

CHAPTER 3

ORTHOGRAPHIC PROJECTION

3.1 *Introduction*

The purpose of mechanical engineering drawing is to indicate the shape and size of an object or a machine part. All objects have three dimensions such as length, breadth and height. The exact shape of an object may be produced with the help of projection. **Projection** is the process in which the rays of sight taken in a particular direction from an object to form an image on a plane called **plane of projection** or picture plane. The image on the plane is called the view of the object. There are various types of projections, such as orthographic, oblique and perspective depending on the direction of the rays of sight.

3.2 *Orthographic Projection*

When the rays of sight are made in a perpendicular direction to the plane of projection, it is called **orthographic projection**. The word orthographic is obtained from the Greek words: orthos, meaning straight, correct, at right angles to; and graphikus, meaning to write or describe by drawing lines. In the orthographic projection the observer stands in the infinite distance so that the rays of the sight appear to be parallel with each other theoretically (Figure 3.1). The perpendiculars, which are used to draw the view in the orthographic projection, are called the **projectors**. When a view is generated using perpendiculars from all the points of the object to the picture plane, it is called **orthographic view**.

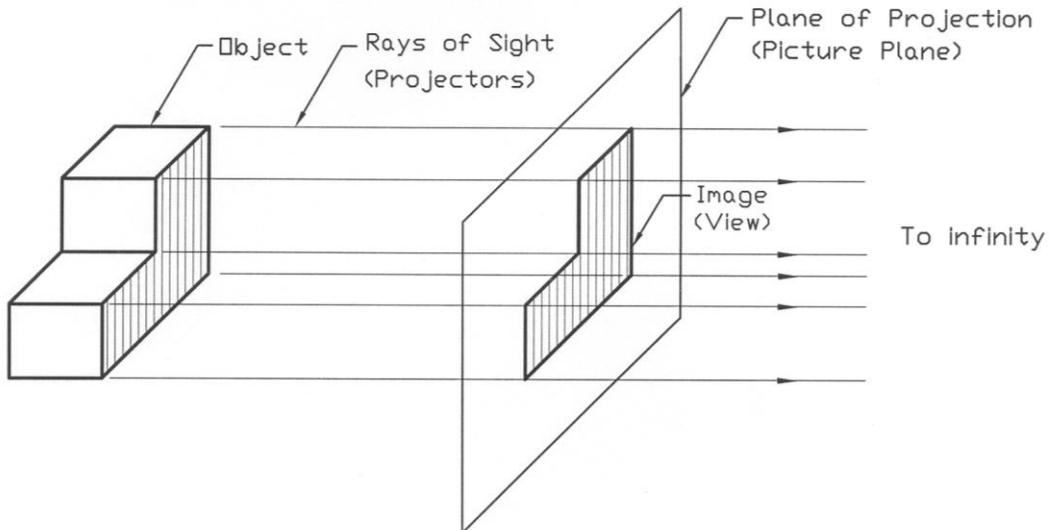


Figure 3.1: Orthographic Projection

In the oblique projection the rays of sight are parallel with each other but they are at an angle (not perpendicular) to the plane of projection. While in the perspective projection the rays of sight occur at an angle to the plane of projection but they are not parallel with each other, rather they converge to a point (Figure 3.2); as if an observer sees the image of the object on the plane of projection from his eye located at that point.

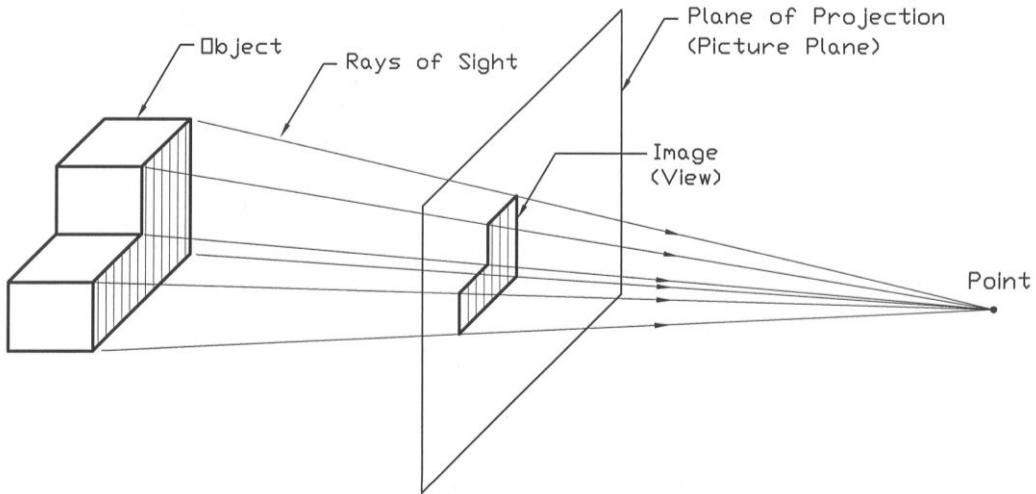


Figure 3.2: Perspective Projection

More than one plane may be required to represent the object completely. In that case the planes are positioned horizontally and vertically at right angles to each other. Total six possible views may be obtained such as, front, back, top, bottom, left and right sides. However, six views are rarely required. The number of views should be just sufficient to represent the shape of the object completely. For most of the objects, those adjacent views are necessary of which front view is the common one. Two views and sometimes one view may be good enough to represent an object completely.

3.3 Types of Projections

Orthographic projection can be produced in four different angles (known as dihedral angles), which are formed by horizontal, and vertical planes. The angles are shown in Figure 3.3. The first and the third angles are used only for the projection. First angle is used for the First angle projection while third angle is used for the Third angle projection. In Figure 3.4 the difference of first and third angle projections has been illustrated showing the relative positions of the observer, object and the picture plane. The object is positioned in the first quadrant for the first angle projection and in the third quadrant for the third angle projection. In order to eliminate the clumsiness, only one image for each projection has been taken into consideration in this figure.

The observer is located at infinity so that the rays of sight become parallel and fall in perpendicular direction to the picture plane. In the Third angle projection the picture plane is placed in between the object and the observer. On the other hand in the First angle projection the object is placed in between the observer and the picture plane. In Bangladesh usually the Third

angle projection is used. They are used in U.S.A., Canada and many other countries. On the other hand First angle projection is used in many European and other countries. However, only the Third angle projection will be taken into consideration throughout this book.

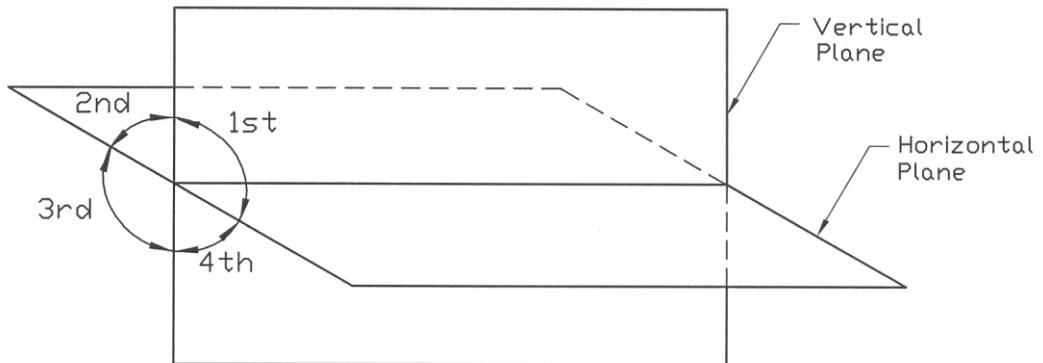


Figure 3.3: Four Different Angles

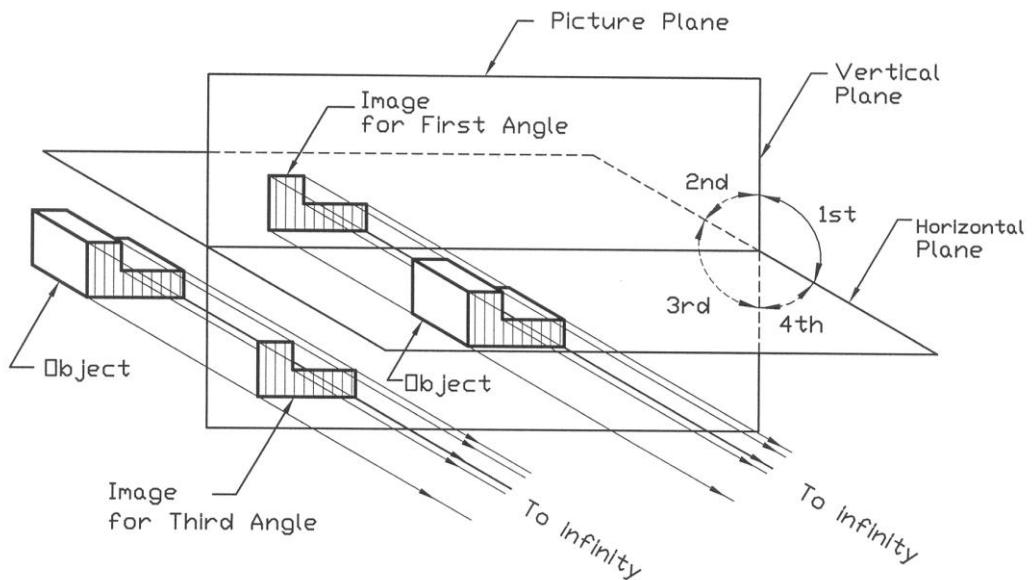


Figure 3.4: Difference Between First and Third Angle Projections

3.4 *Third Angle Projection*

The development of the Third angle projection has been illustrated in Figures 3.5 to 3.8. In Figure 3.5, a six-sided transparent box in the third angle projection has been shown. This transparent box with an object showing views on the various planes has been presented in Figure 3.6. There are six sides but here only four sides are considered to represent the object. The two other sides rear and bottom, have been omitted. The projection plane upon which the front view is projected is called

the frontal plane (a-b-c-d is the frontal plane) and that upon which the top view is projected is called the horizontal plane (d-c-g-h is the horizontal plane) as shown in the figure. While the projection plane upon which the side view is projected is called the profile plane (a-d-h-e is the profile plane).

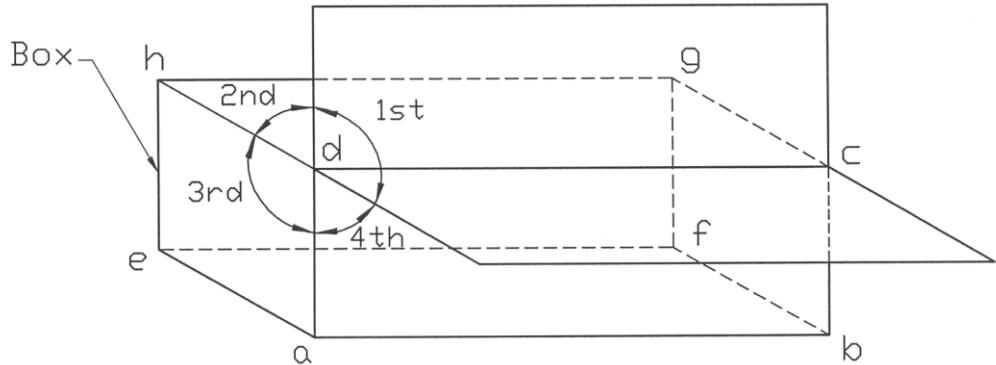


Figure 3.5: Six-Sided Transparent Box in Third Angle Projection

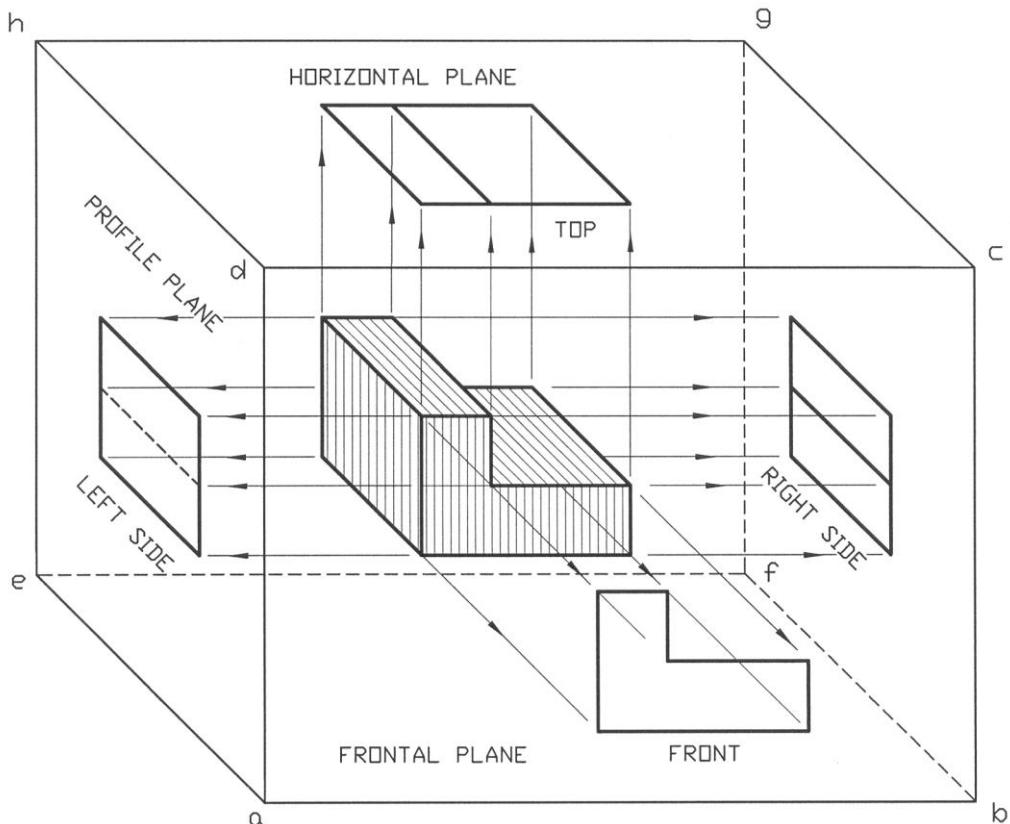


Figure 3.6: Views in Third Angle Projection

The process of unfolding the box has been shown in Figure 3.7. The views on the sides are also given here. In Figure 3.8 the relative positions of the views on the sides of the unfolding box have been provided.

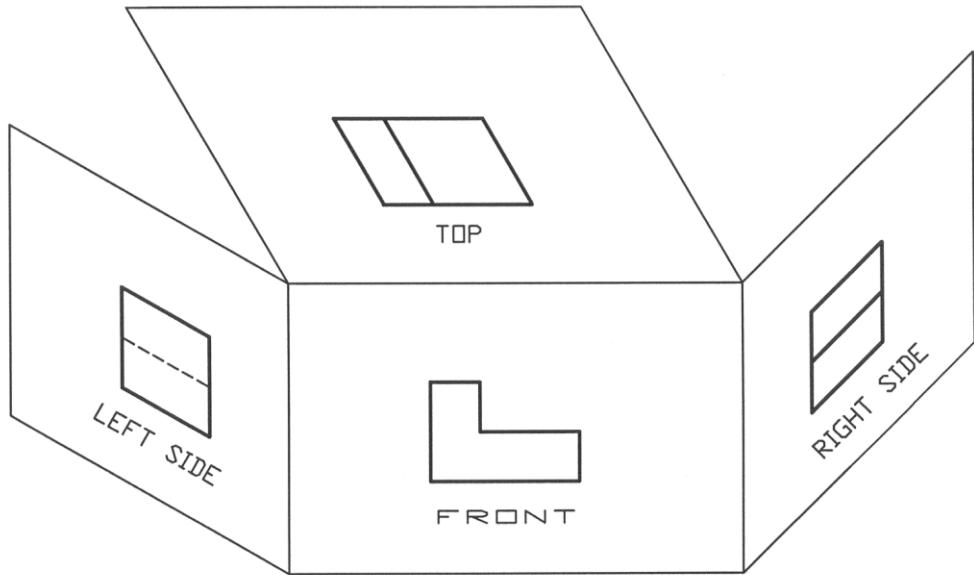


Figure 3.7: Views on Sides of Unfolding Box in Third Angle Projection

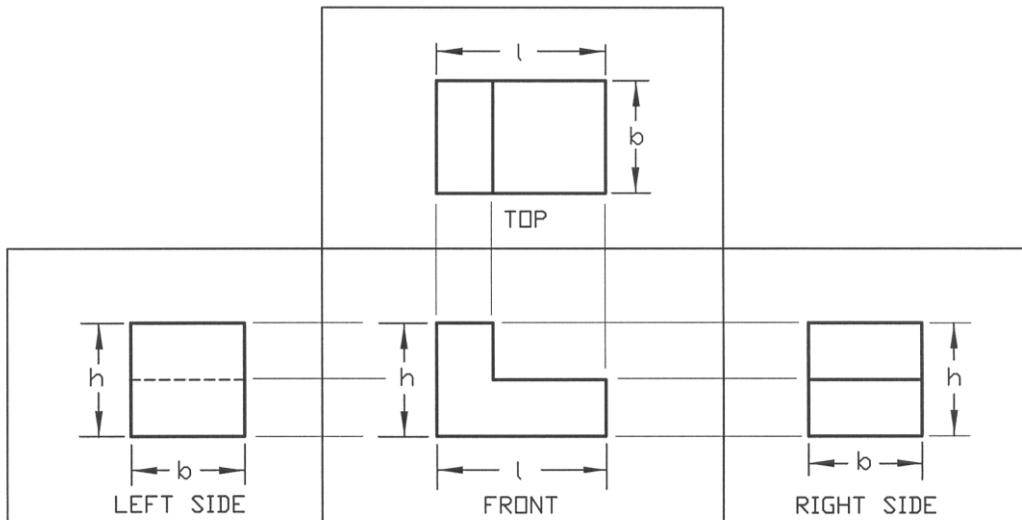


Figure 3.8: Relative Positions of Views on Sides of Unfolding Box in Third Angle Projection

3.5 First Angle Projection

The development of the First angle projection has been illustrated in Figures 3.9 to 3.12. The six-sided transparent box for the First angle projection has been shown in Figure 3.9. While an object showing the four views on the sides of the transparent box has been presented in Figure 3.10. In this figure front view is shown in the frontal plane (e-f-g-h is the frontal plane), top view in the horizontal plane (a-b-f-e is the horizontal plane) and side view on the profile plane (a-d-h-e is the profile plane). Views on the sides of the unfolding box in the First angle projection are given in Figure 3.11. On the other hand the relative positions of the views on the sides of the unfolding box have been shown in Figure 3.12.

