number of views required and the proper combination of such views.

The number of views required for describing an object clearly and completely depends upon the extent of complexity involved in it. Based upon the number of views required, the drawings can be classified into the following categories:

1. One-view drawing
2. Two-view drawing
3. Three-view drawing

It may be noted that only minimum number of views, that will describe the object clearly and completely, should be drawn.

One-view drawing

Object having cylindrical, square or hexagonal features can be completely described by a single orthographic view. Such a drawing is called *one-view drawing*. Here, the features are expressed by a note or an abbreviation.

In Figure 3.9, the cylindrical part is indicated by the notation ϕ and the square part is indicated by the notation □. The square part is identified by drawing thin crossed diagonal lines on the feature. Plate of any size can be described by a single orthographic view. The thickness of the plate may be expressed by a note.

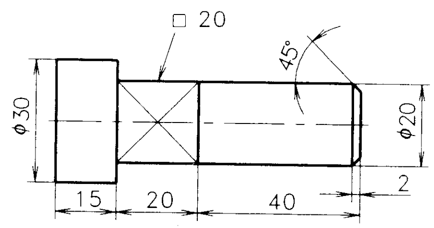


Figure 3.9 A pin (one view drawing).

Two-view drawing

Objects which are symmetrical about two axes can be represented clearly and completely by two views. Such a drawing is called *two-view drawing*.

The largest face, showing most of the details and having minimum number of hidden lines, is selected as the front view. The second view may be the top or the side view.

It may be noted that any two views will not be sufficient to describe an object completely. Proper combination of the views should be selected. Isometric views of three prisms and the plan of these prisms are shown in Figure 3.10(i). The front and top views of these prisms shown in Figure 3.10(ii) are not sufficient to describe them completely. But, the front and side views of these prisms describe the objects clearly and completely. Side views of the prisms are shown in Figure 3.10(iii).

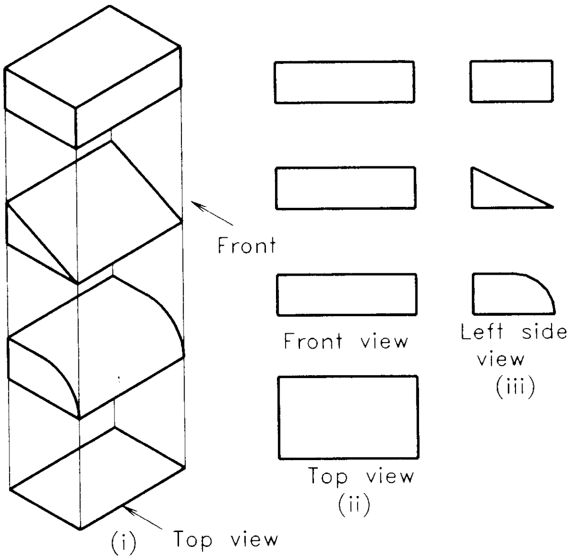


Figure 3.10 Two-view drawing of prism.

Three-view drawing

Most of the objects can be represented clearly and completely by three views. Such a drawing is called *three-view drawing*. The largest face showing most of the details is selected as the front view. Here, the object is placed in its functional position as far as possible and with the principal faces parallel to the planes of projection. A three view drawing of a cast iron block is shown in Figure 3.11.

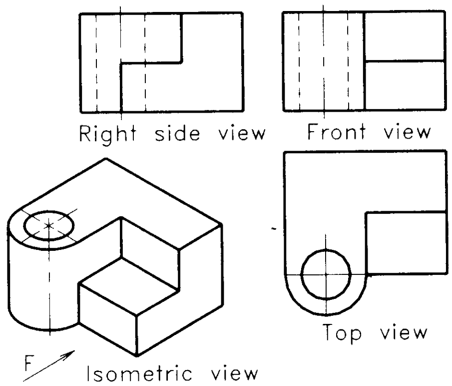


Figure 3.11 Three view drawing of a cast iron block.

3.7 USE OF LINE TYPES AND DIMENSIONING OF VIEWS

Orthographic views are drawn with proper line types as allowed by BIS. Figure 3.12 shows three orthographic views of an object drawn in first angle projection with proper line types and dimensioning. The pictorial view is also given for reference. The important points to be considered are given below.

Use of line types

1. The visible edges and all the outermost edges and surfaces are represented by continuous thick lines, i.e. Type A lines.

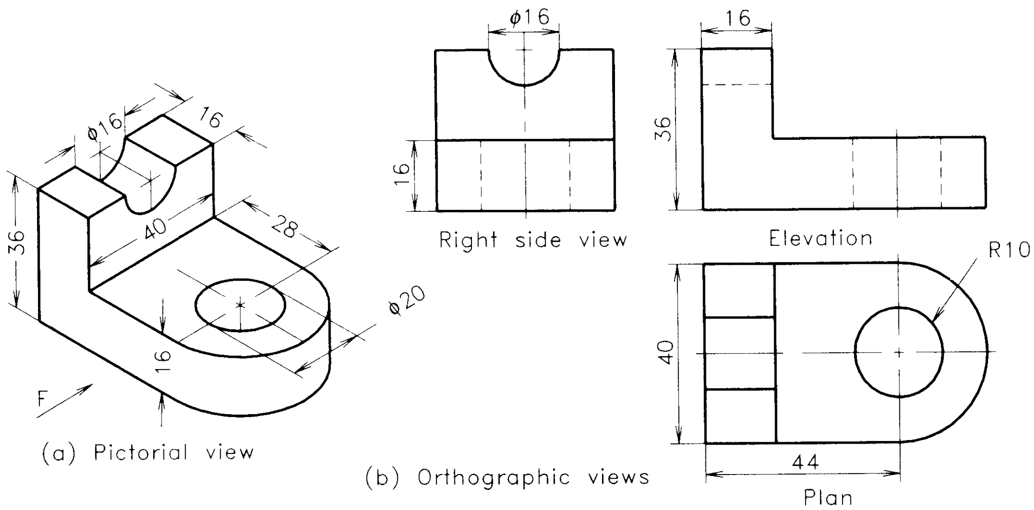


Figure 3.12 A machine part.

2. The hidden details are shown only if they are required. They are represented by short dashes using Type E or F lines. The method of drawing hidden lines and the rules for superimposing them are explained in Chapter 1.
3. Thin chain line (Type G) is used to represent centre lines and lines of symmetry.
4. Orthographic projections of machine parts generally have holes, circles, lines of symmetry, etc. Hence, the fixing of the view location and the further construction of shapes are progressed only after drawing all the important centre lines of the related views.
5. As a rule, a circular hole or projection should be drawn with the centre lines in horizontal and vertical directions. On a pitch circle, the hole centre is represented by the pitch circle drawn with chain line, and an intersecting radial chain line is drawn from the centre of the pitch circle.
6. Thin continuous line (Type B) is used for sketching views, section lines, construction lines and dimension lines.
7. Projection lines and reference lines are assumed to be invisible in the orthographic views of objects, even though they are compulsory for orthographic views of solids. It has to be noted that projection lines are not drawn, but the views and their details should lie in the exact alignment obeying the rules of projection.

Dimensioning of orthographic views

1. Dimensioning of orthographic views of objects is done by following Method–1, as described in Chapter 2.
2. The dimension lines are drawn using thin continuous (Type B) lines and the text is printed using thick single stroke letters as explained in Chapter 1.
3. The complete dimensional values have to be shown on the related orthographic views. They may be distributed in all the related views almost evenly.
4. Writing dimensional values on hidden details and over the view should be avoided.
5. There is no need of repeating a dimension, directly or indirectly. For example, the closing dimension has to be avoided if the total length is given.

3.8 PRINCIPLE OF VISUALIZATION OF OBJECTS

Visualization is the medium through which the details given in a drawing is translated to the reader, resulting clear understanding of the shape of the object. This ability of visualization is mainly governed by a person's knowledge of the principles of orthographic projection.

Reading a drawing can be defined as " The process of recognizing and applying the principles of orthographic projections to interpret the shape of an object from the orthographic views".

The method of visualizing shapes is illustrated in Figure 3.13. To understand the shape of the object, break down it into simple geometrical forms like prisms, cylinders, cones, etc. These shapes may be additions in the form of projections or subtractions in the form of cavities. By assembling them mentally, the final shape is obtained. Here, the rod support is formed by addition of three prisms and subtraction of three cylinders.

While analyzing an orthographic view, it may not be sometimes possible for a beginner to understand whether a part is an addition (projection) or a subtraction (cavity) at a

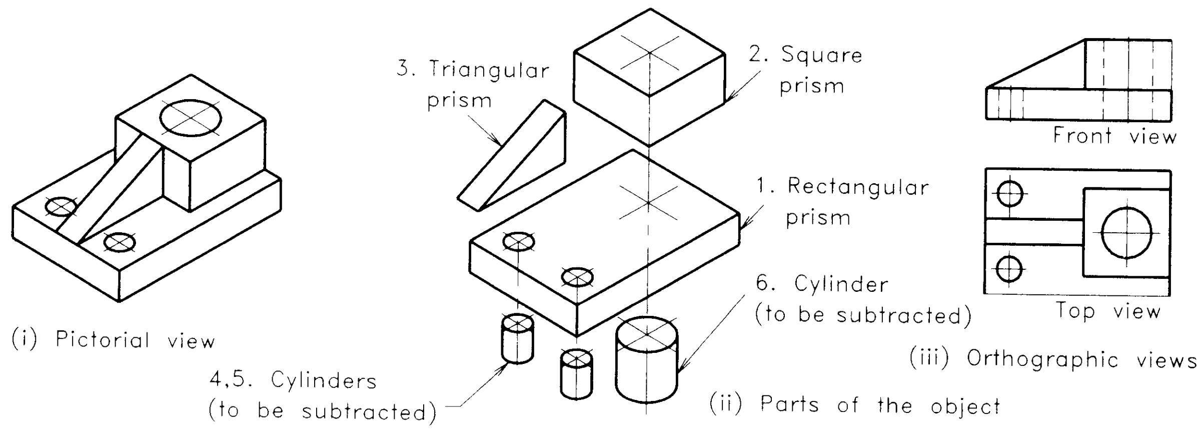


Figure 3.13 A rod support (breaking down method).

glance. He has to read patiently and systematically, all the related views back and forth several times. At the same time, the reader must imagine a three-dimensional object and not a two-dimensional flat projection. Thus, by a mental exercise, the three-dimensional shape of the object becomes clear to the reader.

The method of visualization

A drawing is read by visualizing the shape details one at a time. Similarly, each portion of the drawing is read and they are combined to interpret the whole object finally. The process of reading drawings can be grouped into two sections, such as reading of pictorial views and reading of orthographic views.

Pictorial views

Reading a pictorial view is rather easy and fast compared to orthographic drawings. But pictorial views cannot give full dimensional details, true shapes and other parameters related to geometry, especially when the object is complex. Hence, in engineering profession, pictorial views are used only to show the overall shape of the assembly or that of an individual part. Full details are marked generally on orthographic views. However, for simple objects, the details can be drawn on pictorial views also. The pictorial view may be isometric, oblique or perspective projections, depending on the requirement. The three surfaces (usually top, right and left) and the details on them are read one by one to visualize the object [see Figure 3.14(i)].

