Beginner's Guide

ENGINEERING DRAWING

Vol.1

Technical Drawing

Simple Notes & Practical Task

for Polytechnic Student

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First Publish in 2022

Publisher:

Techure Engineering (M) Sdn.Bhd.
No.11 Jalan 16/149L.
Sri Petaling. 57000 KUALA LUMPUR.

Editorial office:
Crystal Heights Education Sdn. Bhd (1262911-W)
No.26 Jalan 16/149L Sri Petaling 57000 Kuala Lumpur, MALAYSIA.

e ISBN 978-967-19793-6-5

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PREFACE

Focus of the book

This book provides brief notes and practical assignments according to the polytechnic's syllabus. The Focus of the book is to ensure that students who do not have a background in engineering drawing can achieve technical drawing skills.

Notes are also accompanied by exercises and practical tasks to improve students' cognitive and phycomotor levels.

Organisation of the book

The E-Book Engineering Drawing (Technical Drawing) focus on technical drawing following the order of in the syllabus Polytechnic. Each chapter provided examples and practical exercises that can aid comprehension and suitable for polytechnic student.

TABLE OF CONTENT

CHAPTER 1

INTRODUCTION TO TECHNICAL DRAWING

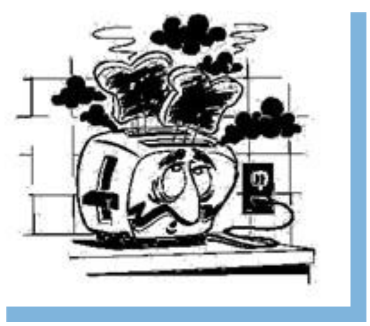
1.0 WHAT IS TECHNICAL DRAWING?

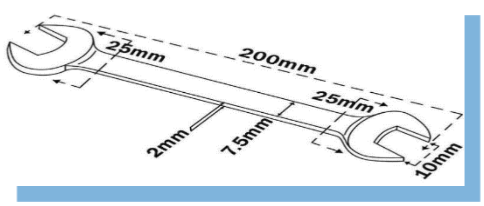
Technical drawings are graphic and technical communication tools. Early humans felt a need to represent the world (hunting scenes) to their peers. The appearance of technology gradually led humans to develop another use for drawing. It became a way to convey technical thought.

(Archimedes, Leonardo da Vinci).

The industrial revolution gave rise to graphic and communication tools, which facilitated the exchange of technical information between individuals. An international organization codified some of these graphic tools so that everyone could understand them.

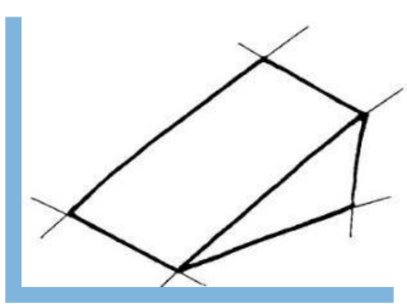
Artistic drawings convey an idea, feeling, mood or situation.



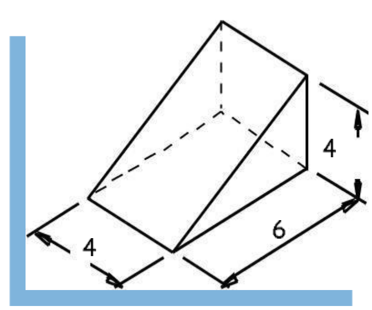


Technical drawings represent the exact shape, dimensions, and composition of an object with a view to its fabrication.

There are two types of drawings. The first is a drawing done without instruments, known as a sketch. The second is a drawing done with instruments, known as a final drawing.



Sketch



Final Drawing

Final drawing

Technical drawings are the common language of those who work in technology. Engineers, architects, designers, technologists, technicians, and specialized workers use them to communicate with each other.

1.1 TYPES OF TECHNICAL DRAWINGS

There are many types of technical drawings, including 3D drawing such as isometric drawing , exploded-view 3D drawings and complete working drawing.

- 3D drawings (isometric, perspective)
- Exploded-view 3D drawings
- Complete working drawings
- Detail drawings (2D orthogonal projections)
- Diagrams are another form of technical drawing with looser, less universal standards.

1.2 INSTRUMENTS AND THEIR USES

For the preparation of neat and scaled pencil drawings, good drafting instruments are to be used. A list of drawing instruments and material required for the same is given as follows:

Pencil

The general designation of a pencil is associated with alpha-numeric symbols such as 2H, 3H, HB, B, 2B, 3B, etc.

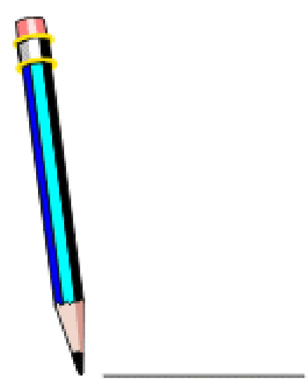


Figure 1.1 Pencil

T-square

A T-square is a tool used in technical drawing, primarily as a guide for drawing straight horizontal lines on a drafting table. It can also be used in conjunction with a set square to draw vertical and angled lines.

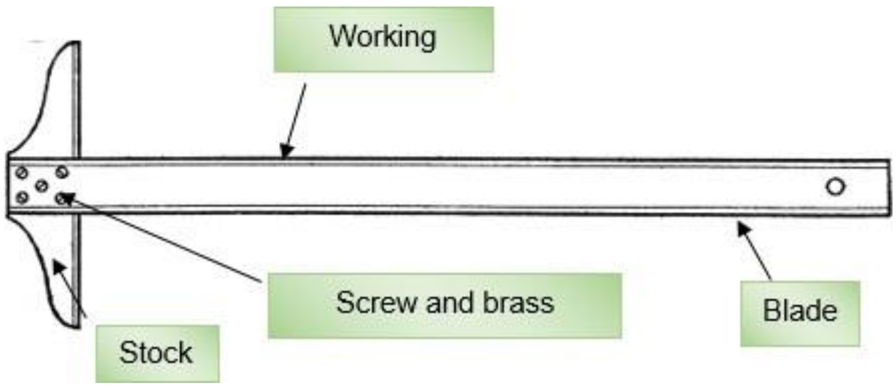


Figure 1.2 T-square

Set Squares

The 30^0-60^0 set square has three angles with the measures of 30^0, 60^0 and 90^0 respectively. Similarly, the 45^0 set square has three angles with the measures of 45^0, 45^0 and 90^0 respectively. Perpendicular lines or the lines at 30^0, 60^0 and 90^0 to the horizontal line can be drawn by using set squares.

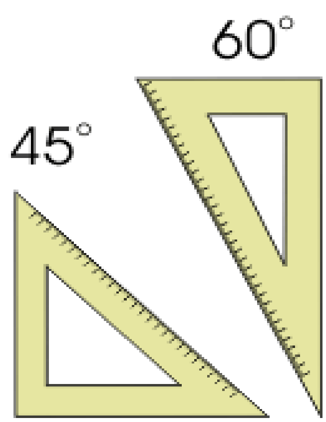


Figure 1.3 Set square

Compass

Compass is used for drawing circles and arcs of circles of required diameter. There are different types of compass available in the market depending upon their sizes, such as large size compass and small size compass.

- Circles up to 120 mm diameters are drawn by keeping the legs of compass straight.
- For drawing circles more than 150 mm radius, a lengthening bar is used.

It is advisable to keep the needle end about 1mm long compared to that of pencil end so that while drawing circles, when the needle end is pressed it goes inside the drawing sheet by a small distance (approximately 1mm).

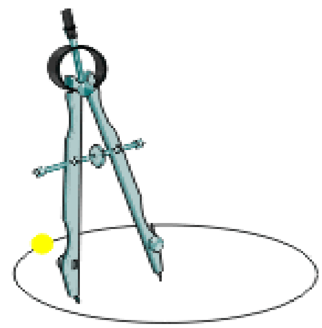


Figure 1.4 Compass

Drawing Board

The standard size of drawing board shown in Table 1.1

Table 1.1 Standard size of drawing board

Sl. No.	Designation	Size in mm (Length X width X thickness)	To be used with sheet sizes
1	D_0	1500x1000x25	**A_0**
2	D_1	100x700x25	**A_1**
3	D_2	700x500x15	**A_2**
4	D_3	500x350x15	**A_3**

Drawing sheet

Drawing sheets of different sizes are available. Figure 1.5 shows the drawing sheets of various sizes such as A0, A1, A2, A3, A4 and A5. The standard sizes of trimmed and untrimmed drawing sheets are given in the Table 1.

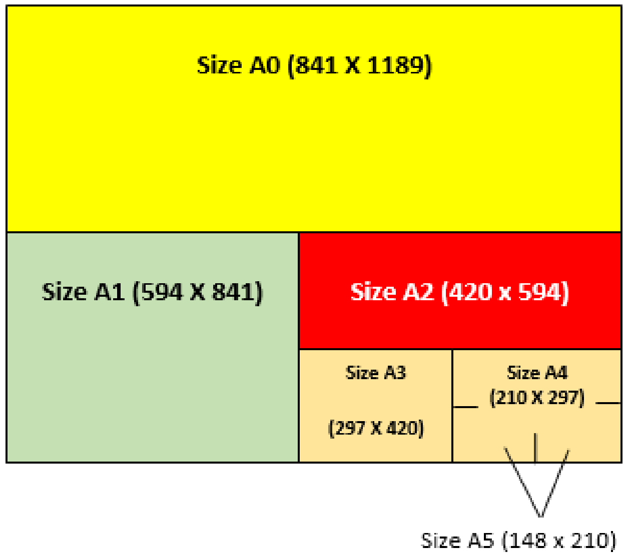
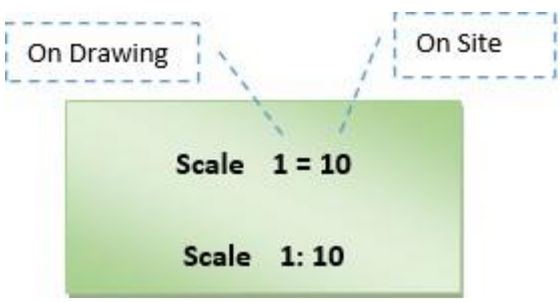


Figure 1.5 Standard size of drawing sheets according to I.S.I

Scales

Scales are used for measurement of lengths and distances on the drawing.



Full size scale	Reducing scale		Enlarging scale
1:1	1:2	1:25	10:1
	1:5	1:50	5:1
	1:10	1:100	2:1

The scales used in the engineering practice to:

a. Prepare or enlarge the drawing

b. Set off dimension

c. Measure distances directly

1.3 TYPES OF SYMBOLS IN ENGINEERING DRAWING.

1.3.1 Machining symbol

Symbol of basic indication of surface texture

Surface texture obtained by any manufacturing process (e.g., turning, grinding, plating, bending). During the design process, surface roughness symbols indicate what is required and efficiencies can be made during the machining process. Figure 1.6 shows basic symbol of surface texture.

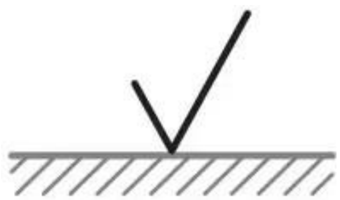
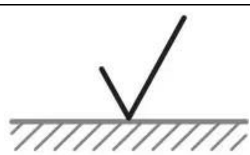
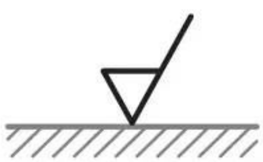
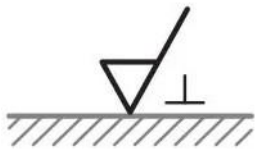
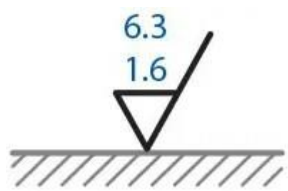
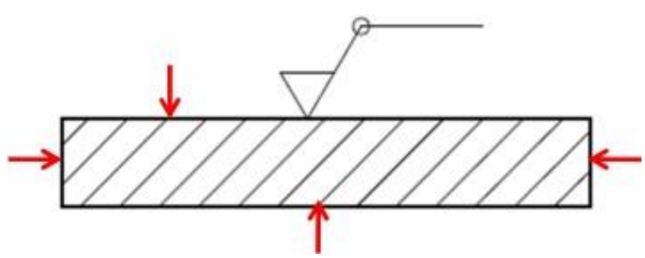


Figure 1.6 Basic symbol

Table 1.2 shows the types of surface texture symbols used for the machining process.

Table 1.2 Symbols of Surface Texture

	Surface texture obtained by any manufacturing process (e.g., turning, grinding, plating, bending)
	Symbol indicating a surface the **requires a removal process** and allowance indicated. Surface texture obtained by material removal by machining Operation (e.g., turning, drilling, Milling, slotting)

<table>
<tr><td></td><td>Removal processing is not allowed.</td></tr>
<tr><td></td><td>Symbol indicating a grain direction (lay).</td></tr>
<tr><td colspan="2"><u>Examples</u> indicating the Ra upper limit. This symbol shows maximum and minimum roughness values.
</td></tr>
<tr><td colspan="2"><u>Example</u> positions of Symbols
</td></tr>
<tr><td colspan="2">Symbol of indication of round surface texture
</td></tr>
</table>

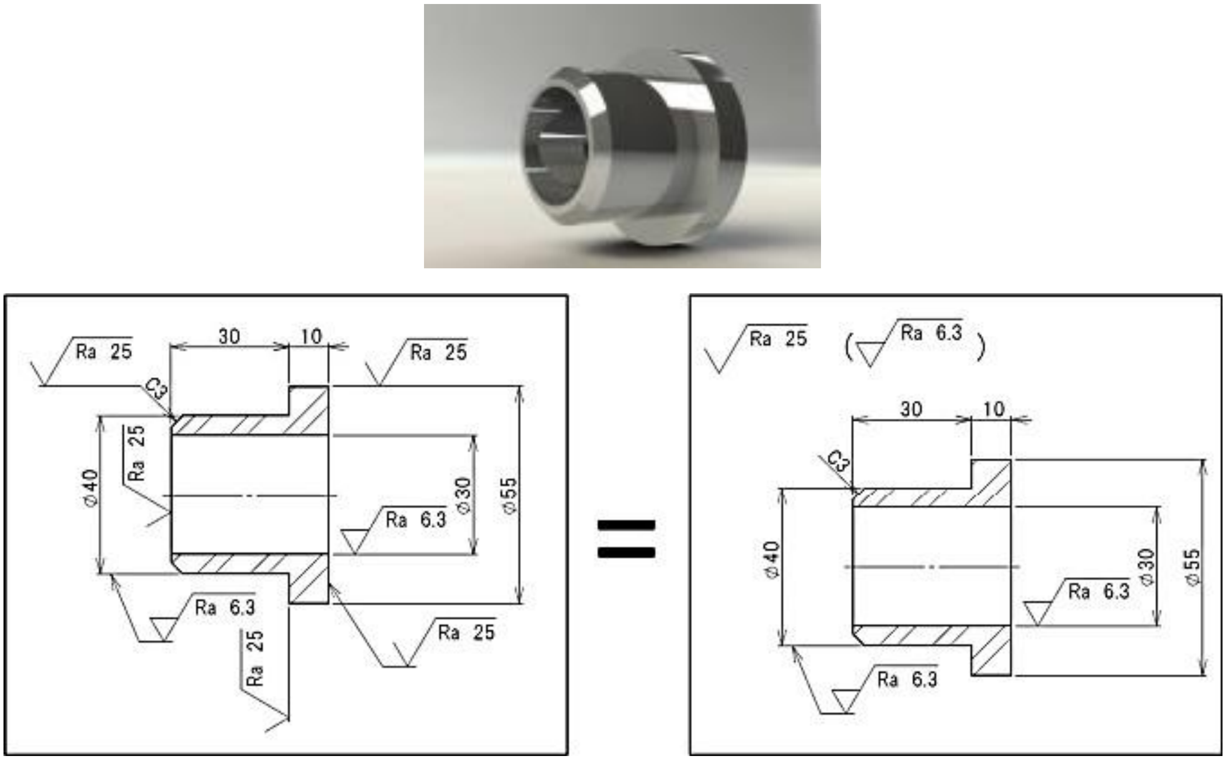


Figure 1.7 Simple indication of a part of which most of the surfaces in the drawing have the same surface texture.

Reference of Surface Texture

<table>
<tr><th>Ra(μ m)</th><th>Function</th><th colspan="2">Finishing</th></tr>
<tr><td>0.05</td><td>mirror surface</td><td colspan="2">lapping</td></tr>
<tr><td>0.1</td><td rowspan="2"></td><td colspan="2" rowspan="2">emery paper</td></tr>
<tr><td>0.2</td></tr>
<tr><td>0.4</td><td>surface for sliding O−ring</td><td rowspan="4">fine machining</td><td></td></tr>
<tr><td>0.8</td><td>surface for O−ring flange</td><td rowspan="3">electrical discharge machining</td></tr>
<tr><td>1.6</td><td rowspan="2"></td></tr>
<tr><td>3.2～6.3</td></tr>
<tr><td>10</td><td>fits</td><td colspan="2" rowspan="3">normal machining</td></tr>
<tr><td>12.5～25</td><td rowspan="2"></td></tr>
<tr><td>50</td></tr>
</table>

1.3.2 Welding Symbols

Welding symbols, when properly applied to drawings and, as importantly, when correctly interpreted, offer a potentially convenient way of controlling the welding of a particular joint. This point focuses on those welding symbols associated with typical applications with ASME Code items.

Position of Weld Symbols on Drawing

The complete method of representation of the welds on the drawing comprises, in addition to the symbol, the following Figure 1.8.

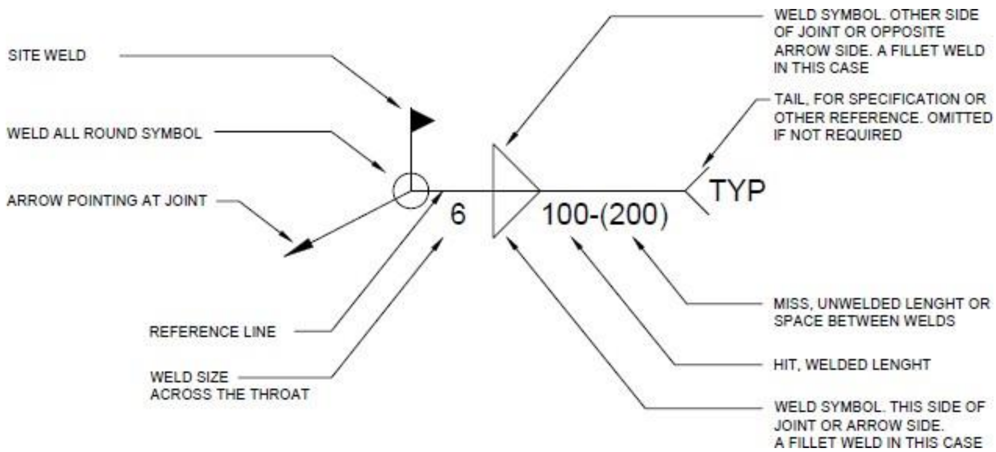


Figure 1.8 Welding Symbols on Drawing

The Arrow

The first element of a welding symbol to consider is the arrow. The arrow is an essential part of every welding symbol and must point to the joint to be welded. The stem of the arrow should not be a horizontal line on the drawing. The side of the joint to which the arrow points is, by definition, the "arrow side" of the joint, and the opposite side of the joint is the "other side" of the joint (Figure 1.9).

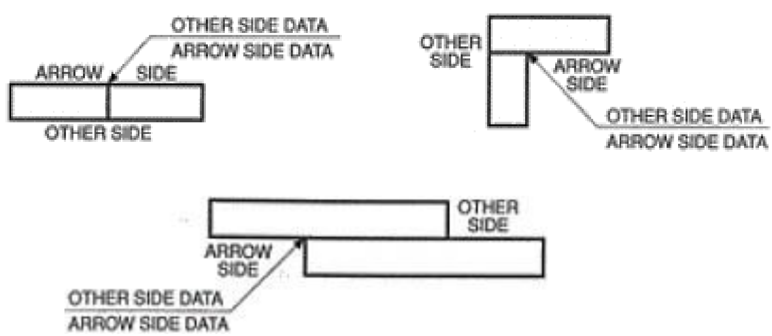


Figure 1.9 Arrow point of welding symbol

The Reference Line

Another essential part of all welding symbols is the reference line, which is a straight line, drawn horizontally on a drawing, and connected to the arrow. The arrow may be connected to either end of the reference line (Figure 1.8).

The Tail

A third element to be considered is the "tail" of the welding symbol. The tail is drawn as a greater-than (>) or less-than (<) symbol, connected at the end of the reference line opposite the arrow. Information for which there is no specific provision elsewhere in the symbol is placed to the left or right of the tail as appropriate.

Groove Welds

Additional information may be included in a welding symbol, even if also included in a WPS. For example, V-, U-, bevel-, or J-groove welds may be specified to provide increased weld size in each joint, compared to that obtainable with a square-groove weld. The choice is usually made based on cost for the completed weld. A groove-weld symbol may be added to a welding symbol, below the reference line, to specify a weld only on the "arrow side" of the joint (single weld); above the reference line, to specify a weld only on the "other side" of the joint (also a single weld); or weld symbols may be added both below and above the reference line, to specify a double weld (Figure 1.10)

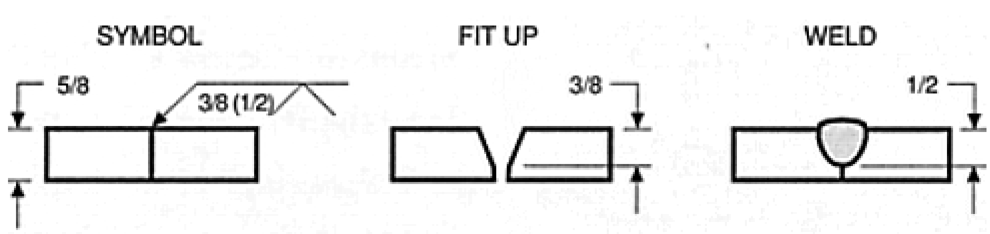


Figure 1.10 Groove-weld symbol

Checkout list of such weld symbols refer to table 1.3 given below.

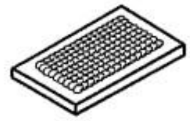
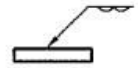
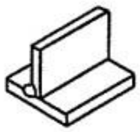
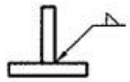
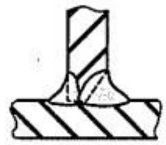
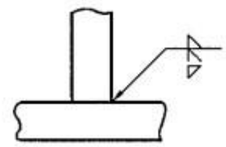
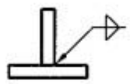
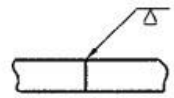
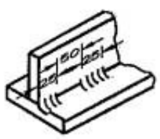
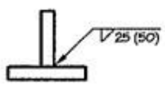
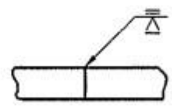
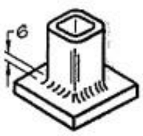
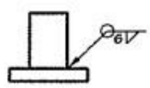
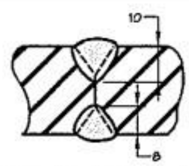
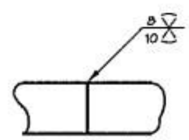
Table 1.3 Table of elementary welding symbols

BASIC GAS AND ARC WELDING SYMBOLS	
	FILLET
	BEAD
	GENERAL BUTT
	SQUARE BUTT
	SINGLE BEVEL BUTT
	SINGLE VEE BUTT
	SINGLE 'U' BUTT
	SINGLE 'J' BUTT
	PLUG OR SLOT
	STUD
	SURFACING

REISITANCE WELDING SYMBOLS	
	SPOT
	SEAM
	MASH SEAM
	STICH
	MASH STICH
	PROJECTION
	FLASH BUTT
	RESISTANCE BUTT

SUPPLEMENTARY WELDING SYMBOLS	
	WELD ALL ROUND
	FLUSH CONTOUR
	WELD ON SITE
	BACKING STRIP OR BAR
	FLUSH SURFACE FINISH
	CONVEX SURFACE FINISH
	CONCAVE SURFACE FINISH
	BACKING WELD RUN
TYP	TAIL, FOR NOTES

Table 1.4 sample of welding symbols as they would appear on a drawing.