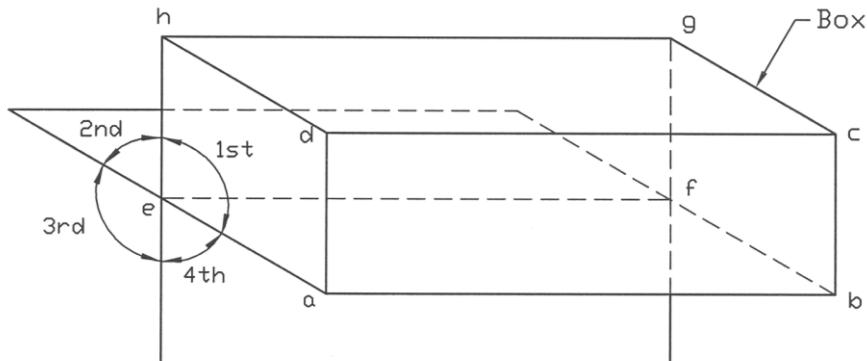


Figure 3.9: Six-Sided Transparent Box in First Angle Projection

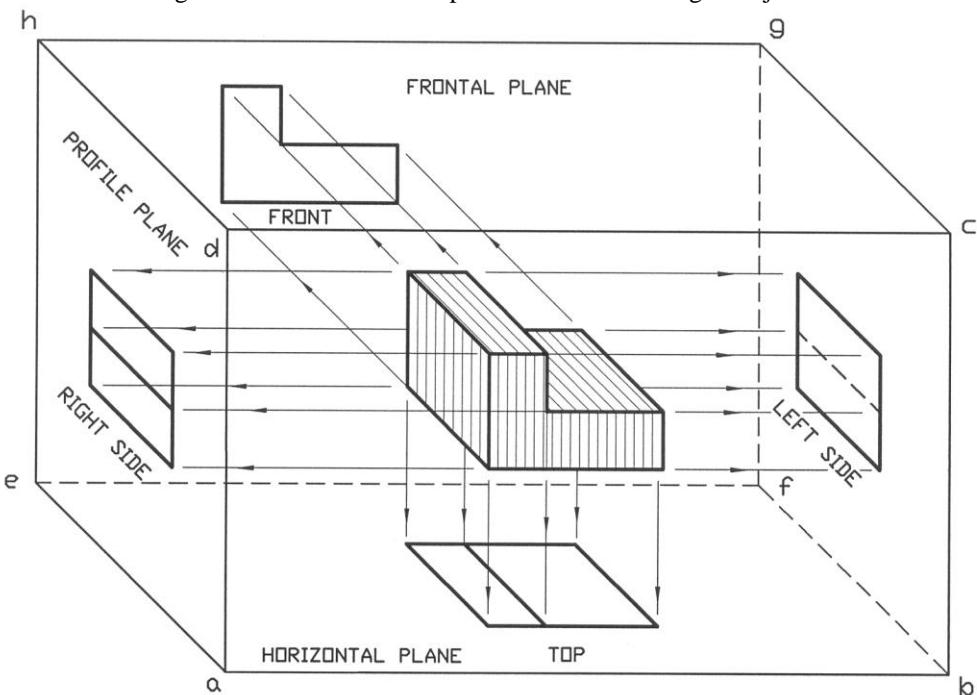


Figure 3.10: Views in First Angle Projection

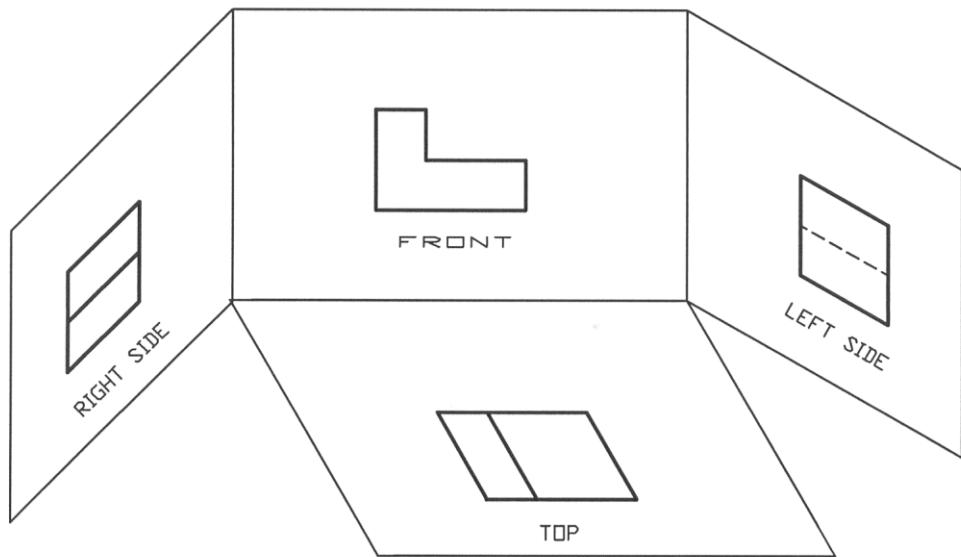


Figure 3.11: Views on Sides of Unfolding Box in First Angle Projection

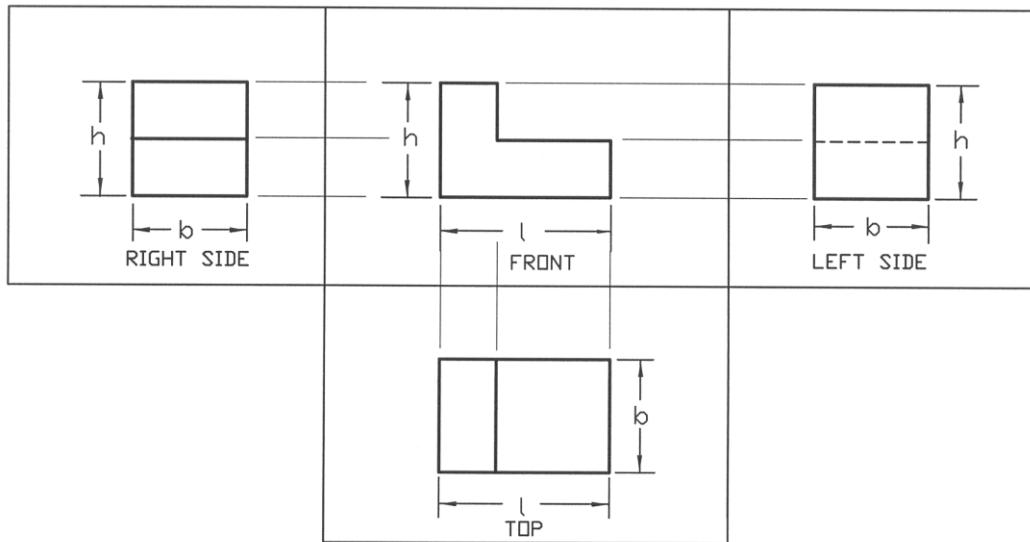


Figure 3.12: Relative Positions of Views on Sides of Unfolding Box in First Angle Projection

3.6 Method of Projecting Views

There are several methods of projecting views in the orthographic projection, which are shown in Figures 3.13a to 3.13d. In the projection there is a relationship of the different views. It is usual

practice to draw the front view first, then the top and side views are drawn in reference to the front view with the help of the vertical and horizontal projection lines. This can be done using T-square, triangles and compasses when drawing is performed manually. In making projection lines as shown in Figure 3.13b it requires to use the compass in addition to T-square and triangles. The projection lines between the different views have been shown in Figure 3.13.

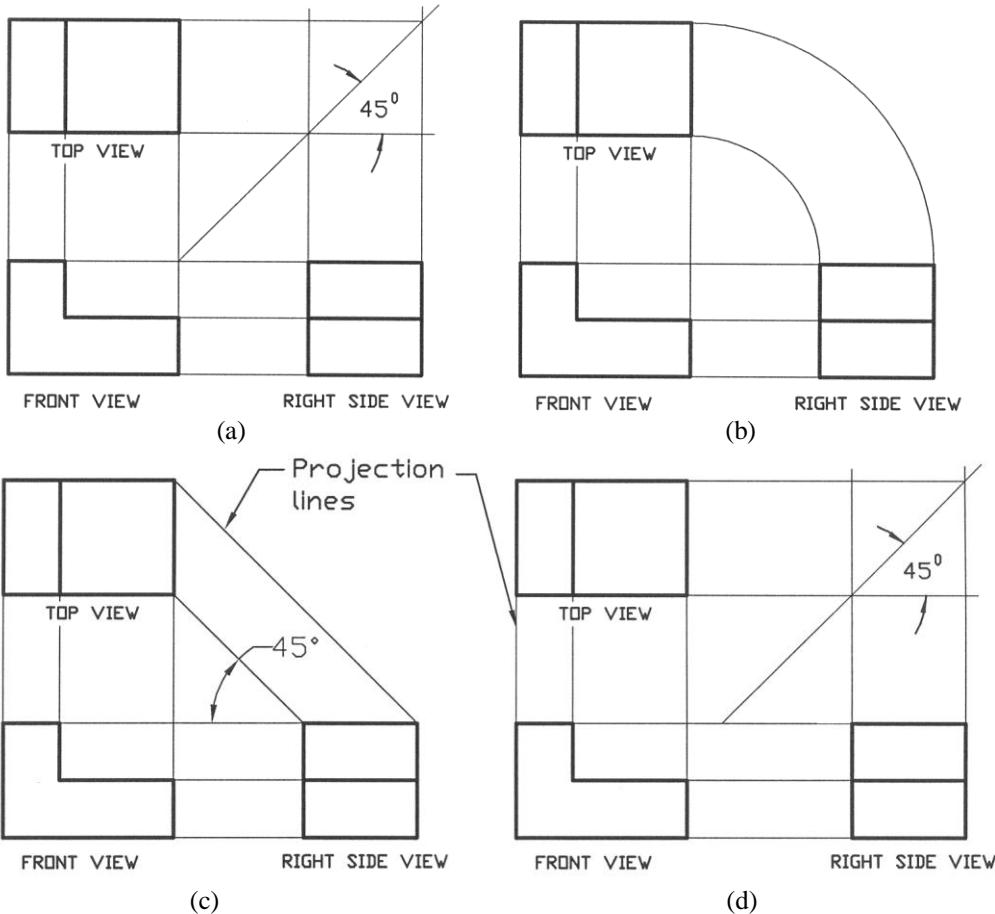


Figure 3.13: Different Methods of Projecting Views

The spacing between the views has to be determined beforehand. It will depend on many factors such as, space required for the dimensions, space required for writing views and space required for writing essential notes. The space should be sufficient in order to give the dimensions avoiding any crowding. However, the excessive space should be avoided. The beginners may choose the space in between the views as 30 to 40 mm. In Figures 3.13a to 3.13c the interspacing between the views has been made as equal. However, if it is necessary different spacing may be used as well; an example of that is shown in Figure 3.13d. Any method of projecting views as described in Figure 3.13 may be used. However, the projection as described in Figure 3.13a is mostly used. In Figure 3.14, the orthographic projection of an object has been provided as a further example.

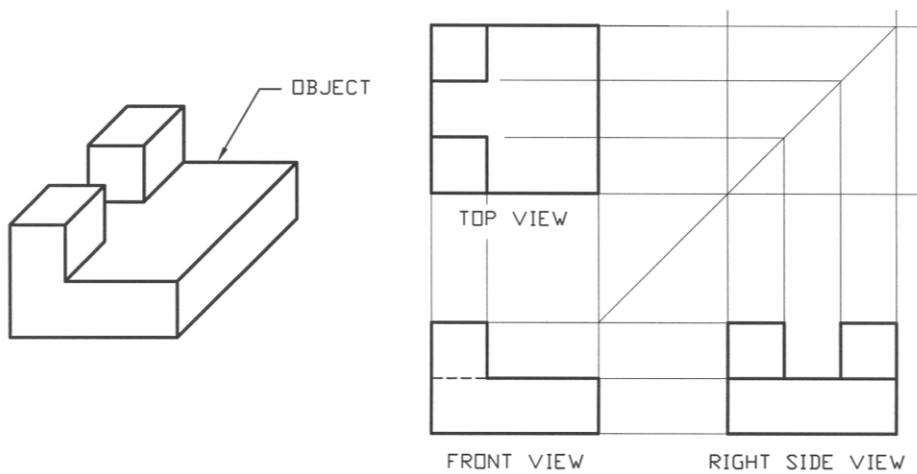


Figure 3.14: Orthographic Projection

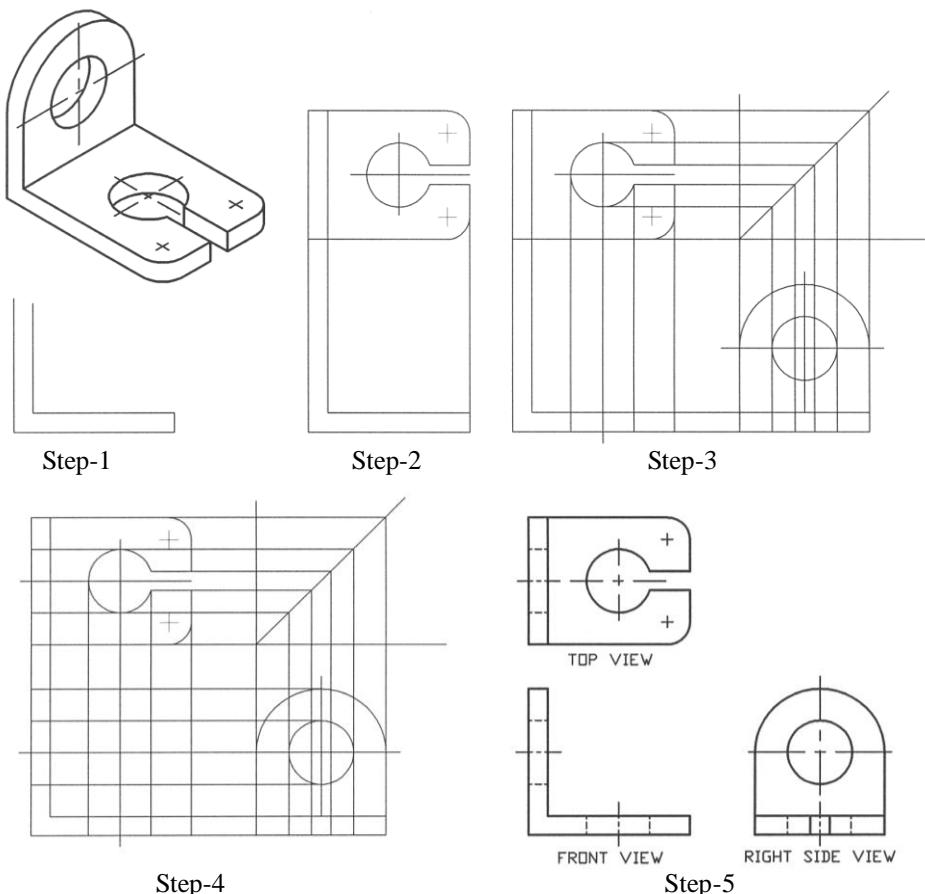


Figure 3.15: Typical Steps in Drawing a Part

In Figure 3.15 typical steps in drawing a part have been illustrated. The projection has been started from the front view but before completion of the front view, other views have been projected in parallel. It is observed that the front view is also projected in reference to the top and sides views. It can be noted here that the thin lines have been used in projecting the preliminary views. When the views are projected completely, the projection lines are erased out and the views are completed using the lines of appropriate thickness as shown in the figure. In Figure 3.16 an example of the first angle orthographic projection is shown.

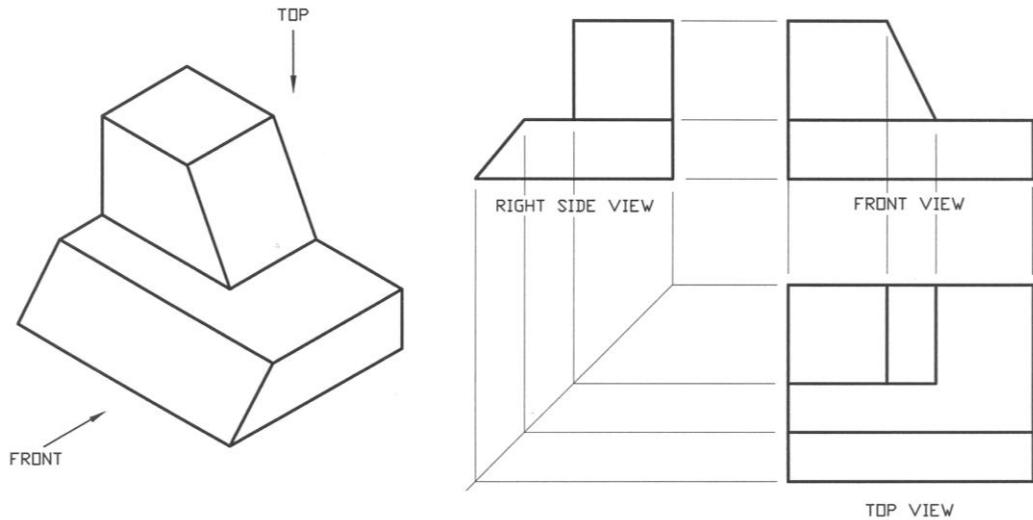


Figure 3.16: First Angle Projection

3.7 Fillets and Rounds

The sharp internal corners are made rounded in a casting in order to avoid the possibility of stress crack. These rounded internal corners are called fillets. On the other hand the external sharp corners are made rounded for safety and appearance. These rounded external corners are called rounds. In Figure 3.17 fillets and rounds are shown.