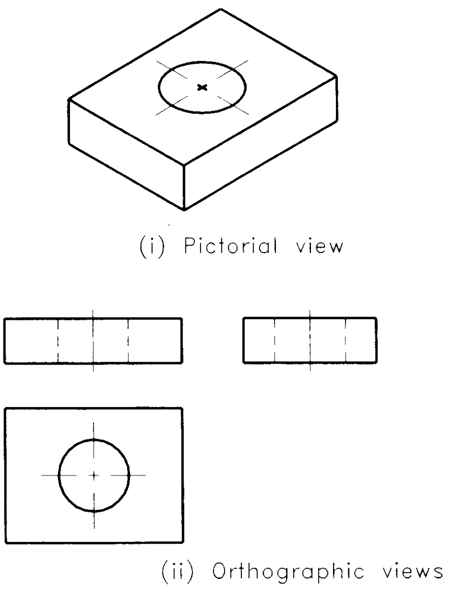


Figure 3.14 Visualization of a plate.

Orthographic views

Reading of orthographic views is primarily a reversal of the process of making drawings. For a beginner, the reading of orthographic views can be assumed as the formation of a pictorial view from orthographic views. Figure 3.14(ii) shows an example to this kind of reading. From the orthographic views, the pictorial view is shaped and sometimes sketched. Simple objects can be visualized in pictorial form, but for complex objects this is difficult.

Another method of reading is by recognizing the geometry of the solids forming the object. Figure 3.15 gives one set of front view, side view and 4 different shapes of top views. By reading the front and side views, the shape of the object may be recognized as a rectangular plate having a cut from the front side. The shape of the cut is fully understood by reading the top view. The possible different forms of cuts are shown as A, B, C and D, which are matching the front and side views. Now the shape is finalized mentally by the three-view combination. An experienced person reads the drawing within shortest time by going through the three or more views and analyzing the geometry of each part subconsciously. The reader shifts his eyes rapidly back and forth from the front view to the top view or side views and finalizes the shape in his mind.

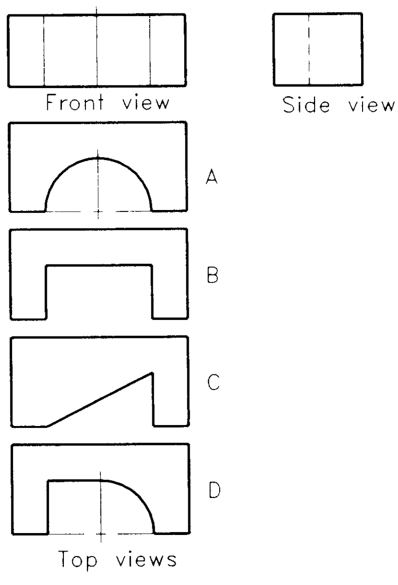


Figure 3.15 Different top views to suit a set of front and side views.

To visualize an object from orthographic views, the reader must have reasonable knowledge about the principles of orthographic projection. He must acquire a complete understanding of the meaning of various types of lines, areas, etc. Then he has to exercise the mental process of interpreting them. By reading different sets of orthographic views of simple to complex objects, one can become an expert in visualization.

The general procedure of reading orthographic views contains the following steps.

1. Obtain a general idea about the overall shape of the object and study the dominant features by referring all the related views.
2. Start reading the simpler individual features as well as the dominating ones. Preference may be given to familiar shapes and read them completely by noting the extend of hole, thickness of rib, etc.
3. After reading all familiar and simple features, start reading unfamiliar and complex features.
4. Note the relationship between individual parts and their way of joining. This is more relevant for assembly drawings.
5. Finally, read the details, specifications and similar minute informations. The areas which are found completed in first sight are read once again to make it clear and the reading process is completed.

Meaning of lines and areas in orthographic drawings

Engineering drawings of three-dimensional objects are prepared completely on two-dimensional drawing sheets by drawing lines and areas. Hence, the meaning of lines and areas should be clearly known to understand the graphic language.

Representation of a line

A line on a drawing may represent the following directional changes on an object:

1. An edge view of a surface
2. An intersection of two surfaces
3. A surface limit

An *edge view of a surface* is a line showing the edge of a surface which is perpendicular to the plane of projection. An *intersection of two surfaces* is a line. The intersecting surfaces may be of plane, curved or spherical shape. A *surface limit* is a line showing the reversal of direction of a curved surface.

Representation of an area: An area in a drawing represents the projected surface area of an object. If a surface of an object is perpendicular to the plane of projection, that surface area is represented by a line in the view on that plane of projection. The meaning of an area in a drawing can be understood only after analyzing the corresponding part in the other view or views.

The representation of an area in orthographic views can be grouped in the following ways:

1. Area parallel or perpendicular to the planes of projection
2. Area inclined to two planes of projection and perpendicular to the other
3. Area inclined to all the three planes of projection
4. A curved area, perpendicular to one of the plane of projection
5. A hidden area

The representation of hidden areas are similar to that of visible ones, but they are shown by short dashes. These areas may be sometimes confusing to read because the areas may overlap or even coincide with each other.

3.9 SUGGESTED DRAFTING PROCEDURE

To develop speed and accuracy in drawing, it is better to follow a certain order of drafting. All the instruments required for drawing should be placed at their proper locations in order to save time. The steps to be followed in making orthographic views are suggested below:

1. Decide the directions of the principal view (front view) and the combination of views such that it will best describe the object. Prepare freehand sketches of the required views of the given object [see Figure 3.16(i)] and mark the overall dimensions on these views.
2. Considering the number of views to be drawn, with their overall dimensions and the size of the drawing sheet being given, select a suitable scale. But in industrial practice, the size of the drawing sheet is to be selected according to the number of views, overall dimensions and the scale of the drawing. The scale should be selected without spoiling the clarity of the drawing.
3. Draw the border line and outline of the title block. Leave sufficient space in between the views and the border line of the sheet. Care must be taken to provide necessary space for printing dimensions, notes, etc. [see Figure 3.16(ii)]. As far as possible, provide equal space between the views for a better appearance.
4. Mark centre lines at appropriate places [see Figure 3.16(iii)].
5. As far as possible, draw the details simultaneously in all the views. The following order of priority may be preferred as:
   1. Circles and arcs

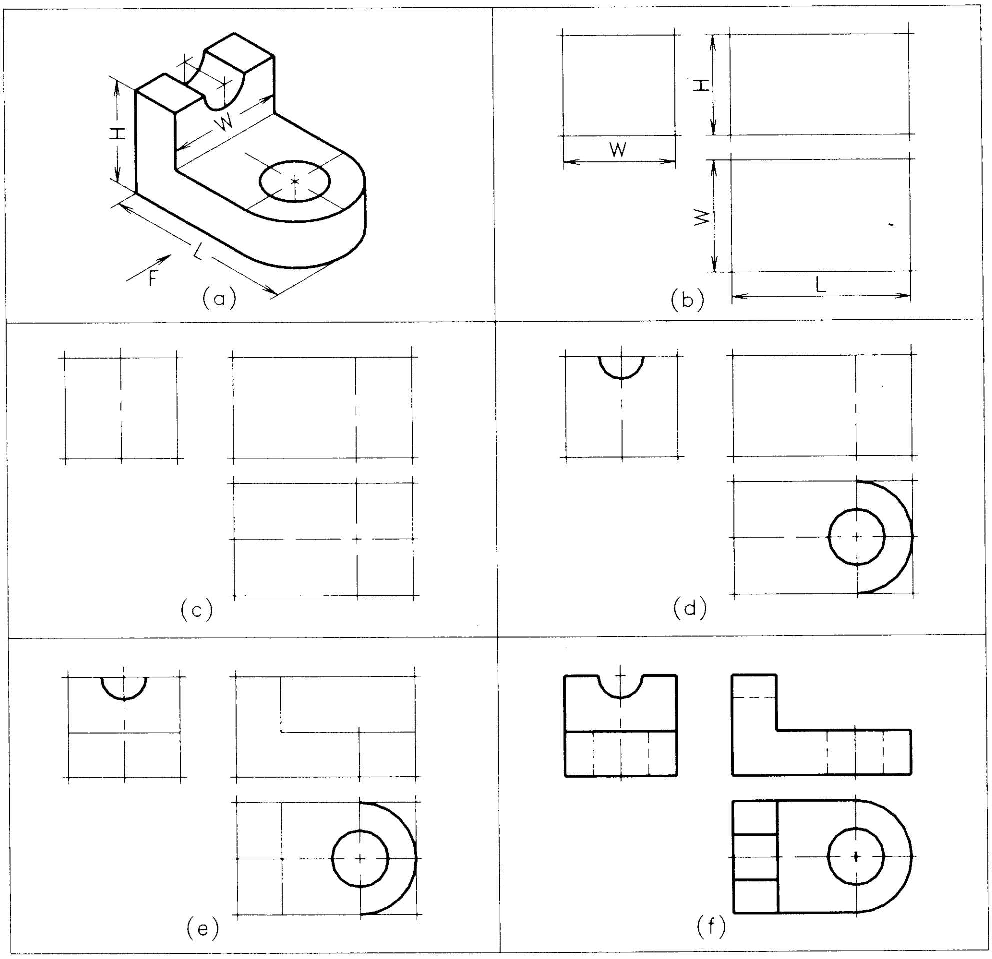


Figure 3.16 Drawing procedure for orthographic views.

2. Straight lines which form the major shape of the object
3. Straight lines, curves for the minor details like fillets, rounds, etc.

6. Draw all the details, except the hidden lines in all the views.
7. Erase all the unnecessary lines, construction lines, etc. Finish the drawing by thickening the appropriate lines.
8. Draw the hidden lines [see Figure 3.16(vi)].
9. Enter all the dimensional values, distributing them appropriately in all the views.
10. Draw section lines, if any.
11. Name the views if necessary. Also enter other data necessary for the completion of the drawing. Check the drawing carefully and see whether there is any missing dimension, details, etc.
12. Print the title block details.

Notes

1. Unless and otherwise specified, follow first angle projection method.
2. Symbol of the projection should be shown in the title block of the drawing sheet.
3. If third angle projection method is used along with first angle projection as a special requirement, it should be shown below the drawing by symbol or in writing.
4. Students are advised to name the orthographic views below them, until they develop the capacity to identify the views.
5. Projection lines and construction lines are not shown in orthographic views of objects.
6. Every circle should has two centre lines intersecting at the centre.
7. Axis of symmetry as well as axis of cylindrical holes, etc. should be drawn with the centre lines.

8. Choose a larger scale always for better clarity of views.
9. The hidden lines in a drawing should be minimised by orienting the object properly. Unimportant hidden details may be avoided, especially when the drawing is a complicated one.
10. While orienting an object for orthographic projection, the most important vertical face should be selected for the front view.
11. Front view is assumed to be the primary view for orthographic projection and all the remaining views are oriented in relation to the front view.
12. All the views should be drawn in the correct location with respect to front view as if there are projection lines. Shifted position of a view is assumed to be a spelling or grammar mistake, which will lead to wrong meanings in the graphic language.

3.10 VISUALIZATION OF OBJECTS FROM PICTORIAL VIEWS AND DRAWING OF ORTHOGRAPHIC VIEWS

A pictorial view shows three mutually perpendicular planes (faces), generally the top, left and right sides. An object can be fully understood by breaking down it into primary geometrical shapes. Then the three faces and their combinations for each part are identified for recognizing the visible and hidden surfaces. The following examples explain the visualization objects and the conversion to orthographic views.

Objects having plane surfaces

Objects having plane surfaces alone may have the surface parallel to, inclined to or oblique to the reference planes. Figure 3.17 shows simple examples to these type of surfaces.