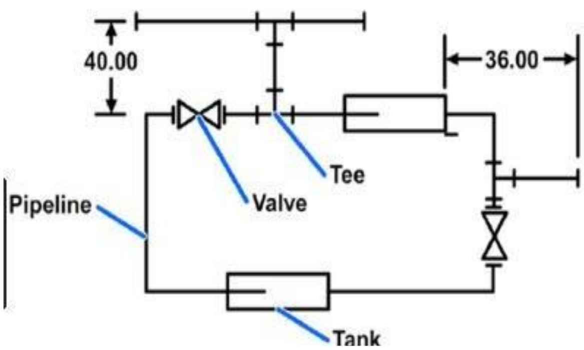
Sketch of welding	Symbolic representation	Sketch of welding	Symbolic representation
			
			
			
			
			

1.3.3 Piping Symbols

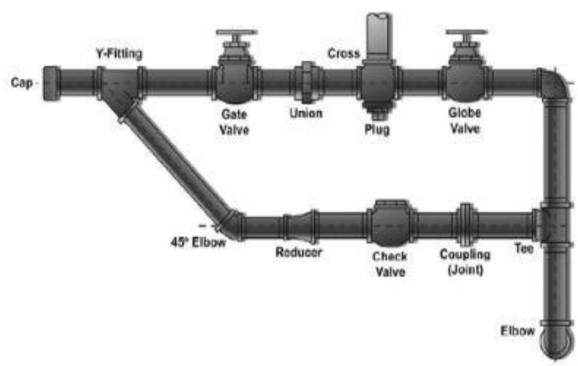
The two types of projection used in plumbing and piping diagrams are projection orthographic and isometric (pictorial).

Orthographic pipe drawings show single pipes either straight or bent in one plane only. Orthographic pipe drawings may be single-line drawings where you draw the center line of the pipe as a thick line and add valves and fittings, or double-line drawings where you draw each valve and fitting. Use the single-line method when speed is essential. Double-line drawings are generally used in applications, such as catalogs, where visual appearance is more

important than drawing time. Orthographic pipe drawings are sometimes used on more complicated piping systems. Figure 1.11 shows an example of a single-line and a double-line orthographic piping drawing.



Single-line orthographic piping drawing



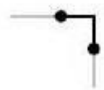
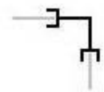
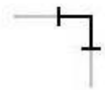
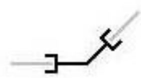
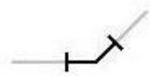
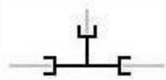
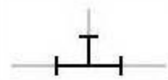
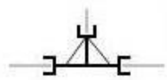
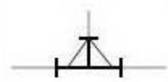
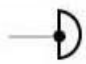
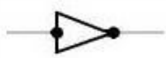
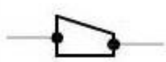
Double-line orthographic piping drawing

Figure 1.11 single-line and a double-line orthographic piping drawing

Various symbols are used to indicate piping components, instrumentation, equipment in engineering drawings such as Piping and Instrumentation Diagram (P&ID), Isometric Drawings, Plot Plan, Equipment Layout, Welding drawings etc.

Checkout list of such symbols from table 1.4 given below.

Table 1.4 Piping Symbols

Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image
	Elbow 90°				Elbow 90°	
	Elbow 45°				Elbow 45°	
	Tee equal				Tee equal	
	Tee reducing				Tee reducing	
	Cap				Cap	
	Reducer concentric		...	...	Reducer concentric	...
	Reducer eccentic		...	...	Reducer eccentic	...
Image	Fittings	Butt weld Symbol	Socket Weld Symbol	Threaded Symbol	Fittings	Image

Note: Symbols are shown in black lines. Lighter lines show connected pipe and are not parts of the symbols.

1.5 Dimensioning

A drawing describes the shape of an object. For complete details and object, its size description is also required. The information like distance between surface and edges with tolerance, location of holes, machining symbols, surface finish, type of material, quantity, etc. is indicated

on the drawing by means of lines, symbols, and notes. The process of furnishing all this information on a technical drawing as per a code of practice is called *dimensioning.*

1.5.1 Elements of dimensioning

The following are the elements of dimensioning:

1. Projection line
2. Dimension line
3. Leader line
4. Termination of dimension line
5. Dimensional text

These elements of dimensioning are shown in Figure 1.12.

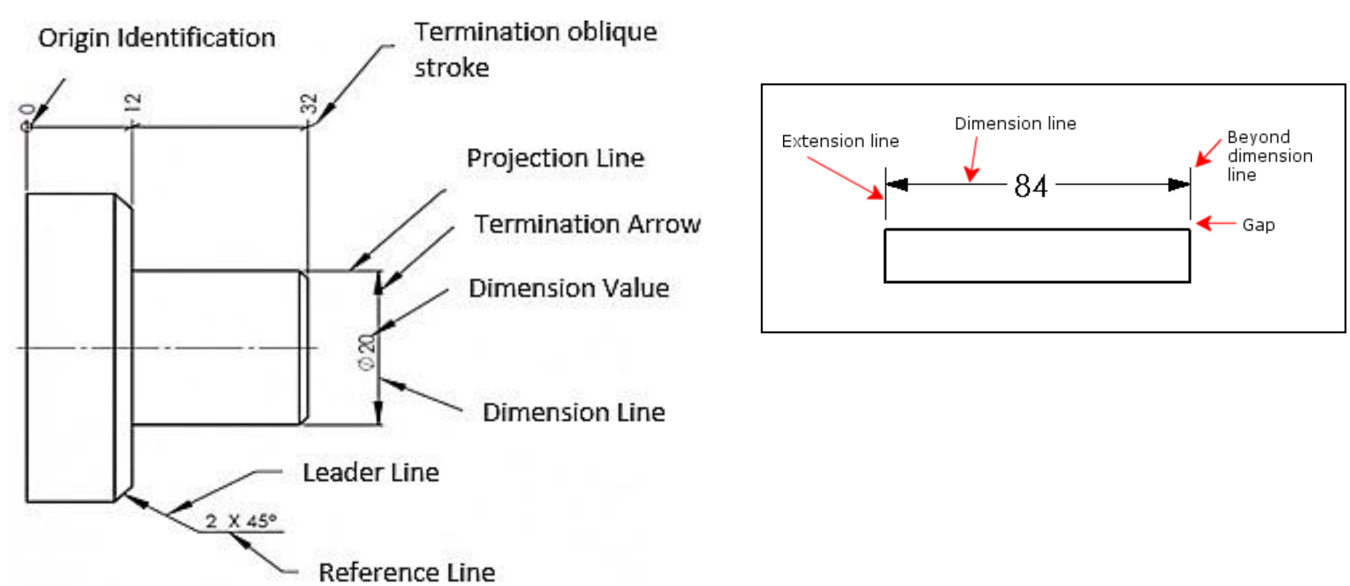
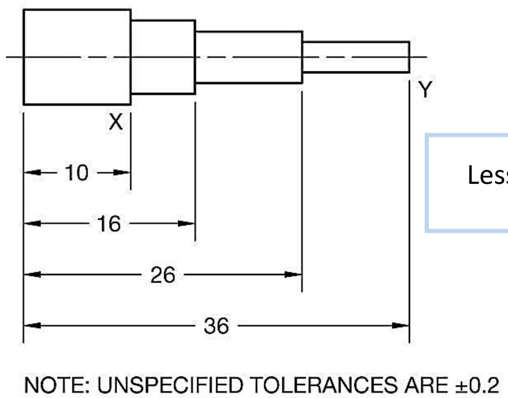


Figure 1.12 Elements of Dimensioning

Baseline Dimensioning

Size or location of features controlled from a common reference plane. Reduces possibility of tolerance stacking.

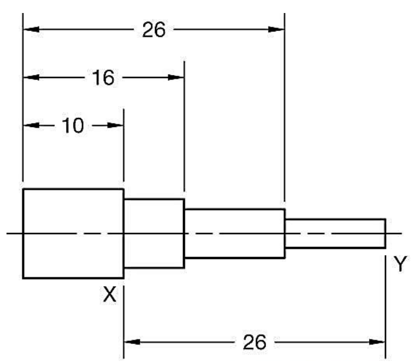


Less tolerance accumulation between X and Y

Figure 1.13 Baseline Dimensioning

Direct Dimensioning

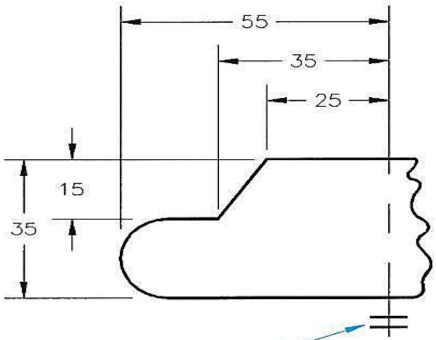
Results in the least tolerance stacking



Least tolerance accumulation between X and Y

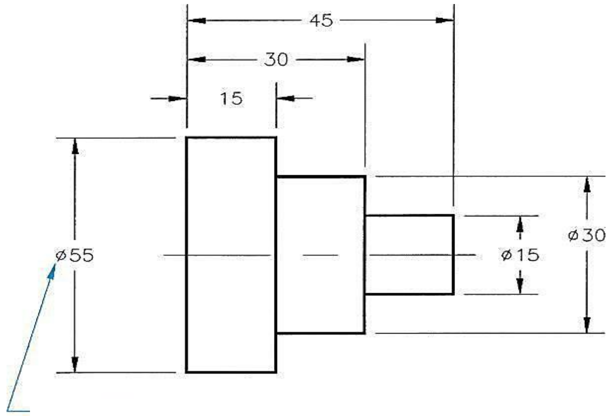
Figure 1.14 Direct Dimensioning

Dimensioning Symmetrical Object



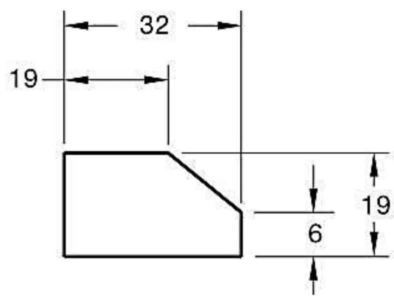
Symmetrical Symbol

Dimensioning Cylinders

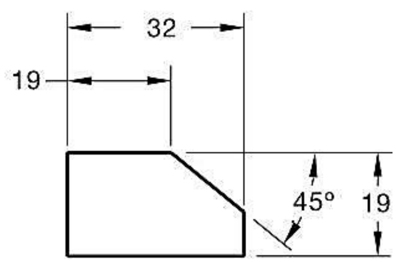


Diameter Symbol

Dimensioning Angular Surfaces

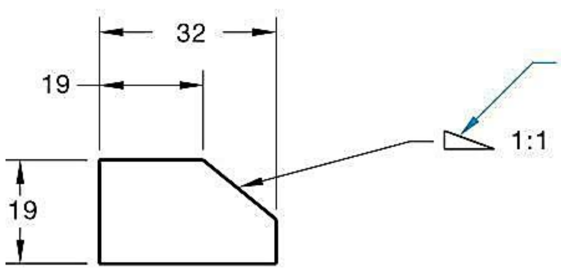


Coordinate Method

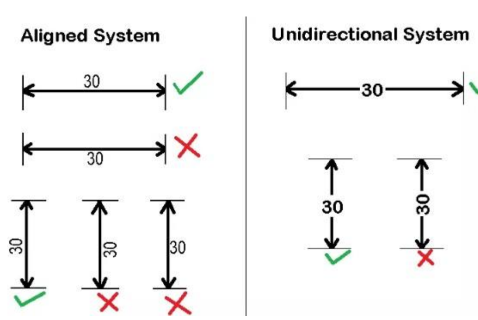


Angular Method

Flat Taper Symbol



Flat Taper Note



Exercise 1

1. A T-square is used for drawing

   a) Horizontal lines c) vertical lines

   b) inclined lines d) Lines at any angle

2. Which statement is true?

   a) 2H pencil is harder and lighter than 2B c) 2H pencil is harder and darker than 2B

   b) 2H pencil is softer and lighter and 2B d) 2H pencil is softer and darker and 2B

Exercise 2

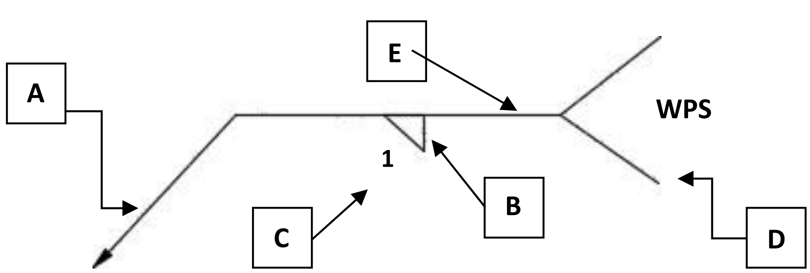
1. In a title block there is a title box with the heading 'size' in it. If size 'A3' is printed in this box, what information is being given?

2. The 'scale' box has the notation 1:2 in it. What information is being indicated here?

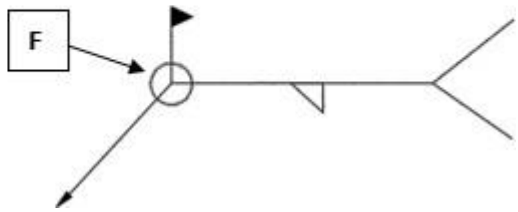
3. The 'scale' box has the notation 5:1 in it. What information is being indicated here?

4. Name A, B, C, D, E, and F.

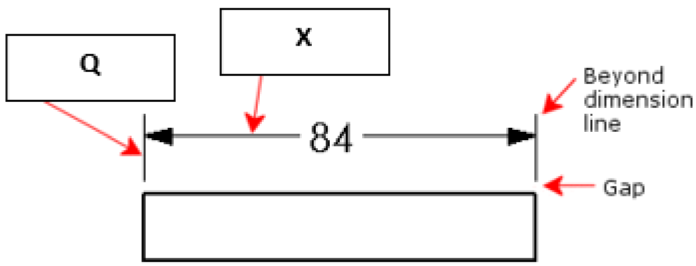
(i)



(ii)



4. Name Q and X



CHAPTER 2

GEOMETRICAL DRAWING

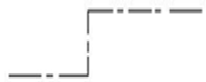
This chapter is concerned with the construction of plane geometric figures. Plane geometry is the geometry of figures that are two-dimensional, i.e., figures that have only length and breadth. Solid geometry is the geometry of three-dimensional figures. There are an endless number of plane figures, but we will concern ourselves only with the more common ones – the triangle, the quadrilateral, and the better-known polygons.

2.1 LINES

Various types of lines used in general engineering drawing.

Table 2.1 Convention of various types of lines and thickness

Appearance	Name of a line	Application of the line
	Continuous thick straight line	Drawing the main outline of the object
	Continuous thin straight line	Dimension lines, Extension (Projection) lines, Leader lines, hatching, short center lines.
	Continuous thick straight with zigzags (long break line).	When a part is wide and long such that its length cannot be accommodated on the sheet, it is shown broken by this type of line.
	Dashed thick line	Showing hidden edges
	Dashed thin line	Also, for showing hidden edges. Use either thick or thin line but use any one type in one drawing.
	Continuous thin wavy line (short break line)	Limit of partial interrupt. When a part is narrow and long and that it cannot be completely shown, use this type of line for intermediate break.
	Center Line (Chain thin)	Drawing symmetrical objects. Objects are symmetrical about this axis.

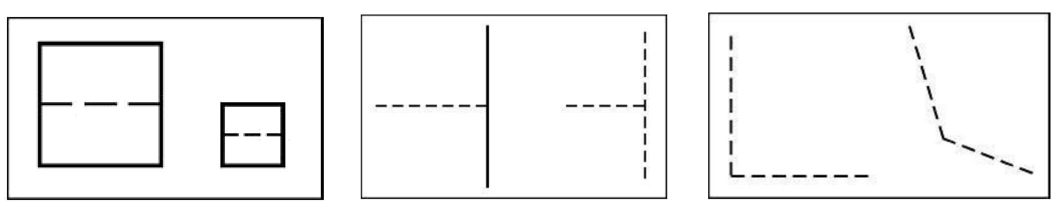
	Chain thin, thick at ends and corners	Showing cutting planes. If the cutting plane is straight, only a thin straight chain line with thick ends is shown.
	Chain thick	Lines or surfaces of special requirement.

LINE CREATION AND USE

Hidden Lines

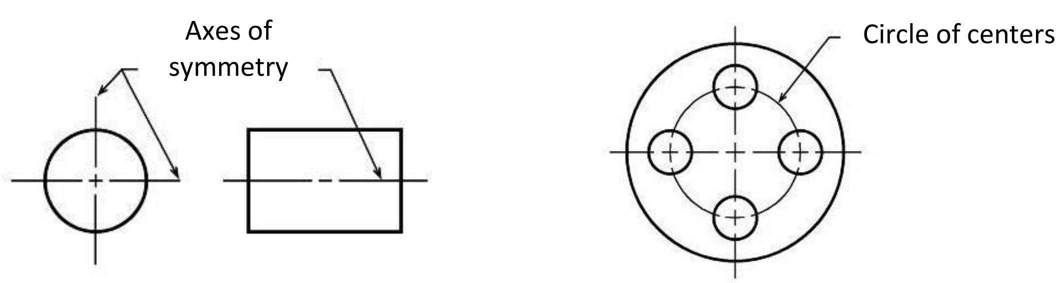
Hidden lines represent edges and boundaries that cannot be seen

- The length of the hidden line dashes may vary slightly as the size of the drawing changes.
- Hidden lines should always begin and end with a dash.
- Dashes should join at corners.

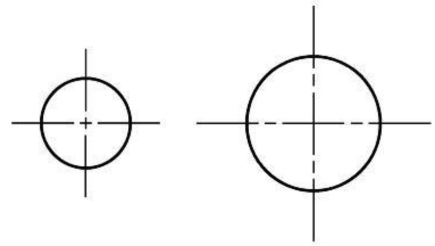


Center Lines

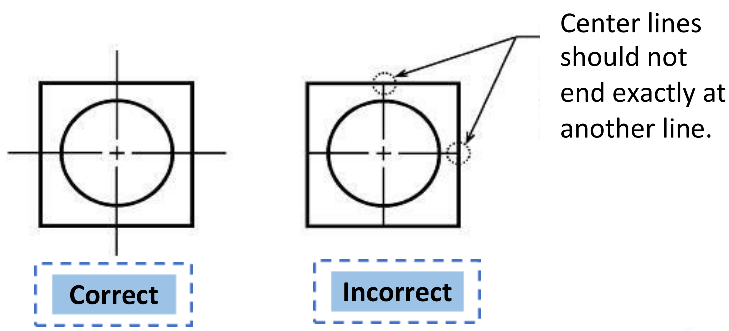
Center lines represent axes of symmetry. They are also used to indicate circle of centers and paths of motion.



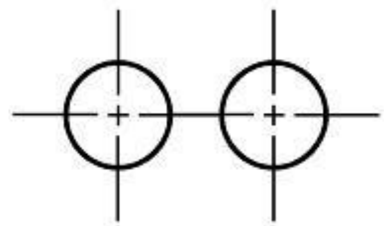
- Center lines should start and end with long dashes.
- Center lines should intersect by crossing either the long dashes or the short dashes.



- Center lines should extend a short distance beyond the object or feature.



- Center lines may be connected within a single view to show that two or more features lie in the same plane. Center lines should not extend through the space between views.



2.1 DRAWING SHEETS AND TITLE BLOCK

Drawing sheets are white papers of good quality used for the preparation of pencil drawings. One of the surfaces of the drawing sheet is usually smooth. This smooth surface is used for drawing.

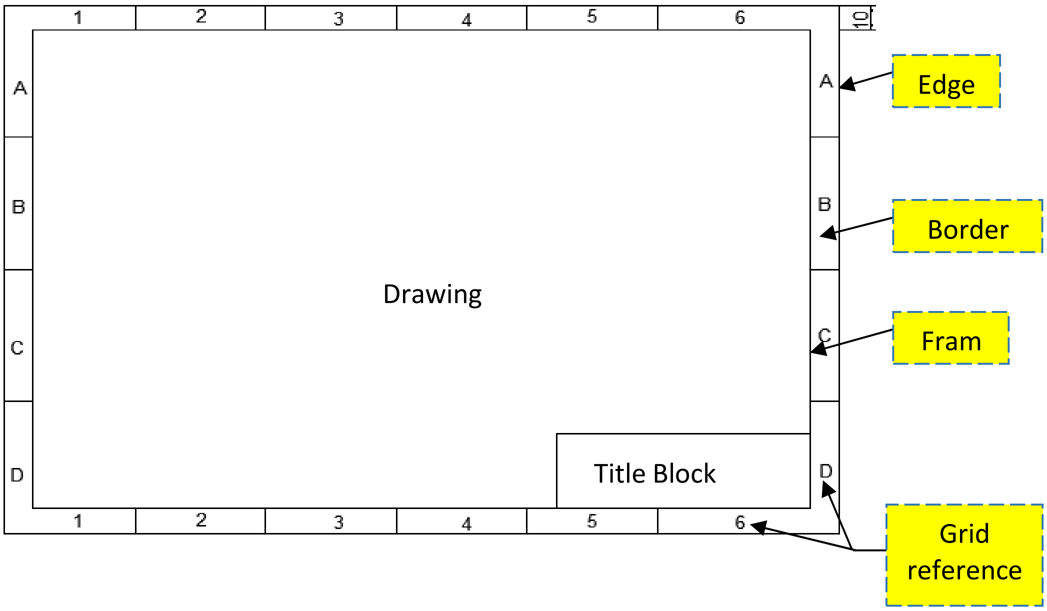


Figure 2.1 General features of a drawing sheet

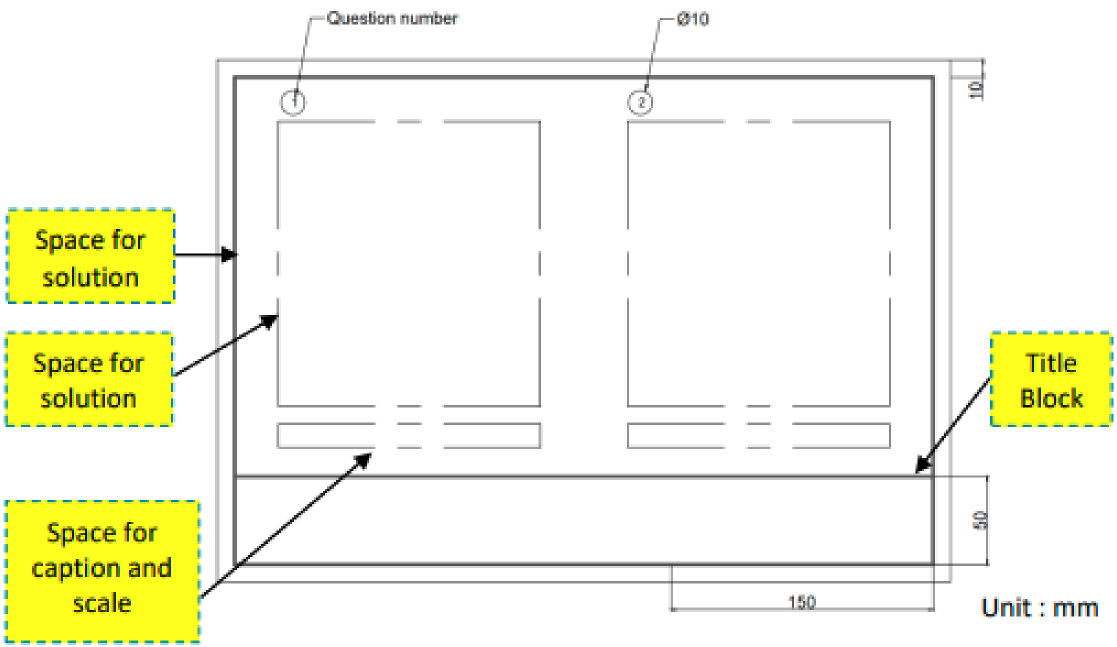


Figure 2.2 Layout of drawing sheet for class work.