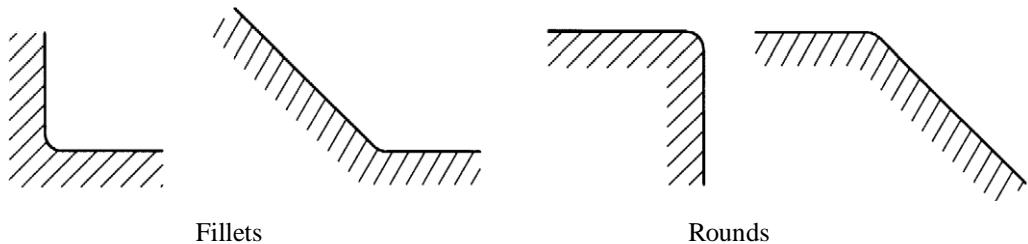


Figure 3.17: Fillets and Rounds

3.8 Projection Symbol

Projection symbols according to ISO 128 – 1982(E) for Third Angle and First Angle are shown respectively in Figure 3.18a and Figure 3.18b. It is usual practice to locate the ISO projection

symbol in the lower right hand corner of the drawing adjacent to the title block as shown in Figure 3.18c. From the symbol one can easily identify the type of projection (First Angle or Third Angle) used to perform the drawing.

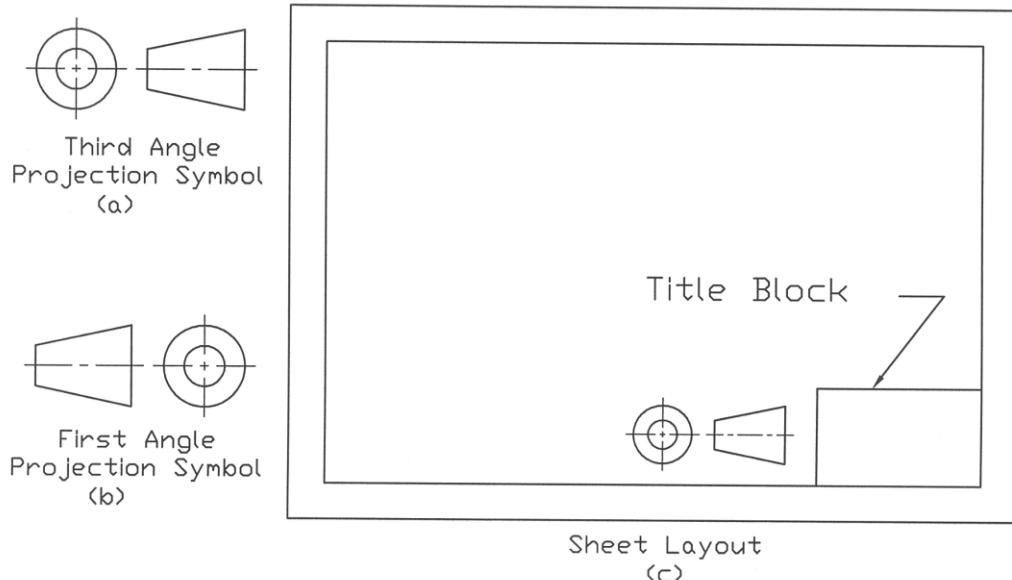


Figure 3.18: Projection Symbol

Example Problems

Note: For solutions see the following section of ***Solutions for Example Problems***. The scaled drawings are provided on the squared paper.

Prob. P3.1 - P3.24: Draw the necessary orthographic views of each of the objects (Fig. P3.1 – P3.24) to best represent them on the squared or plain papers. Free hand drawings may be done.

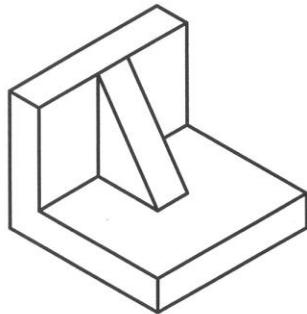


Fig. P3.1

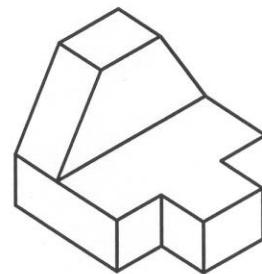


Fig. P3.2

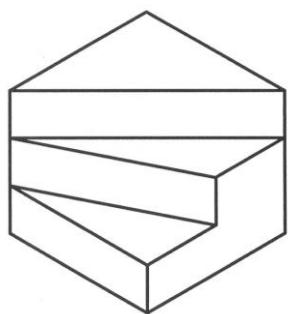


Fig. P3.3

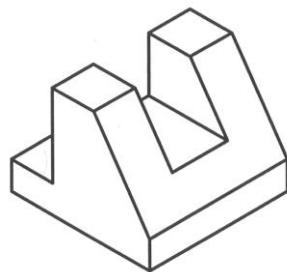


Fig. P3.4

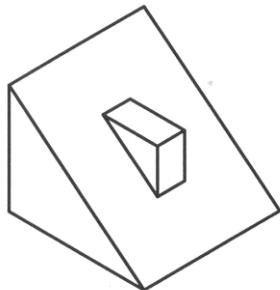


Fig. P3.5

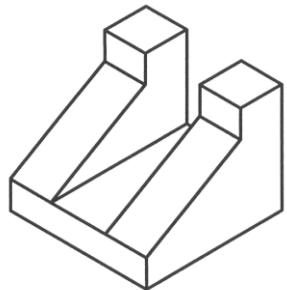


Fig. P3.6

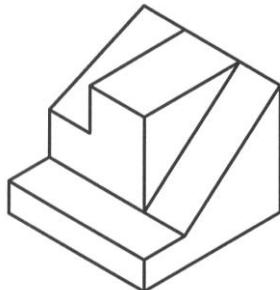


Fig. P3.7

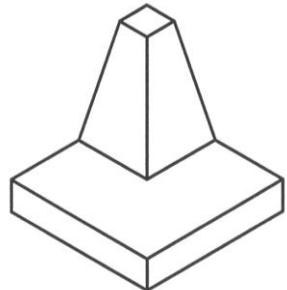


Fig. P3.8

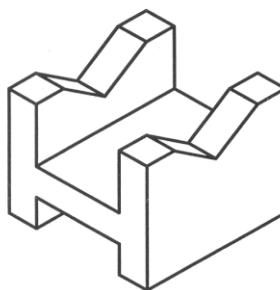


Fig. P3.9

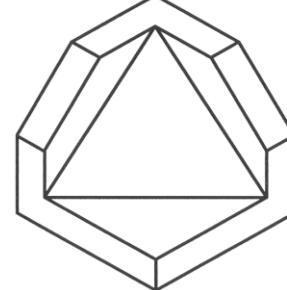


Fig. P3.10

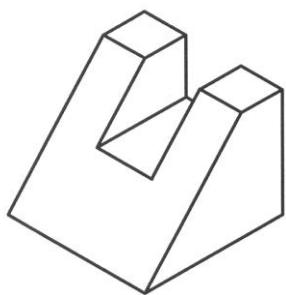


Fig. P3.11

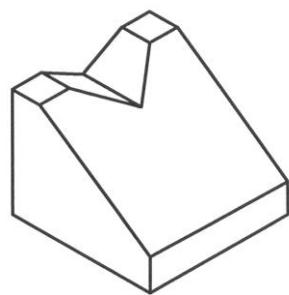


Fig. P3.12

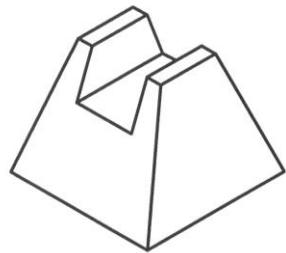


Fig. P3.13

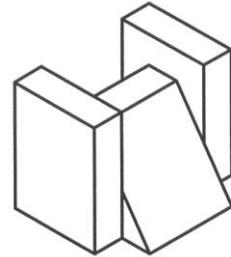


Fig. P3.14

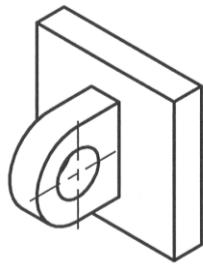


Fig. P3.15

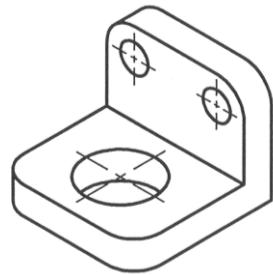


Fig. P3.16

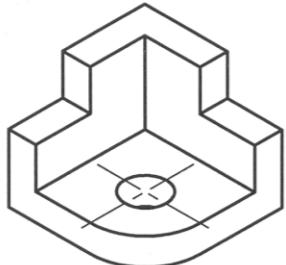


Fig. P3.17

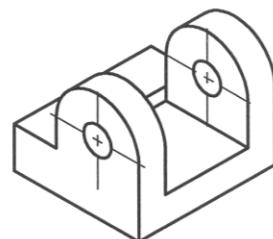


Fig. P3.18

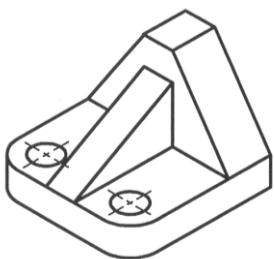


Fig. P3.19

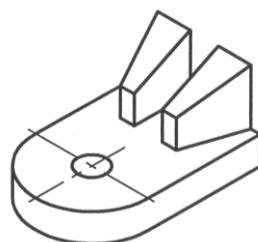


Fig. P3.20

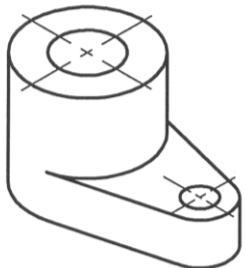


Fig. P3.21

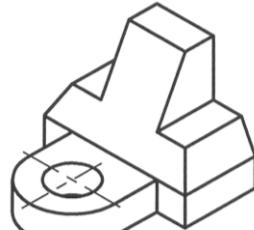


Fig. P3.22

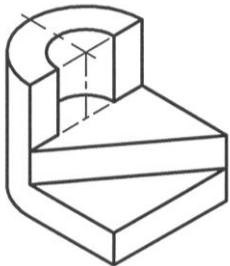


Fig. P3.23

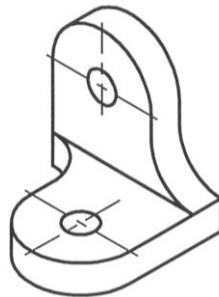


Fig. P3.24

Prob. P3.25 – P3.40: Complete the missing views from the given views as shown in Fig. P3.25 – P3.40.

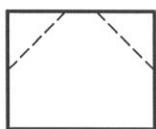
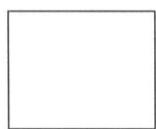


Fig. P3.25

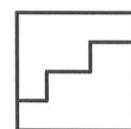
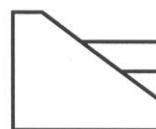


Fig. P3.26

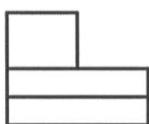
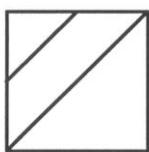


Fig. P3.27

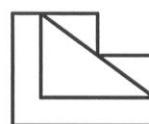
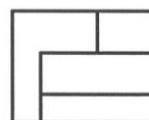


Fig. P3.28



Fig. P3.29

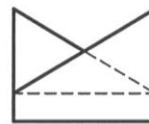


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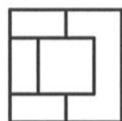


Fig. P3.31

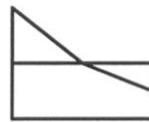
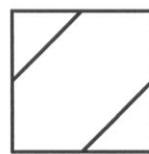


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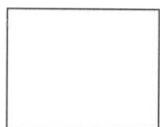
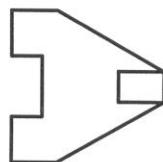


Fig. P3.33



Fig. P3.34

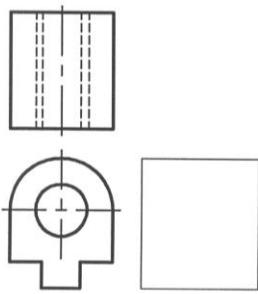


Fig. P3.35

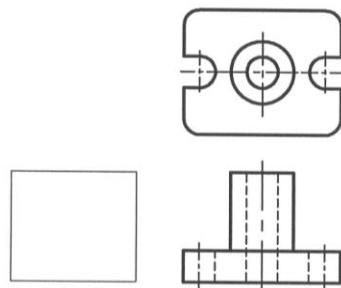


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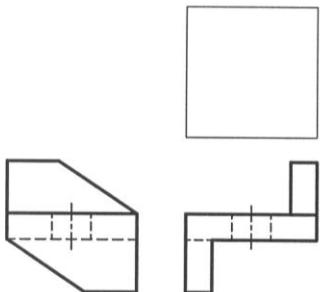


Fig. P3.37

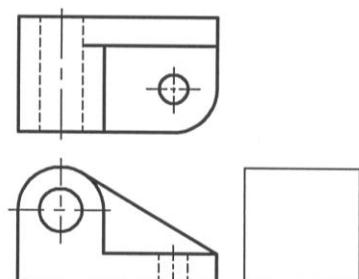


Fig. P3.38

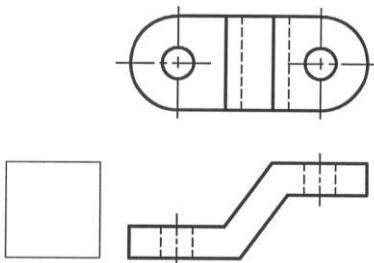


Fig. P3.39

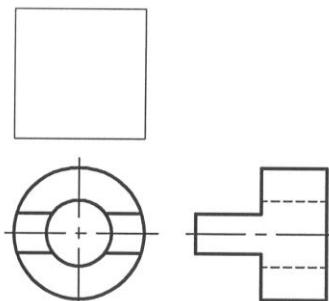


Fig. P3.40

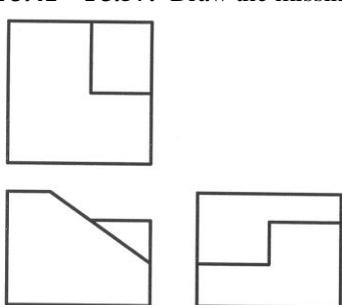


Fig. P3.41

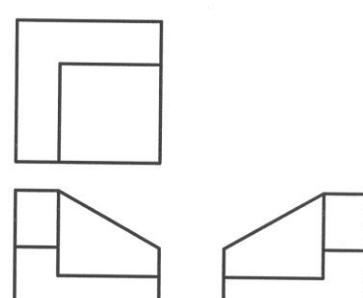


Fig. P3.42

Prob. P3.41 – P3.57: Draw the missing line/lines in the views as shown in Fig. P3.41 – P3.57.

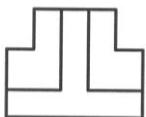


Fig. P3.43

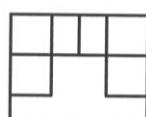
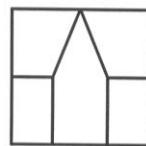


Fig. P3.44

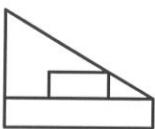
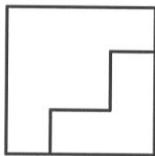


Fig. P3.45

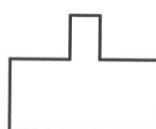
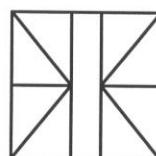


Fig. P3.46

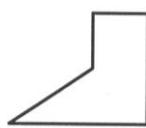
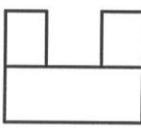
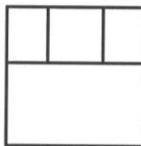


Fig. P3.47

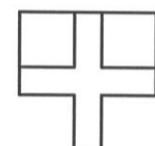
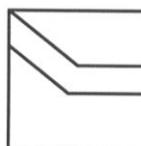
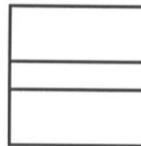


Fig. P3.48

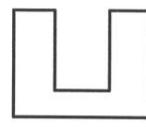
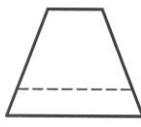
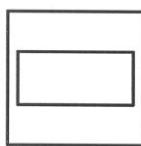


Fig. P3.49

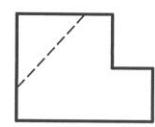
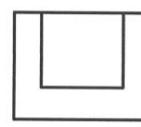
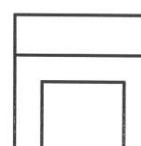


Fig. P3.50

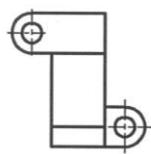


Fig. P3.51

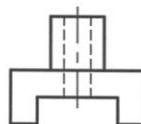


Fig. P3.52

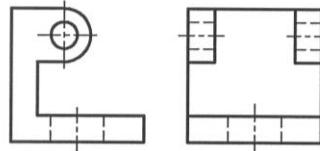
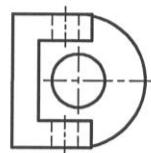


Fig. P3.53

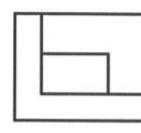
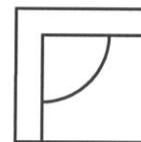


Fig. P3.54

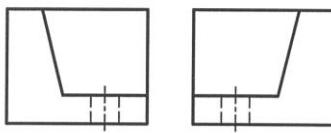
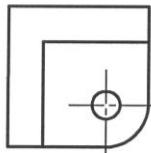


Fig. P3.55

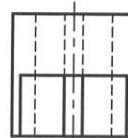


Fig. P3.56

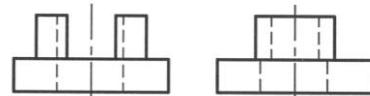
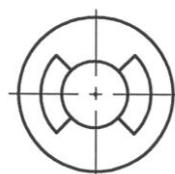


Fig. P3.57

Prob. P3.58: Draw top, front and right side views of the holder as shown in Fig. P3.58.

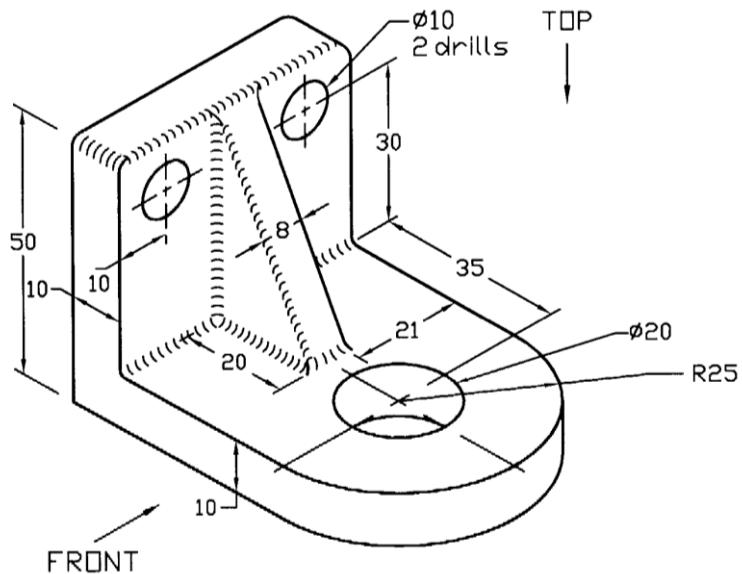


Fig. P3.58

Prob. P3.59: Draw the top, front and right side views of the support as shown in Fig. P3.59.