Parallel surface

If a surface of an object is parallel to one of the reference planes of projection, the projection of the surface on that plane to which it is parallel will have its true size and shape. The projection of a surface which is normal to the plane of projection, is represented by a straight line.

Inclined surface

If a surface of an object is perpendicular to one of the principal planes and inclined to the other two principal planes, the projections of the surface to which it is perpendicular will be a straight line, inclined to the other two reference lines. The projections of the surface on the reference planes to which it is inclined will appear foreshortened.

Oblique surface

If a surface of an object is inclined to the three reference planes, the surface can be called as an *oblique surface*. If a surface is an oblique one, its projection will show areas on the three reference planes can be represented only by areas which will not give its true size and shape.

Example 3.1

An isometric view of a parallel key is shown in Figure 3.18. Draw its front, top and left side views. The direction of the arrow, *F* shows the front side of the key.

Refer Figure 3.19. Follow the procedure explained in Section 1.9 to get the views.

Example 3.2

Draw the front, top and right side views of the angle-bracket shown in Figure 3.20(i).

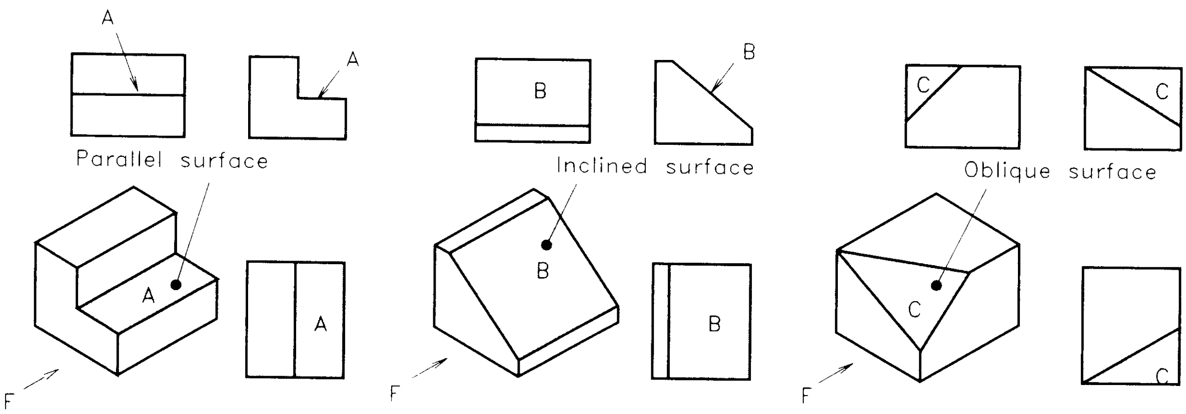


Figure 3.17 Objects having plane surfaces.

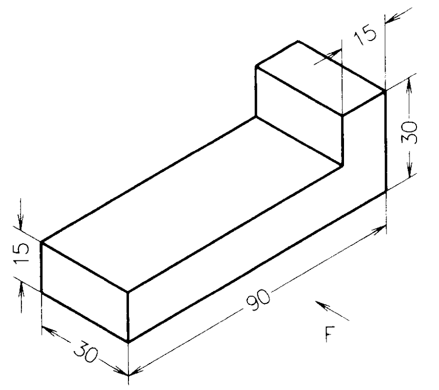


Figure 3.18 Parallel key (pictorial view).

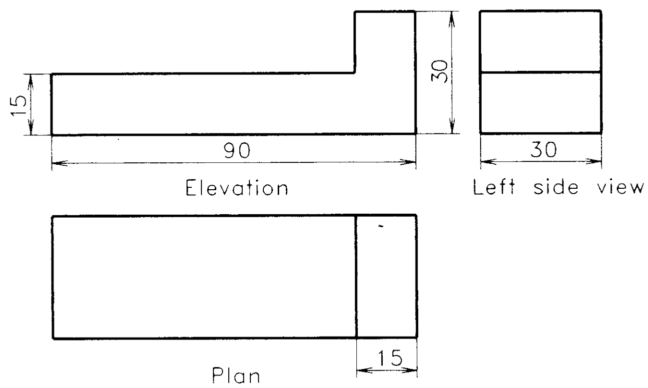


Figure 3.19 Parallel key (orthographic view).

Refer Figure 3.20(ii). Follow the procedure explained in Section 1.9.

Example 3.3

Figure 3.21(i) shows an isometric view of a rectangular block having an oblique surface. Draw the front view looking in the direction of *F*. Add the top and the right side views.

Refer Figure 3.21(ii). Follow the procedure explained in Section 3.9.

Objects having curved surfaces

Objects may have curved surfaces such as cylindrical external surfaces, cylindrical internal surfaces like holes, fillets and rounds in addition to the plane surfaces.

Cylindrical surfaces

If a curved surface of an object is perpendicular to one of the principle planes, its projection on that plane can be represented by a curved line, while its projection on the other two principal planes can be represented by two foreshortened areas. Consider a plate having a circular hole drilled in it. The top view of this hole, when the plate is kept horizontally, will be a circle but it appears to be rectangles in the front and the side views. In the top view, two mutually perpendicular

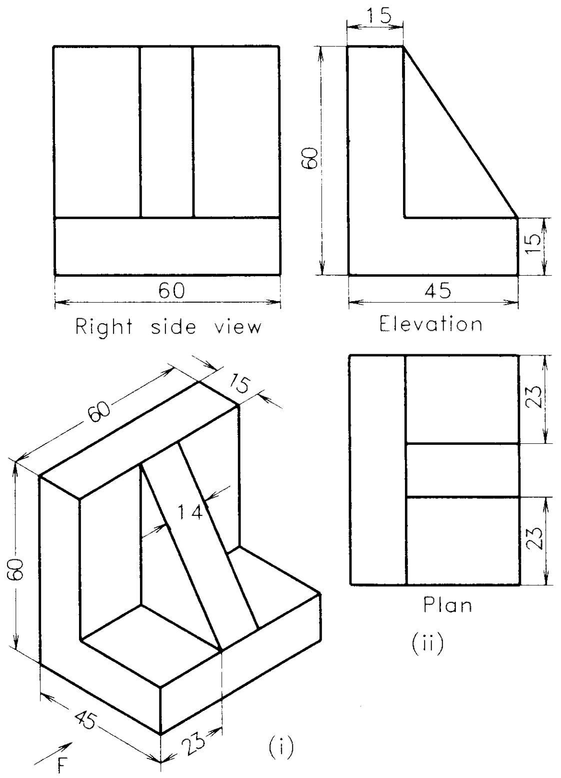


Figure 3.20 Angle-bracket.

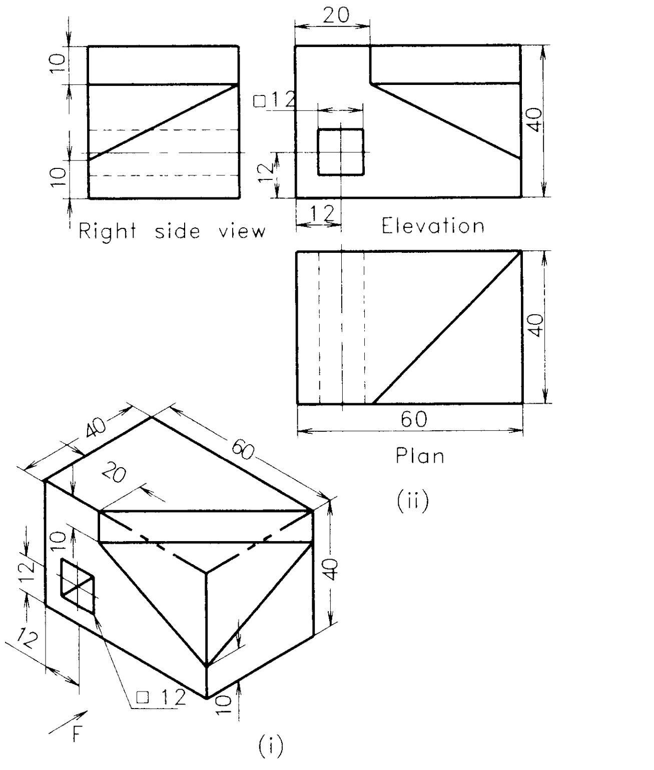


Figure 3.21 A block.

centre lines are shown to locate the centre of the circle and in the other view the axis of symmetry should also be marked as shown in Figure 3.22.

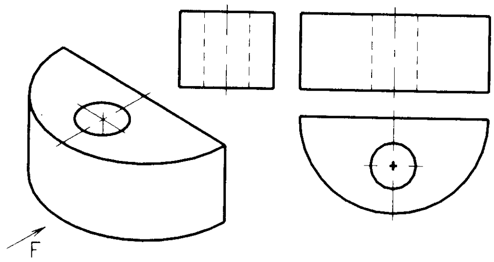


Figure 3.22 Cylindrical surfaces.

If the depth of the hole is not given, it is considered to be a through hole. Through *hole* is a hole which goes entirely through the object. If a hole is not a through one, it is called a *blind hole*. The depth of a blind hole should be clearly indicated.

Fillets and rounds

A filled-in interior corner on a casting is called *fillet*. Fillets are actually rounded internal corners or angles. Sharp interior corners are difficult to cast or forge and also they are weak. The radius of a fillet depends upon the thickness of the metal and other design requirements.

A rounded external corner on a casting is called *round*. External corners or angles are rounded for the appearance and comfort of persons who handle the casting.

Fillets and rounds actually prevent intersecting surfaces as they eliminate abrupt change in direction. This leads to certain problems in orthographic projections and the view becomes confusing (see Figure 3.23). To avoid this, lines are projected from approximate intersections.

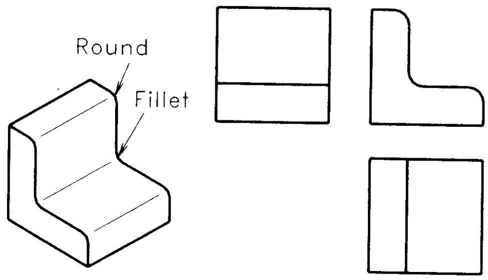


Figure 3.23 Fillets and rounds.

The radius of a fillet or round may sometimes be given on the view itself or as a general instruction. If the radius is not specified but the shape is shown in the given view, the radius may be assumed as 3 to 6 mm depending on the size of the object.

Example 3.4

Draw the three principal views of a cylindrical block shown in Figure 3.24(i).

Refer Figure 3.24(ii).

Example 3.5

Isometric view of a shaft support is shown in Figure 3.25(i). Draw the front view, looking in the direction of the arrow *F*. Also draw top and the side views. Use a suitable scale.

Refer Figure 3.25(ii).