TITLE BLOCK

A title block is normally drawn at the *bottom* right –hand of the drawing sheet and it should be visible when prints are folded. Inside the title block is printed important information such as *Name, Title and Date.*

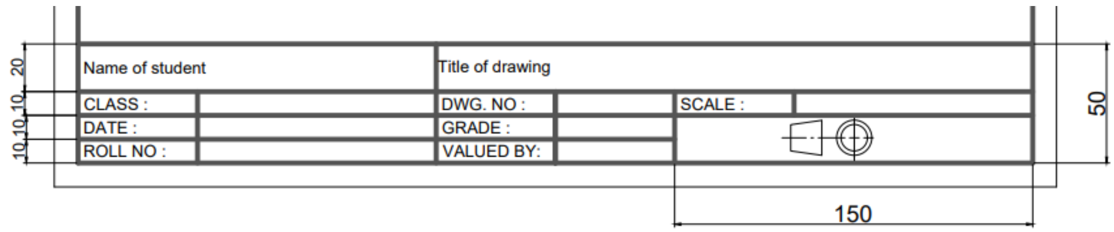


Figure 2.3 Layout of the title block for class work.

The measurements for the drawing paper sheets shown in **table 2.2.**

Table 2.2 Paper size

Paper size	Border width (mm)		Dimensions of drawing sheets (mm)
	Both sides	Top and bottom	
A0	20	20	1189 X 841
A1	20	20	841 x594
A2	10	10	594 x 420
A3	10	10	420 x 297
A4	10	10	297 x 210

Note: The sides of metric drawing paper sheets are in the ratio of 1: √2. Area of the A0 size = $1m^2$

LETTERING

Lettering is an important part of engineering drawing. It gives information regarding size, and instructions, in the form of notes and dimension. The writing of alphabets and numerals such as A, B, C, D………Z and 1, 2, 3……9, 0 respectively is called **Lettering**. Mainly, there are two types of lettering most used in engineering drawing. Gothic Lettering and Roman Lettering.

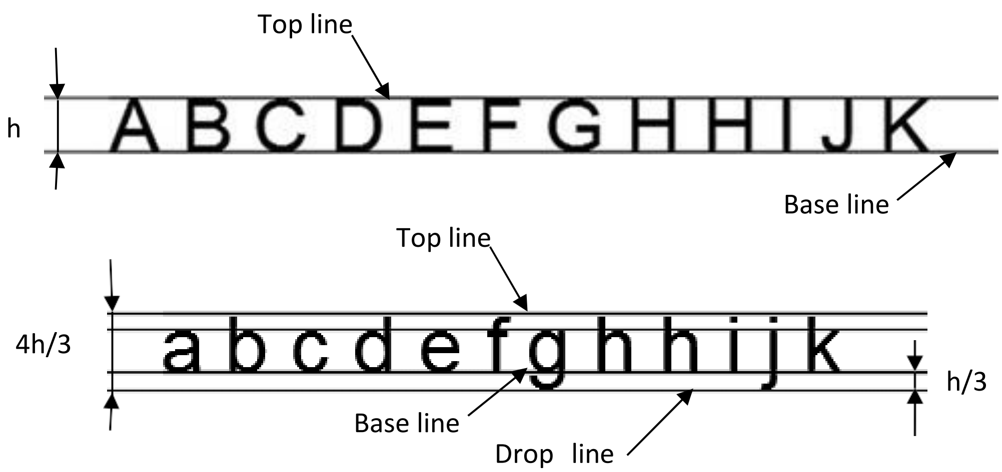


Figure 2.4 Guidelines

Height Of Lettering

The height **"h"** of the capital letter is taken as the base of dimensioning. All letters should be capital, except where lower case letters are accepted internationally for abbreviations.

Table 2.3 shown that the recommended size of lettering.

Table 2.3 Size of lettering

ITEM	SIZE h (mm)
Drawing number in Title Block and letters denoting Cutting Plane Section	**10, 12**
Title of Drawing	**6, 8**
Sub-titles and Headings	**3, 4, 5, 6,**
Notes, such as Legends, Schedules, Material list, Dimensioning	**3, 4, 5**
Alteration, Enteries and Tolerances	**2, 3**

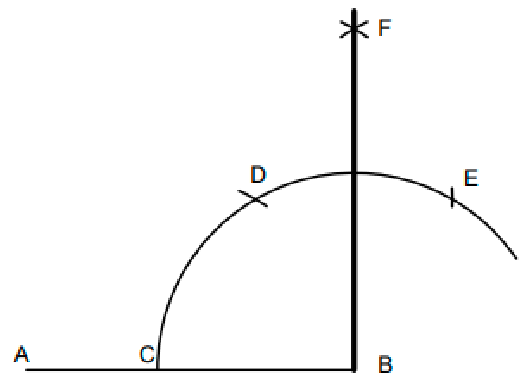
2.3 GEOMETRICAL DRAWING

In course of engineering drawing, it is of often necessary to make certain geometrical constructions to complete an outline. The following basic constructions are given for reference.

To draw a perpendicular from the end of a line

AB is the given line.

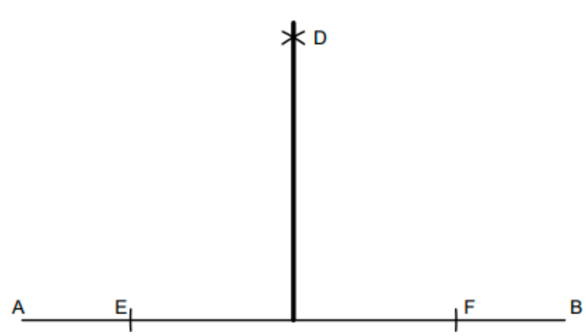
1. With center B and radius less than AB, draw an arc to intersect AB at C.
2. From C, and with the same radius, mark off D; from D, and with the same radius, mark off E.
3. From D and E draw any two equal arcs to intersect at F.
4. Join BF to give the required perpendicular.



To draw a perpendicular from a point in a line (*method 1*)

AB is the line, and C is the point on it.

1. With center C and any radius, draw equal arcs to cut AB at E and F.
2. From E and F describe equal arcs to intersect at D.
3. Join CD to give the required perpendicular.

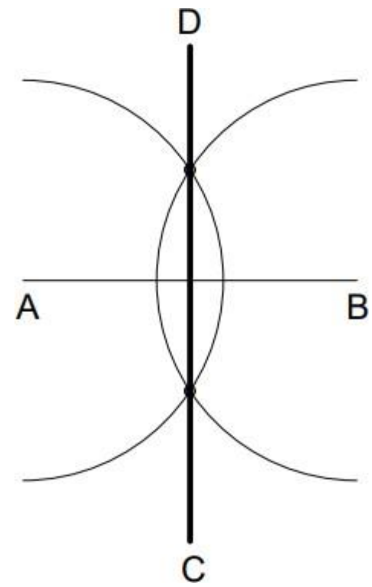


C

To draw a perpendicular from a point in a line (*method 2*)

AB is the given line.

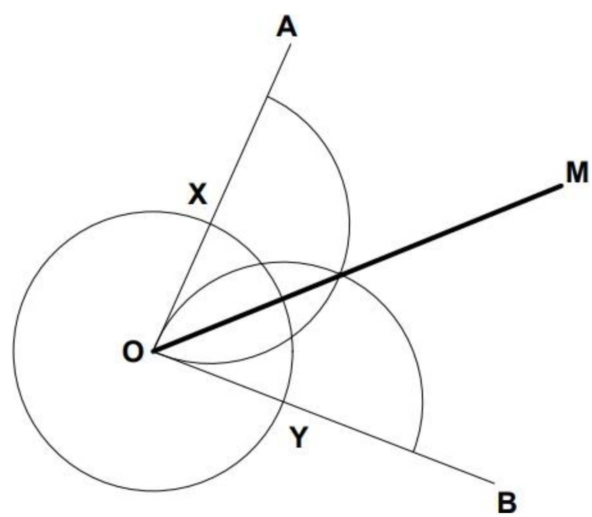
1. From point A and B describe an equal arc to cut AB.
2. Draw equal arcs to intersect at C and D.
3. Join CD to give the required perpendicular.



To bisect a given angle

AOB is given angle.

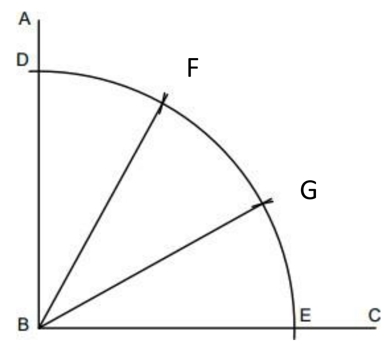
1. From O draw an arc or circle to cut OB and OA at X and Y respectively.
2. With centers X and Y, draw equal arcs to intersect at M.
3. Join OM, the required bisector of the angle.



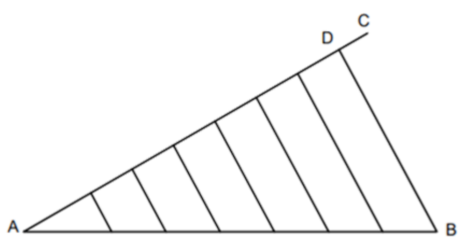
To trisect a right angle

ABC is the given right angle.

1. With center B and any radius, construct arc DE.
2. From D and E and with the same radius, mark off F and G respectively on arc DE.
3. Join FB and GB to trisect the right angle.



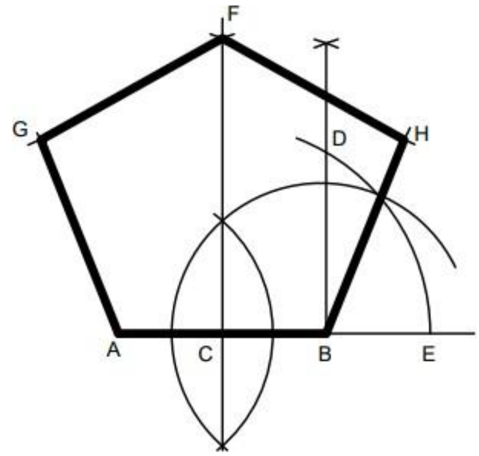
To divide a line into any number of equal parts, say six



AB is the given line.

1. Draw AC at an angle of approximately 30^0 to AB.
2. Mark along AC six equal lengths, each approximately equal to one-sixth of AB.
3. Join the sixth mark, D on AC, to B.
4. Using sliding set square, draw lines parallel to DB from the points of division on AC to intersect AB and give the required points of division.

To construct a regular pentagon on a given line



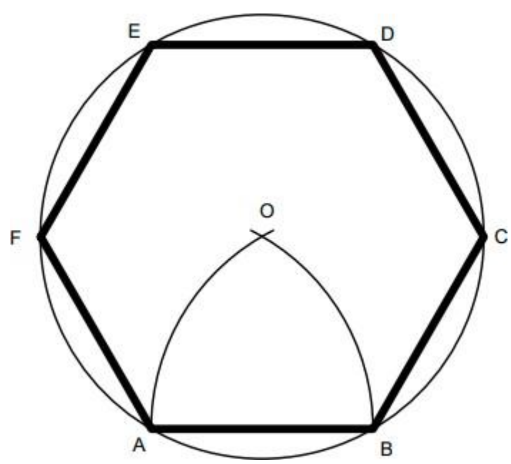
AB is the given line.

1. Bisect AB at C
2. Erect a perpendicular at B (construction 5mm), and mark off BD equal to AB.
3. With C as center and radius CD, draw an arc to intersect AB produced at E.
4. From A and B, and with radius AE, draw arcs to intersect at F.
5. With radius AB and centers A, B and F, draw arcs to intersect at G and H.
6. Join FG, GA, FH, and HB to complete the pentagon.

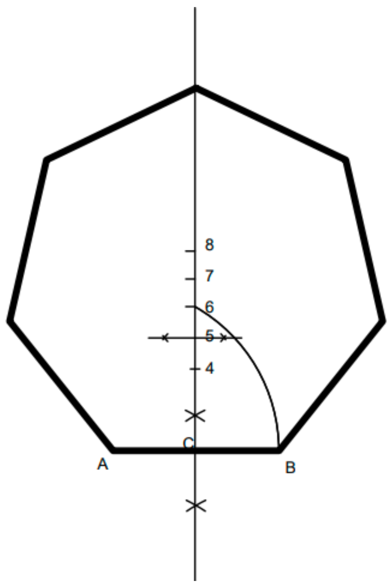
To construct a regular hexagon on a given line

AB is the given line.

1. From A and B, and with radius AB draw two equal arcs to intersect at O.
2. With radius OA or OB and center O, draw a circle.
3. From A or B, using the same radius, step off arcs around the circle at C, D, E, and F.
4. Join these points to complete the hexagon.



To construct heptagon, given side length



AB is the given line.

1. Bisect AB at C. Along the bisector marks off C4 equal to AC.
2. With center A and radius AB, draw an arc to intersect the bisect at 6.
3. Bisect distance 4-6 to give 5.
4. Add distance 4-5 to 6 to give 7 and so on.

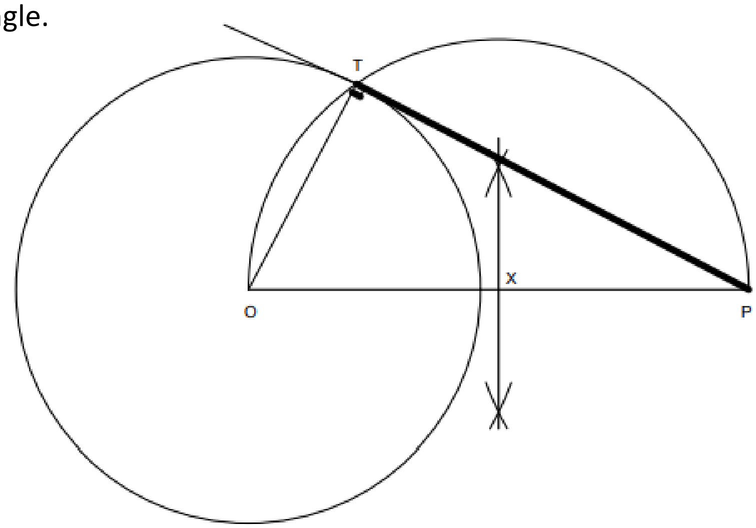
   These points are the centers of circles around which AB will step that number of times.
5. With center 7 and radius 7A, draw a circle. Step AB around seven times and join the points to give a heptagon.

To draw a tangent to a circle from an outside point

O is the center of the given circle, and P is the point outside it.

1. Join OP, and bisect OP at X.
2. Draw a semicircle on OP to intersect the given circle at T. Join PT to give the required tangent.

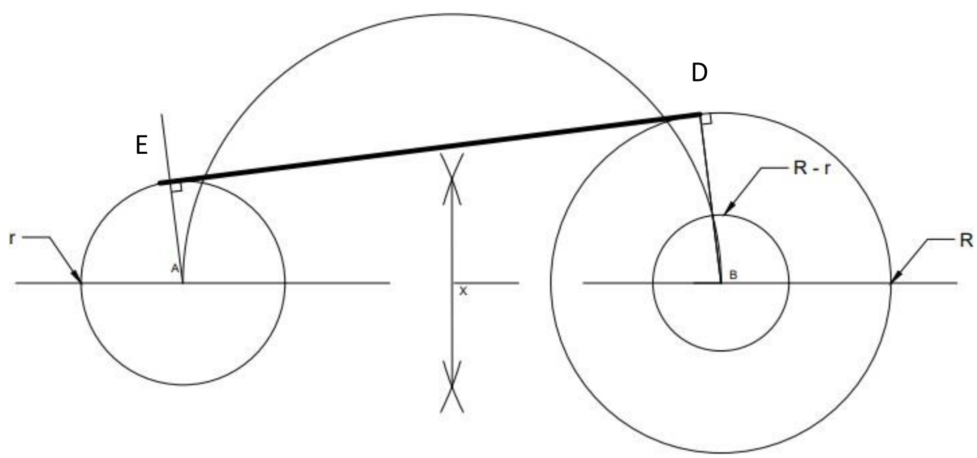
Note: Angle OTP is a right angle.



To draw a direct common tangent to two given circles

A and B are the centers of two given circle of radius r and R respectively.

1. With center B and radius R-r, describe a circle.
2. Bisect AB at X, and draw a semicircle on AB to cut circle R – r at C.
3. Join BC, and produce it to cut the larger circle at D.
4. Draw AE parallel to BD.
5. Join ED to give the required tangent.



THE ELLIPSE

An ellipse is a closed symmetrical curve with a changing diameter which varies between a maximum and minimum length.

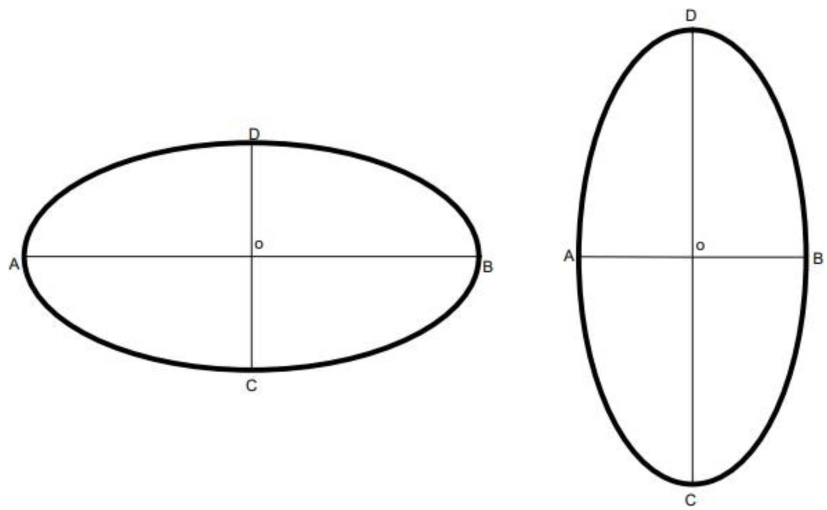
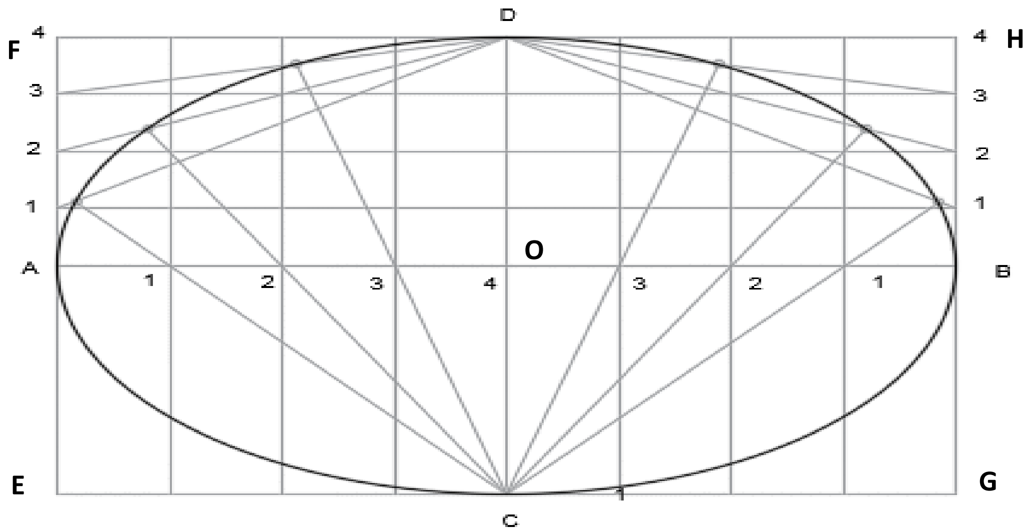


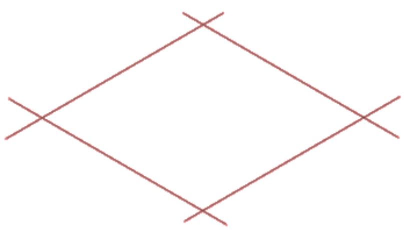
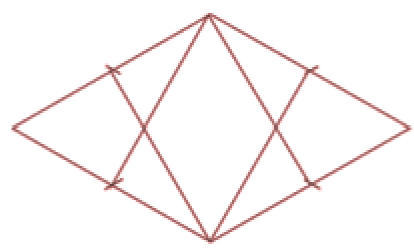
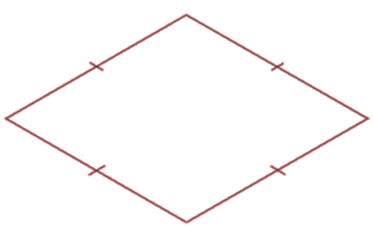
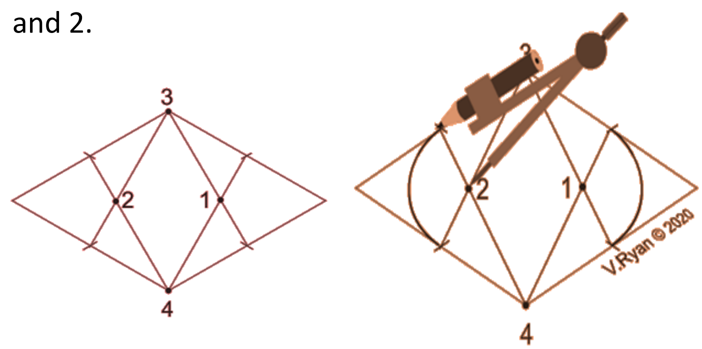
Figure 4 Horizontal and vertical ellipses

To construct an ellipse using rectangular method

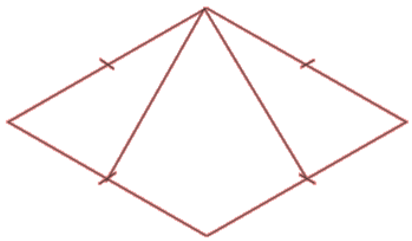
1. Draw the major and minor axes, AB, and CD to bisect each other at right angles at O.
2. Draw a rectangle EFGH of length AB and width CD.
3. Divide AO and AE into four equal parts.
4. Join C to the points of division on AE.
5. Join D to the points of division on AO, and produce these lines to meet C1, C2, and C3 to give three points on the ellipse.
6. Using horizontal and vertical ordinates from these points, obtain three points in each of the three quadrants.
7. Draw a freehand curve through these points to give the required ellipse.



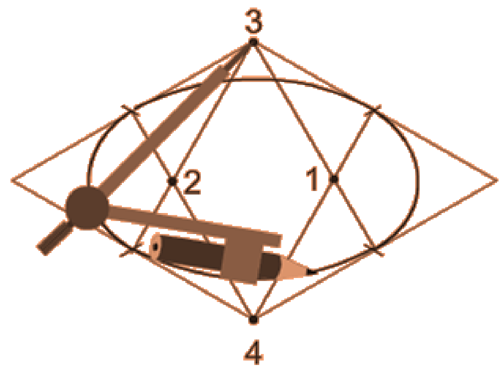
To construct an isometric ellipse

Step 1: Draw an isometric square 	**Step 4:** Draw from the bottom corner to each of the centre points. 
Step 2: Divide each side in half 	**Step 5:** Draw 'arcs' using a compass with center 1 and 2. 

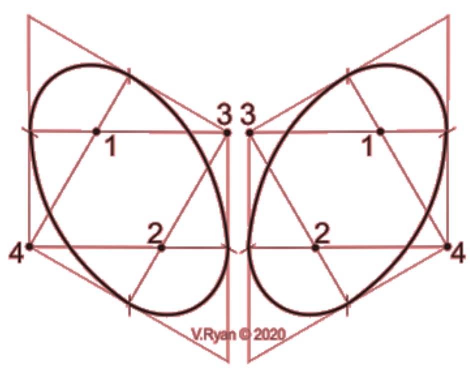
Step 3: Draw from the top corner to each of the center points.

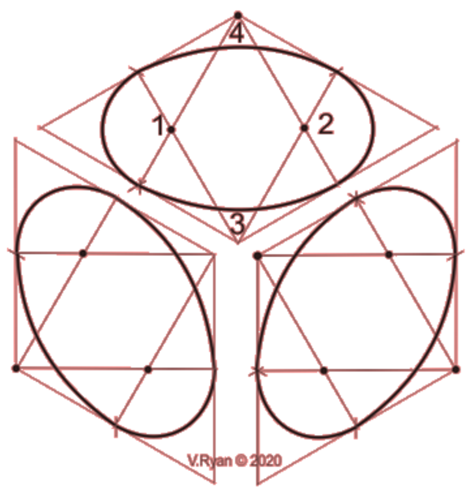


Step 6: Draw 'arcs' using a compass with centres 3 and 4, completing the isometric circle.