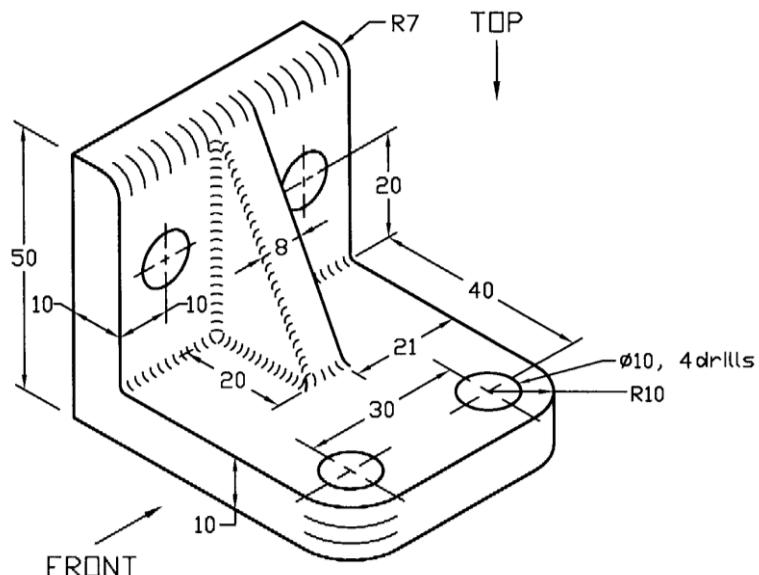


Fig. P3.59

Prob. P3.60: Draw top, front and right side views of the bracket as shown in Fig. P3.60.

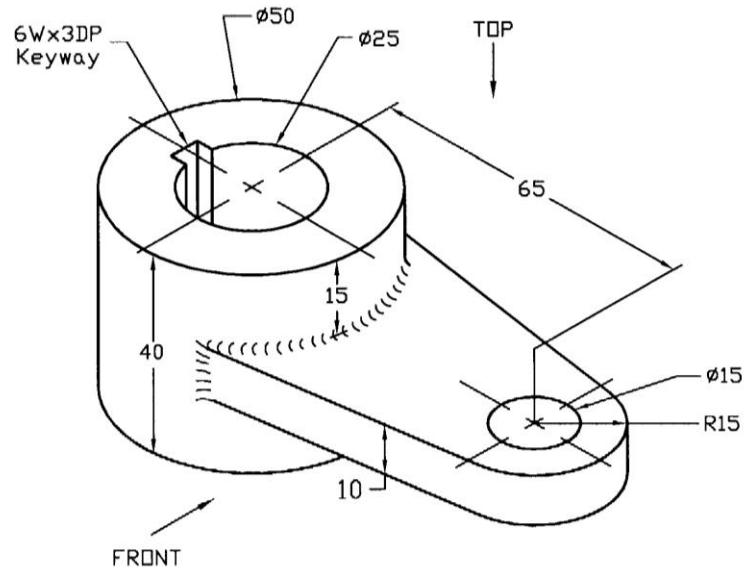


Fig. P3.60

Prob. P3.61: Draw the top, front and right side views of the bracket as shown in Fig. P3.61.

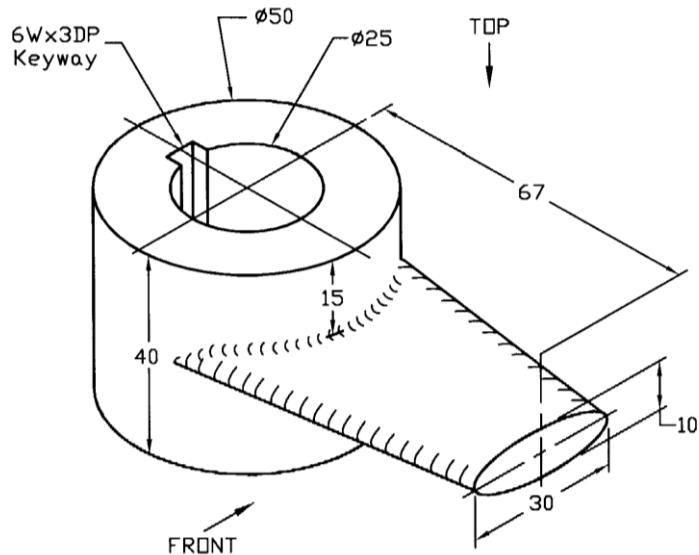


Fig. P3.61

Prob. P3.62: Draw the top, front and right side views of the fixer as shown in Fig. P3.62.

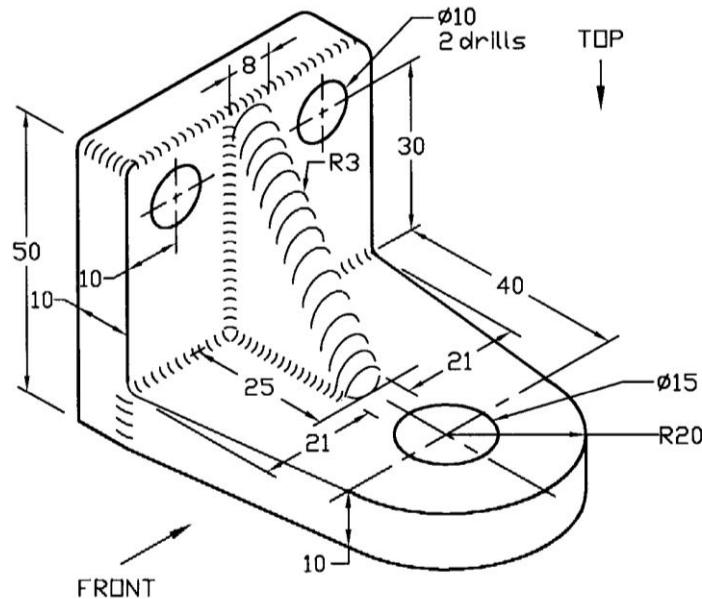


Fig. P3.62

Prob. P3.63: Draw the top, front and right side views of the guide block as shown in Fig. P3.63.

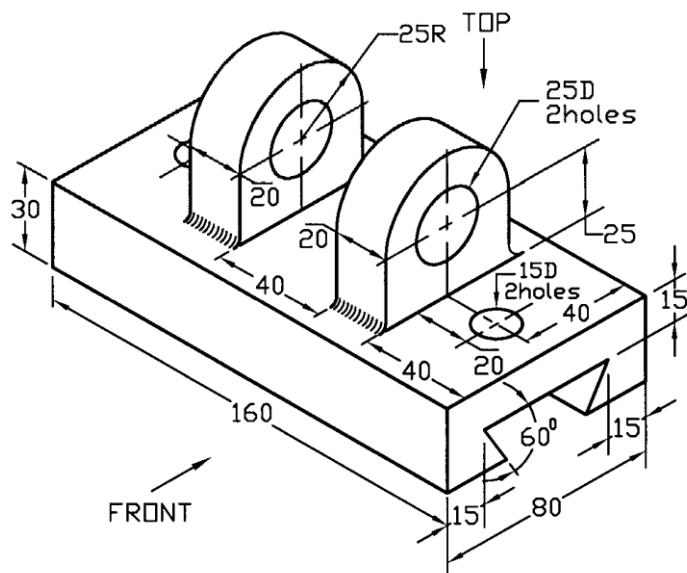


Fig. P3.63

Prob. P3.64: Draw the top, front and left side views of the bearing as shown in Fig. P3.64.

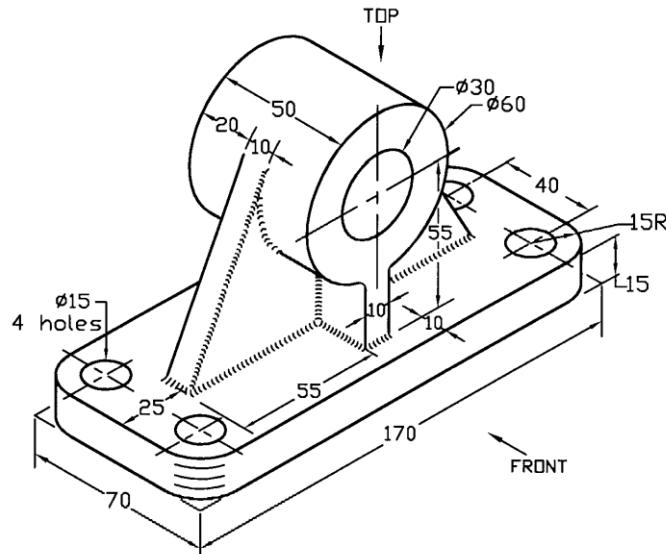


Fig. P3.64

Prob. P3.65: Draw the top, front and left side views of the end bracket as shown in Fig. P3.65.

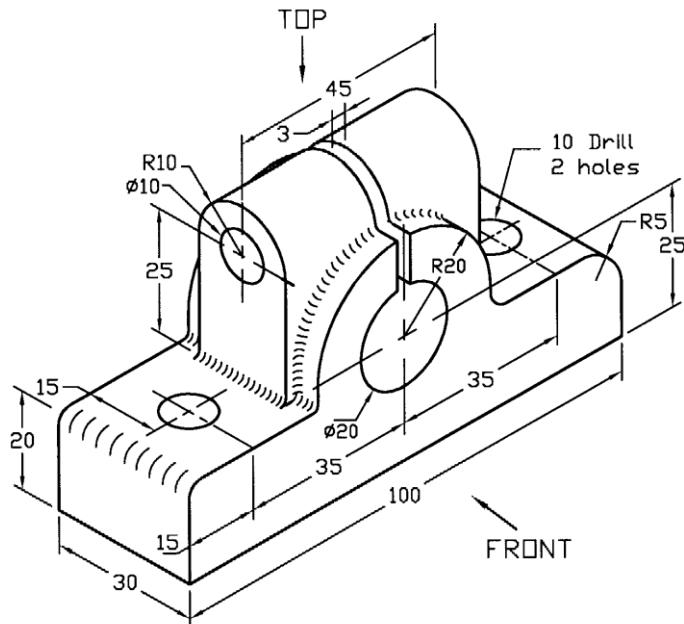


Fig. P3.65

Prob. P3.66: Draw the top, front and left side views of the bearing bracket as shown in Fig. P3.66.

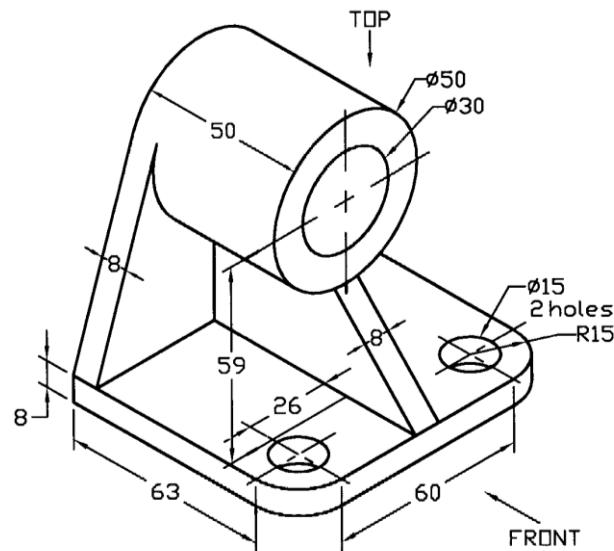


Fig. P3.66

Prob. P3.67: Draw the top, front and right side views of the bearing bracket as shown in Fig. P3.67.

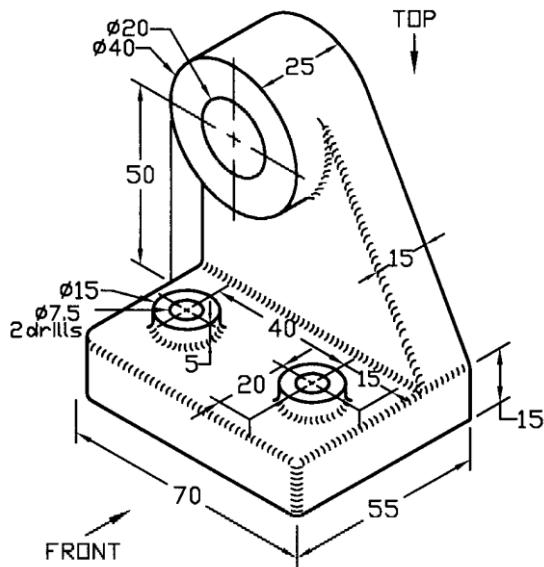
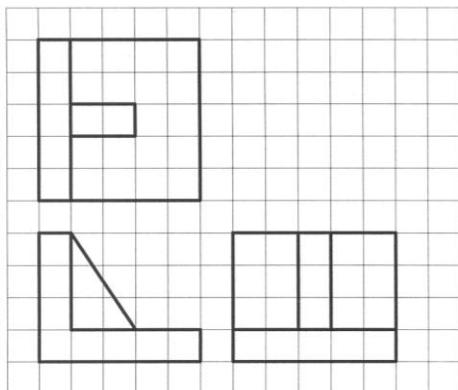
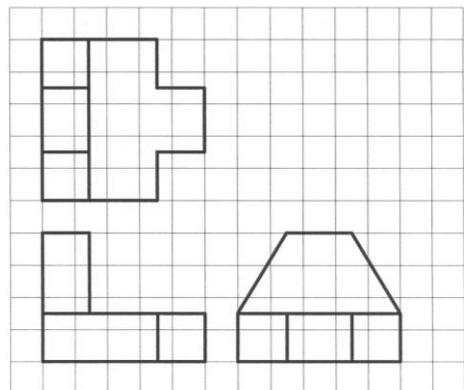
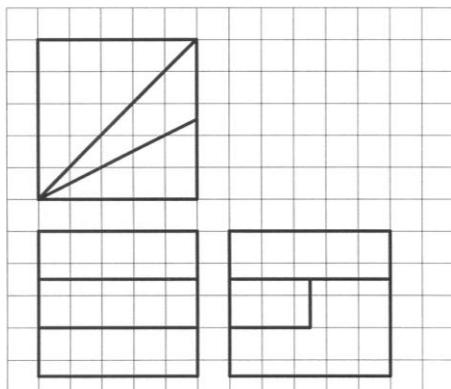
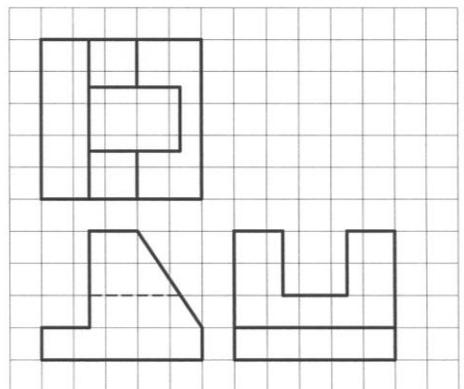
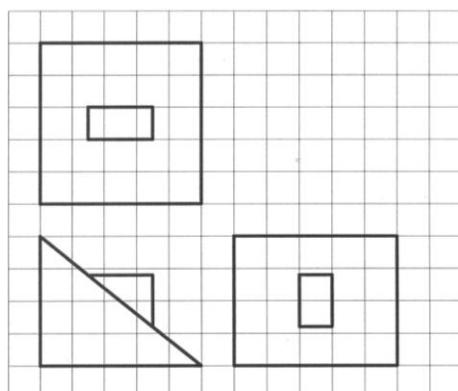
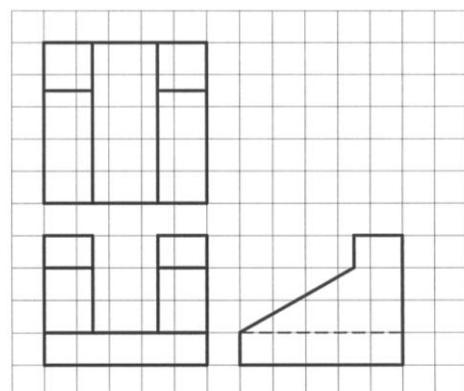
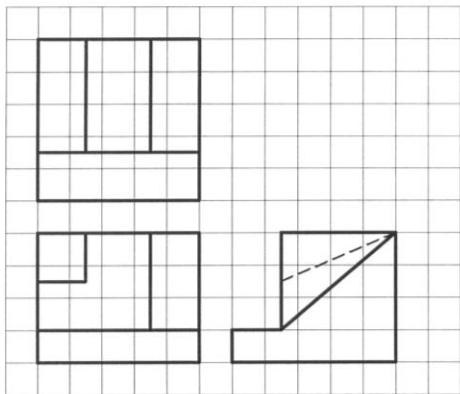
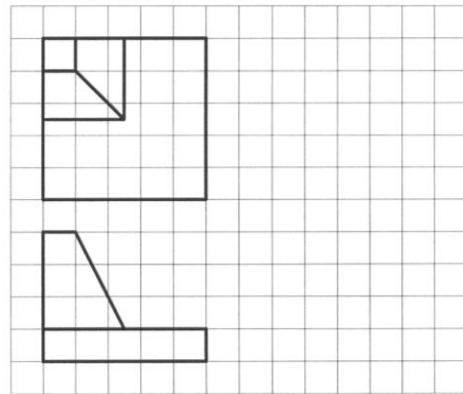


Fig. P3.67

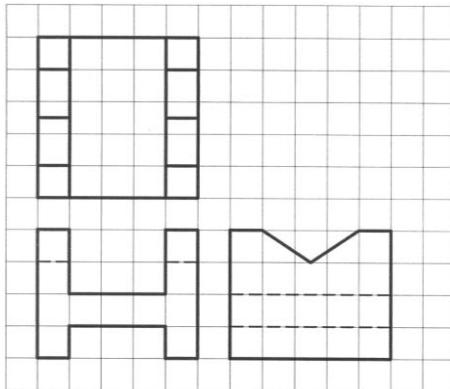
Solutions for Example Problems**Solution of P3.1****Solution of P3.2****Solution of P3.3****Solution of P3.4****Solution of P3.5****Solution of P3.6**