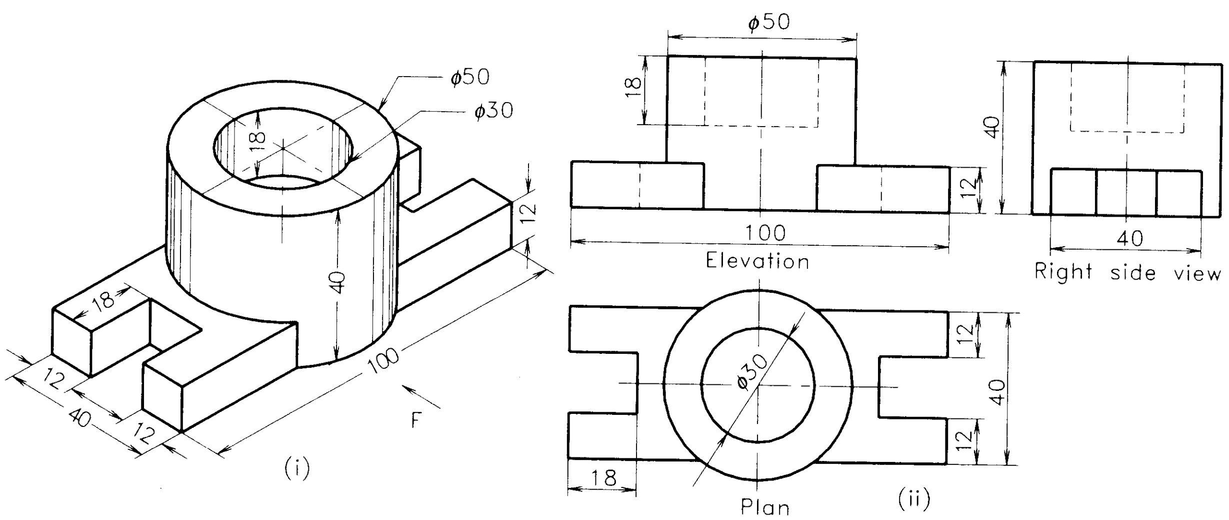


Figure 3.24 Cylindrical block.

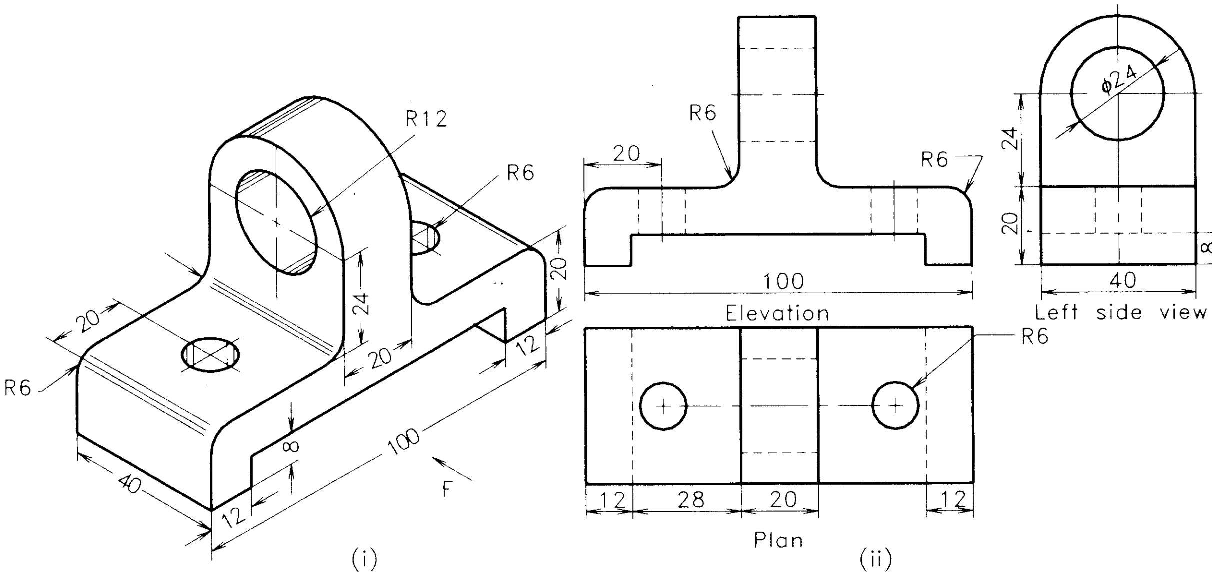


Figure 3.25 Shaft support.

Example 3.6

Isometric view of an object is shown in Figure 3.26(i). Draw the following views:

1. Front view, looking in the direction of the arrow *F*.
2. Top view
3. Side views from right

Refer Figure 3.26(ii).

Third angle projection of objects

In third angle system of projection, the object is assumed to be placed in the third quadrant and the views are obtained in the same side of viewing as explained in the Section 1.3. Except the change of position of views, there is no practical difference between first angle projection and third angle projection. In third angle projection, the top view is obtained on the top side of front view, the right side view is obtained on

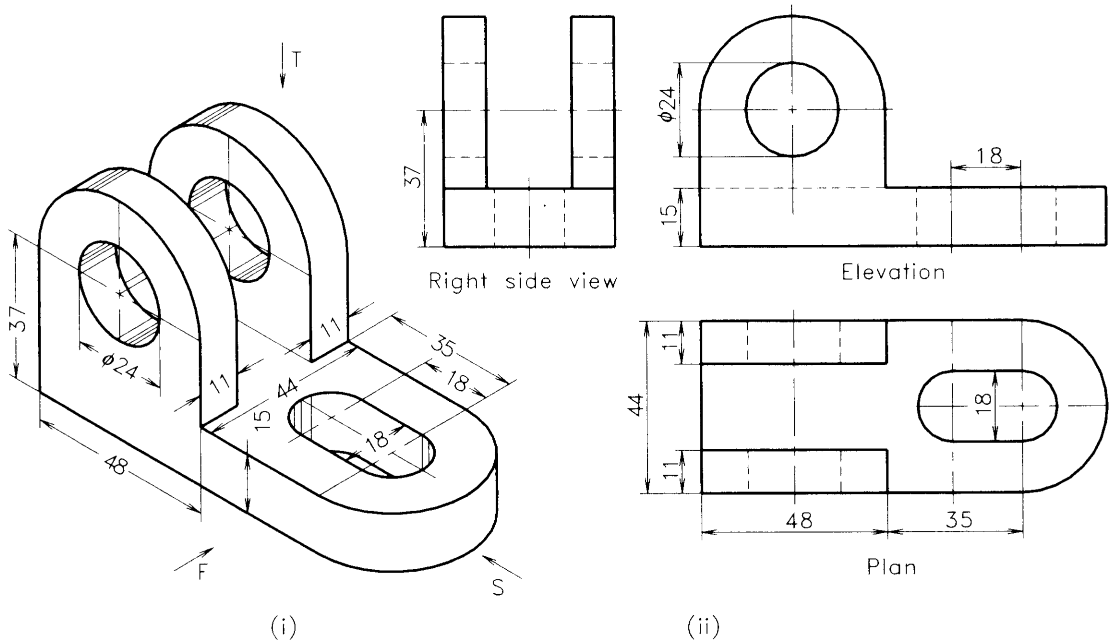


Figure 3.26 Bearing block.

the right side of front view, and so on. This difference may be noted in the following example.

Example 3.7

Draw the front, top and right side views of an adjustable rod support shown in Figure 3.27(i). Use third angle projection method.

Refer Figure 3.27(ii).

Draw the views as shown in figure, following the procedure explained above. Add an extra note "THIRD ANGLE PROJECTION" below the views.

3.11 AUXILIARY VIEWS

Auxiliary view is a projection obtained on the auxiliary plane when viewed in a direction perpendicular to the inclined surface. *Normal view* is another term used for this kind of projection. The method of projecting the view of the inclined surface of an object onto an auxiliary plane is similar to orthographic projection.

An auxiliary view is generally a partial view of an object showing only the inclined surfaces. A complete auxiliary view, showing the entire object, is not shown usually as it may result in a confused appearance of the view. The method of laying out an auxiliary view using reference arrows is shown in Figure 3.28.

Location of auxiliary views

If a view cannot be placed in its correct position, as per the angle of projection followed, Bureau of Indian Standards permits the following ways to layout the views (see Figure 3.29).

1. ***Special (full) auxiliary views:*** If the direction of viewing is different from those for the *six views*, or if the view cannot be placed in its correct position, reference arrows as shown in Figure 3.28 shall be used to indicate the view direction and the views shall be placed on the same side. Such views are grouped under the name special (full) auxiliary views.

2. ***Partial auxiliary views:*** These views may be used where a complete view would not improve the information to be given. Partial view shall be cut off by continuous thin freehand line or straight lines with zigzag.

3. ***Local auxiliary views:*** For symmetrical items, it is permitted to give a *local auxiliary view* instead of a complete or partial view. Local auxiliary view should be drawn in third angle projection, regardless of the arrangement used for the general execution of the drawing.

A local view shall be drawn with continuous thick line and shall be connected to the principal view by a centre line.

Auxiliary views thus coming under any one of the following types of views, namely special, full, partial or local auxiliary views. As directed by BIS, the auxiliary views are

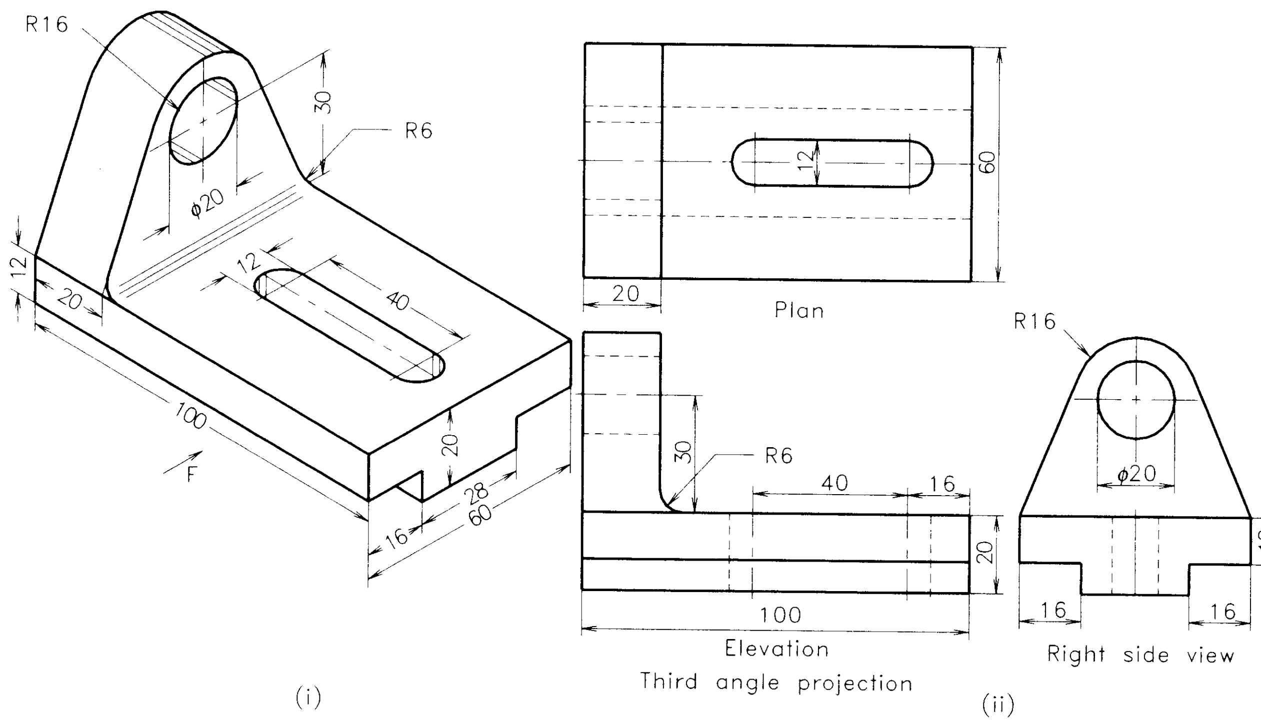


Figure 3.27 Adjustable rod support.