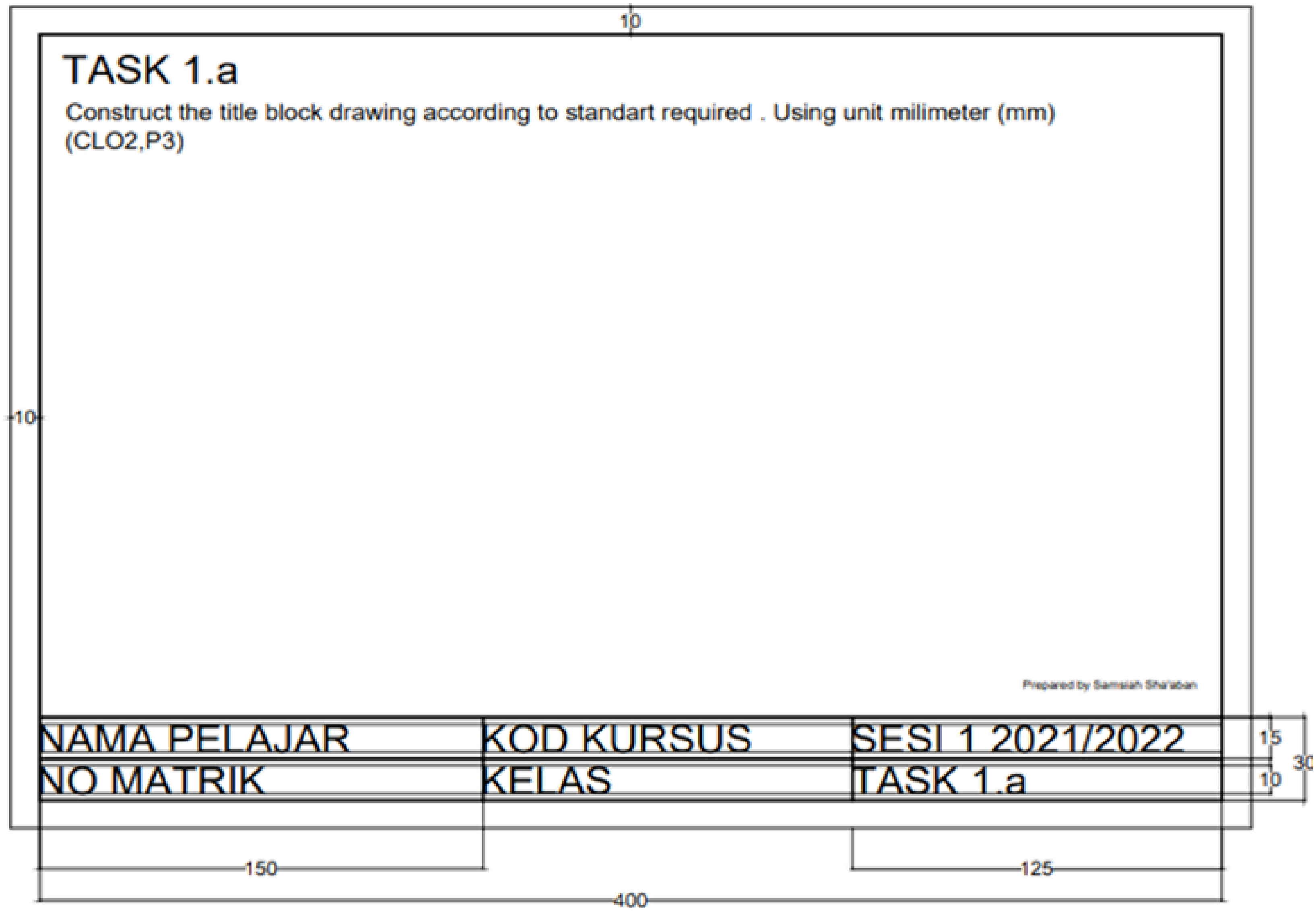
The same technique can be used to draw isometric circles in any **3D position.** The marking out is shown below.





Source: https://technologystudent.com/designpro/drawdex.htm

PRACTICAL TASK 1: GEOMETRI (Line & Title block)



PRACTICAL TASK 2: GEOMETRI (Triangle & Rectangular)

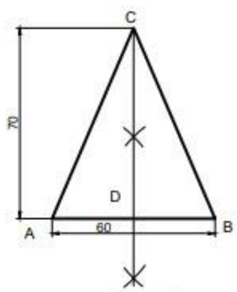


Figure 1

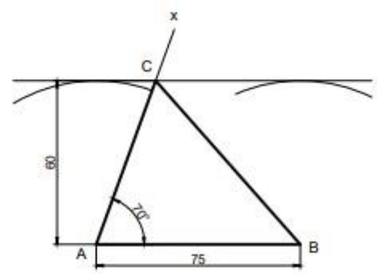


Figure 2

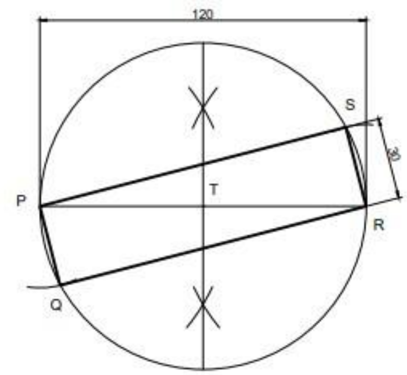


Figure 3

B

A triangle has a base length AB = 60mm and DC = 70mm. Construct the triangle shown in the Figure 1

Construct the scalene triangle shown in the Figure 2

A rectangle has a diagonal distance of 120 mm and one of its side is 30mm. Construcrt the rectangle shown in Figure 3

Prepared By Samsiah Sha'aban

NAMA PELAJAR	KELAS	PRACTICAL TASK 1.b
NO.PEND	POLITEKNIK NILAI	SKALA : 1:1

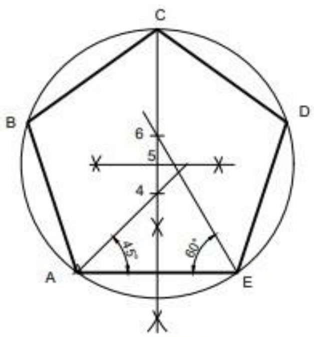


Figure 4

Using 45° and 60 ° method, construct a pentagon of sides AE 60 mm.

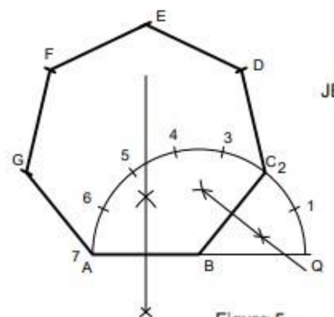


Figure 5

Using 360 ° angle divison method, construct a Heptagon of sides 45 mm.

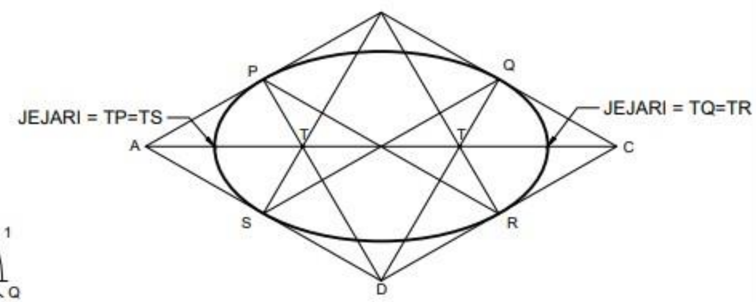


Figure 6

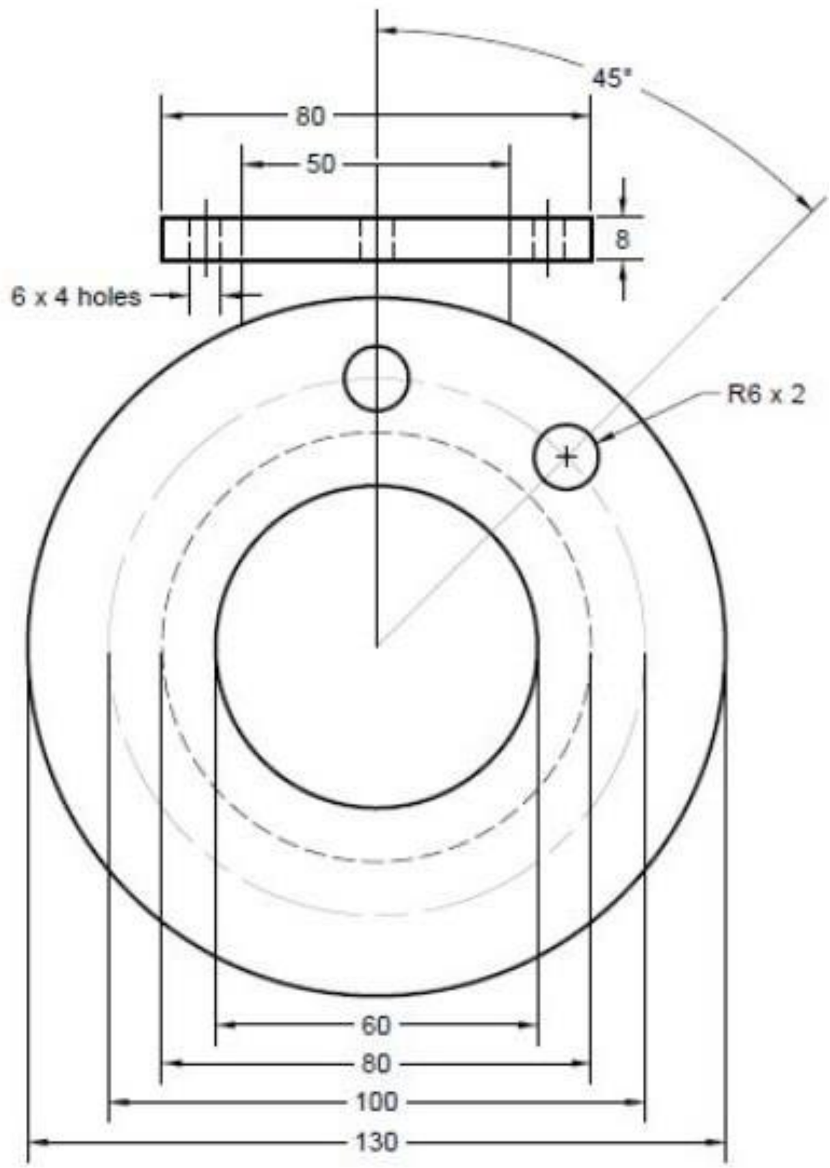
Construct the ELIPSE shown in the Figure 6

Prepared By Samsiah Sha'aban

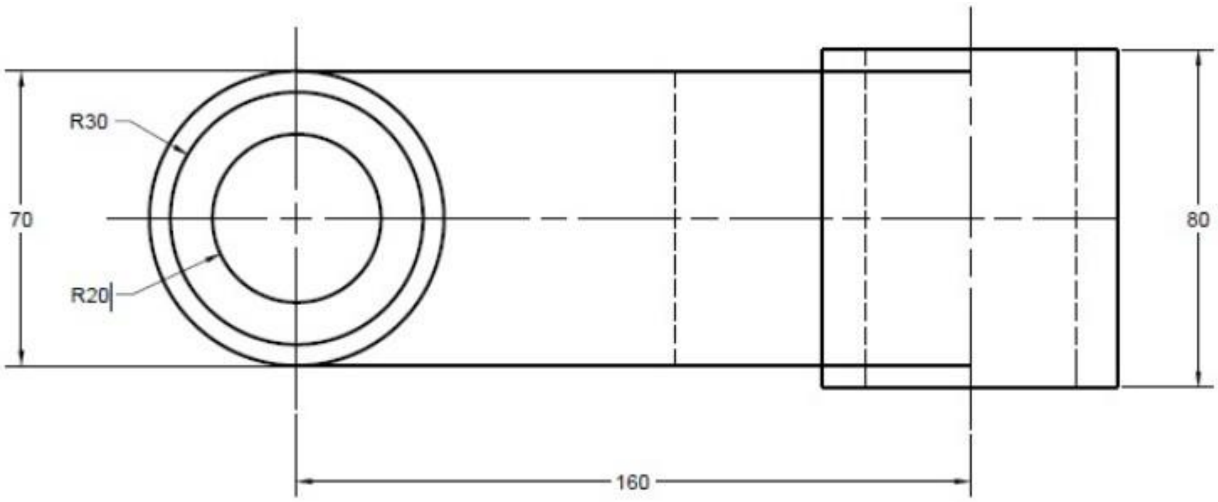
NAMA PELAJAR	KELAS	PRACTICAL TASK 1.b
NO.PEND	POLITEKNIK NILAI	SKALA : 1:1

PRACTICAL TASK 4

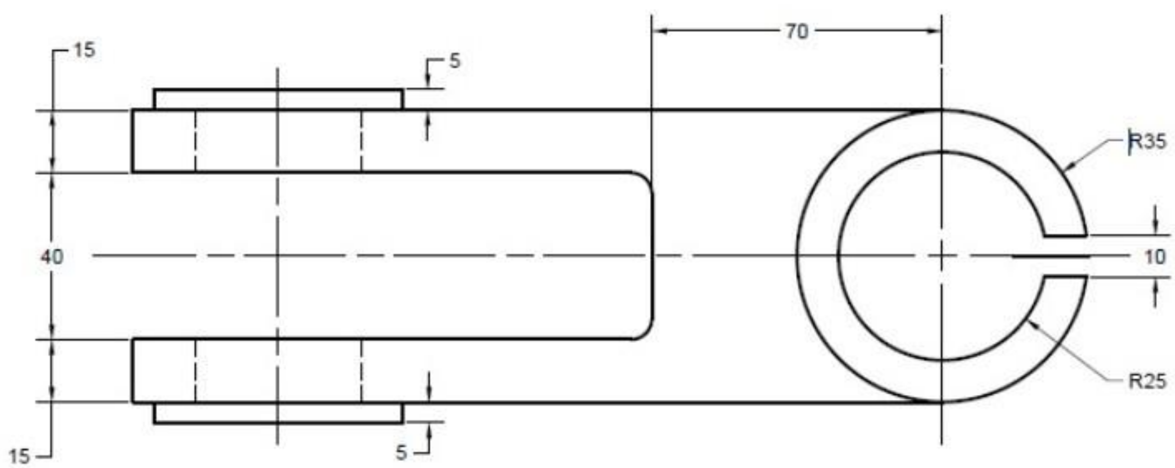
1. **Construct** the diagram below **without using a proctactor** for the angles.



2. **Construct** the diagram below **without using a proctactor** for the angles.



3. **Construct** the diagram below **without using a proctactor** for the angles.



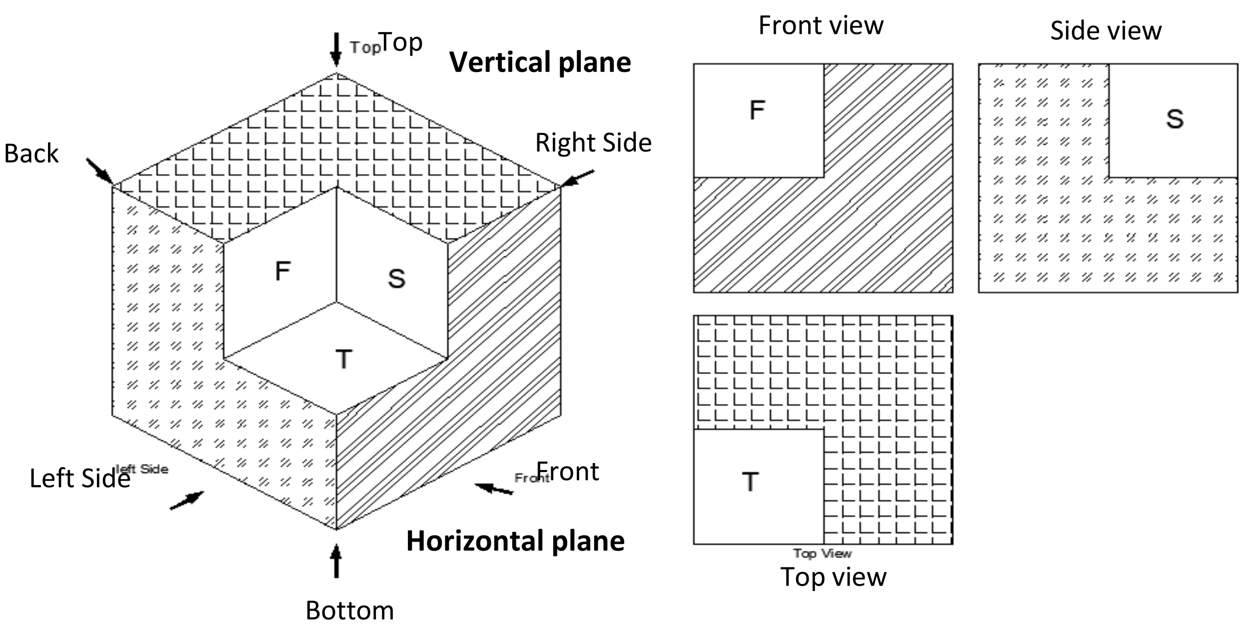
CHAPTER 3 A

ORTHOGRAPHIC PROJECTION

3.0 ORTHOGRAPHIC PROJECTION

Orthographic projections show views of the object, as seen from three principal directions name as front, top and side view. From the **top view**, is known as a plan. The orthographic projection on a vertical plane, which is seen from either the **side view** or the **front view**, is known as elevations. Orthographic projection drawing give accurate information on the design as well as the size of an object.

3.1 PRINCIPLE PICTURE PLANE



(a) Viewing directions **(b) Three main views**

Figure 3.1 Orthographic Views

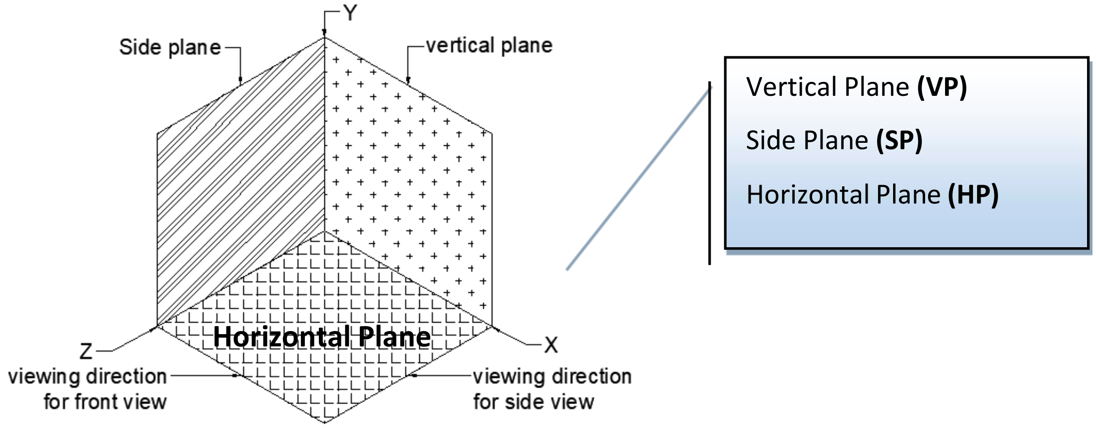


Figure 3.2 Principal Planes

3.2 METHODS OF ORTHOGRAPHIC PROJECTION

The drawing of a plan, a front view and a side view of an object can also be combined on a piece of paper which is divide into four quadrants. Orthographic projections are drawn using two commonly use:

1. First angle methods
2. Third angle methods

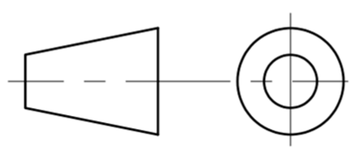
Comparison Between First Angle and Third Angle Projection

The position of the front elevation is at the top of the plan. The side elevation is drawn on the left side or the right side of the front elevation, depending on the viewing direction.

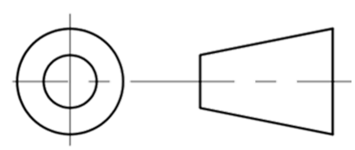
First Angle Projection	Third Angel Projection
The object is imagined to be in first quadrant.	The object is imagined to be in third quadrant.
The object is lies between the observer and plane of projection	The plane of projection lies between the observer and object.
The plane of projection is assumed to be non-transparent.	The plane of projection is assumed to be transparent.
W**hen views are** drawn in their relative position Top view comes below Front view, Right side view drawn to the left side of elevation.	When view are drawn in their relative position Top view comes above Front view, Right side view drawn to the right side of elevation.

Symbol Projection

The projection method adopted for a drawing is shown by a symbolic figure drawn in the title block.