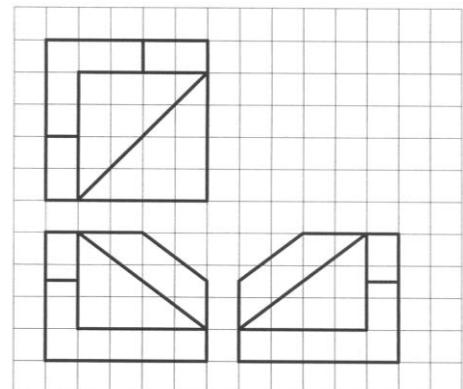
Solution of P3.7



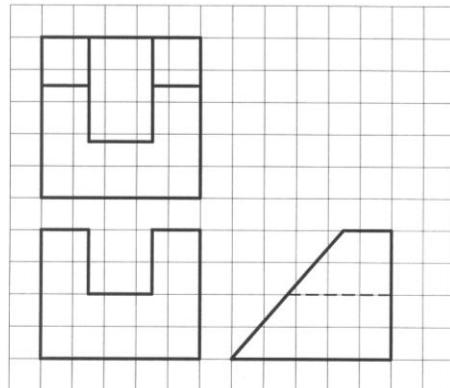
Solution of P3.8



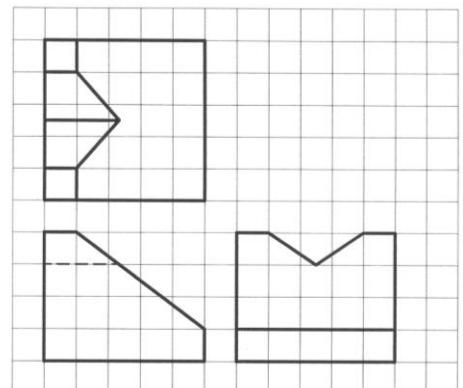
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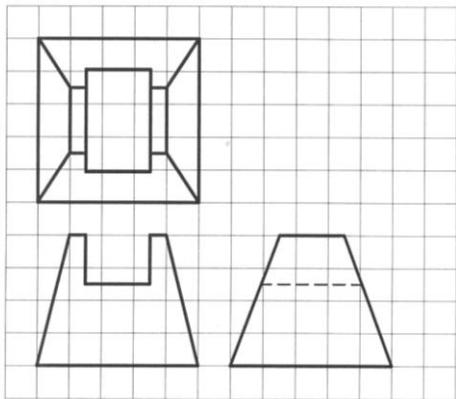
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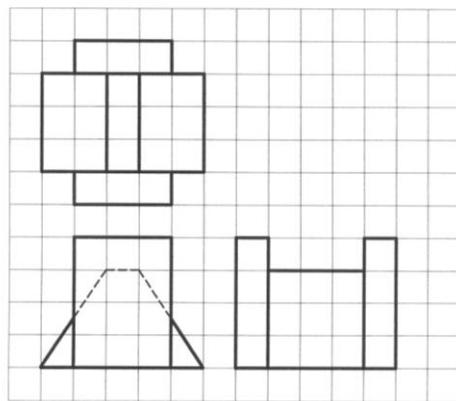
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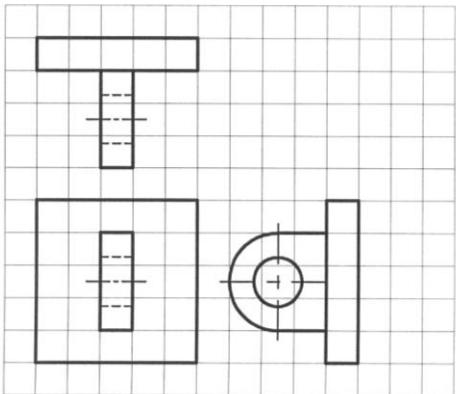
Solution of P3.12



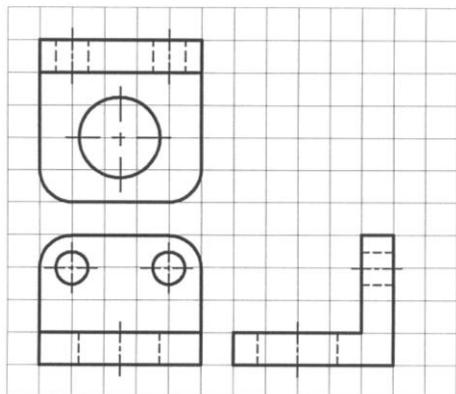
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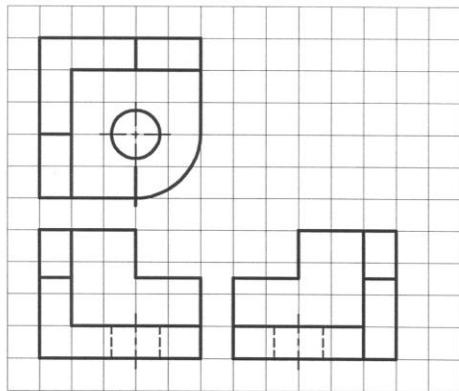
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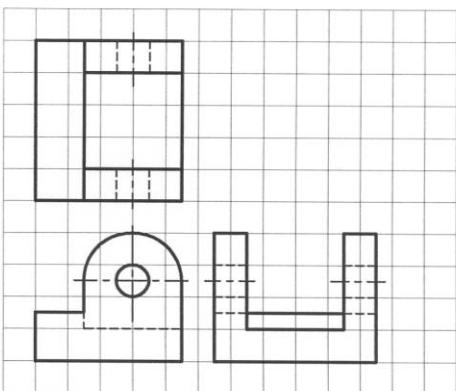
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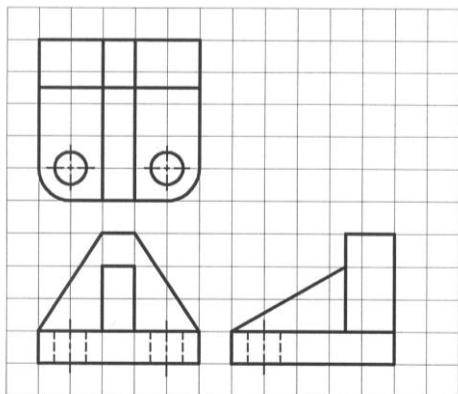
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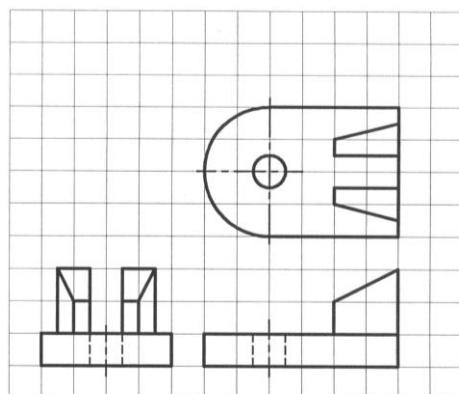
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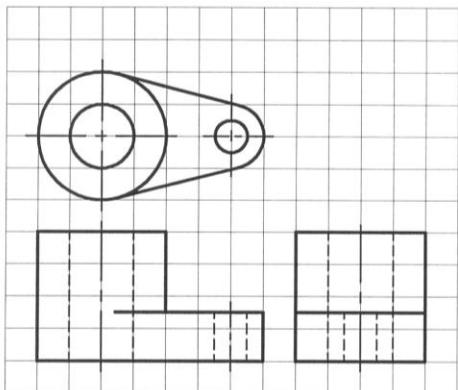
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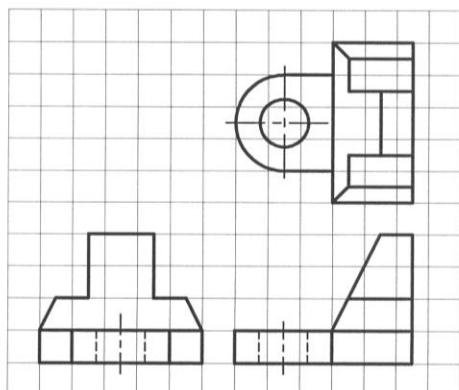
Solution of P3.19



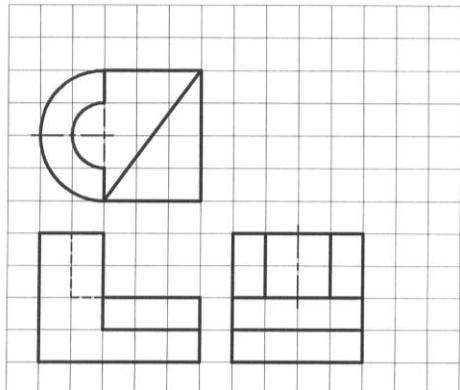
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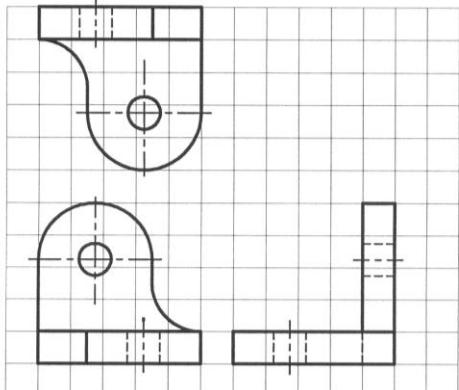
Solution of P3.21



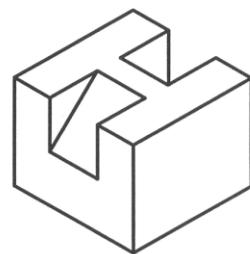
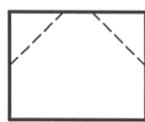
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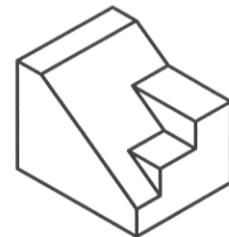
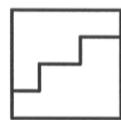
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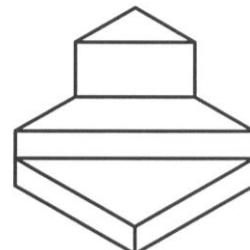
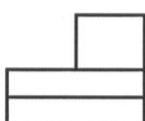
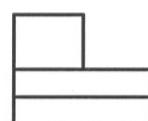
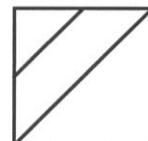
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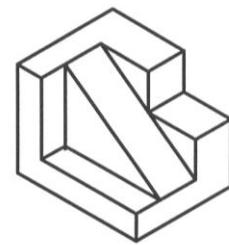
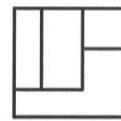
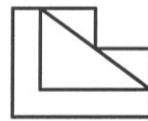
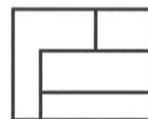
Solution of P3.25



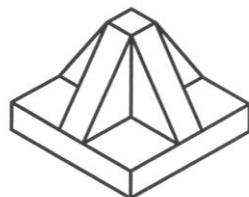
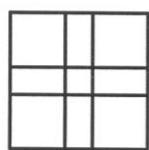
Solution of P3.26



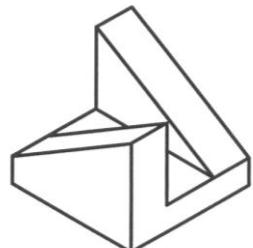
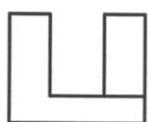
Solution of P3.27



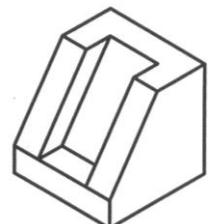
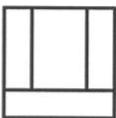
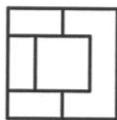
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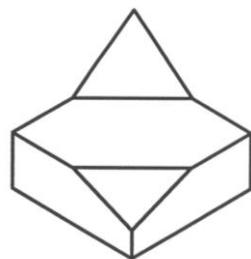
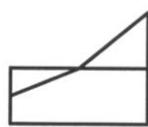
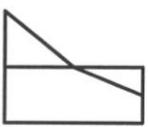
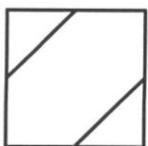
Solution of P3.29



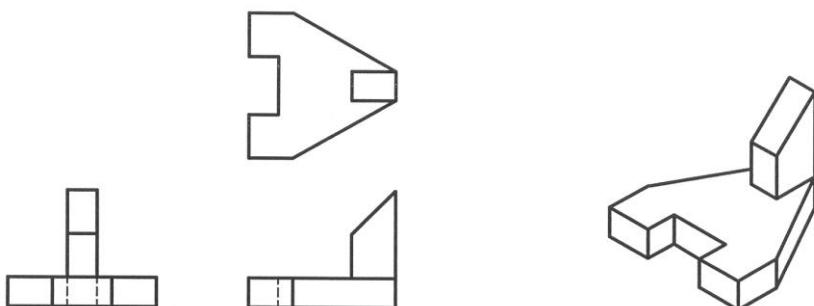
Solution of P3.30



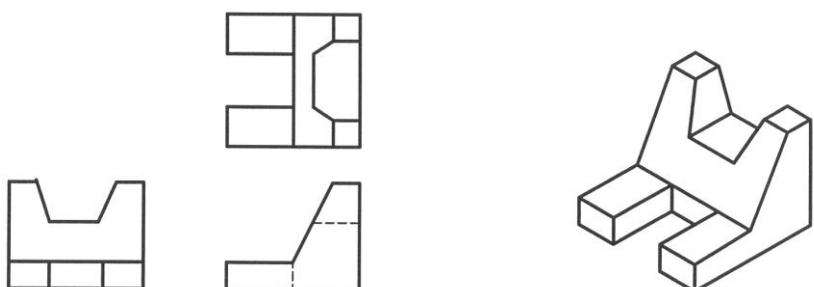
Solution of P3.31



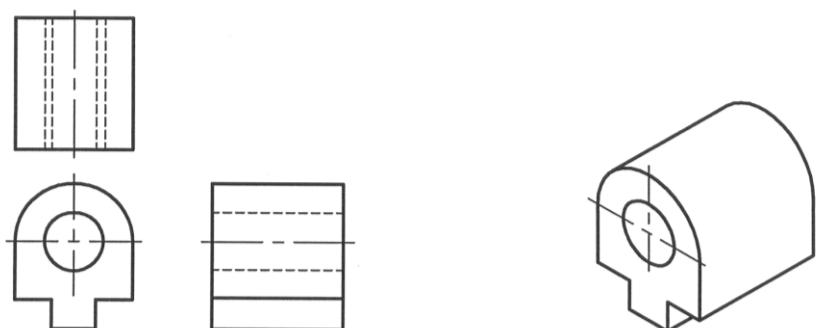
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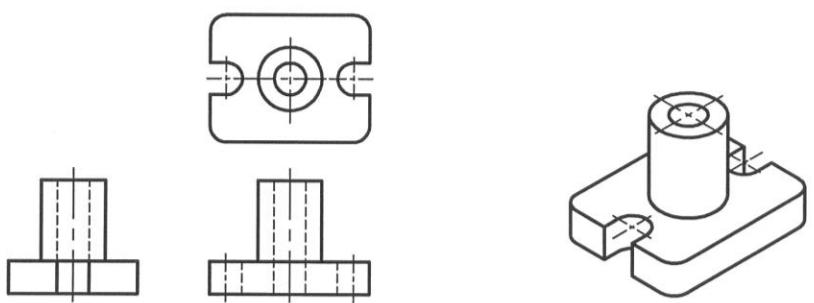
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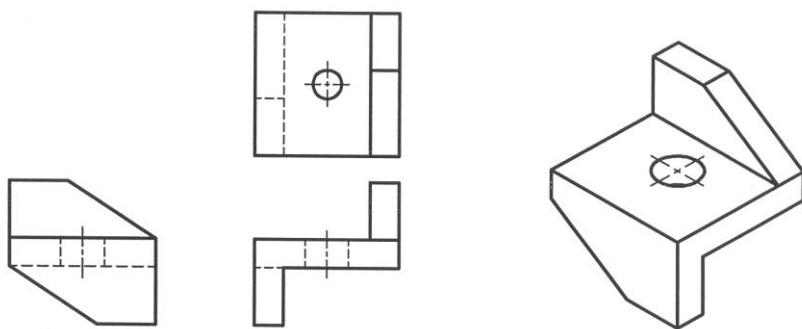
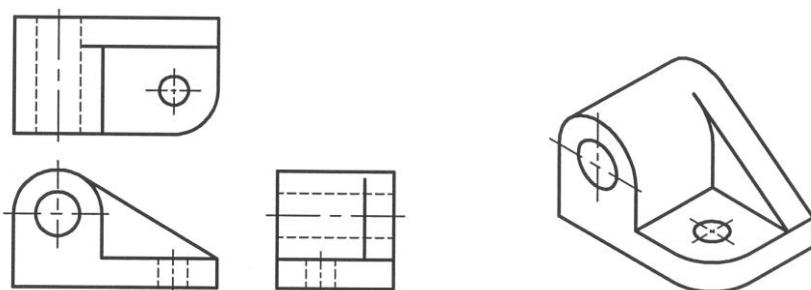
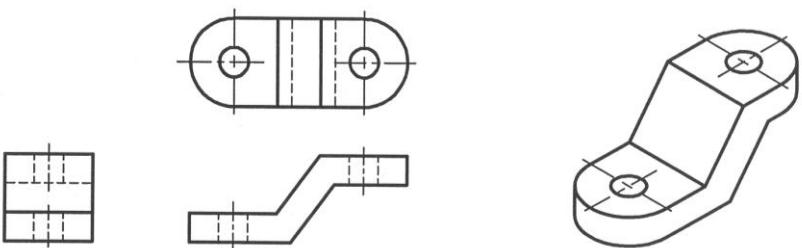
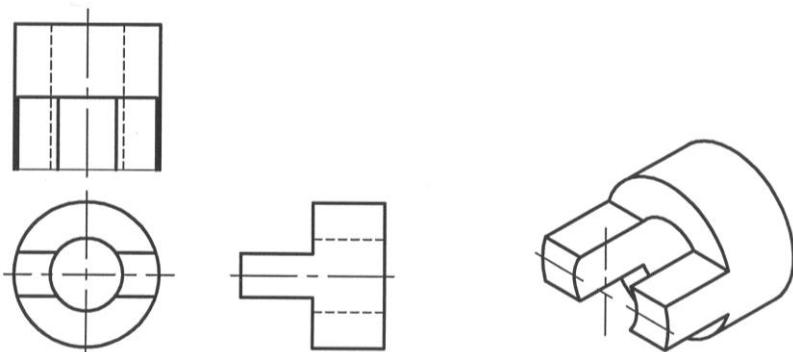
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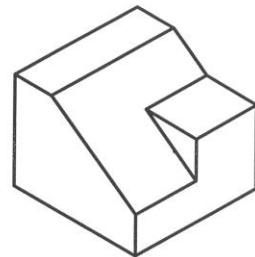
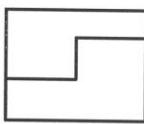
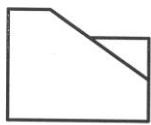
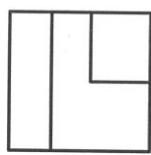
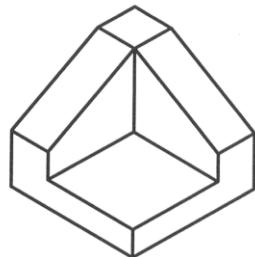
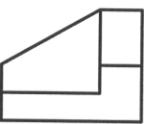
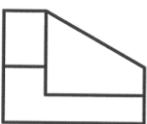
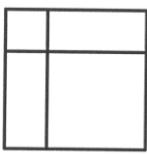
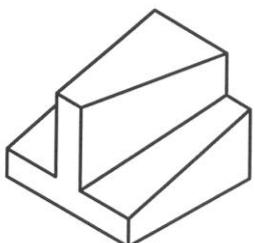
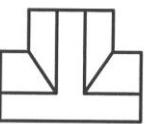
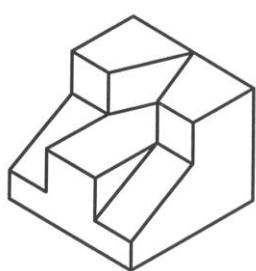
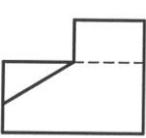
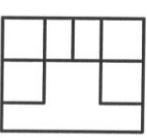
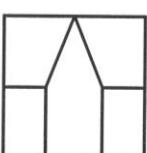