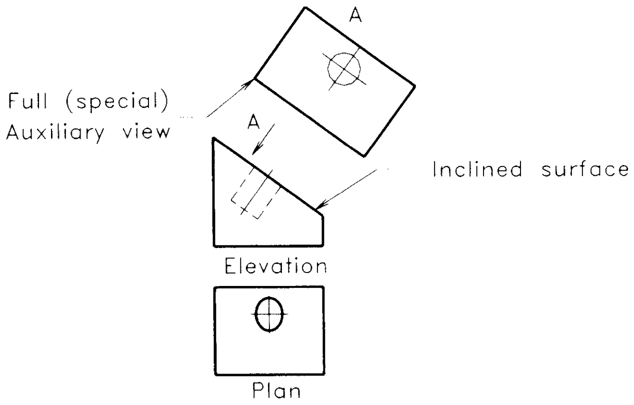


Figure 3.28 Auxiliary view.

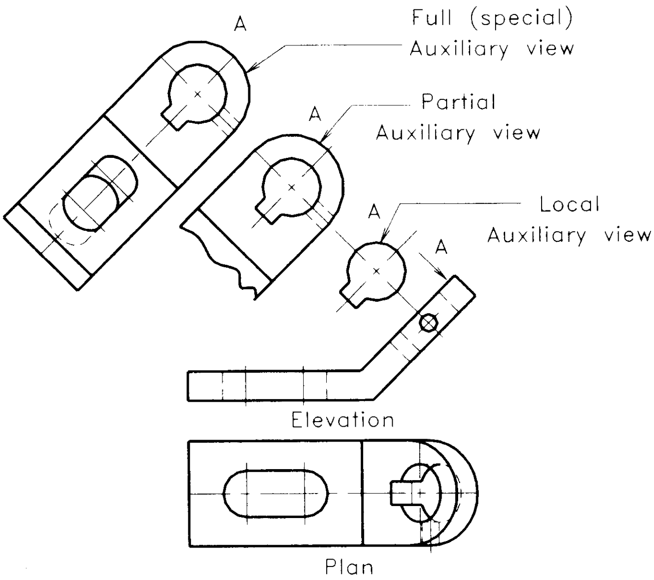


Figure 3.29 Local, partial and full auxilliary views.

placed near by the inclined face itself as shown in Figures 3.28 and 3.29. This follows the layout of auxiliary view in third angle projection. An arrow mark and a name to indicate the direction of viewing is also given.

Symmetrical auxiliary views

An auxiliary view may be symmetrical about a centre line drawn parallel to the trace of the auxiliary plane. For such objects, the view can be prepared by centre line method. The following examples explain the procedure in detail.

Example 3.8

Pictorial view of a machine block is given in Figure 3.30(i). Draw the front view, looking in the direction *F* and also the front auxiliary view of the sloping surface. Need not dimension the figure.

Refer Figure 3.30(ii).

1. Draw the front view of the clamp.
2. Since the sloping side is symmetrical about the centre line, draw the centre line CL, parallel to the inclined edge of front view.
3. Draw the front auxiliary view of the sloping surface after marking dimensions from the centre line.
4. Finish the views using proper line types.

Example 3.9

Pictorial view of a jig angle is given in Figure 3.31(i). Draw the front view, in the direction *F*, side view and side auxiliary view of the inclined surface. Need not dimension the figure.

Refer Figure 3.31(ii).

1. Draw the left side view and front view of the jig angle without the holes.

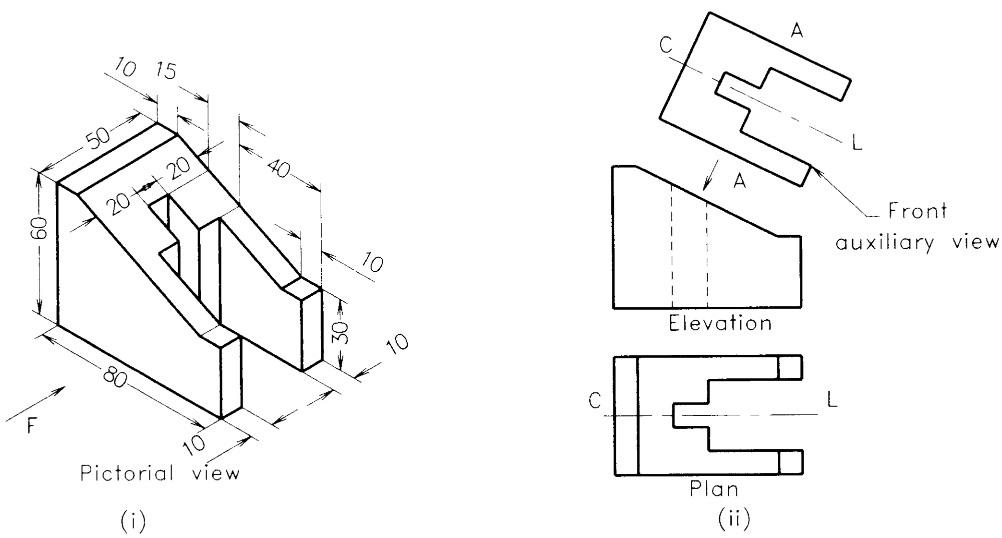


Figure 3.30 A maching block (front auxiliary view).

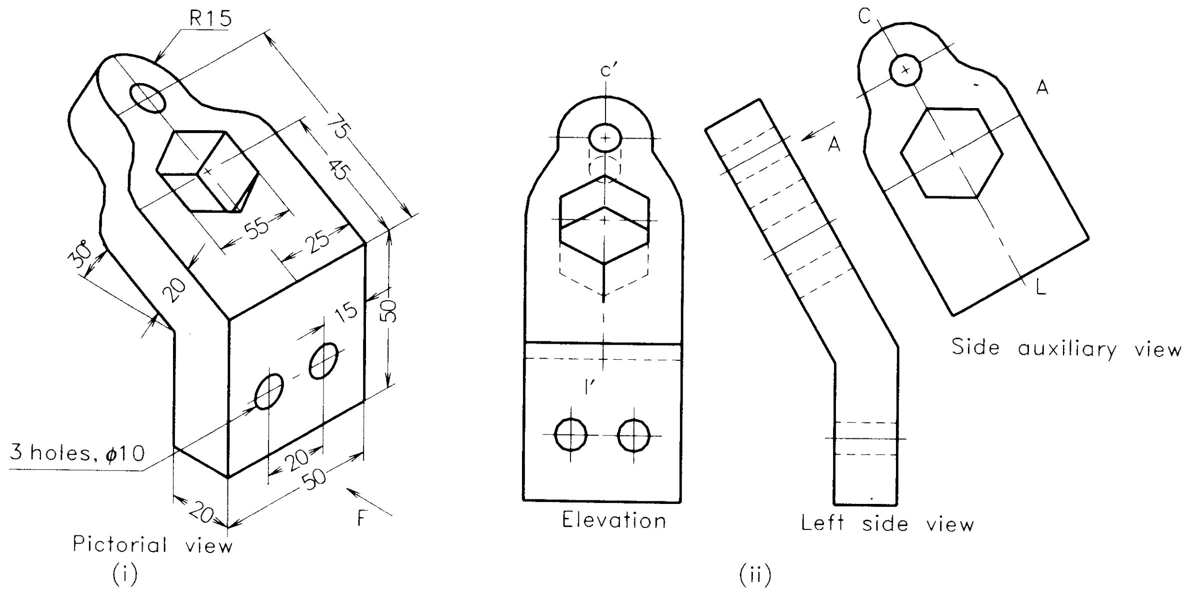


Figure 3.31 A jig angle (side auxiliary view).

2. From the side view, draw the side auxiliary view by centre line method.
3. Complete the side view of the holes and locate the position of the holes in the front view by drawing horizontal projectors.
4. Remove the projection lines, construction lines, etc. and finish the views.

Unsymmetrical auxiliary views

When an auxiliary view is unsymmetrical, reference line method may be used to prepare the auxiliary view. The following example explains the procedure in detail.

Example 3.10

Figure 3.32(i) shows the pictorial view of a machine part with an arrow showing the front side. Draw the front and top views of the machine part and add a top auxiliary view, showing the true shape and size of the sloping surface. Need not dimension the figure.

Refer Figure 3.32 (ii).

1. Draw the front view and then the top view, without details on the sloping surface.
2. Construct the front auxiliary view after marking the reference line RL.

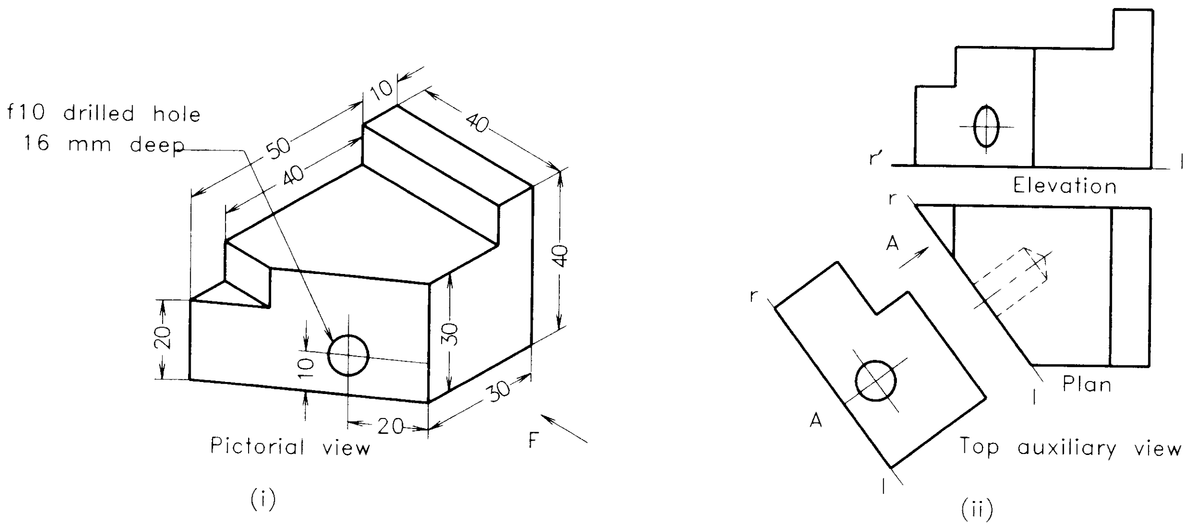


Figure 3.32 A maching part (top auxiliary view).

3. Mark the reference line RL as shown in the top view and transfer the dimensions from the auxiliary view to the top view, and then to the front view by the help of projectors.
4. Remove the construction lines and finish the views.

3.12 VISUALIZATION OF OBJECTS FROM ORTHOGRAPHIC VIEWS

Reading of orthographic views of an object and visualization of the shape can be practised by doing the following types of exercises.

1. Read the given orthographic views, visualize the shape fully, sketch a pictorial view of the object and mark the identification letters.
2. Read the given orthographic views, visualize the shape fully and fill the missing lines in the given orthographic views.
3. Read the given orthographic views, visualize the shape fully and add orthographic views which are not given.

Examples are given below for practice.

Example 3.11

Figure 3.33 shows 3 views of a block. Visualize the object and sketch an isometric view of the block. Identify the surfaces by marking alphabets on the respective surfaces on the pictorial view.