First angle projection



Third angle projection

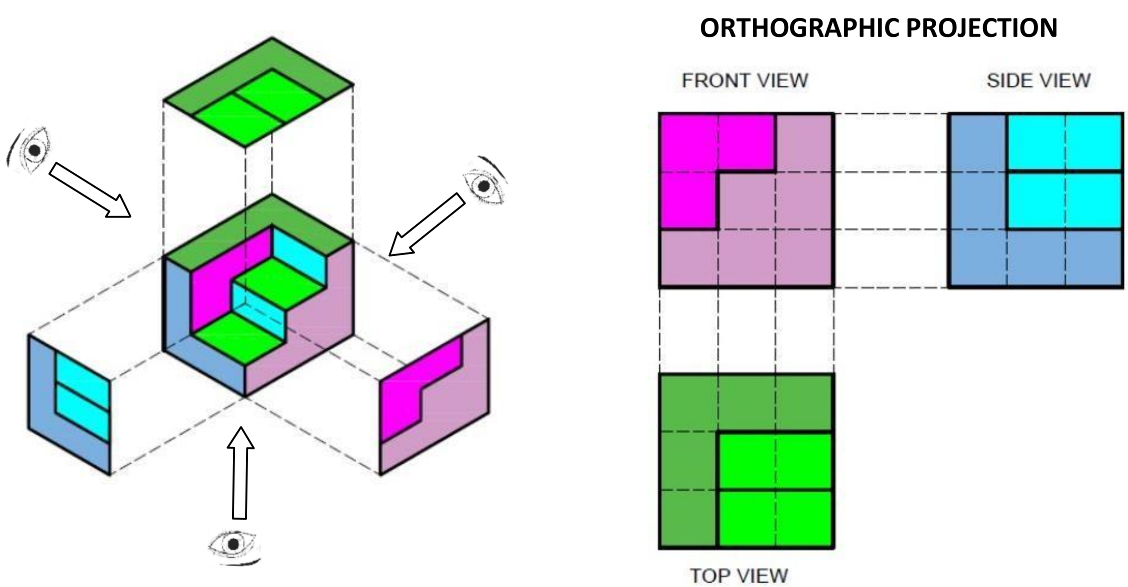


Figure 3.5: First angle projection following anticlockwise

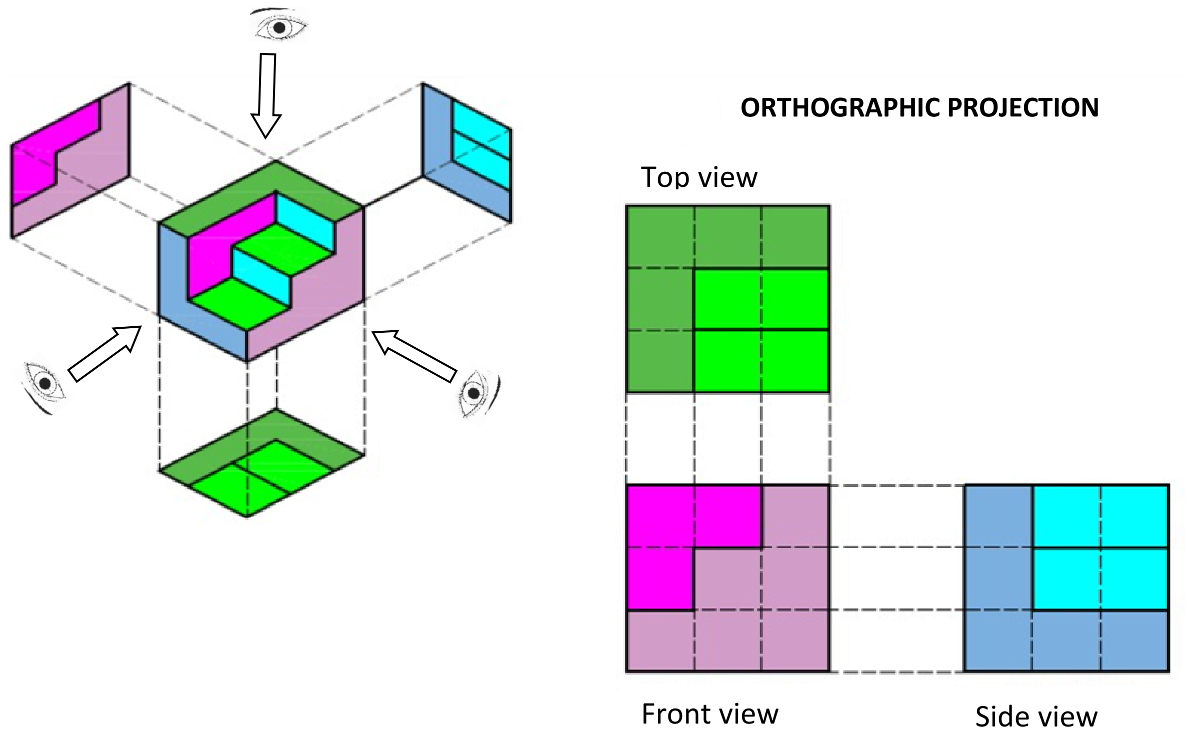
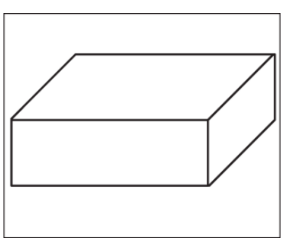
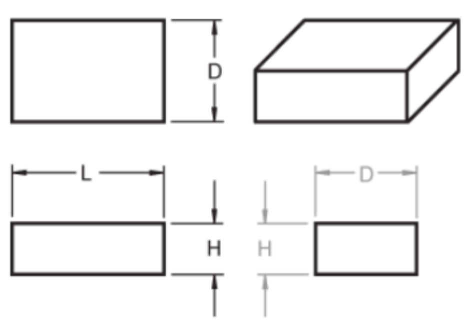


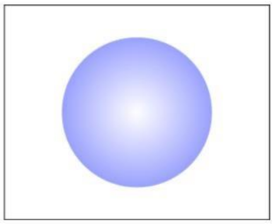
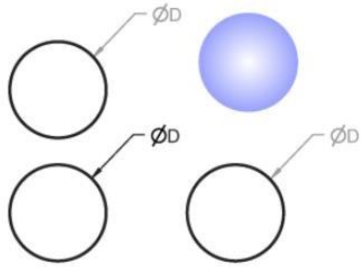
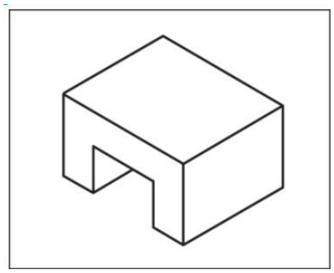
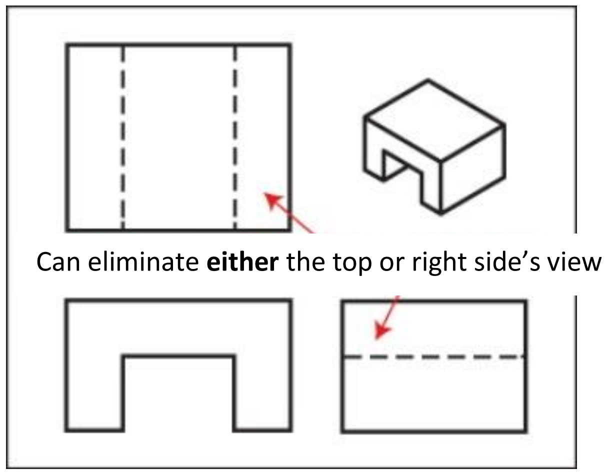
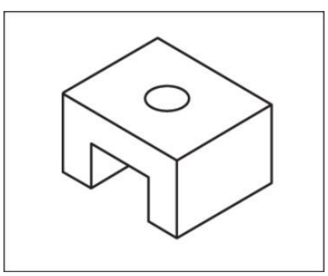
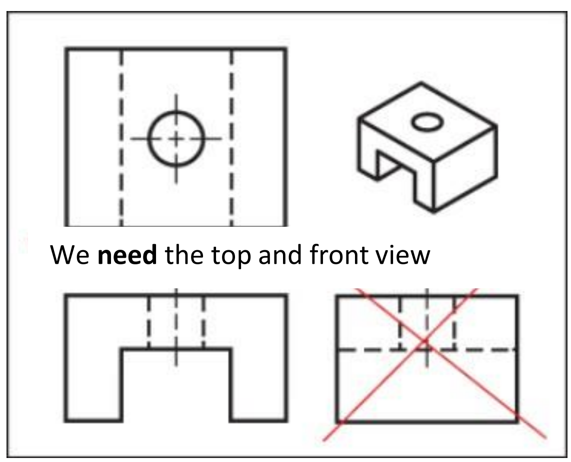
Figure 3.6 Third angle projection following anticlockwise

3.3 NUMBER OF VIEW

How many views do we need to completely describe various part of drawing? Table 1 gives the appropriate number of views and is required to complete the orthographic drawing.

Table 1 Number of views

Parts	View
 **Block**	• A block need **only 2 views** • The right sides view duplicates information 

 **Sphere**	• Only **one view** is needed • The other two view duplicate information 
 **Part 1**	 ** Using third-angle projection
 **Part 2**	 ** Using third-angle projection

View selection has three (3) steps:

Orient the object → **Select the Front view** → **Select adjacent views**

Orient the object

- The object should be placed in its natural position.
- The actual size and shape of the object is described through an orthographic view (as much as possible)

Select the Front view

- The dimensions of the longest object must be indicated as width (in front view)
- Project of the view in the adjacent drawing from the selected front view should appear in its natural position.
- The view with the least number of hidden lines is usually selected as the front view.

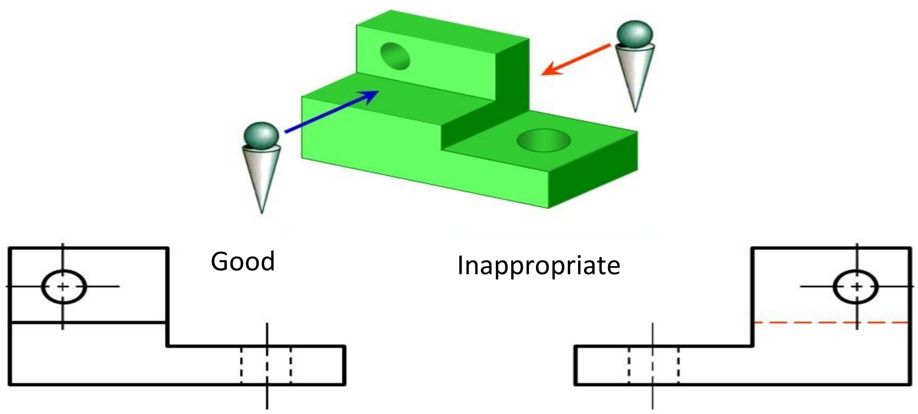


Figure 3.7 Choose the Front view

Select adjacent views

- Choose the view that has the fewest number of hidden lines.
- Choose the minimum number of views that can represent the major features of the object
- Choose the views that are suitable to a drawing sheet

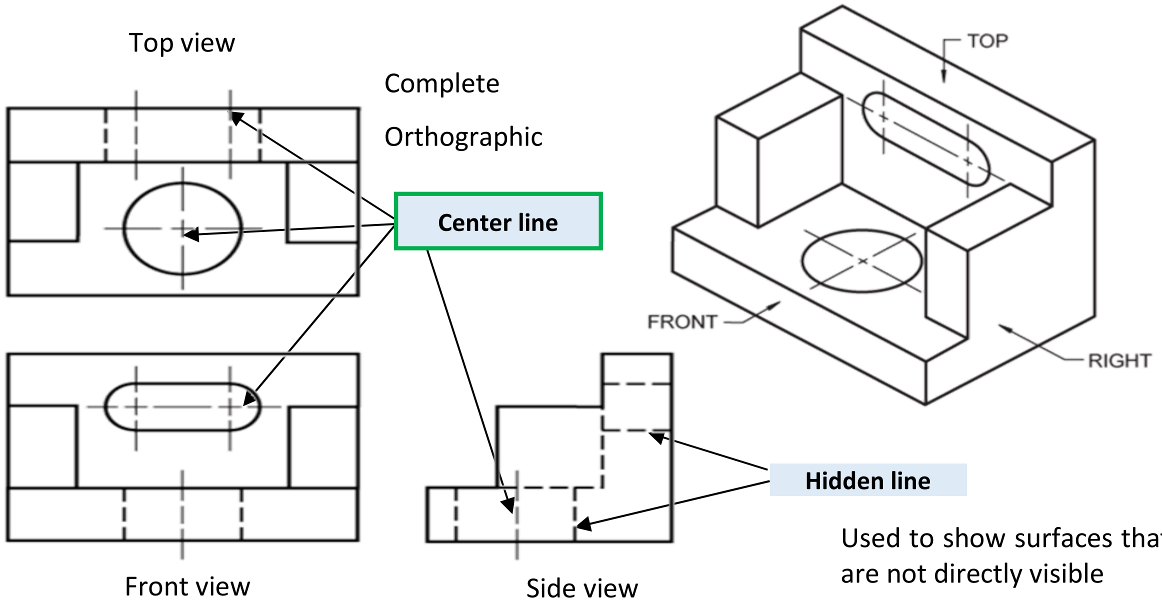


Figure 3.8 Orthographic views using third angle projection

3.4 CHOOSE VISUALIZE THE ORTHOGRAPHIC PROJECTION

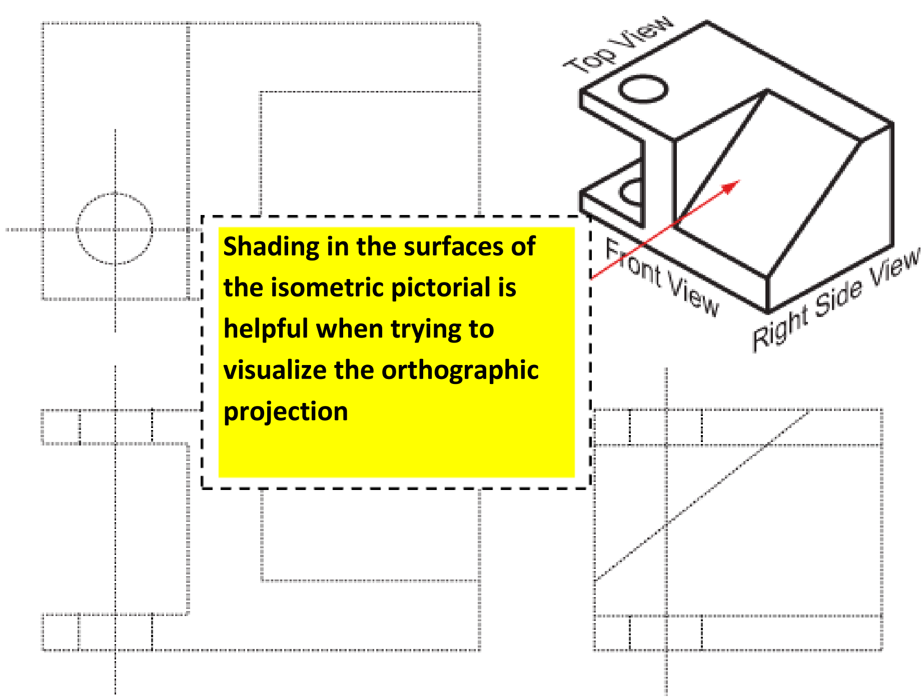
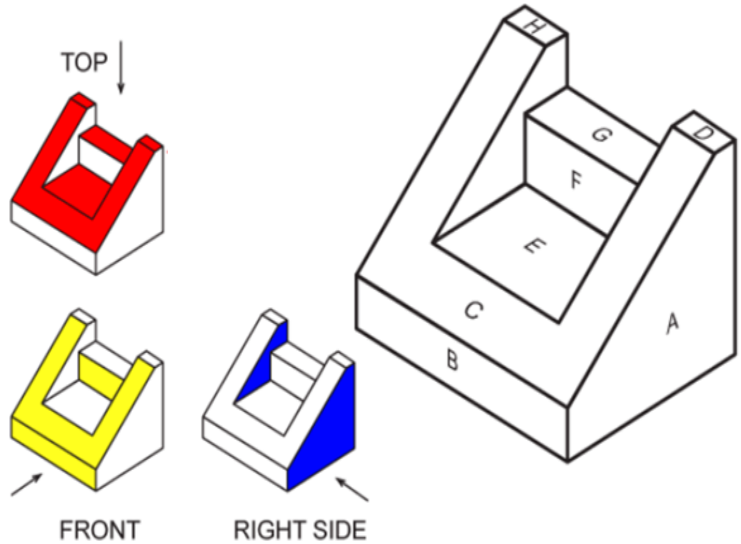


Figure 3.9 Shading in the surface of isometric view

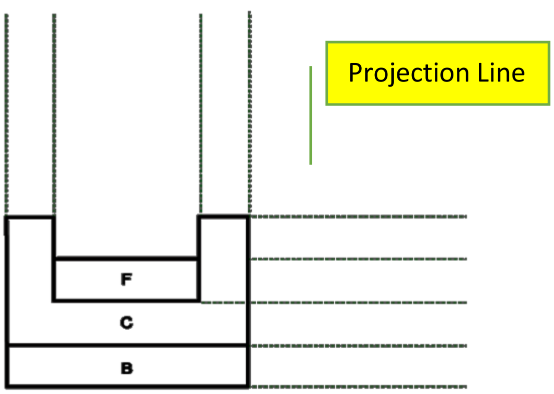
Case 1

Shading in the surface based on types of view

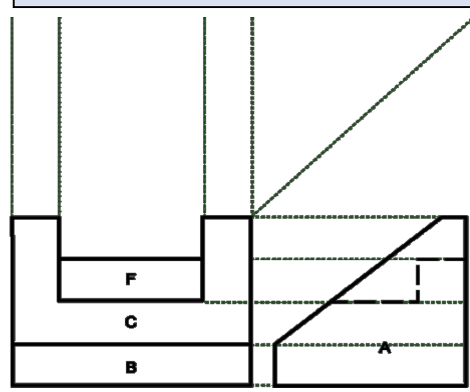


Orthographic Projection using third angle projection

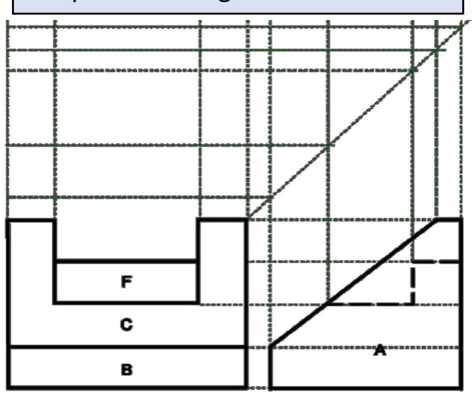
Step 1: Draw top view



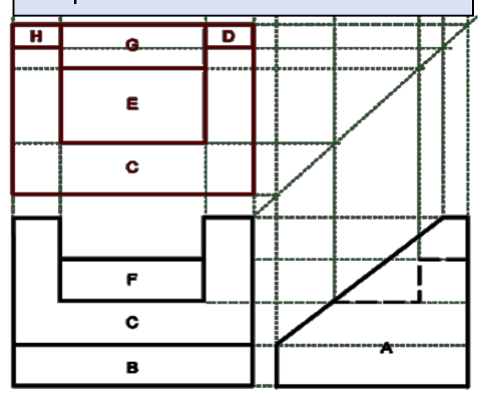
Step 2: Draw side view



Step 3: View Alignment

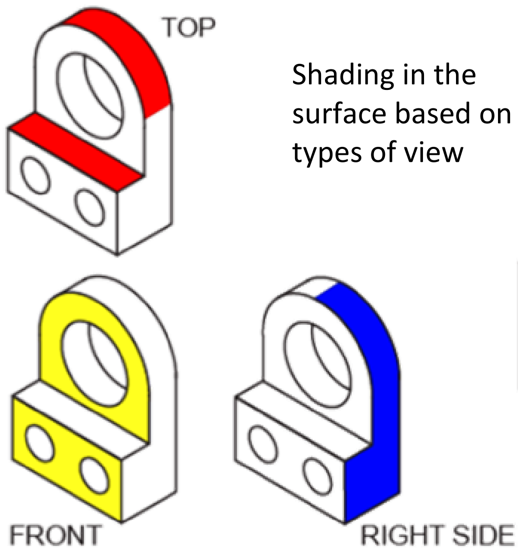


Step 4: Draw front view

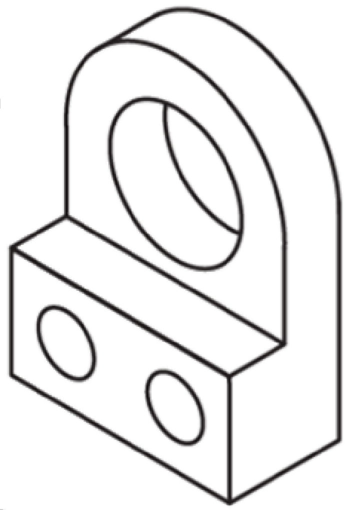


The **top** and **front** view are **aligned vertically** and **share the width dimension**. The **front** and **right** views are **aligned horizontally** and share the **same height dimension**

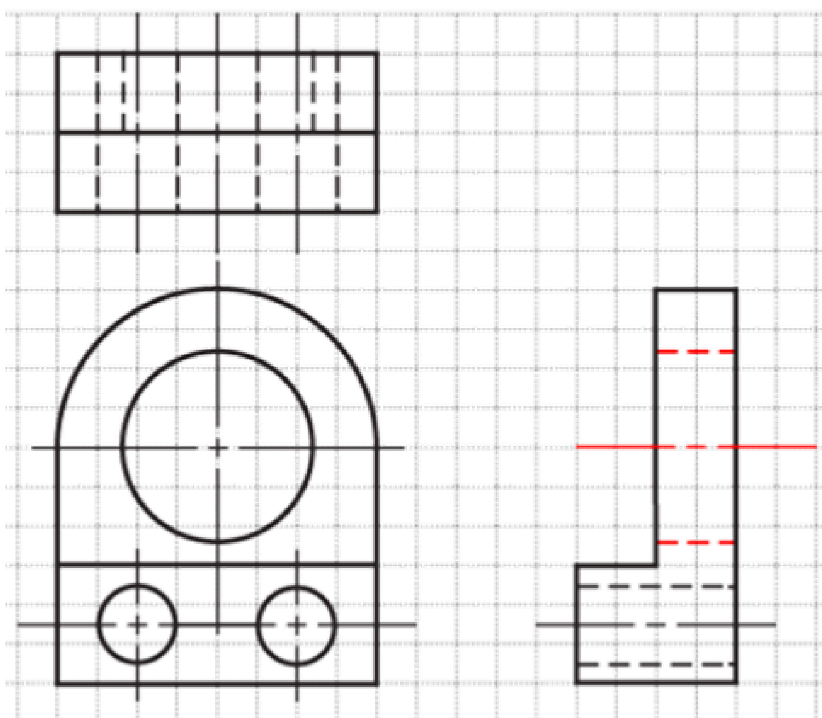
Case 2



Shading in the surface based on types of view



Orthographic Projection using third angle projection



EXAMPLE 1

Draw the following views in **first-angle projection:**

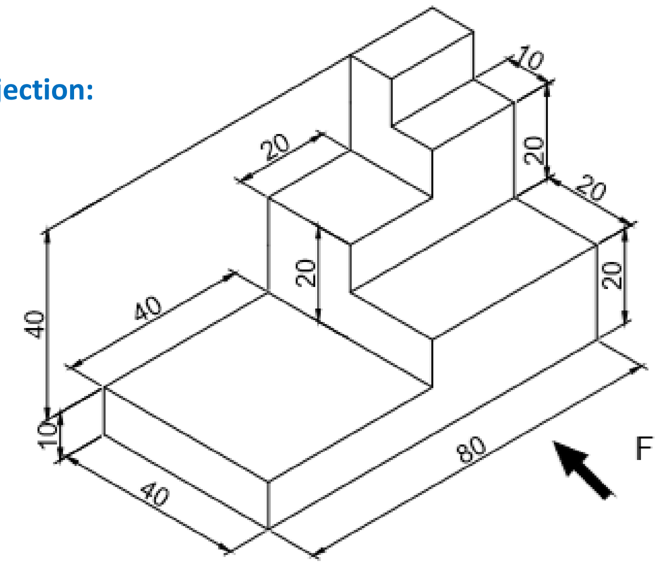
a) a front view from F

b) a side views

c) a plan views

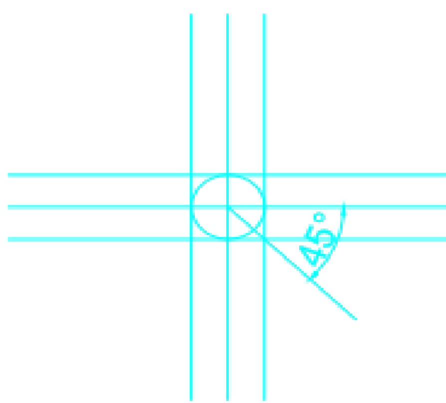
(Scale 1:1)

Fully dimension and identify the drawing.