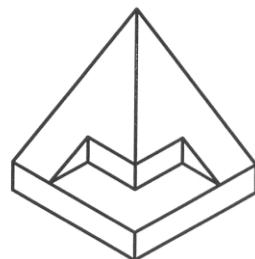
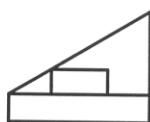
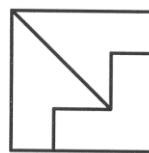
Solution of P3.35



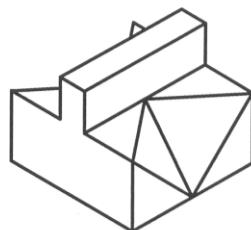
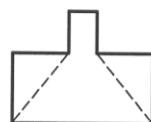
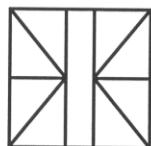
Solution of P3.36

**Solution of P3.37****Solution of P3.38****Solution of P3.39****Solution of P3.40**

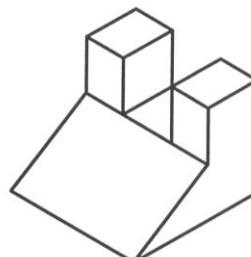
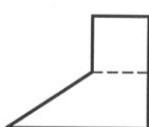
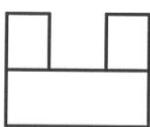
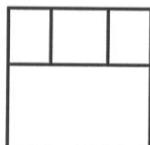
**Solution of P3.41****Solution of P3.42****Solution of P3.43****Solution of P3.44**



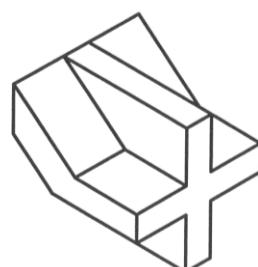
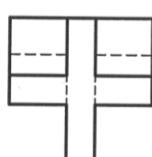
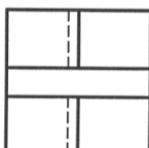
Solution of P3.45



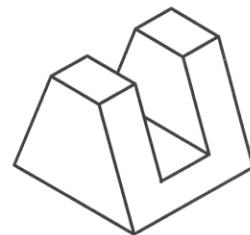
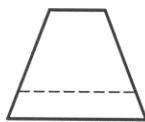
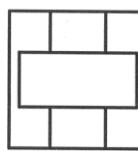
Solution of P3.46



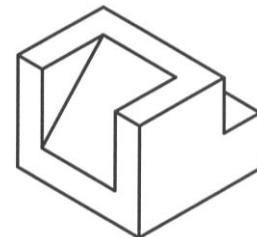
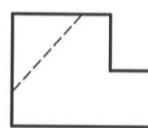
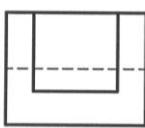
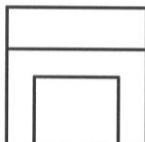
Solution of P3.47



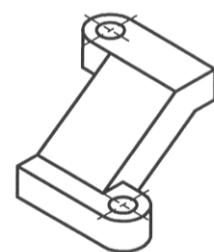
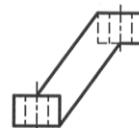
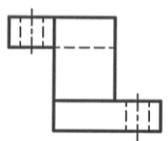
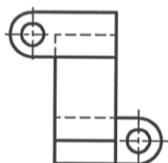
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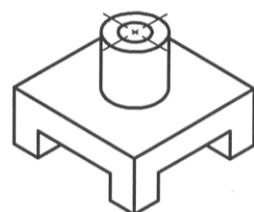
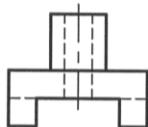
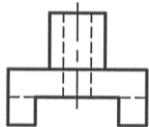
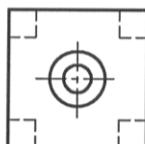
Solution of P3.49



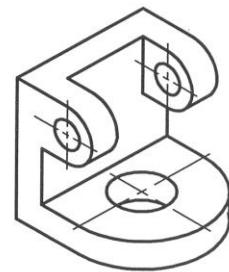
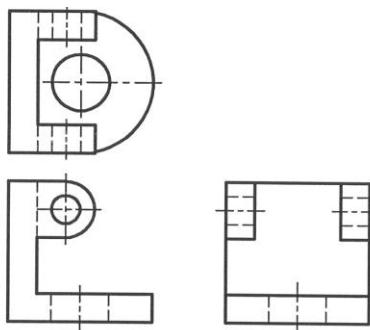
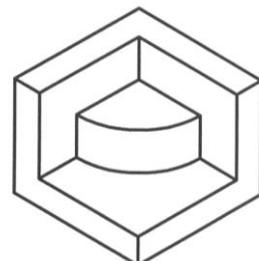
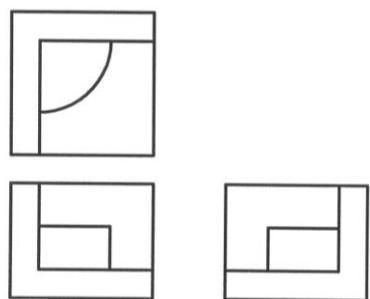
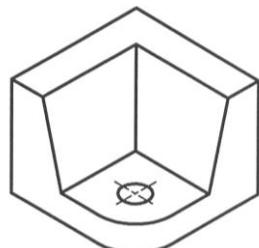
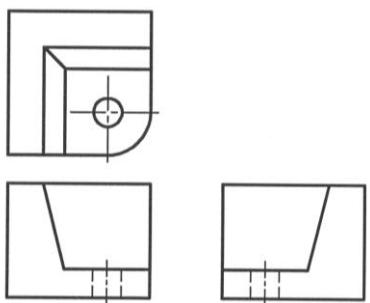
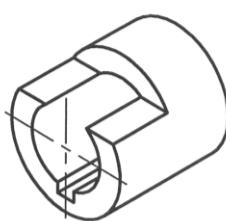
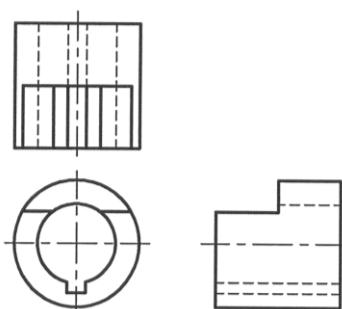
Solution of P3.50

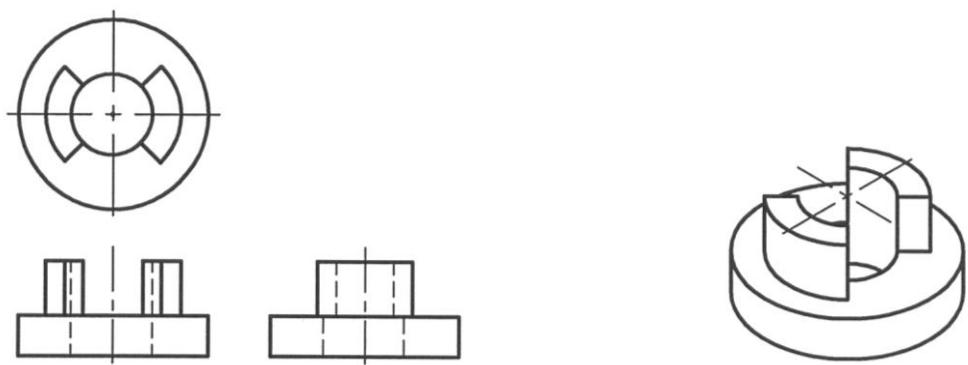


Solution of P3.51

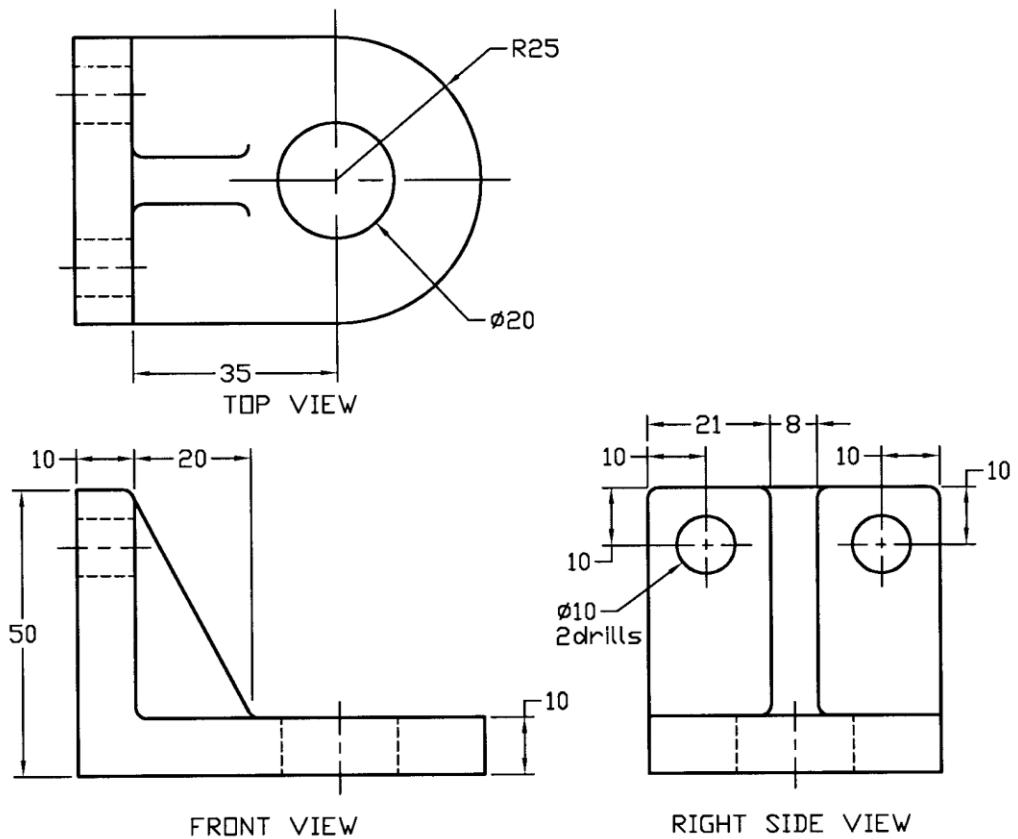


Solution of P3.52

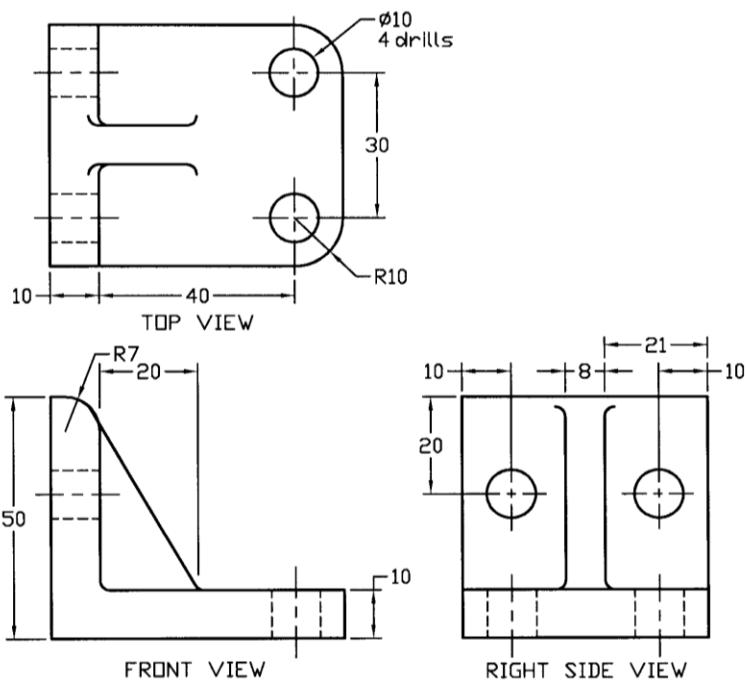
**Solution of P3.53****Solution of P3.54****Solution of P3.55****Solution of P3.56**