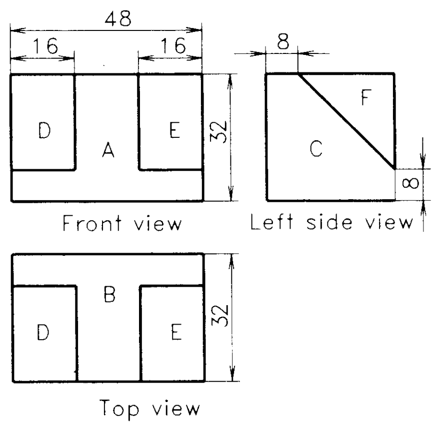


Figure 3.33 Visualization of an object from its orthographic views.

Refer Figure 3.34. Sketch the isometric view. Surfaces of the object are identified by marking alphabets on the respective surfaces.

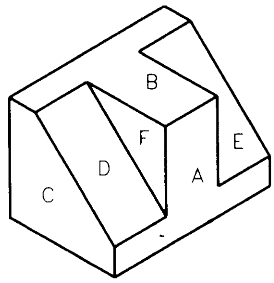


Figure 3.34 Pictorial view of an object (with alphabets marked on the surface)

Example 3.12

Figure 3.35 shows three orthographic views of a bracket with either a line or lines missing in a view. Read the drawing and copy the views after adding the missing line or lines.

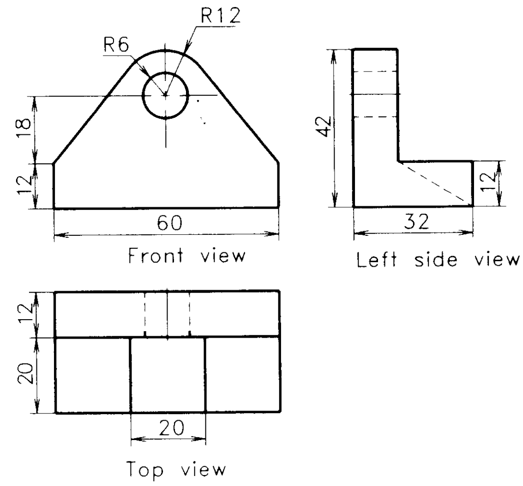


Figure 3.35 Orthographic views of a bracket (some lines are missing).

Refer Figure 3.36. Copy the views of the bracket after adding the missing lines as shown in figure.

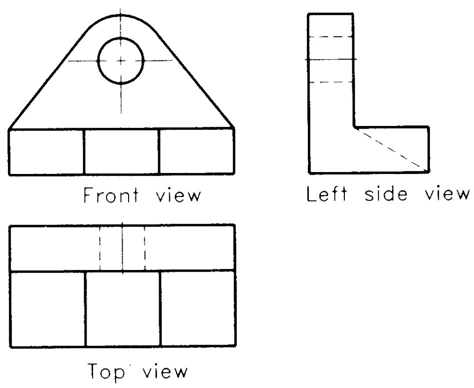


Figure 3.36 Orthographic views of a bracket (no line is missing).

Example 3.13

Two orthographic views of a block are shown in Figure 3.37. Visualize the object, copy the given views and add a view on the right side looking the object from left side.

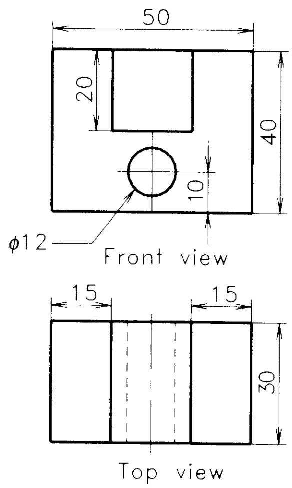


Figure 3.37 Two views of a block.

Refer Figure 3.38. Copy the given top and front views, visualize the object and understand the meaning of each area and line. By referring plan view, draw the side view as shown in figure. Finish the views after removing projection and construction lines.

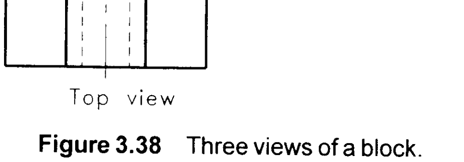


Figure 3.38 Three views of a block.

Example 3.14

Two orthographic views of a simple bearing is shown in Figure 3.39. Copy the front view, visualize the object and draw a side view looking from right side. Dimension the views.

Refer Figure 3.40. Copy the front view, visualize the object and understand the meaning of lines and areas. Project horizontally and mark the widths by measuring from the top view. Complete the view and print dimensions.

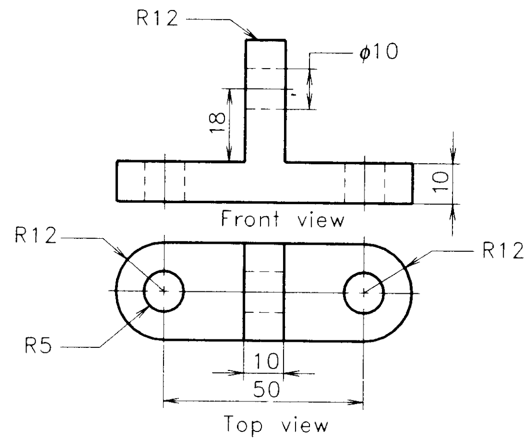


Figure 3.39 A bearing (front and top views).

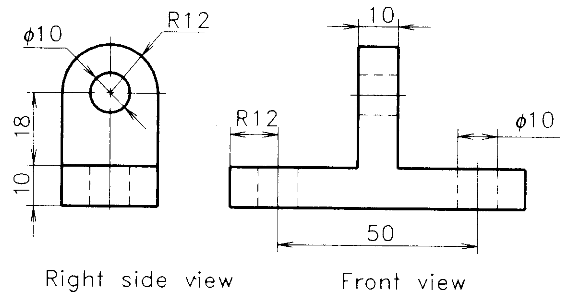


Figure 3.40 A bearing (front and side views).

3.13 CONVENTIONAL REPRESENTATION IN MULTIVIEW PROJECTION

In multiview projection of objects, simplification of drawing of views can be adopted depending on the shape of object, type of view, repetition of a feature, etc., without the expense of clarity of the drawing. The conventions followed as per BIS and the meaning of them are illustrated in the following subdivisions.

1. Intersections

Drawing of intersection of two parts of an object can be presented in any one of the following ways:

(a) *True intersections:* When the true geometrical intersection is drawn, the visible intersection line is represented by thick (Type A) line and the hidden one by short dashes. Refer Figure 3.41. The points of the curve have to be located by projecting the same from the related views.

(b) *Imaginary intersections:* Imaginary intersection lines (such as fillets or rounded corners) may be indicated in a view by means of continuous thin

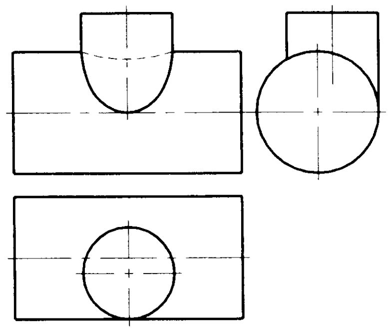


Figure 3.41 True intersection of cylinders.

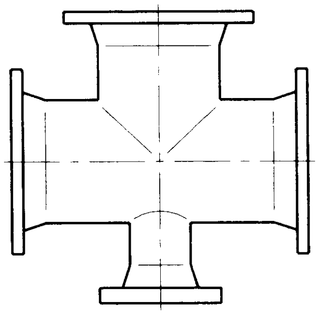


Figure 3.42 Imaginary intersection of cylinders and fillet.

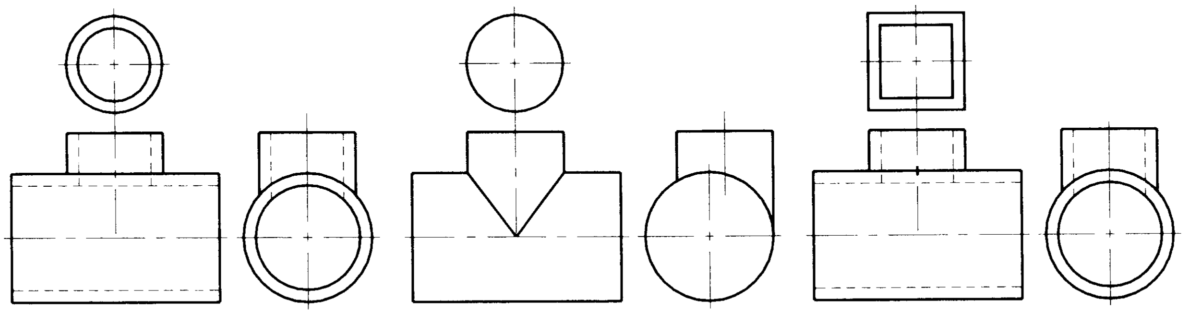
lines (Type B), not touching the out lines. Refer Figure 3.42.

(c) *Simplified representation of intersections:* Simplified representation of true geometric or imaginary intersection lines may be applied at intersections. Curved line of intersection between two cylinders is replaced by two inclined straight lines in Figure 3.43(ii) and between two cylindrical pipes are replaced by visible and hidden straight lines in Figure 3.43(i). When a square or rectangular pipe joins a cylindrical pipe, the displacement of straight line of intersection is omitted as shown in Figure3.43(iii).

As the difference in size between the intersecting parts increases, the simplified representation gives a better approach, provided that the axes of the intersecting parts are both mutually perpendicular and intersect, or nearly so.

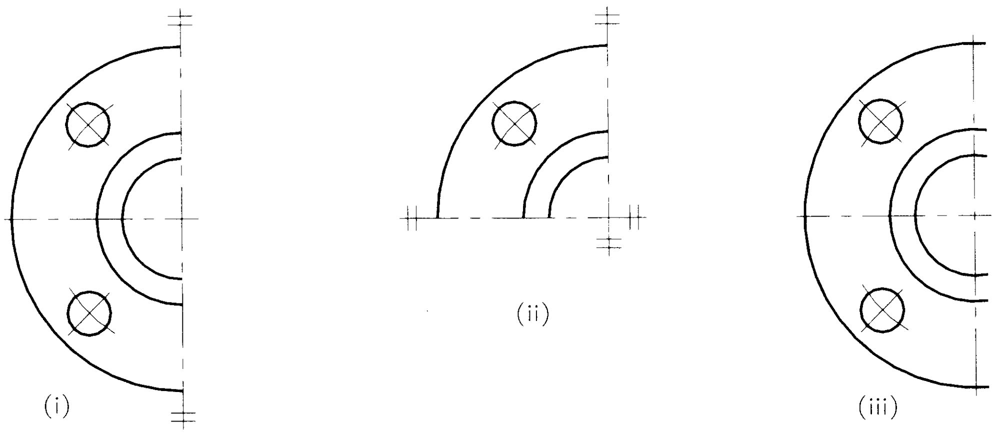
2. Views of symmetrical parts

To save time and space, symmetrical objects may be drawn as a fraction of the whole view such as half or quarter. Refer Figure 3.44(i) and (ii). The line of symmetry is identified at



(i) Two cylindrical pipe. (ii) Two cylinders (iii) Cylindrical and square or rectangular pipes

Figure 3.43 Simplified representation of intersecting parts.



(i) (ii) (iii)

Figure 3.44 Views of symmetrical parts.

its ends by two thin short parallel lines drawn at right angles to it. If the lines representing the object is extending a little beyond the line of symmetry, the short parallel lines may be omitted as shown in Figure 3.44(iii).