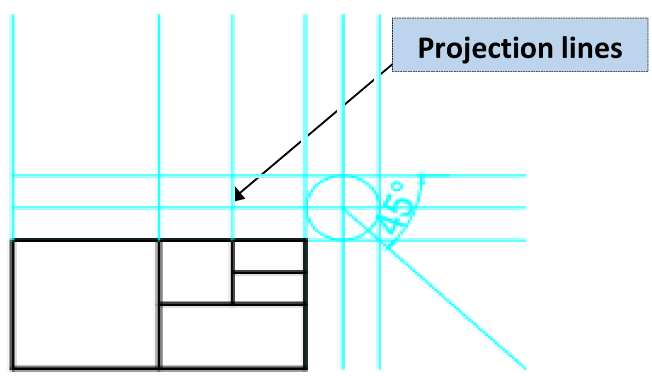


SOLUTION EXAMPLE 1: Using first-angle projection

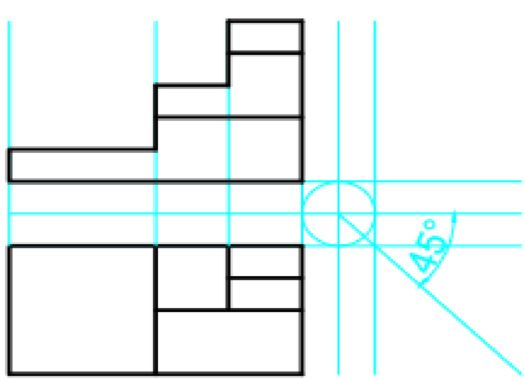
Step 1: Divide into **four quadrants**



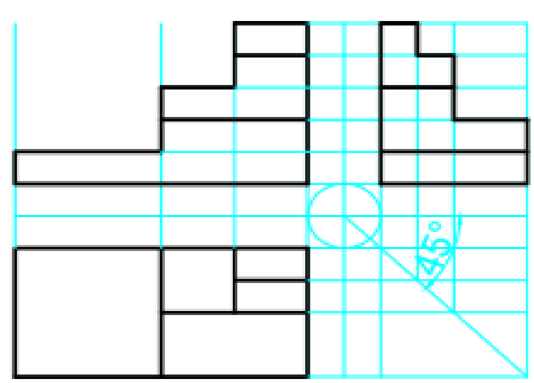
Step 2: START with construct a **plan (top) view**

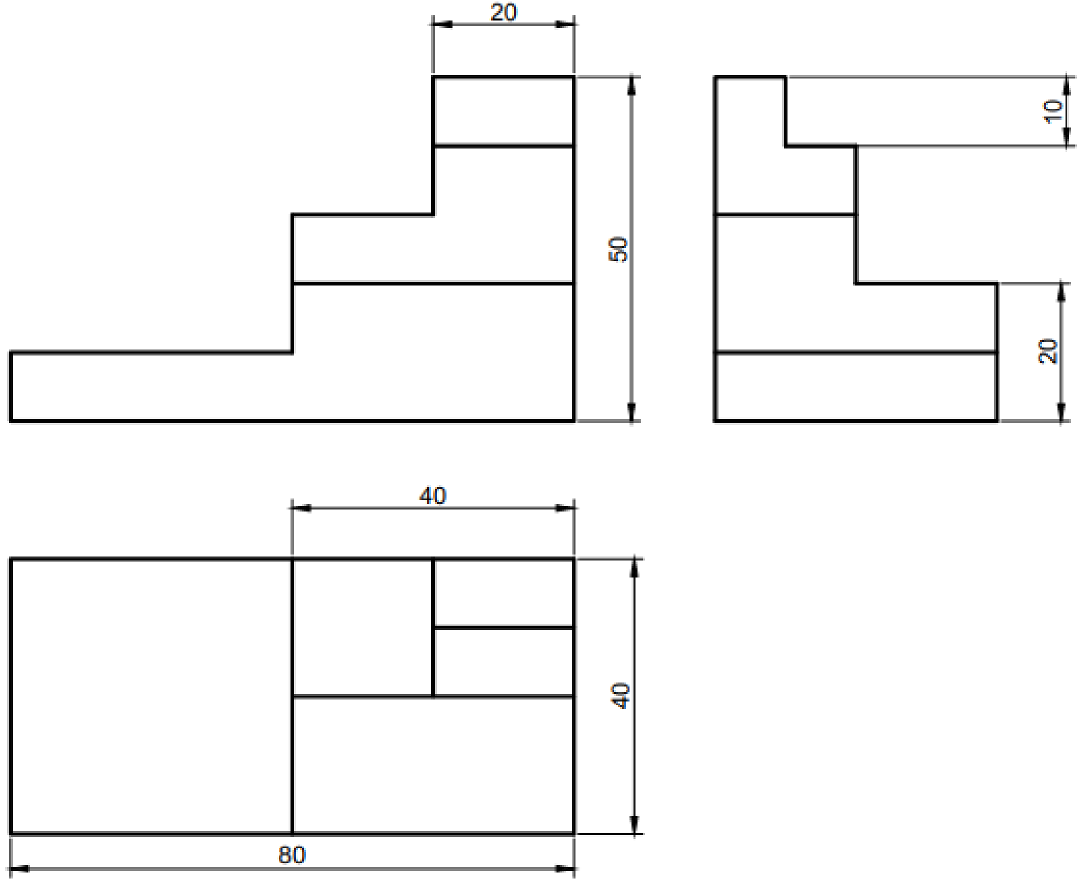


Step 3: construct a **front view**



Step 4: construct a **side view**





SAMSIAH BINTI SHA'ABAN	SX111099MMS03	PRACTICAL TASK 1
POLITEKNIK NILAI	20 / 08 / 2020	DISEMBER 2020

EXAMPLE 2

Draw the following views in **third-angle projection:**

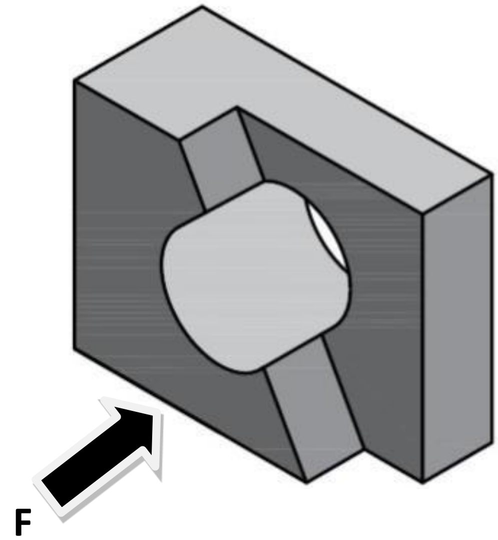
d) a front view from F

e) a side views

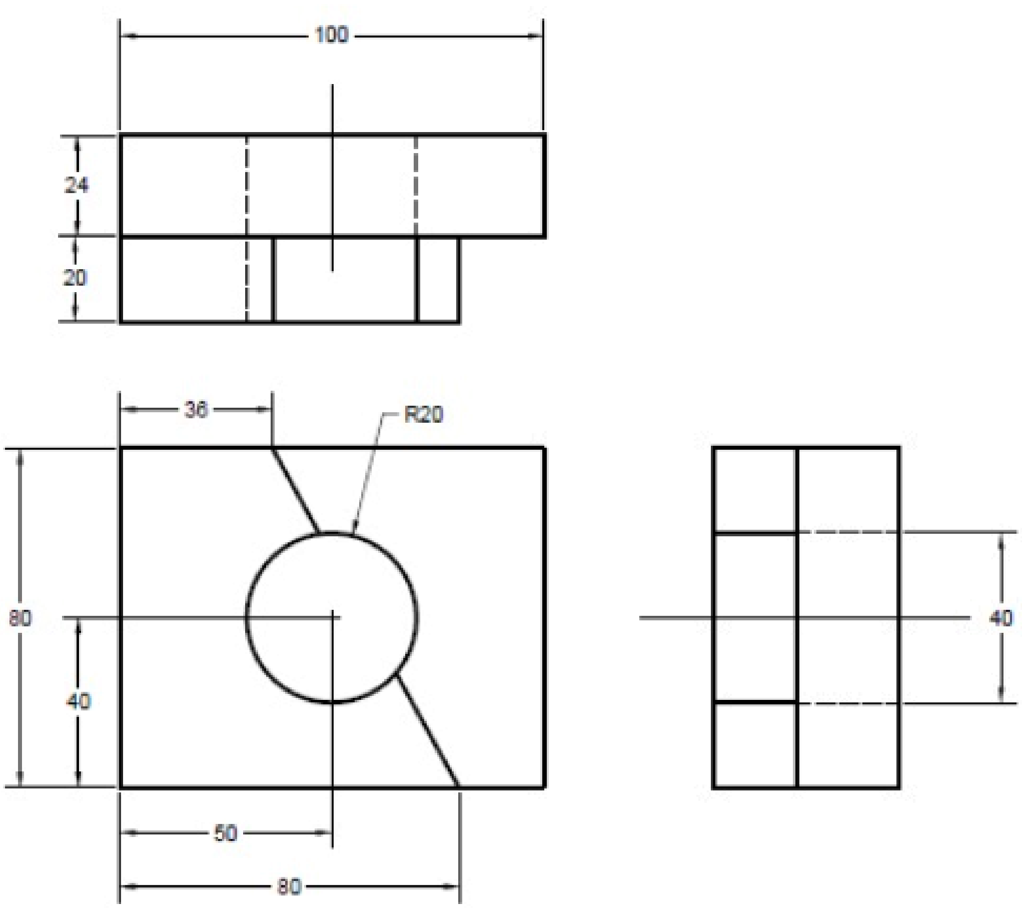
f) a plan views

(Scale 1:1)

Fully dimension and identify the drawing.



SOLUTION EXAMPLE 2: Using third - angle projection



EXAMPLE 3

Draw the following views in **third - angle projection:**

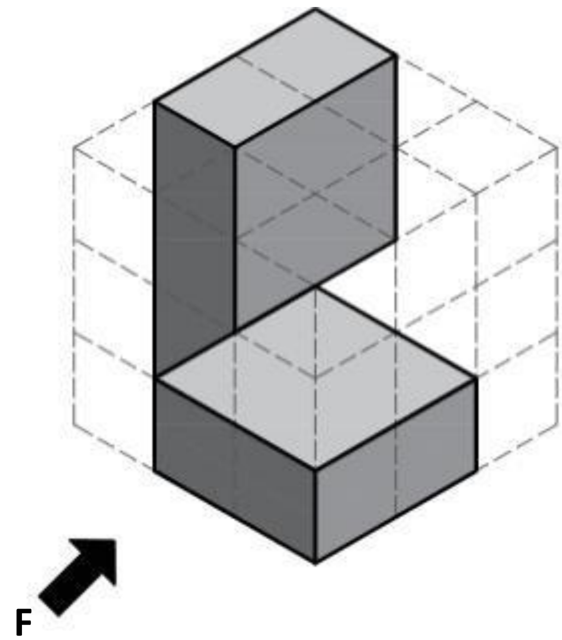
g) a front view from F

h) a side views

i) a plan views

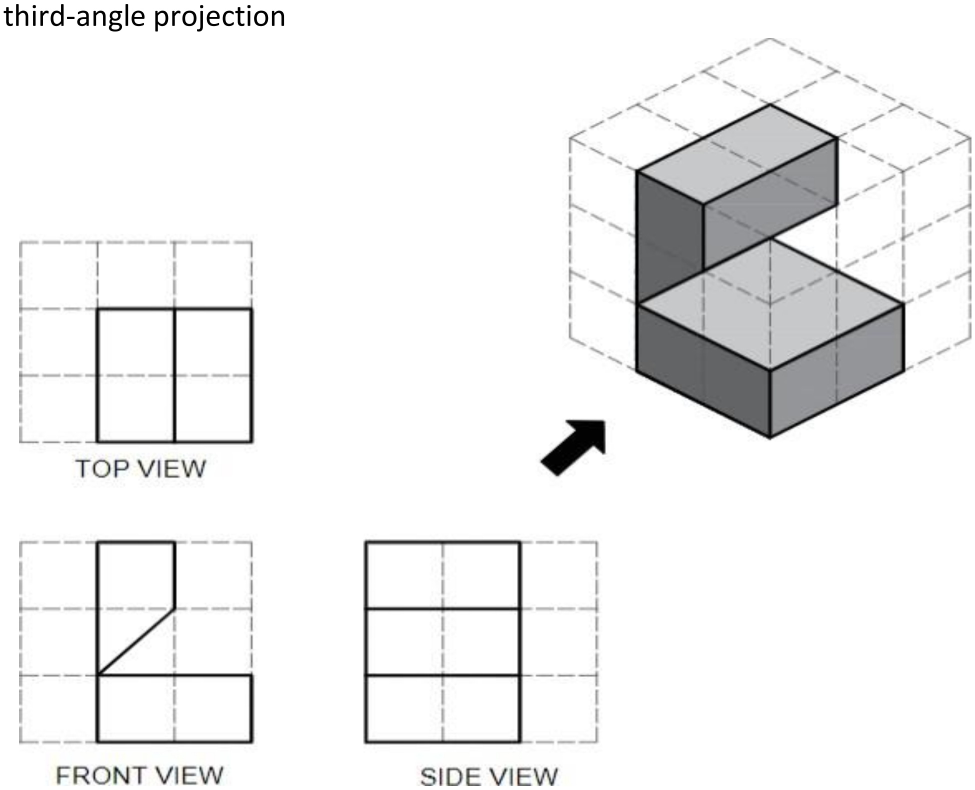
(Scale 1:1)

Fully dimension and identify the drawing.

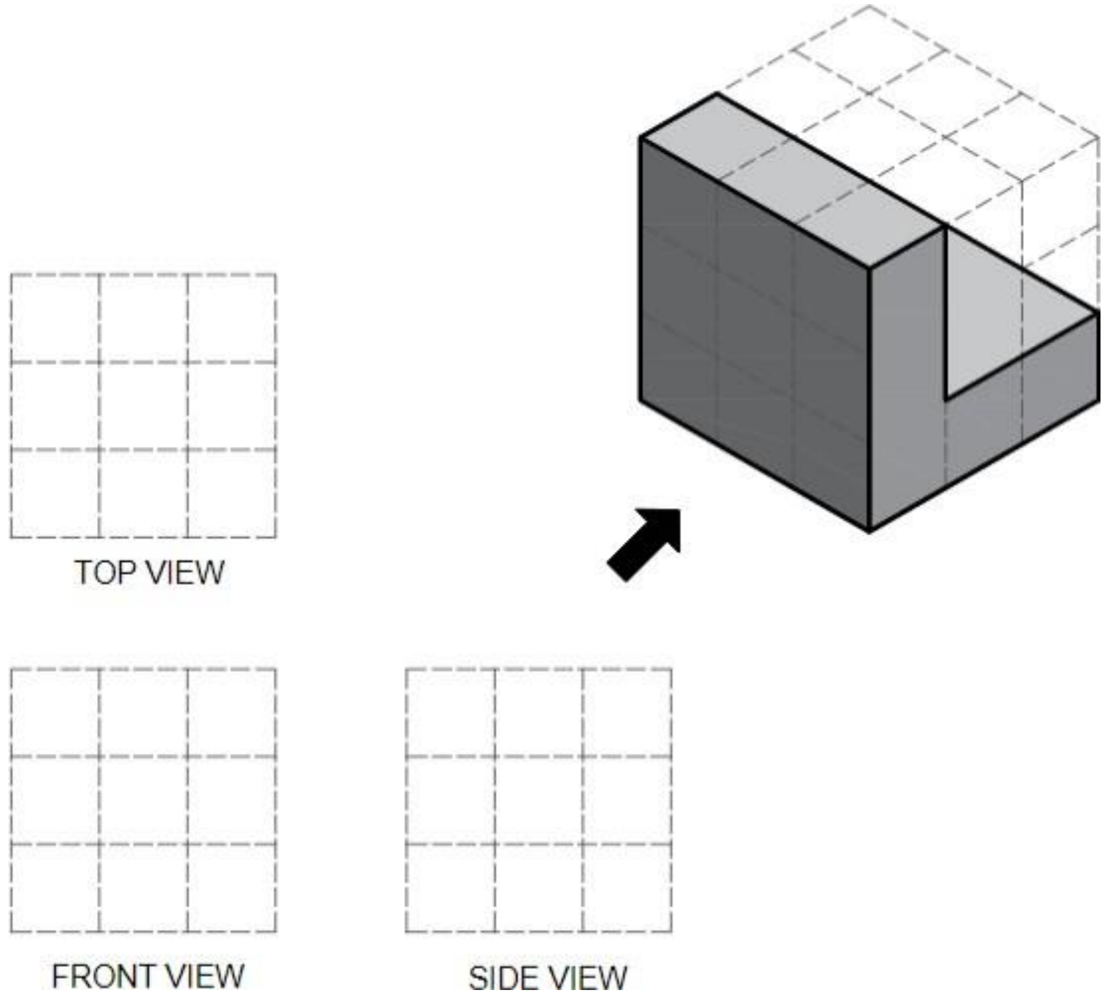


<u>SOLUTION EXAMPLE 3</u>:

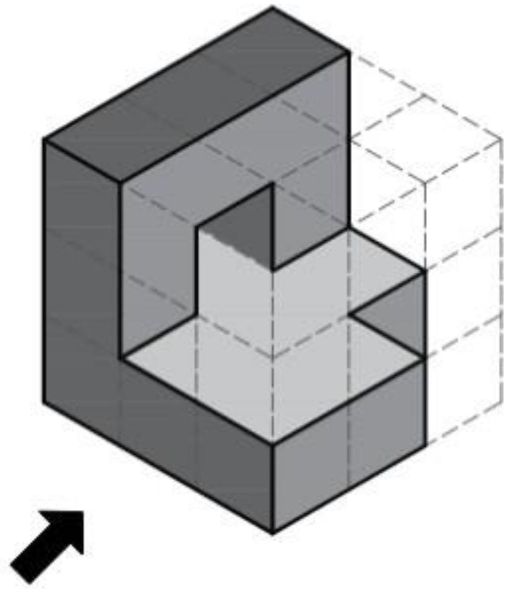
Using third-angle projection



EXERCISE 1: ORTHOGRAPHIC PROJECTION



EXERCISE 2: ORTHOGRAPHIC PROJECTION

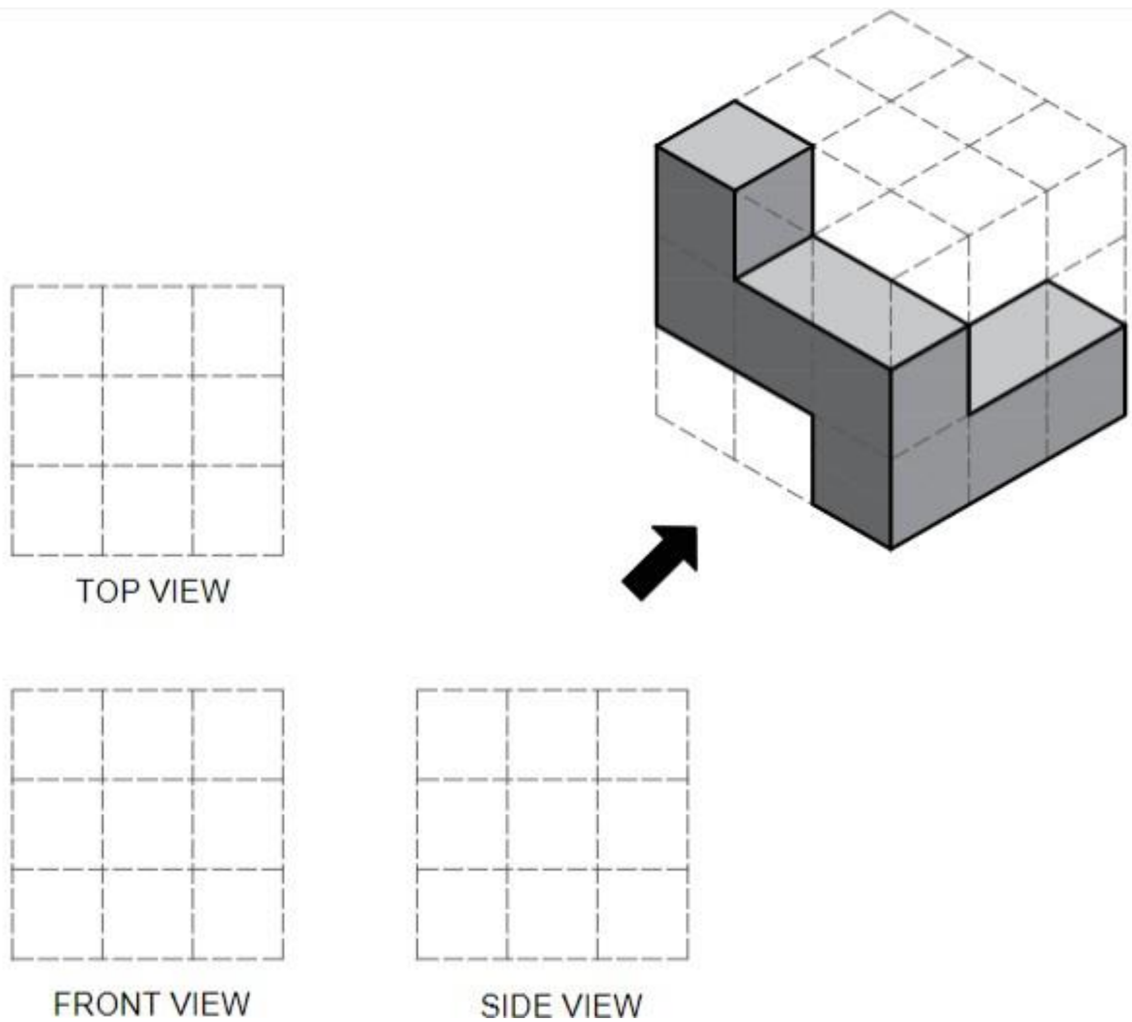


TOP VIEW

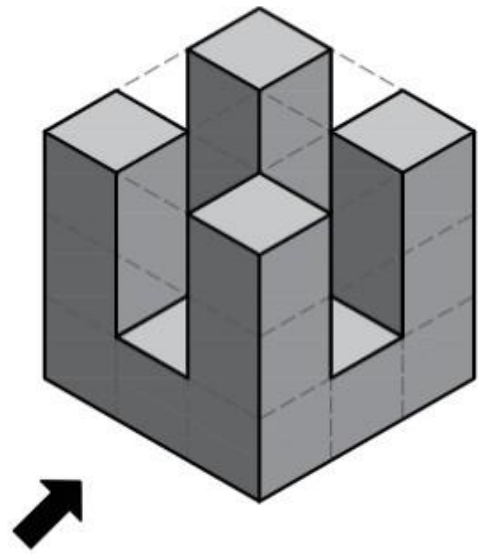
FRONT VIEW

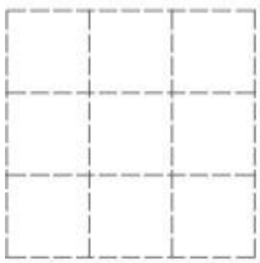
SIDE VIEW

EXERCISE 3: ORTHOGRAPHIC PROJECTION

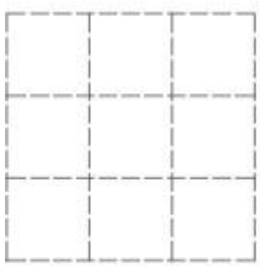


EXERCISE 4: ORTHOGRAPHIC PROJECTION

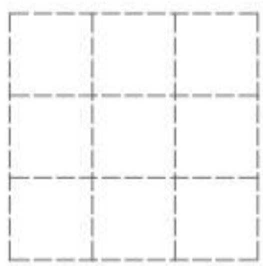




TOP VIEW

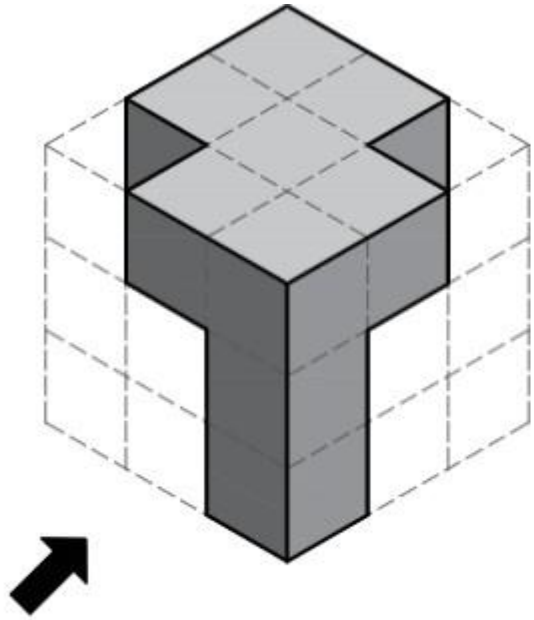


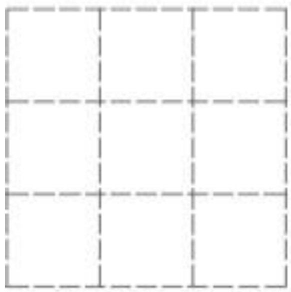
FRONT VIEW



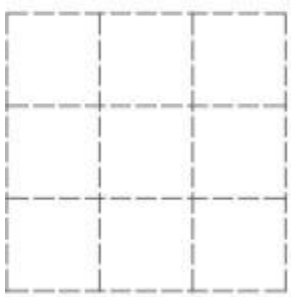
SIDE VIEW

EXERCISE 5: ORTHOGRAPHIC PROJECTION

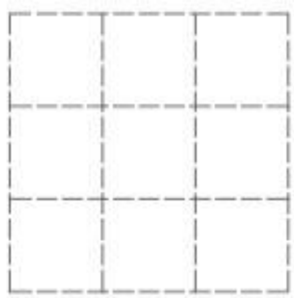




TOP VIEW



FRONT VIEW



SIDE VIEW

PRACTICAL TASK 1

Construct the drawing by using the dimension given.
Figure 1 shows a isometric views.
Draw its orthographic **view.**

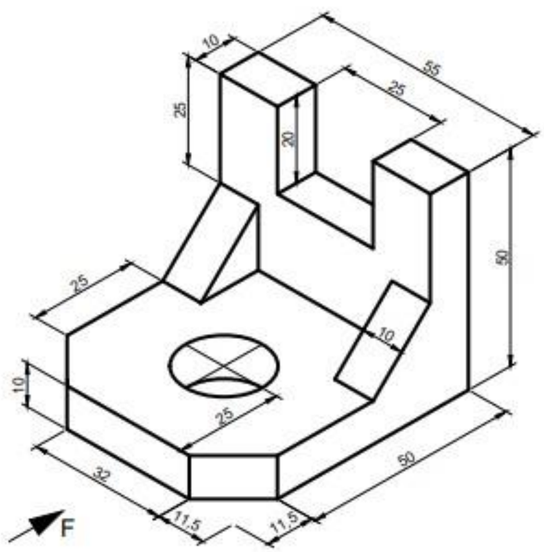
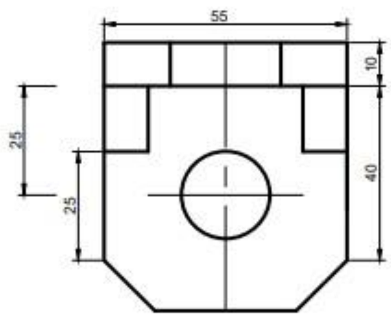


Figure 1
Isometric View

Orthographic projection



Top View

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CHAPTER 3B

ISOMETRIC VIEWS

3.5 ISOMETRIC VIEWS

Isometric drawing is a form of 3D drawing, which is set out using 30-degree angles. It is a type of axonometric drawing, so the same scale is used for every axis, resulting in a non-distorted image. Since isometric grids are easy to set up, once you understand the basics of isometric drawing, creating a freehand isometric sketch is relatively simple.