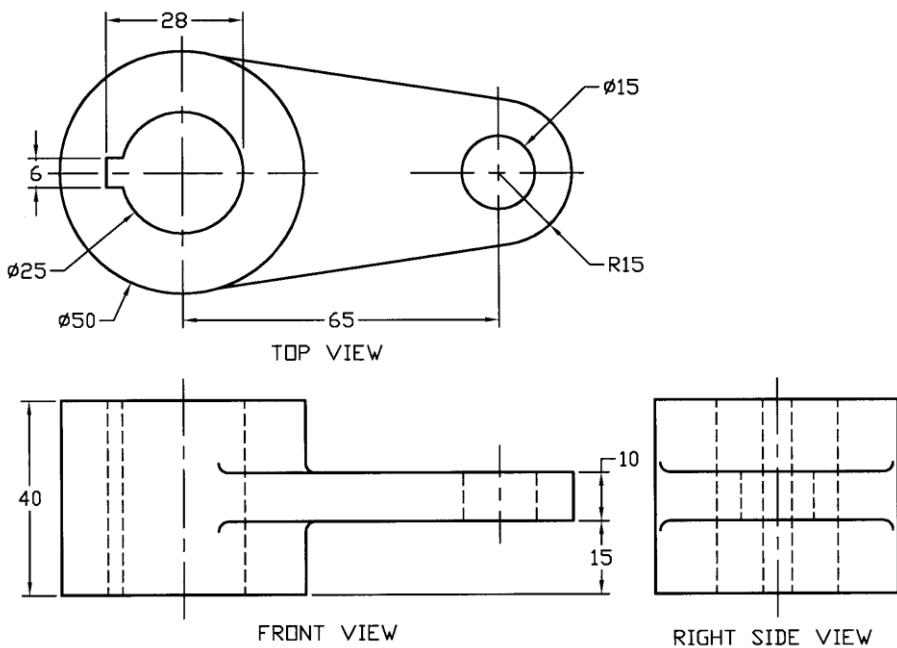
Solution of P3.57



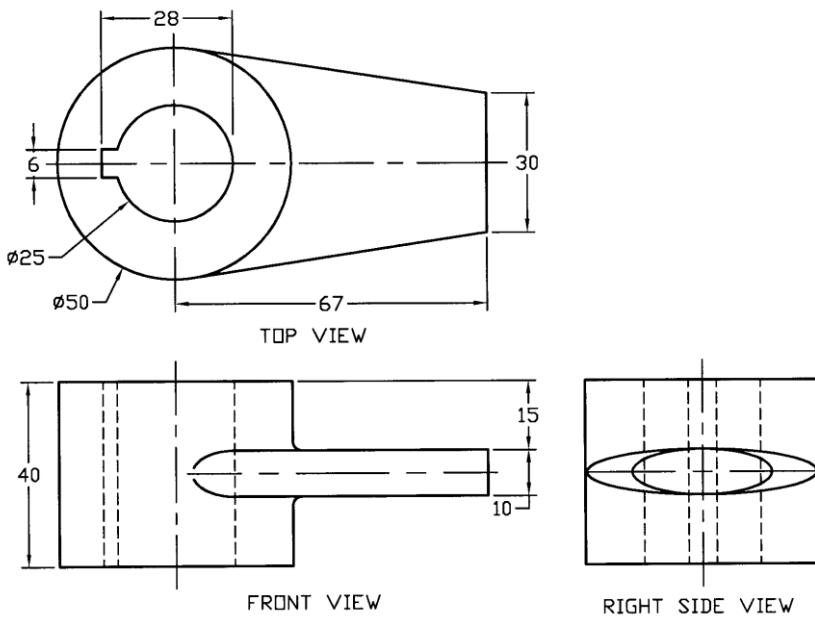
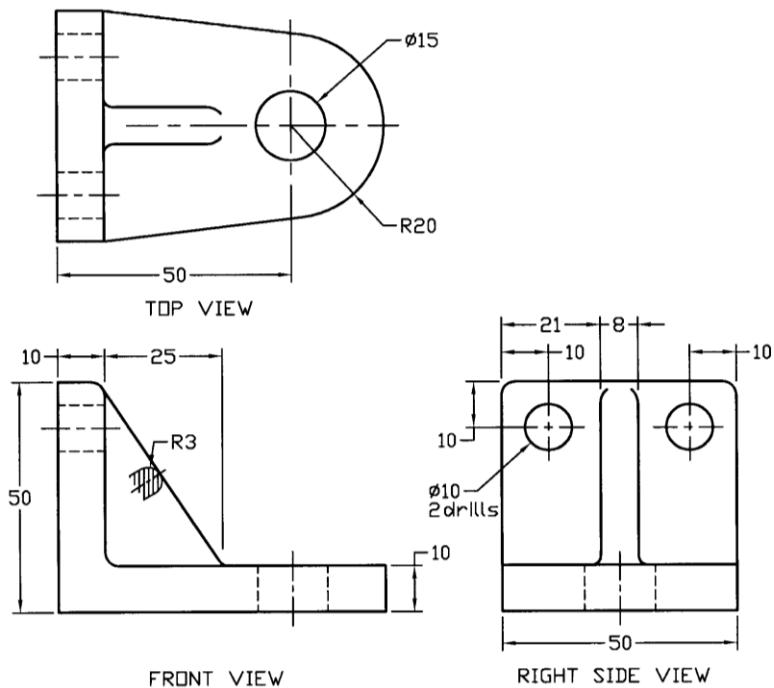
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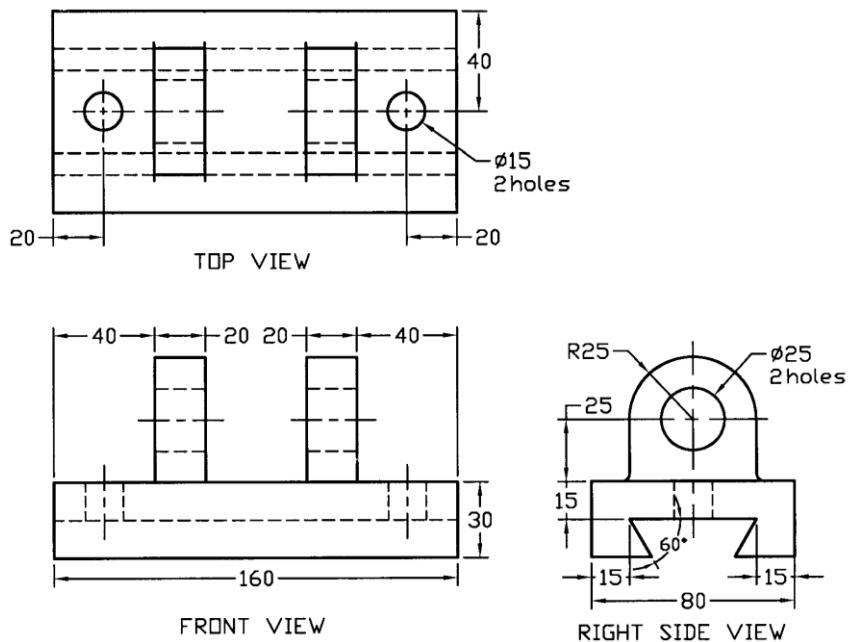
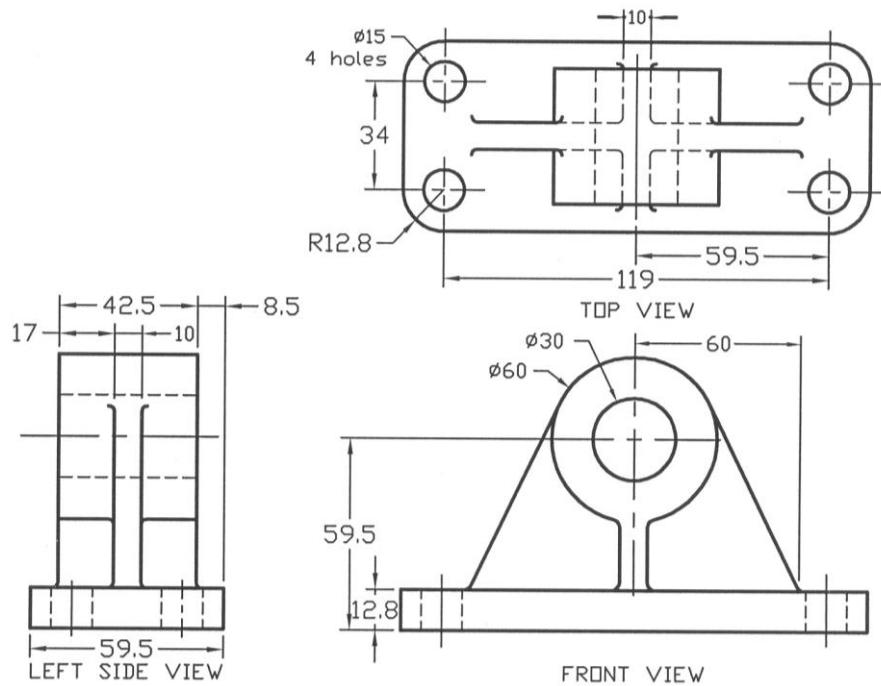


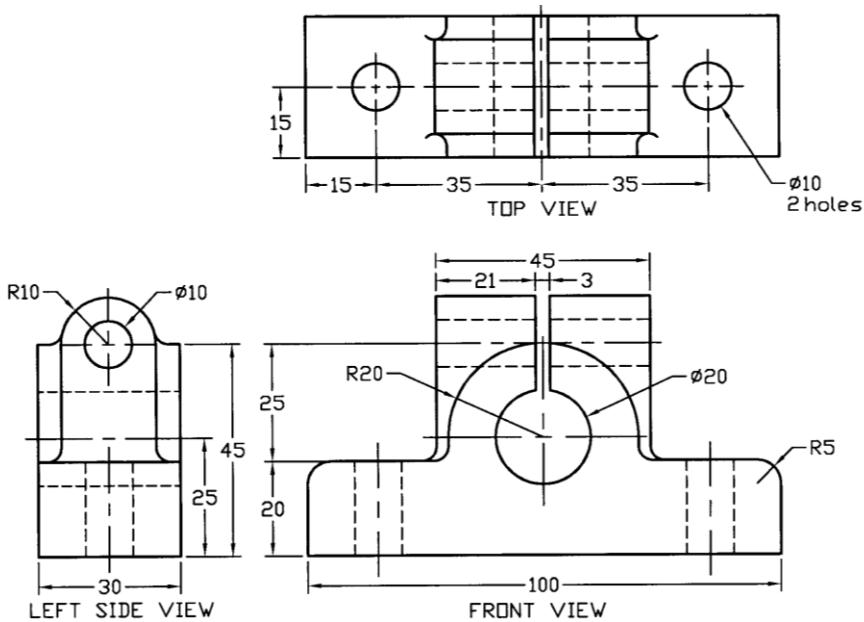
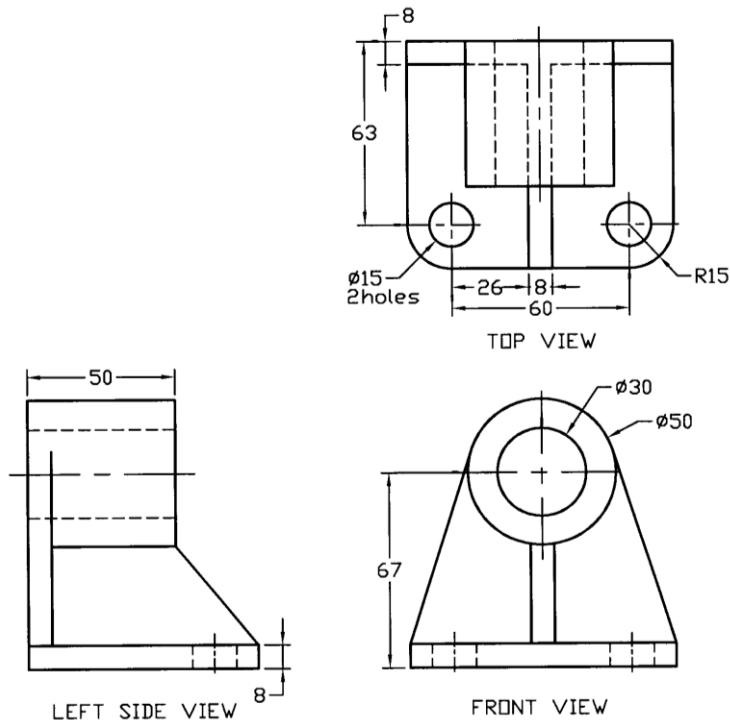
Solution of P3.59

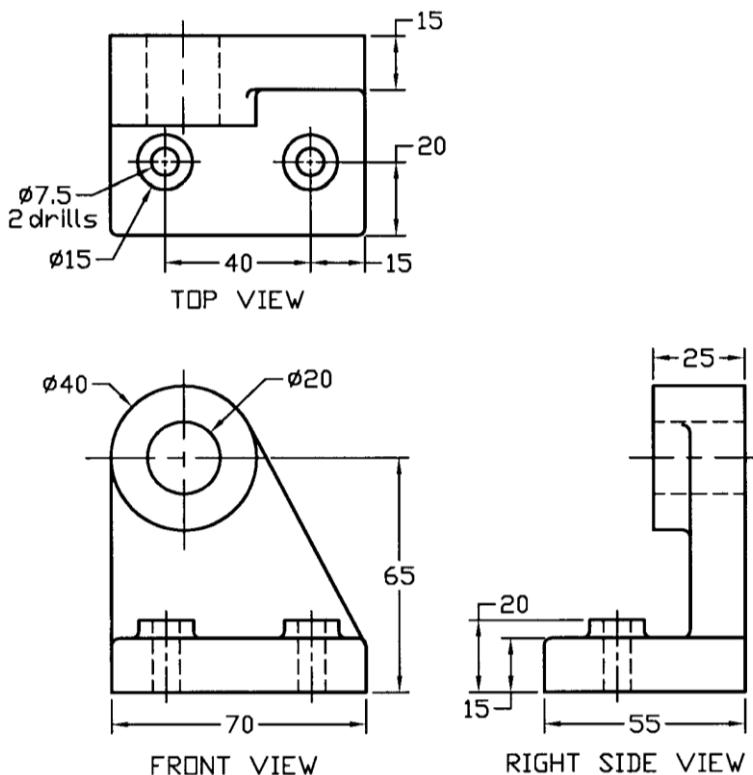


Solution of P3.60

**Solution of P3.61****Solution of P3.62**

**Solution of P3.63****Solution of P3.64**

**Solution of P3.65****Solution of P3.66**



Solution of P3.67

Problems

Prob. P3.68 – P3.91: Draw necessary free hand orthographic projections of the objects as shown in Fig. P3.68 – P3.91. Free hand drawings may be done.

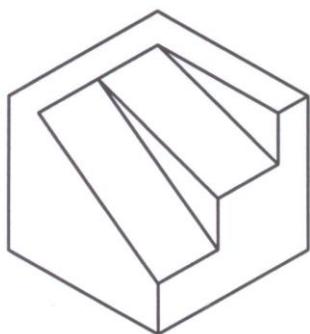


Fig. P3.68

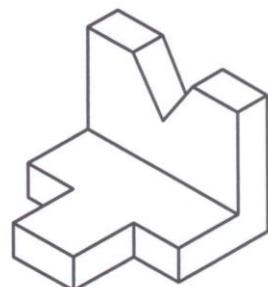


Fig. P3.69

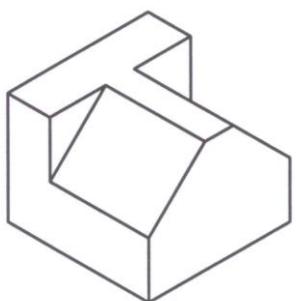


Fig. P3.70

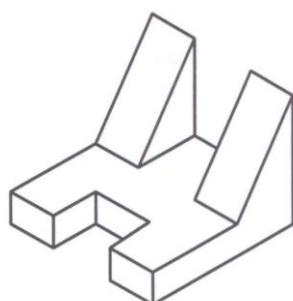


Fig. P3.71

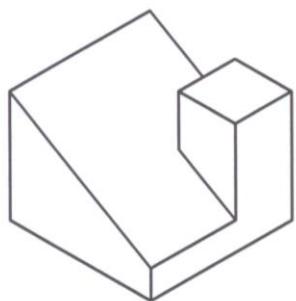


Fig. P3.72

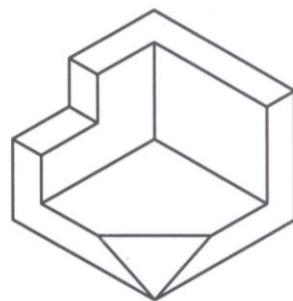


Fig. P3.73

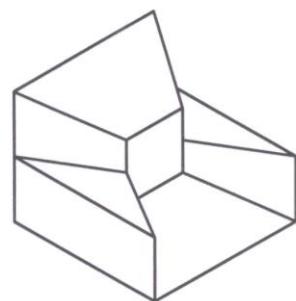


Fig. P3.74

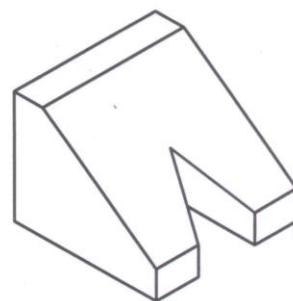


Fig. P3.75

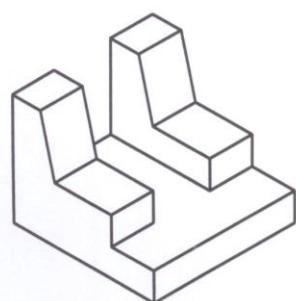


Fig. P3.76

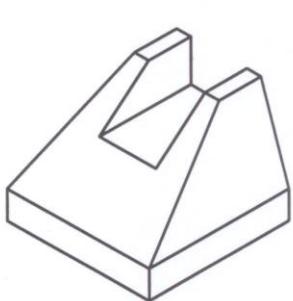


Fig. P3.77

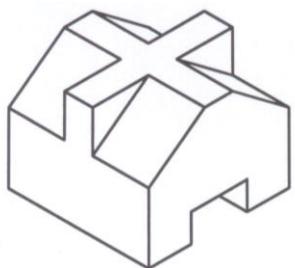


Fig. P3.78

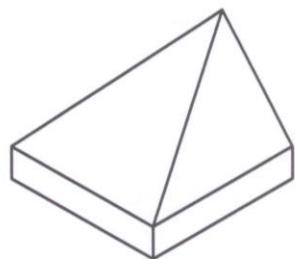


Fig. P3.79

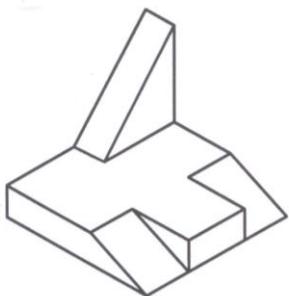


Fig. P3.80

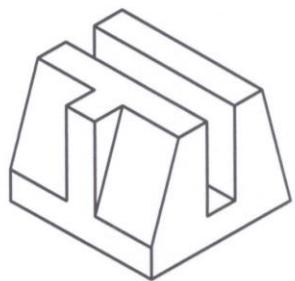


Fig. P3.81

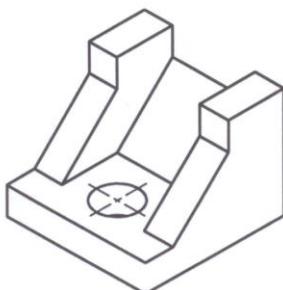


Fig. P3.82

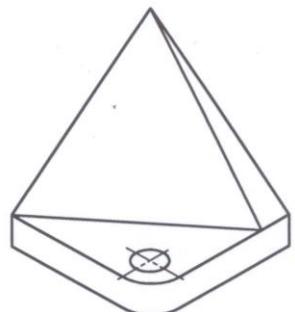


Fig. P3.83

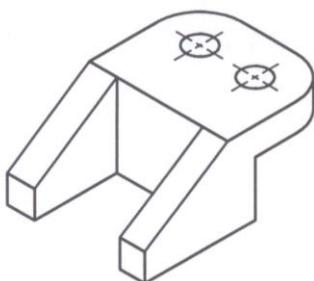


Fig. P3.84

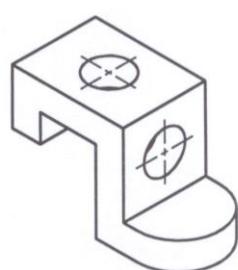


Fig. P3.85

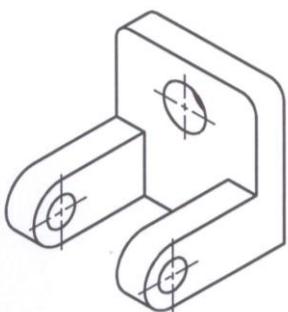


Fig. P3.86

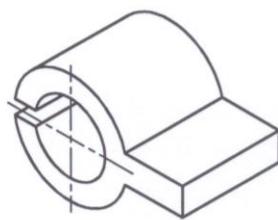


Fig. P3.87

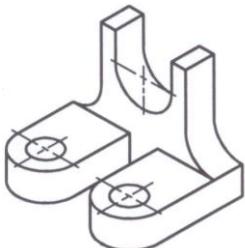


Fig. P3.88

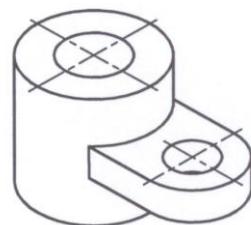


Fig. P3.89

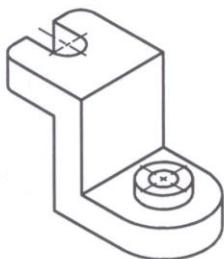


Fig. P3.90

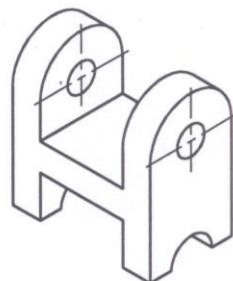


Fig. P3.91

P3.92 – P3.107: Complete the missing view from the views as shown in Fig. P3.92 – P3.107.