3. Interrupted views

In order to save space, it is permissible to show only those portions of a long object which are sufficient for its definition [see Figure 3.45(i) and (ii)].

4. Repetitive features

The presentation of repetitive features may be simplified as shown in Figure 3.46(i) and (ii). In the drawing the number and kind of repetitive features should be defined by dimensioning or by a note.

5. Square ends on shafts and rectangular openings

In order to avoid drawing a supplementary view or section, square ends or tapered square ends on shafts may be indicated by diagonals drawn using thin (Type B) lines [see Figure 3.47(i) and (ii)]. A rectangular or square opening on a flat part can be represented by drawing diagonals using thin (Type B) lines.

6. Adjacent parts

Adjacent part to the main object shall be shown with chain thin double dashed (Type K)- lines. See Figure 3.48. The adjacent part shall not hide the principal part, but may be hidden by the later.

7. Initial outlines

When it is necessary to indicate the initial outlines of a part prior to forming, the initial outline shall be drawn using Type K line (see Figure 3.49).

8. Use of colours

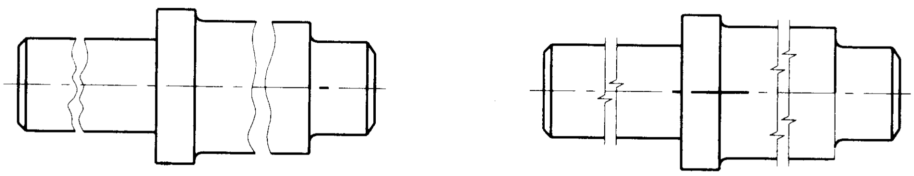
The use of colours on technical drawings is not recommended. If it is essential for clarity, their meanings shall be clearly shown on drawings.

Example 3.15

Pictorial view of Tee joint of a cast iron pipe is given in Figure 3.50(a). Draw the following multiviews:

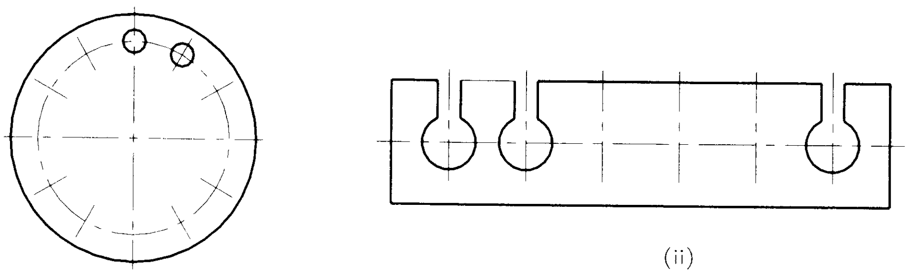
1. Elevation (with simplified representation of the intersection).
2. Plan (fraction view).
3. Side view (with simplified representation of the repetitive feature).

Refer Figure 3.50(b).



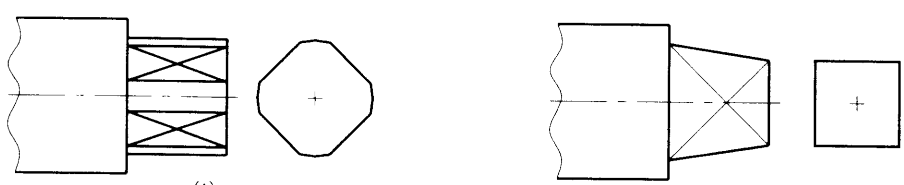
(i) (ii)

Figure 3.45 Interrupted views.



(i) (ii)

Figure 3.46 Repetitive features.



(i) (ii)

Figure 3.47 Square end of shaft.

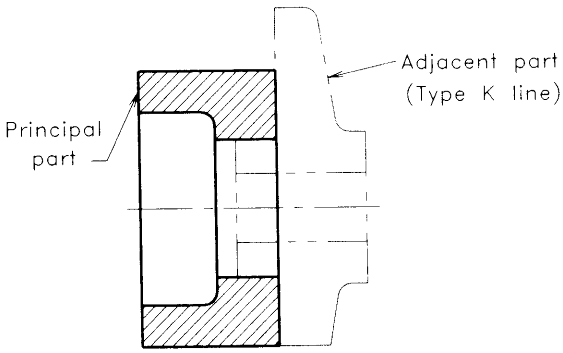


Figure 3.48 Adjacent parts.

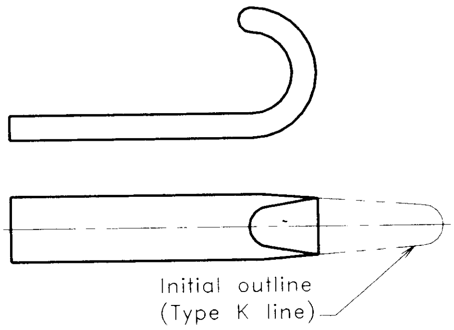


Figure 3.49 Initial outlines.

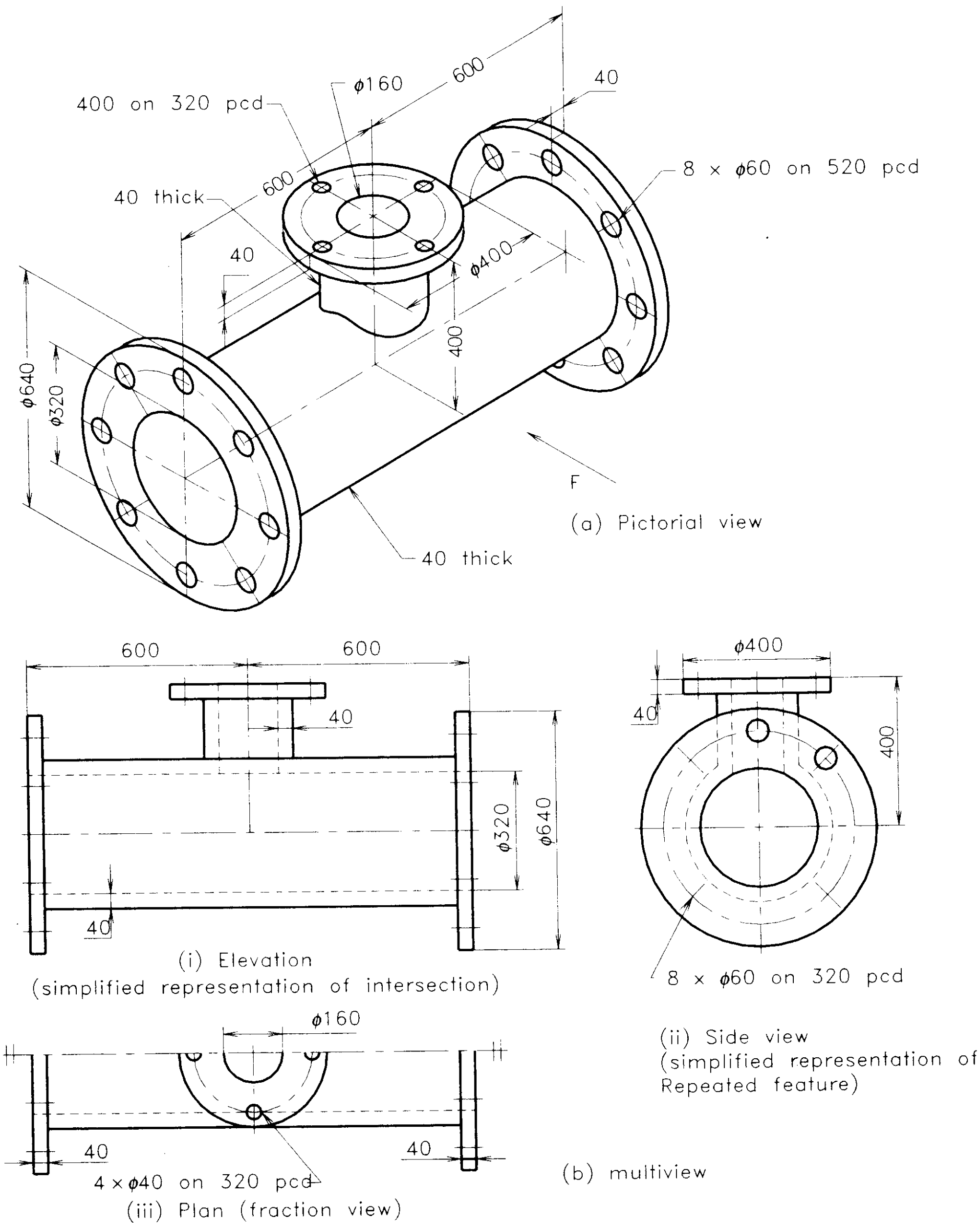


Figure 3.50 Tee.

SECTION A

Draw orthographic views (multiviews) of the machine parts given in pictorial form (see Figures 3.51 to 3.60).

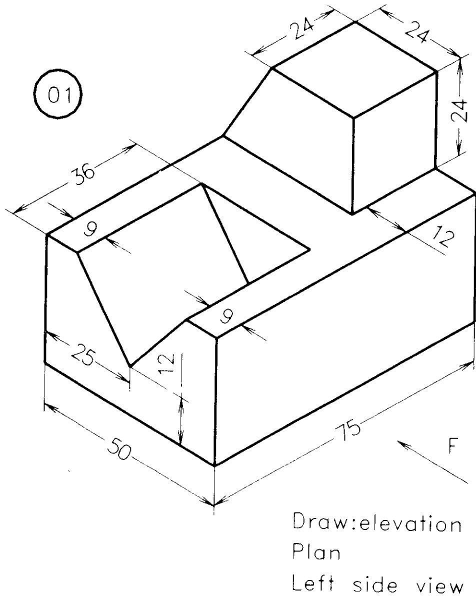


Figure 3.51 A block.

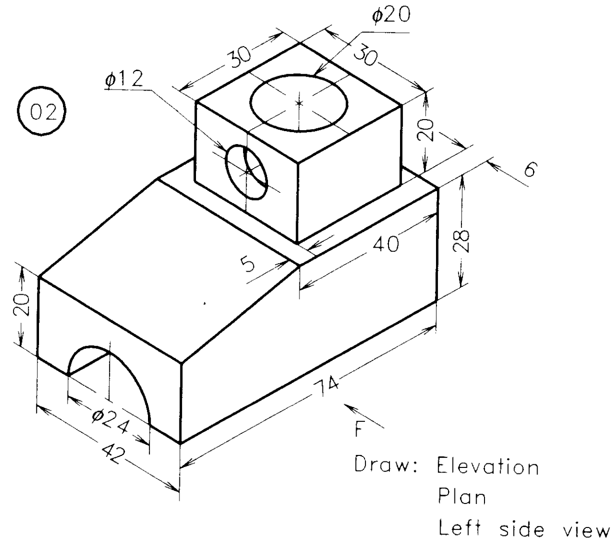


Figure 3.52 A machine part.