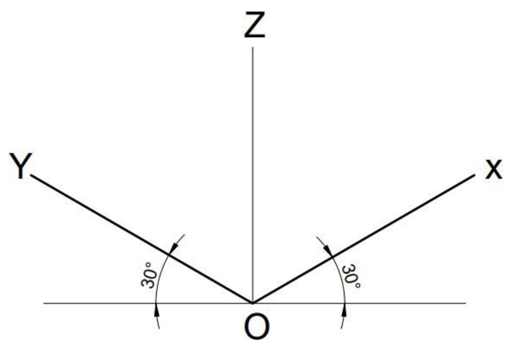


Figure 3.10 Isometric axes

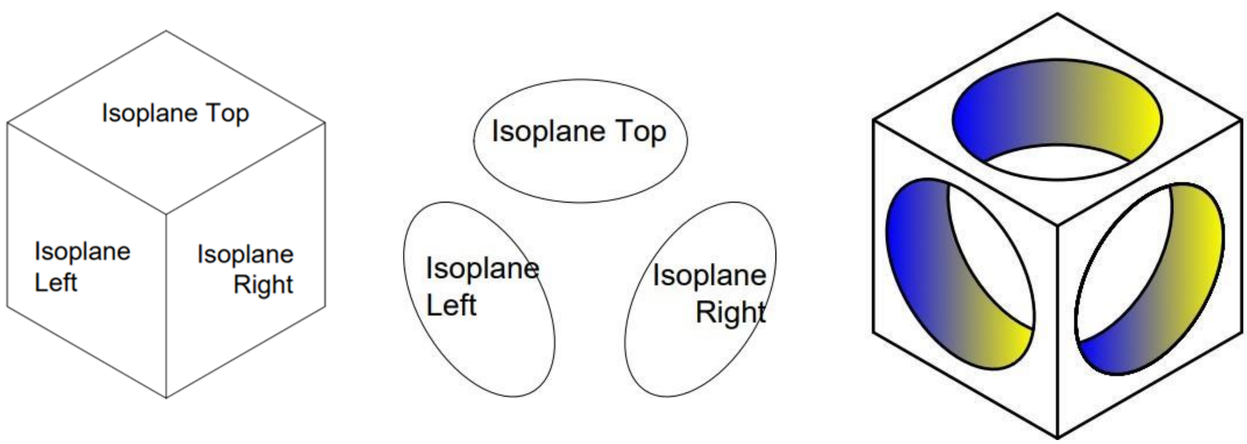


Figure 3.11 Isometric plane

3.6 DRAWING ISOMETRIC VIEWS

Step 1

Starting with an orthographic drawing to obtain the **dimensions and views of isometric objects.**

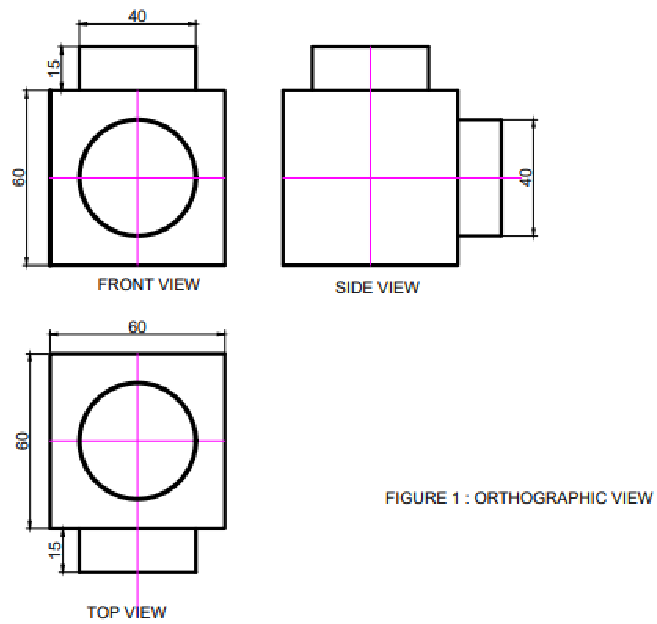


Figure 3.12 Orthographic projection

Step 2

- Draw **two basic 30 degree guidelines**, one to the right and one to the left, then draw vertical guideline in the centre of the drawing. In this example three edges of the cube have been drawn over the guidelines (they are slightly darker)
- Draw guidelines to help start constructing the left and right sides of the cube. Remember to **use a 30-degree set square for the 'angled' lines.**

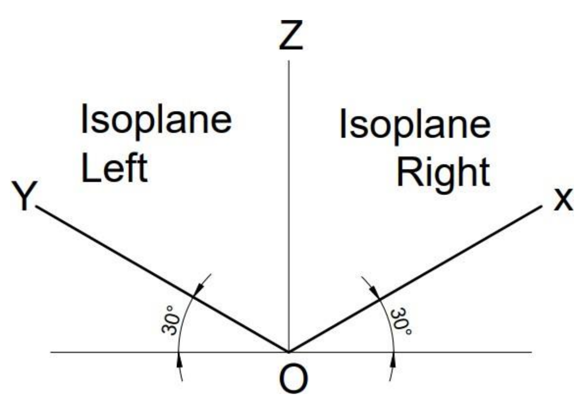
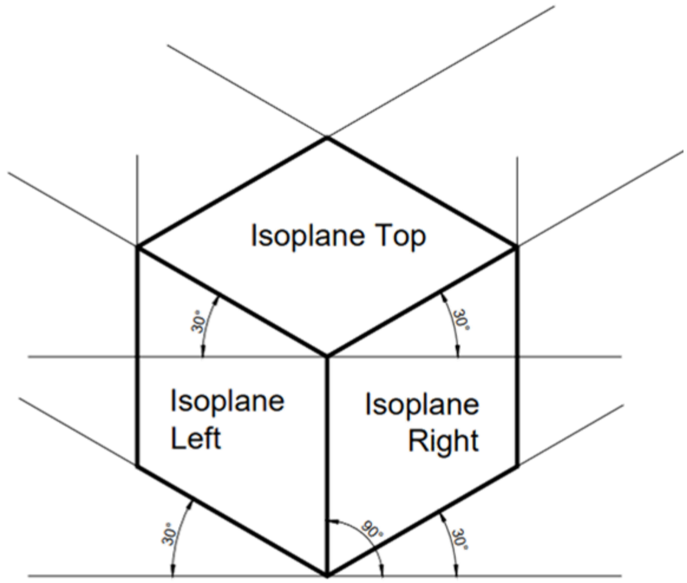


Figure 3.13 Isometric Axes

- The top of the cube can be drawn quite easily by using the set square to draw one edge of the top and then 'flipping' it over to draw the other



Step 3

Follow step to draw isometric ellipse. Complete the isometric view.

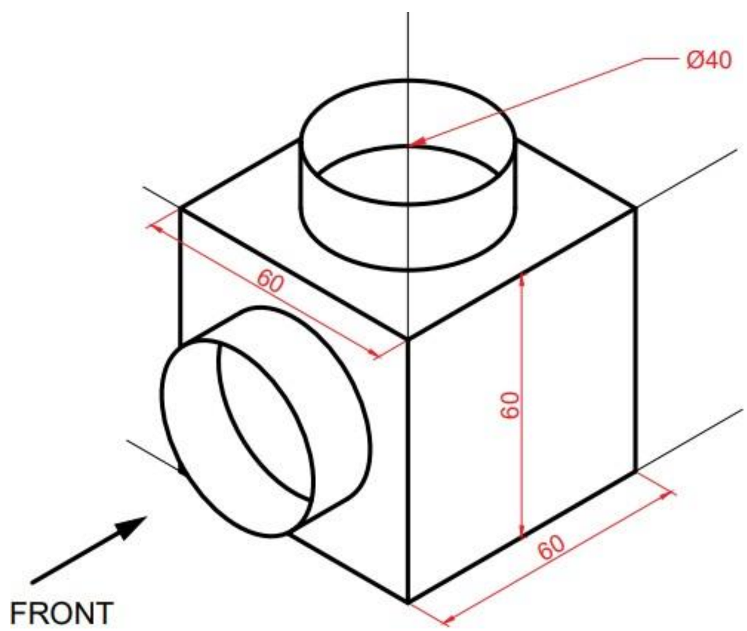
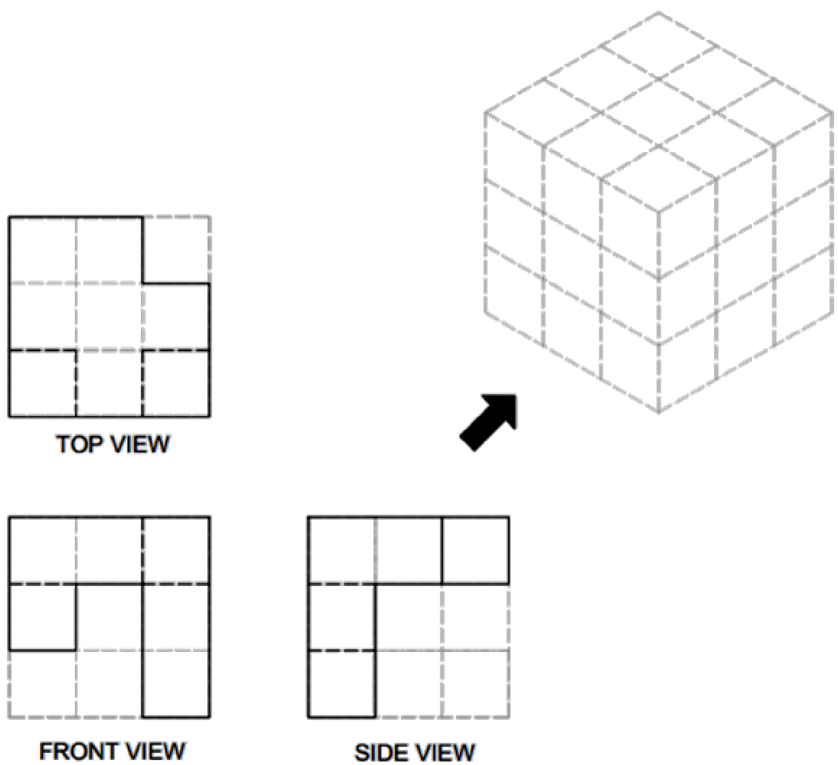
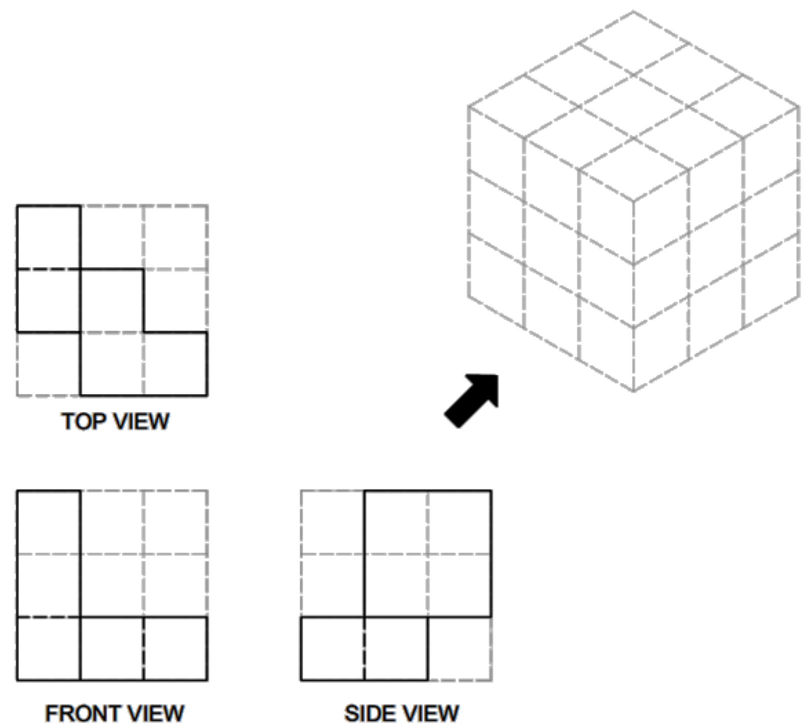


Figure 3.14 Isometric view

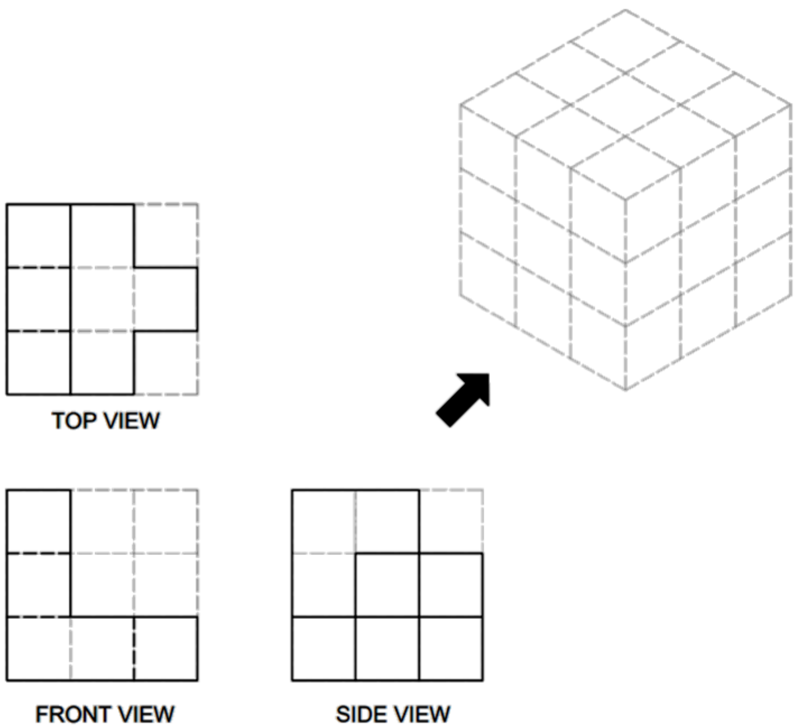
EXERCISE 1: ISOMETRIC VIEW



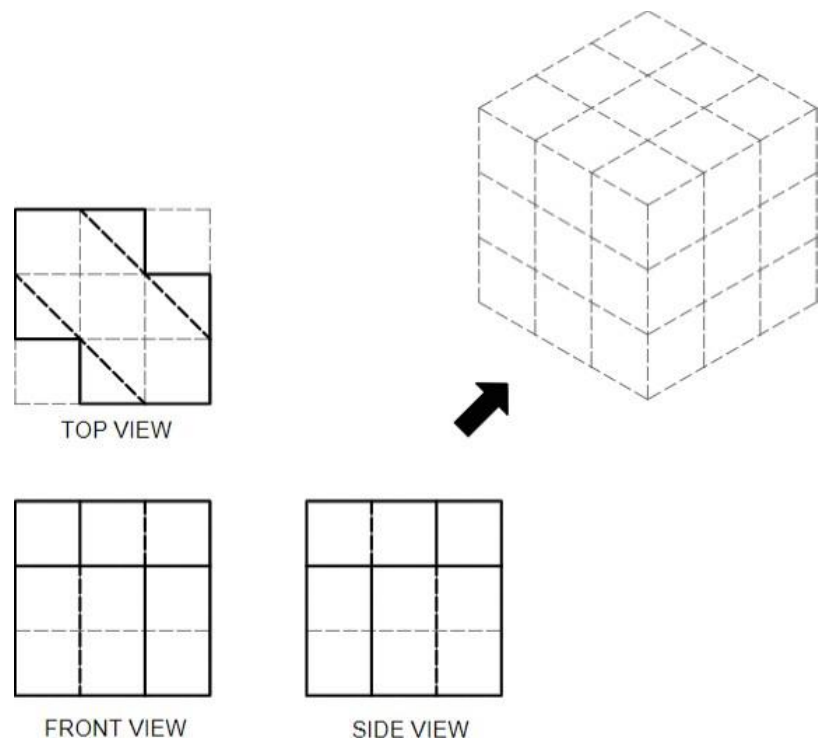
EXERCISE 2: ISOMETRIC VIEW



EXERCISE 3: ISOMETRIC VIEW



EXERCISE 4: ISOMETRIC VIEW



PRACTICAL TASK: ISOMETRIC VIEW

PRACTICAL TASK 1

Construct the drawing by using the dimension given.
Figure 1 shows a orthographic views.
Draw its **isometric view.**

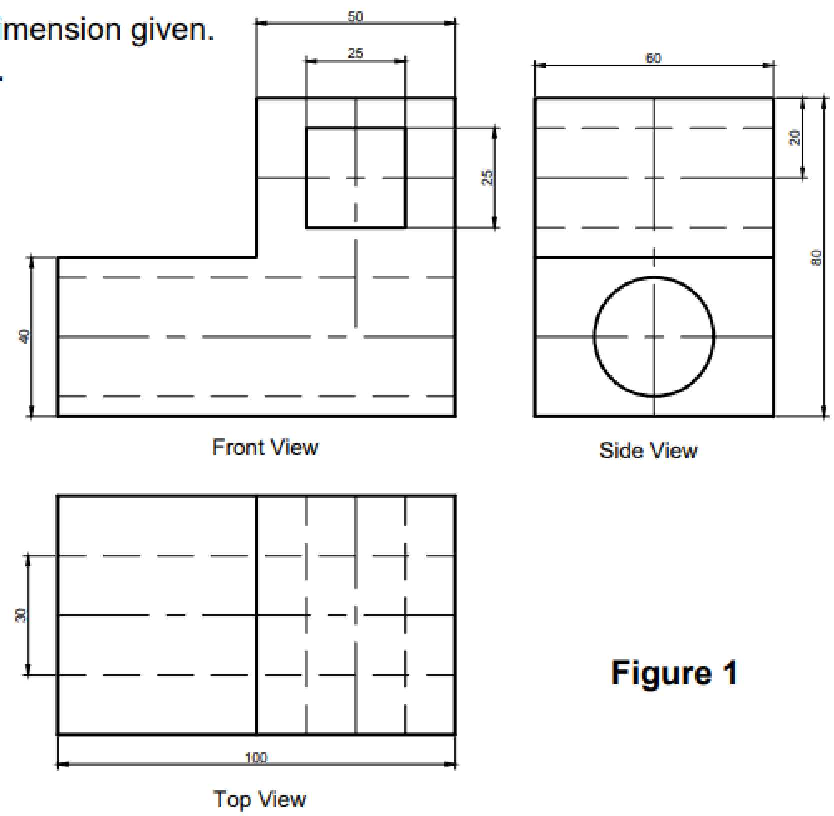


Figure 1

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CHAPTER 4

SECTIONAL VIEWS

4.0 SECTIONING

In an orthographic projection drawing, an '**invisible part'** will be depicted using hidden lines. If too many hidden lines are drawn on a diagram, it can interfere with the clarity of the shape of the object being drawn. To overcome this problem, the object to be drawn will be drawn in **section view** so that the hidden parts can be shown with clearer section lines.

The work of dimensioning such an object is easier compared to an object drawn without being cut (cut) on an orthographic drawing. Figure 4.1 below shows an isometric view of a machined block which has been cut through the centre and moved apart.

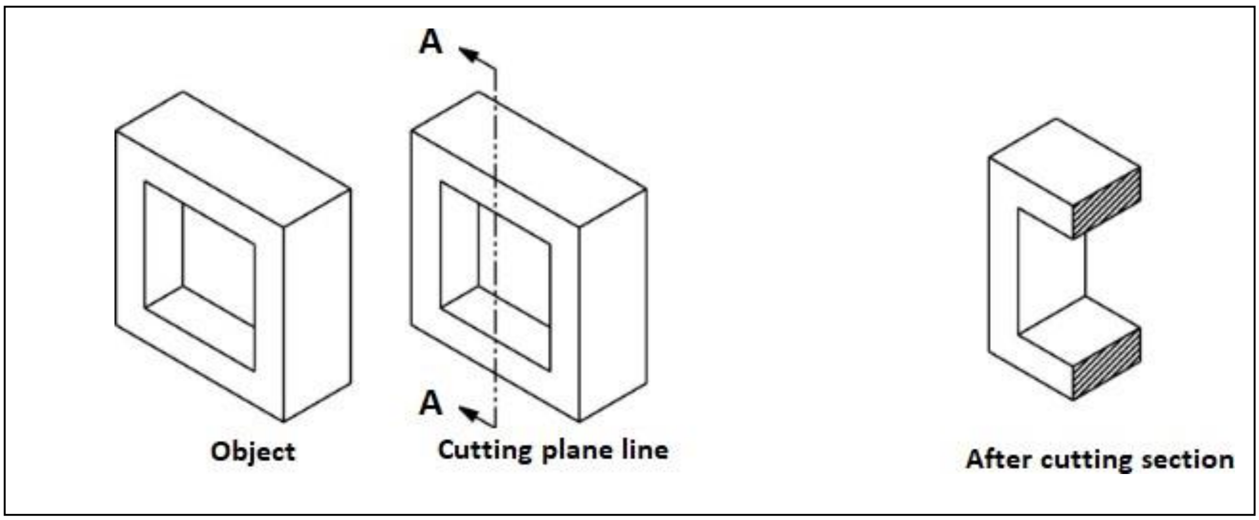


Figure 4.1: Pictorial view of section

4.1 CUTTING PLANE LINE

The cutting plane is represented by a heavy long-short-short-long kind of line terminated with arrows. The arrows in show the direction of view and Figure 4.2 below show the cutting plane line.

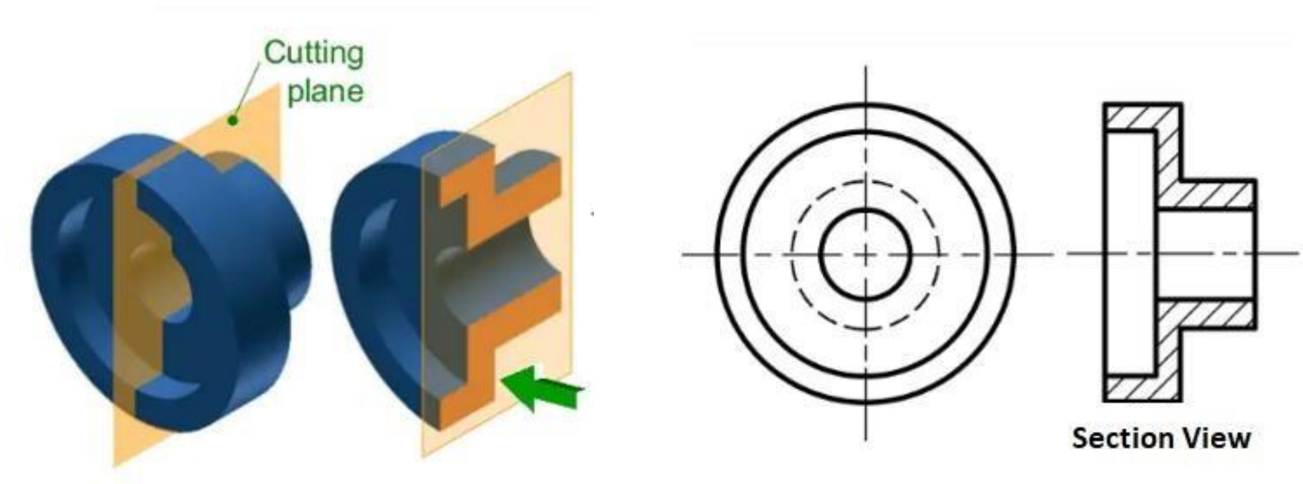


Figure 4.2: Cutting plane line

4.2 TYPES OF SECTIONS

There are several types of sections. All the sectioning for a drawing is depends upon the shape of the object. The type of sections are as below:

1. Full section
2. Half section
3. Offset section
4. Revolved section
5. Removed section
6. Broken out section

- **Full section**

  Full section means that the object is cut in half completely and the view on which part is cut is the one drawn. Full section is used to see the entire inside of an object on one cross section of the object only. Full section drawings are usually used for simple objects only. The direction of the cutting line arrow will determine the direction of the object to be viewed. If the orthographic projection of the view is truncated with a cutting line, the cross -sectional view of the object can be drawn on the front view.