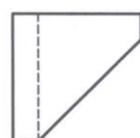
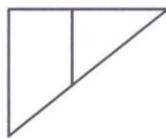


Fig. P3.92

Fig. P3.93

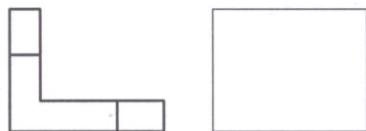
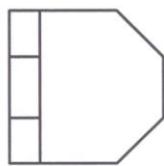


Fig. P3.94

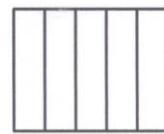


Fig. P3.95

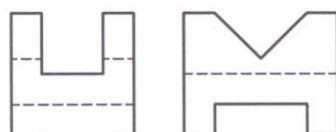


Fig. P3.96

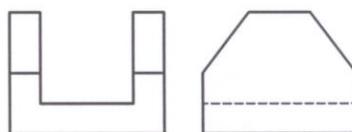


Fig. P3.97

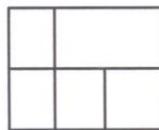


Fig. P3.98

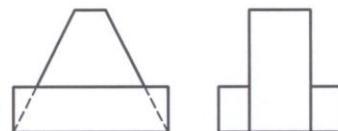


Fig. P3.99

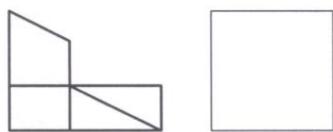
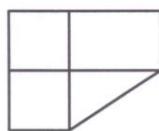


Fig. P3.100

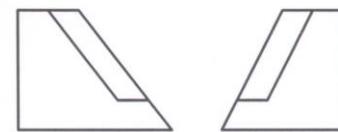


Fig. P3.101

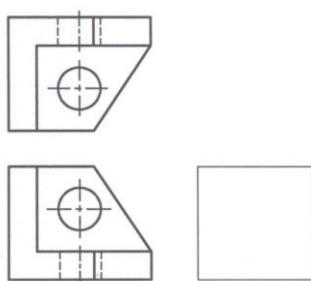


Fig. P3.102

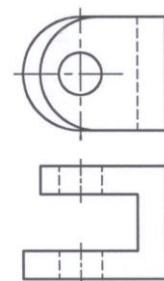


Fig. P3.103

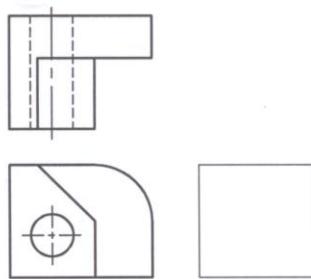


Fig. P3.104

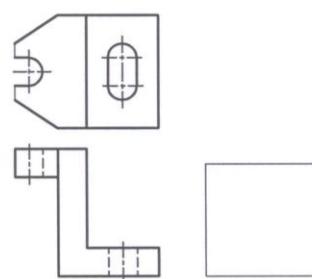


Fig. P3.105

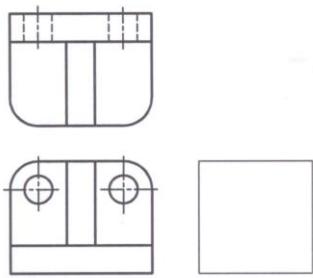


Fig. P3.106

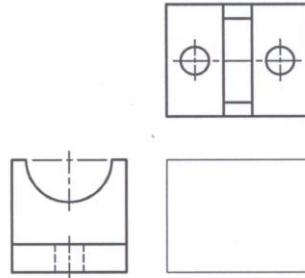


Fig. P3.107

Prob. P3.108 – P3.123: Draw the missing line/lines in the views as shown in Fig. P3.108 – P3.123.

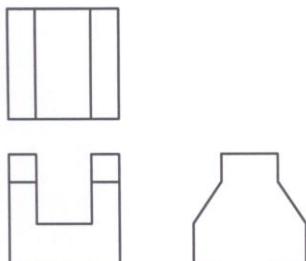


Fig. P3.108

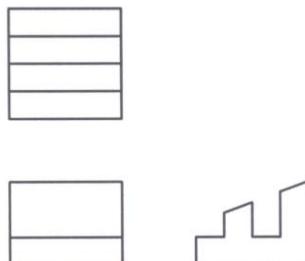


Fig. P3.109

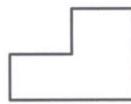
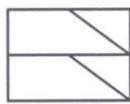
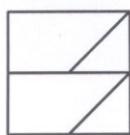


Fig. P3.110

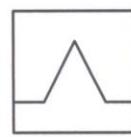
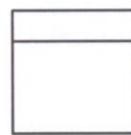


Fig. P3.111

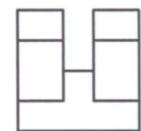
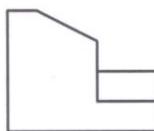
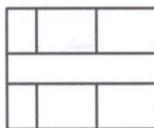


Fig. P3.112

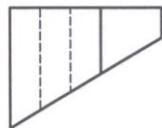


Fig. P3.113

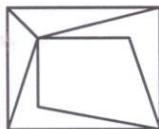


Fig. P3.114

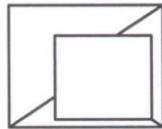


Fig. P3.115

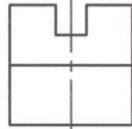
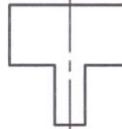
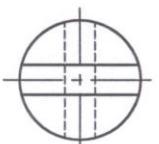


Fig. P3.116

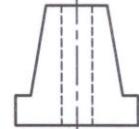
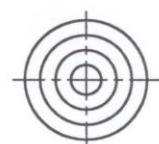


Fig. P3.117

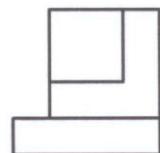
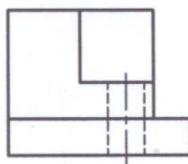
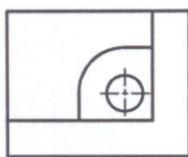


Fig. P3.118

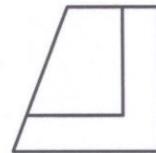
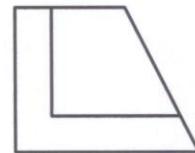
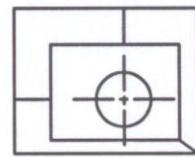


Fig. P3.119

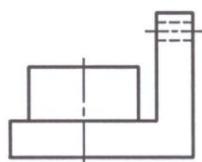
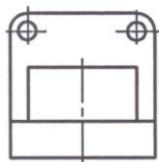
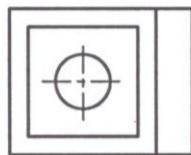


Fig. P3.120

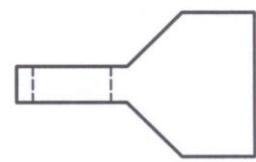


Fig. P3.121

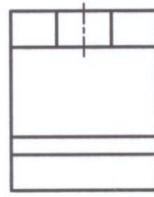
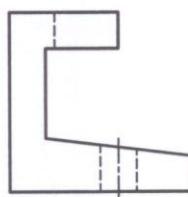
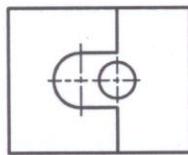


Fig. P3.122

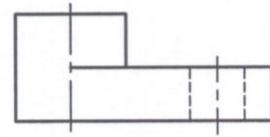
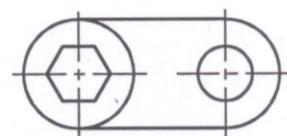


Fig. P3.123

Prob. P3.124: Draw the top, front and left side views of the V-slide as shown in Fig. P3.124.

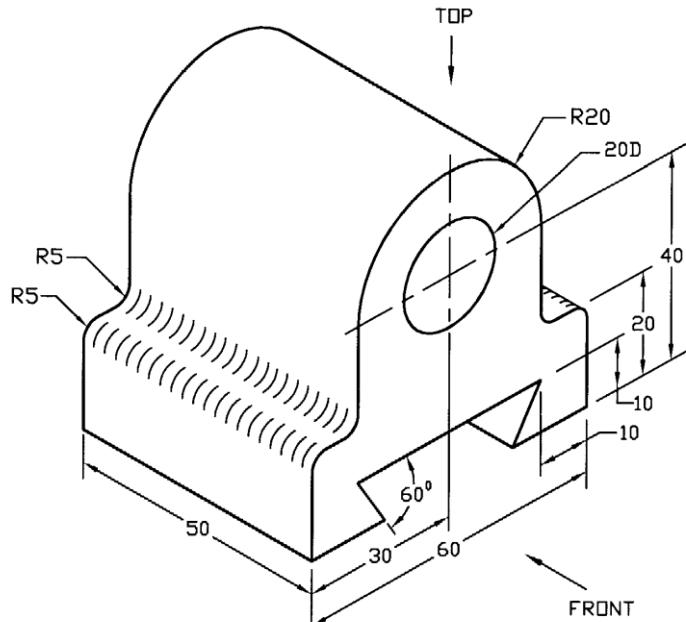


Fig. P3.124

Prob. P3.125: Draw the top, front and right side views of the hanger support as shown in Fig. P3.125.

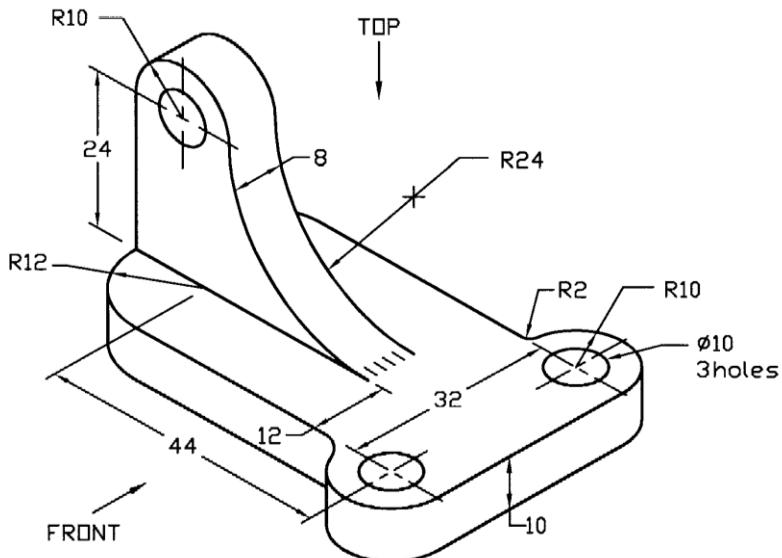


Fig. P3.125

Prob. P3.126: Draw the top, front and left side views of the wedge block as shown in Fig. P3.126.

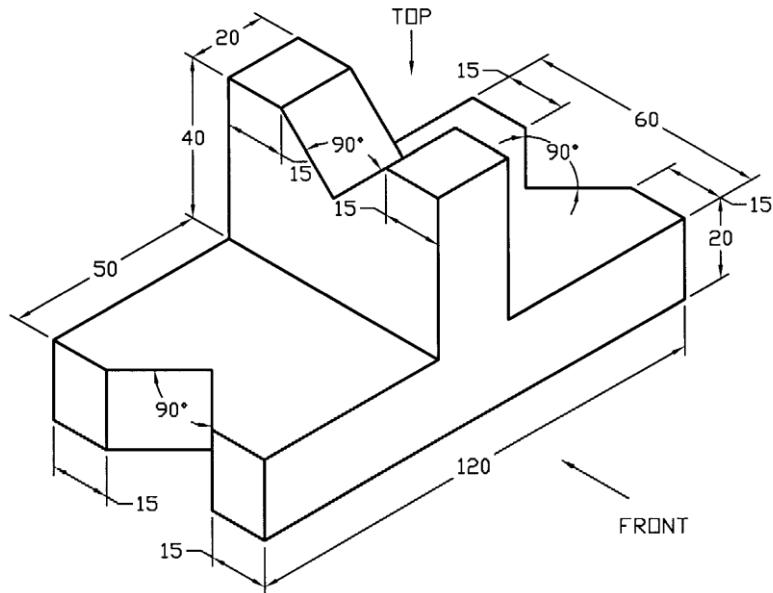


Fig. P3.126

Prob. P3.127: Draw the top and front views of the cylinder as shown in Fig. P3.127.

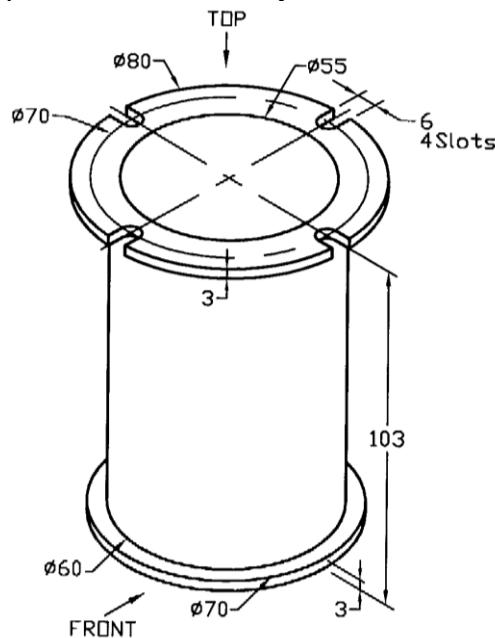


Fig. P3.127

Prob. P3.128: Draw the top, front and left side views of the bearing bracket as shown in Fig. P3.128.

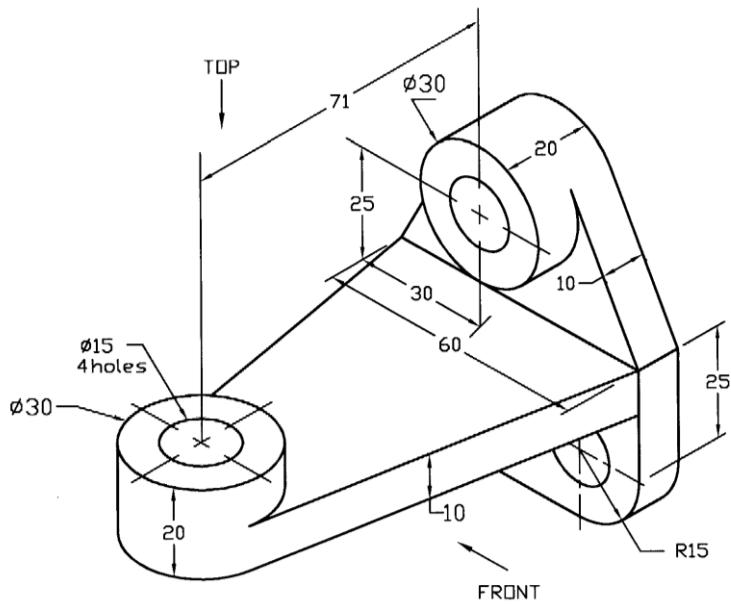


Fig. P3.128

Prob. P3.129: Draw the top, front and right side views of the support block as shown in Fig. P3.129.

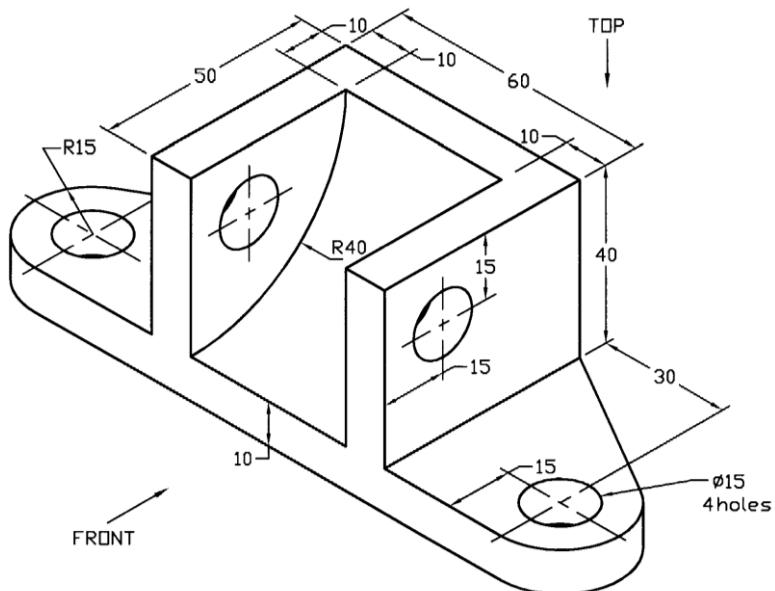


Fig. P3.129

Prob. P3.130: Draw the top, front and right side views of the bracket as shown in Fig. P3.130
(Fillet s are 3mm).

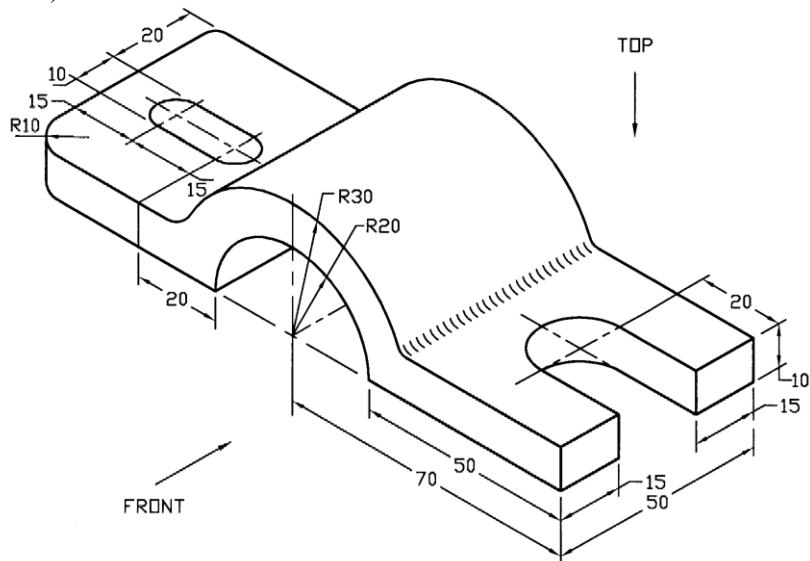


Fig. P3.130

Prob. P3.131: Draw the top, front and right side views of the bracket as shown in Fig. P3.131.

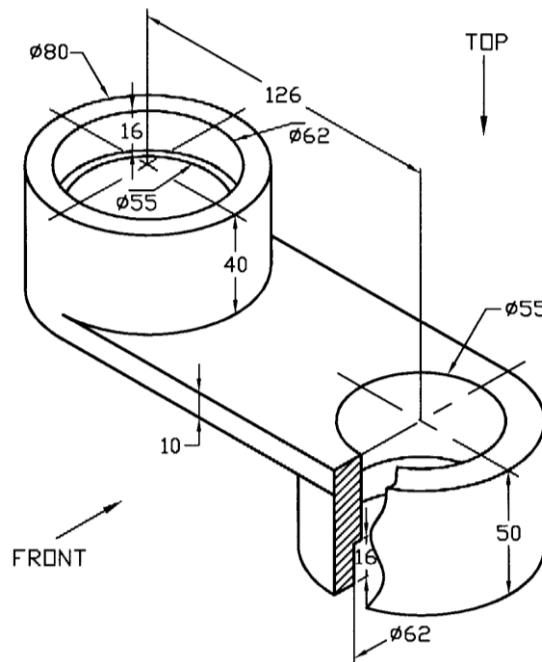


Fig. P3.131