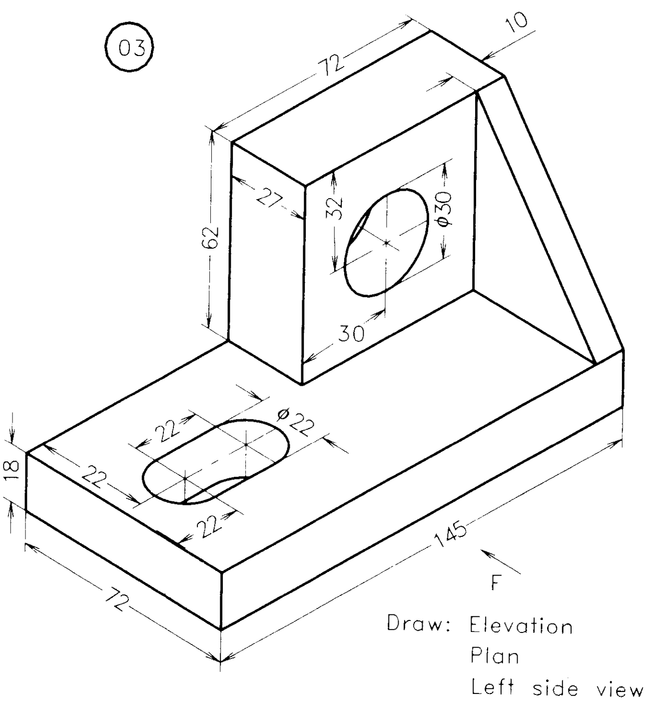


Figure 3.53 A rod support.

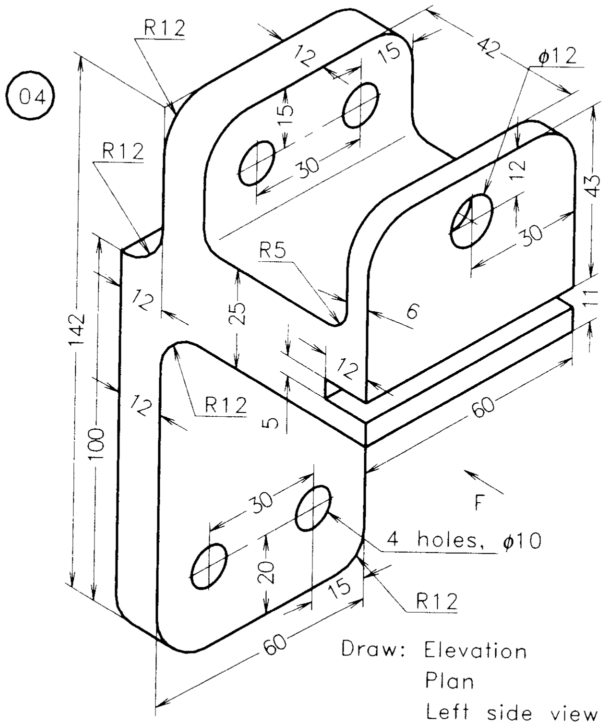


Figure 3.54 A bearing support.

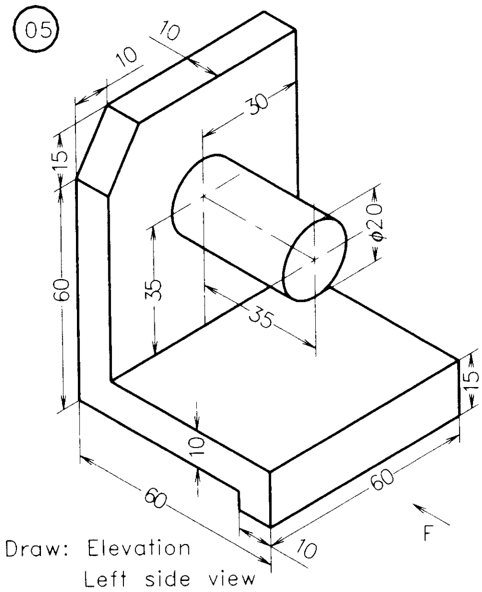


Figure 3.55 A machine part.

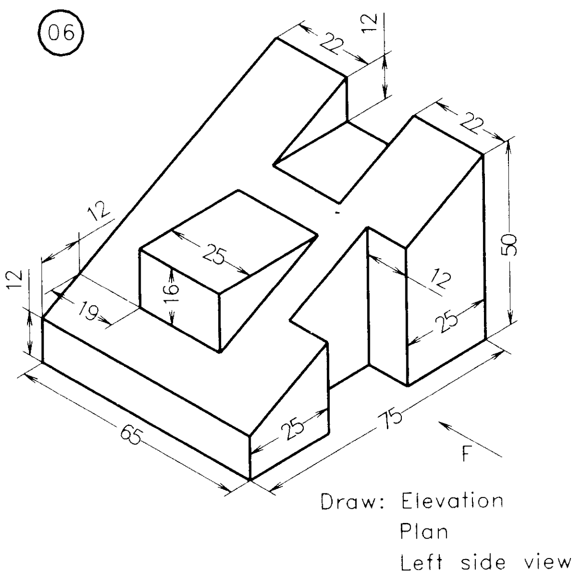


Figure 3.56 A machine block.

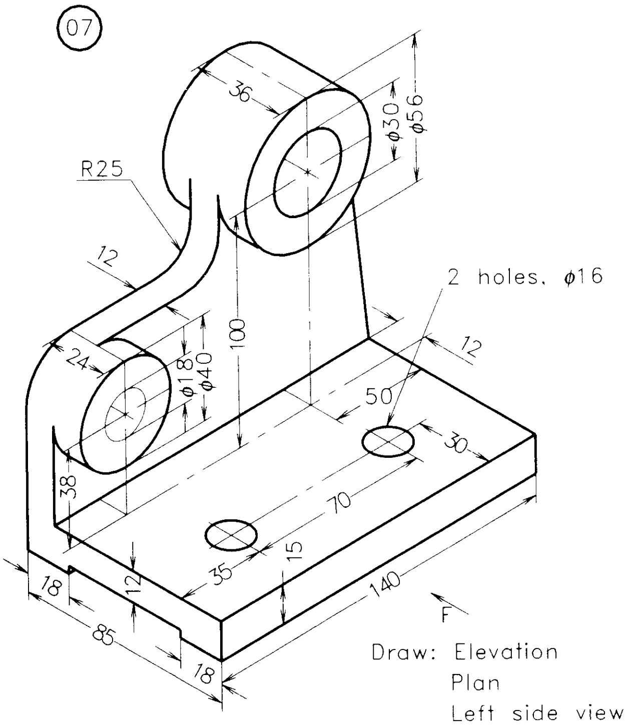


Figure 3.57 End bracket.

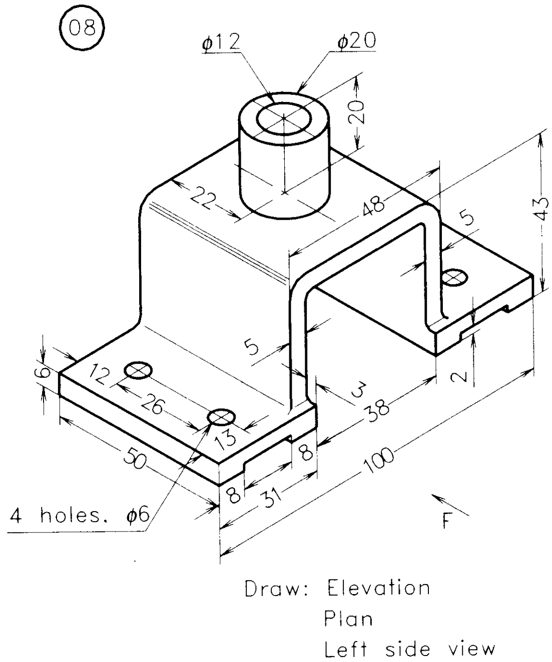
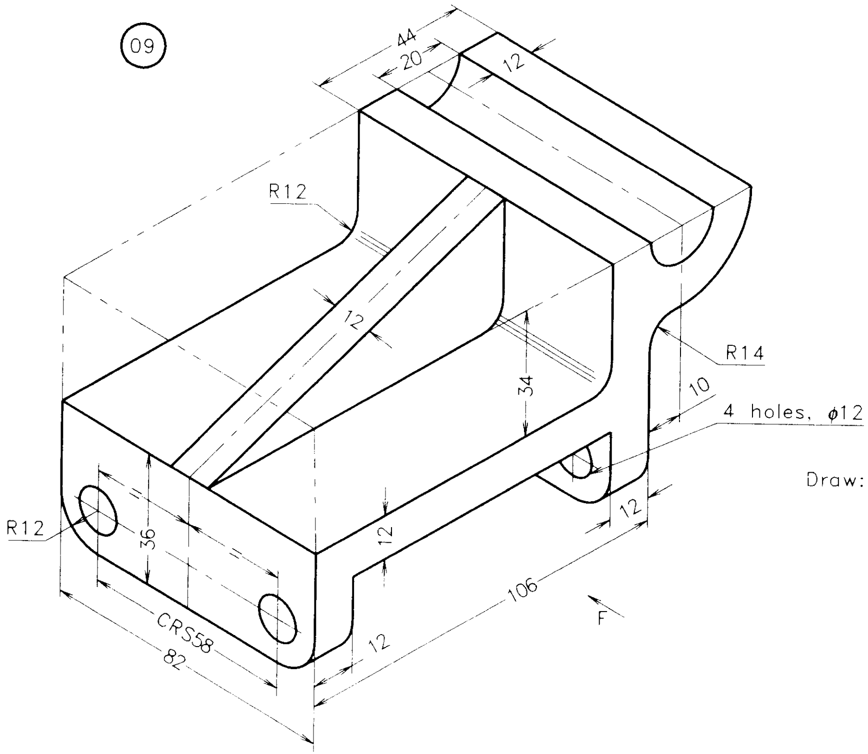


Figure 3.58 Rod support.

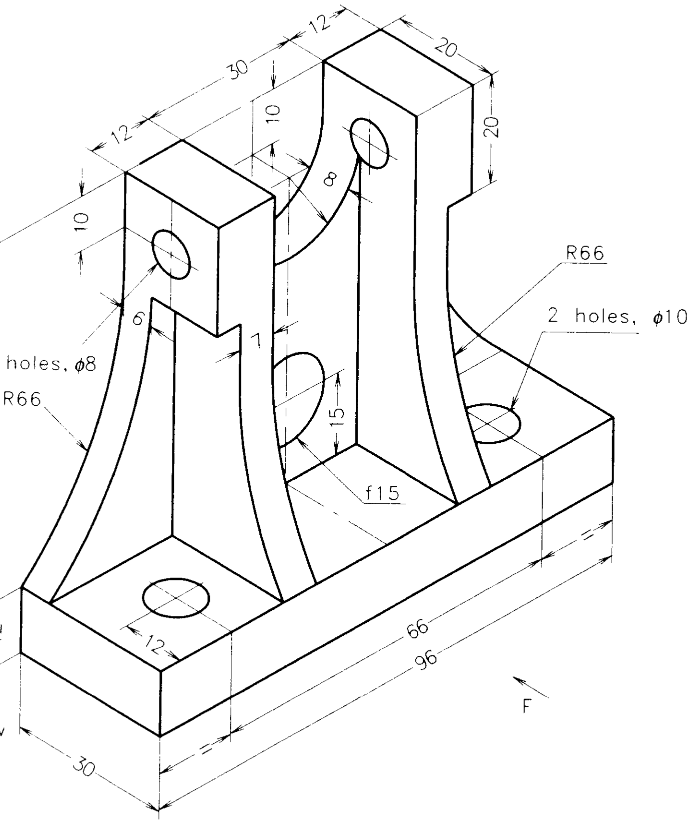
09



Draw: Elevation
Plan
Left side view

Figure 3.59 A rod support.

10



Draw: Elevation
Plan
Left side view

Figure 3.60 Bracket.