  On the other hand, if the front view is cut by the cutting line, the sectional view can be drawn at the top view. If the front view is cut with the cutting line vertically, the view of the section to be drawn is drawn on the side view. Figure 4.3 below shown the type of cutting in the full section.

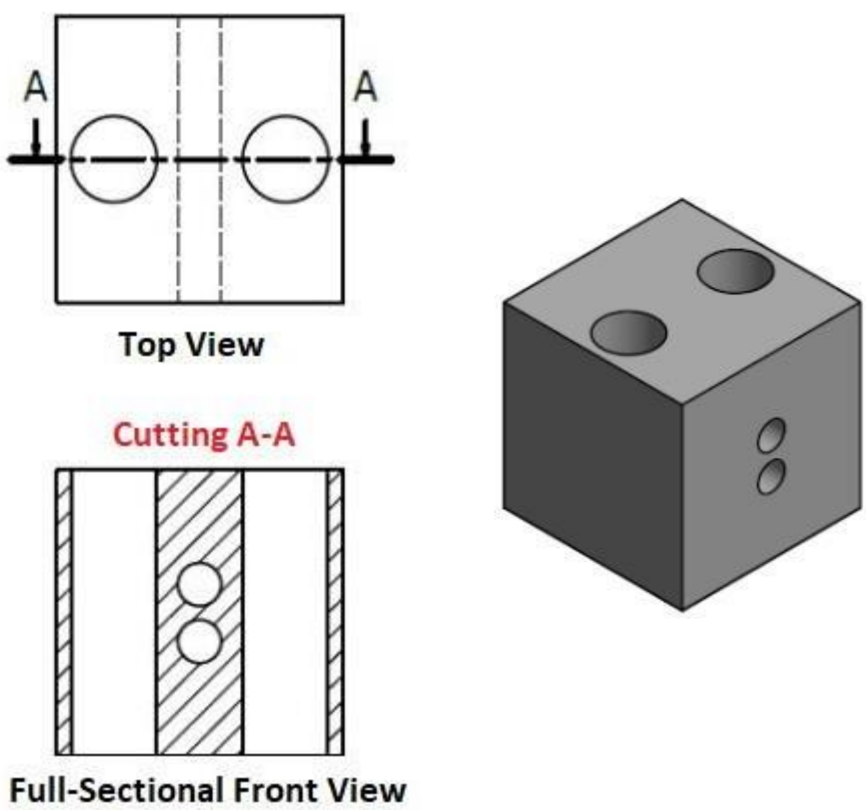


Figure 4.3: Full section cutting plane

- **Half section**

  An object of the same shape such as round, square, etc. does not need to be cut completely because it can be explained by only cutting half (part) of the object as well as can save time drawing. Although this half-section drawing is easy to draw, it is rarely used on drawings that require in-depth explanation, as the dimensioning process in this type of drawing is very difficult. The main use of this drawing is only in equipment assembly drawings because the objects have the same shape which is symmetry. Figure 4.4 below shown the example of Half section.

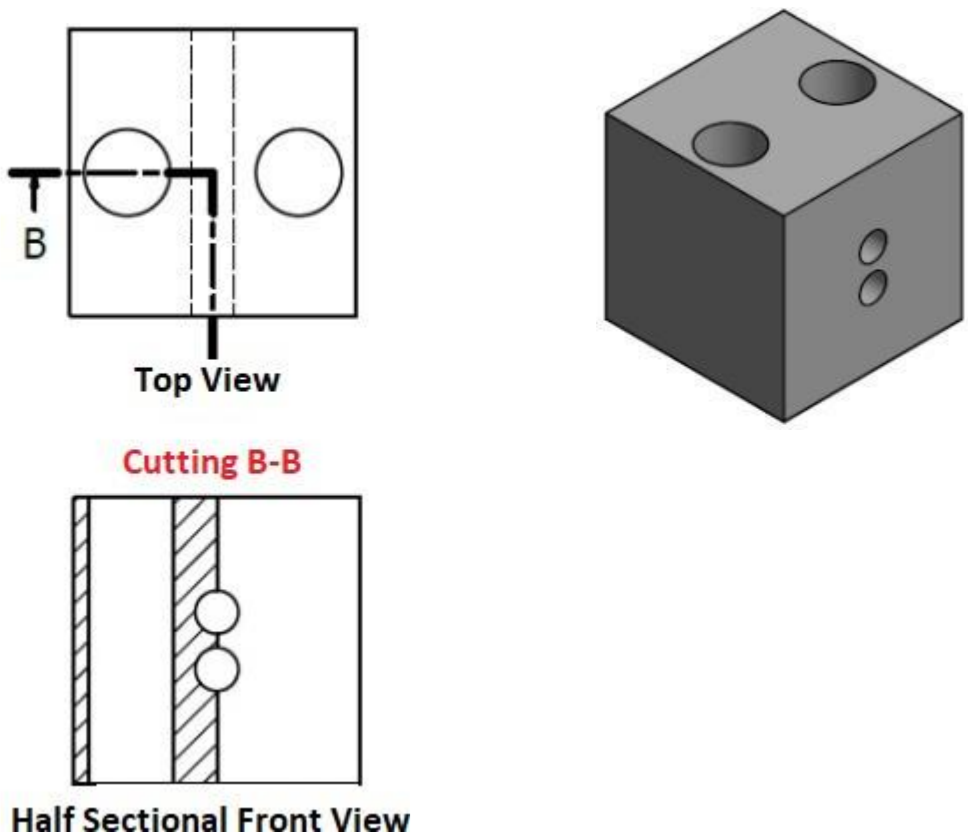


Figure 4.4: Half section cutting plane

- **Offset section**

  This section is actually the same as the full section, the only difference is in terms of the flatness of the cutting line on this section is deviated (not straight). The purpose of deflecting a cutting line is to cut parts that cannot be cut by a straight cutting line, as in a full section. With this diversion important parts that are far from the straight cutting line can be shown using offset sections. Offset section drawings are suitable used to show hidden parts that are at different flattening. Figure 4.5 below shown the example of Offset section.

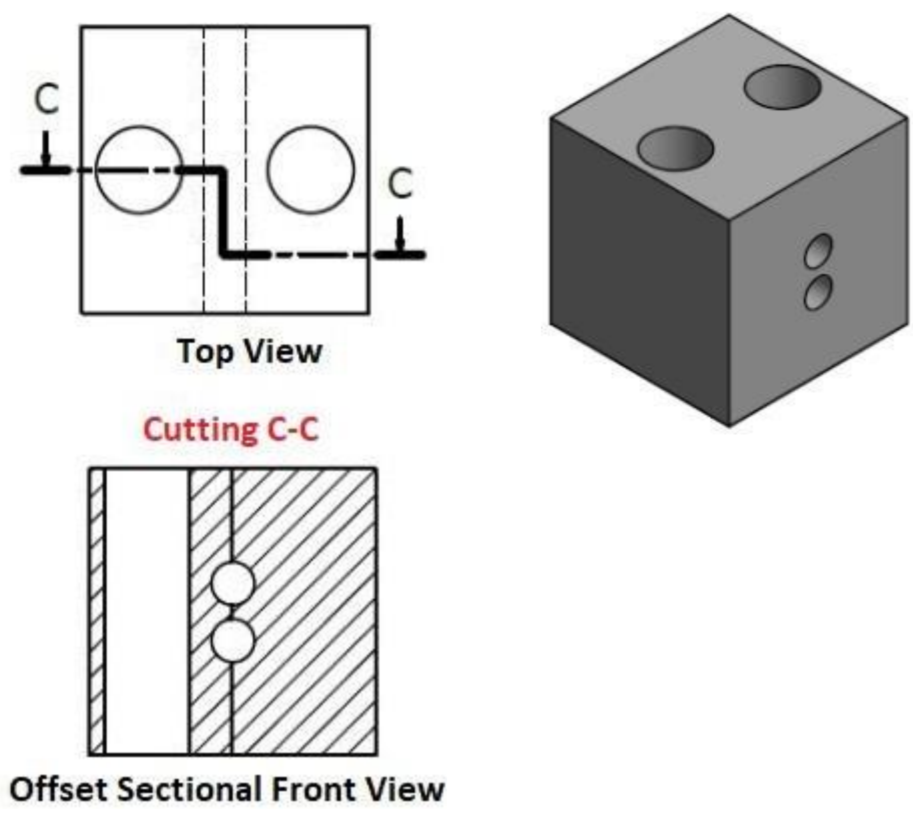


Figure 4.5: Offset section cutting plane

EXAMPLE 1

Isometric Views of a machine part are shown in Figure 1. Draw the Orthographic views for the

- **Top View**
- **Full Sectional A-A Front View**

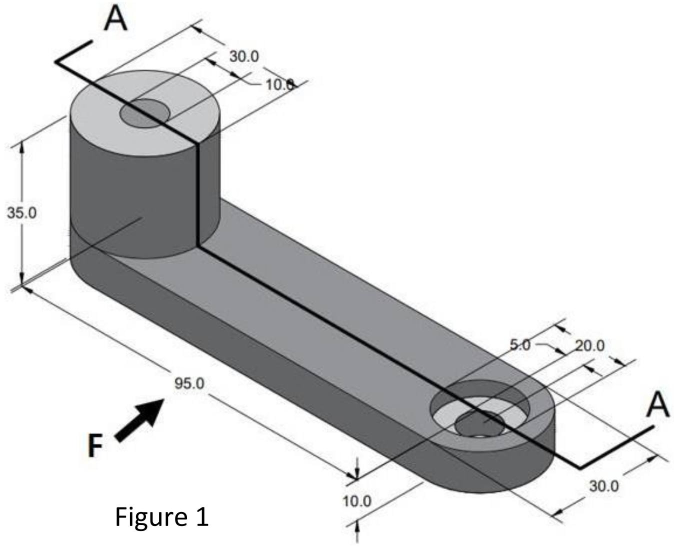
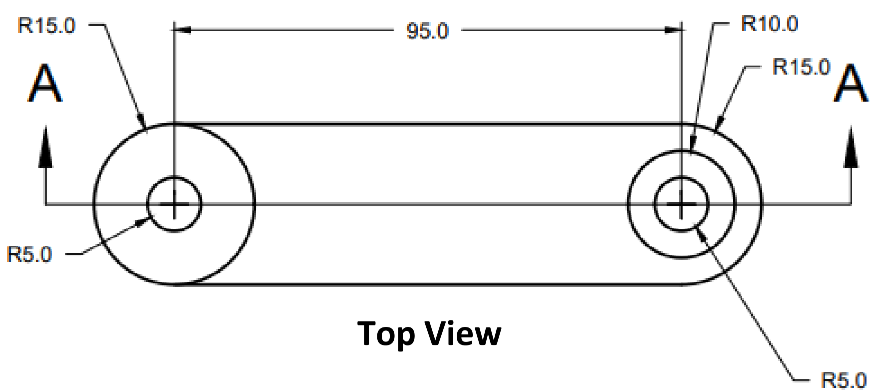
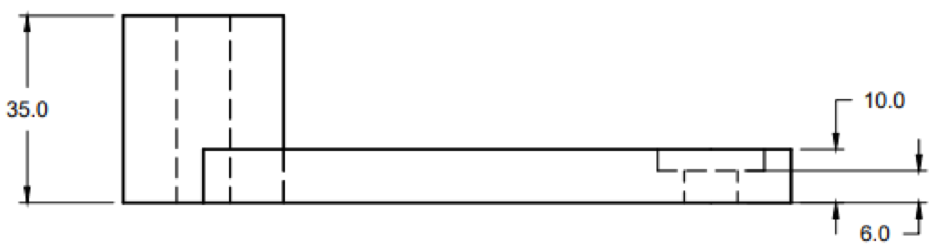


Figure 1

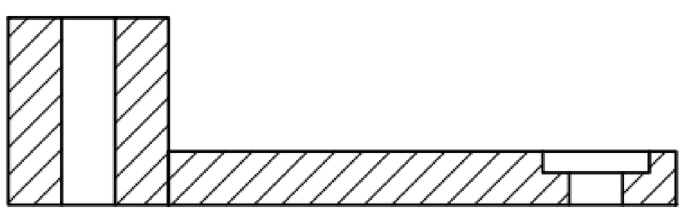
SOLUTION EXAMPLE 1:



Top View



Front View



Full Sectional Front View

EXAMPLE 2

Isometric Views of a machine part are shown in Figure 2. Draw the Orthographic views for the

- **Top View**
- **Half Sectional C-C Front View**

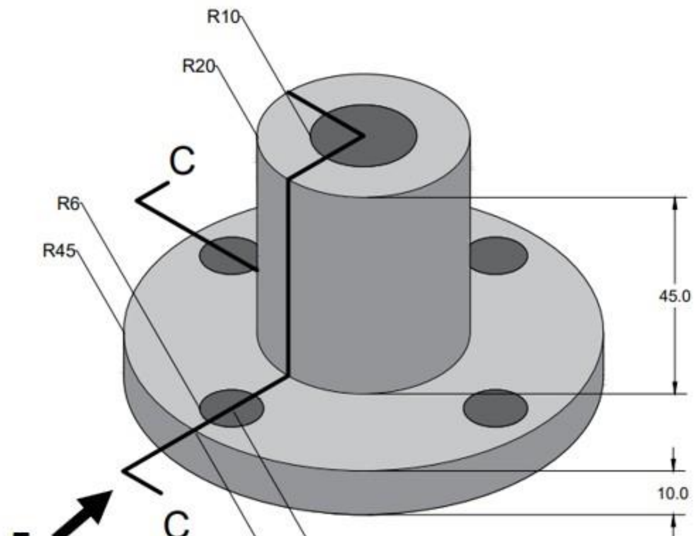
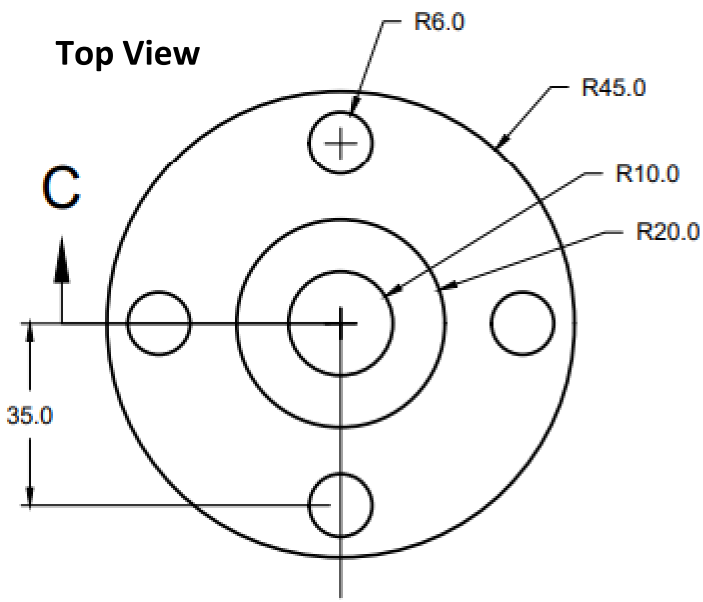
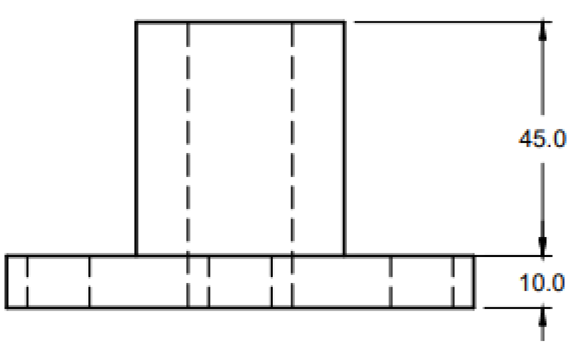


Figure 2

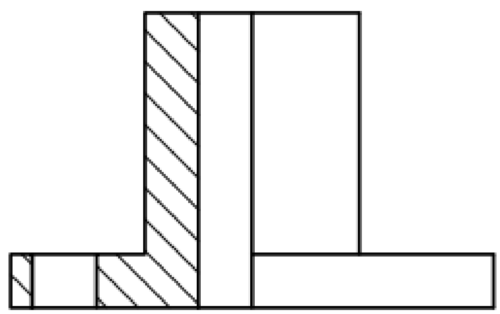
SOLUTION EXAMPLE 2:

Top View





Front View



Half Sectional Front View

EXAMPLE 3

Isometric Views of a machine part are shown in Figure 3. Draw the Orthographic views for the

- **Top View**
- **Offset Sectional B-B Front View**

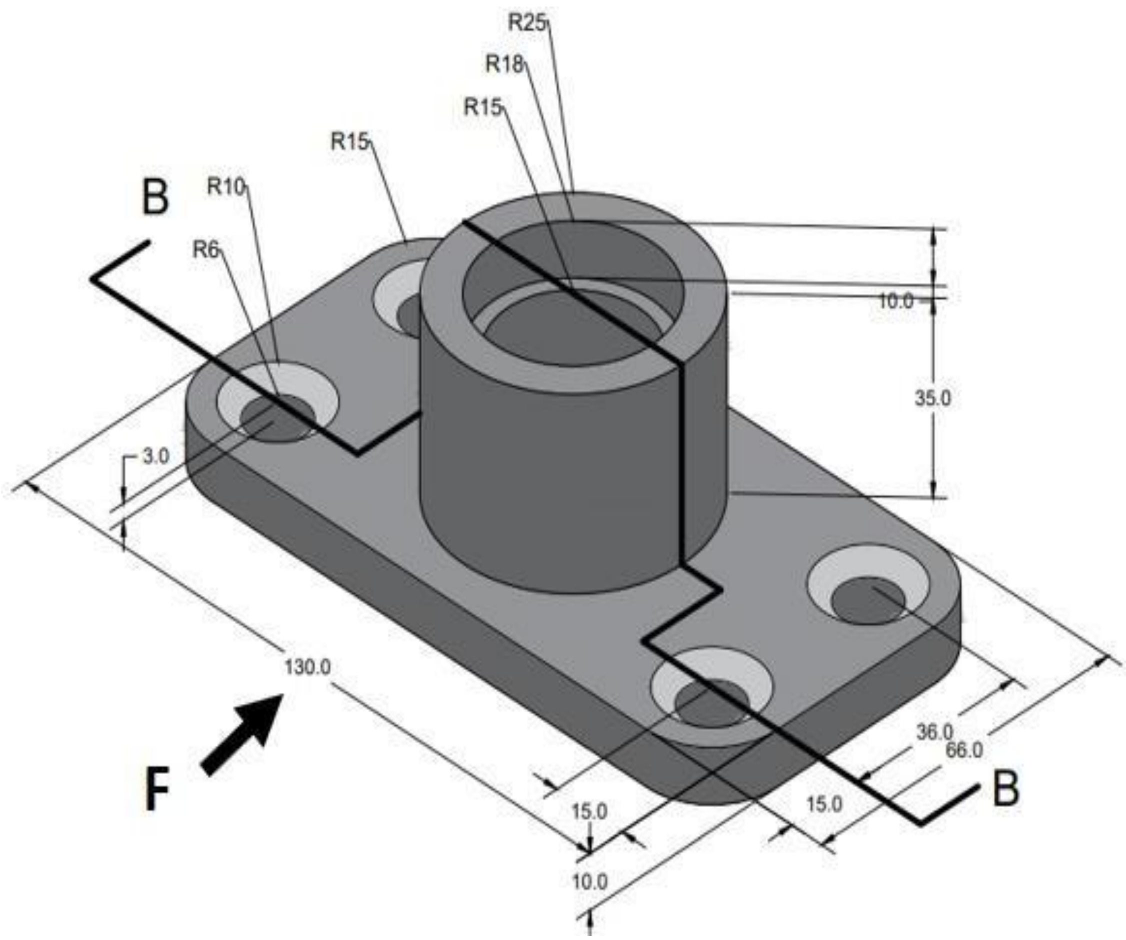
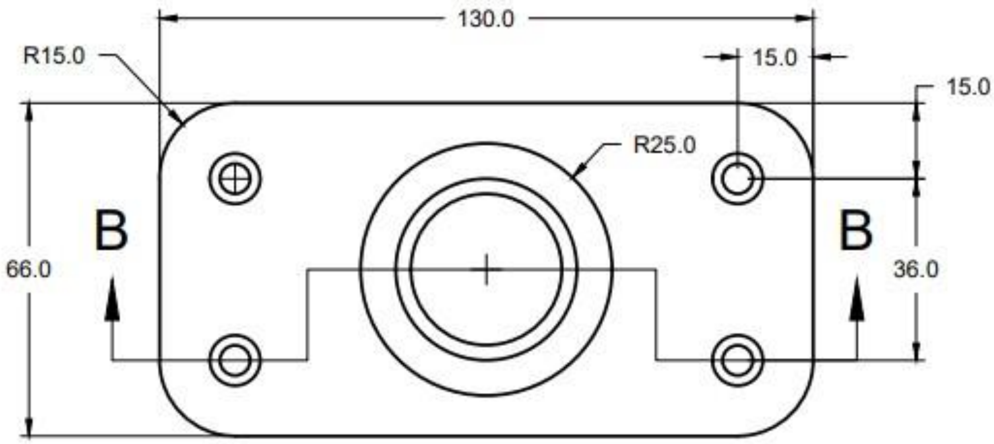
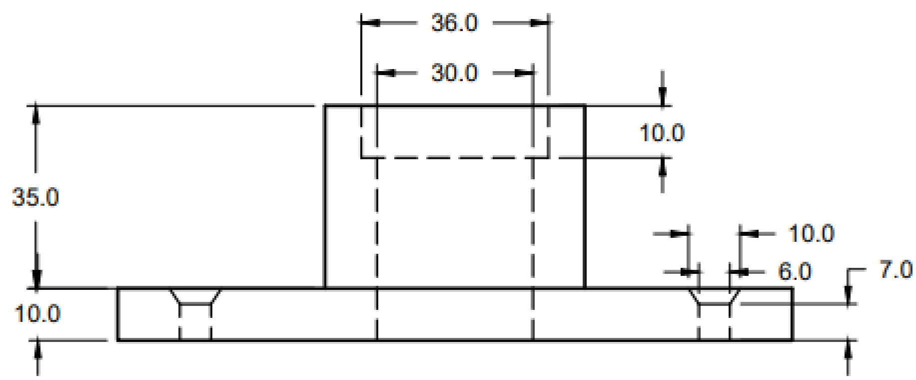


Figure 3

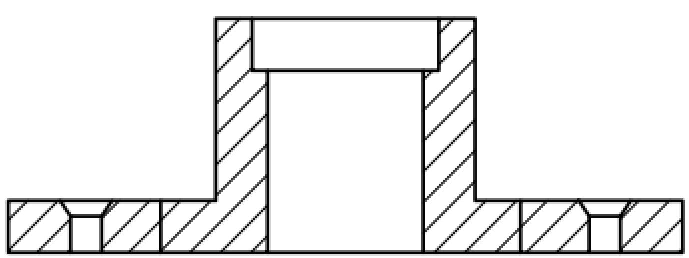
SOLUTION EXAMPLE 3



Top View



Front View



Offset Sectional Front View

EXERCISE 1:

Isometric Views of a machine part are shown in Figure 4. Draw the Orthographic projection for the:

- **Top View**
- **Half Sectional D - D Front View**
- **Side View**

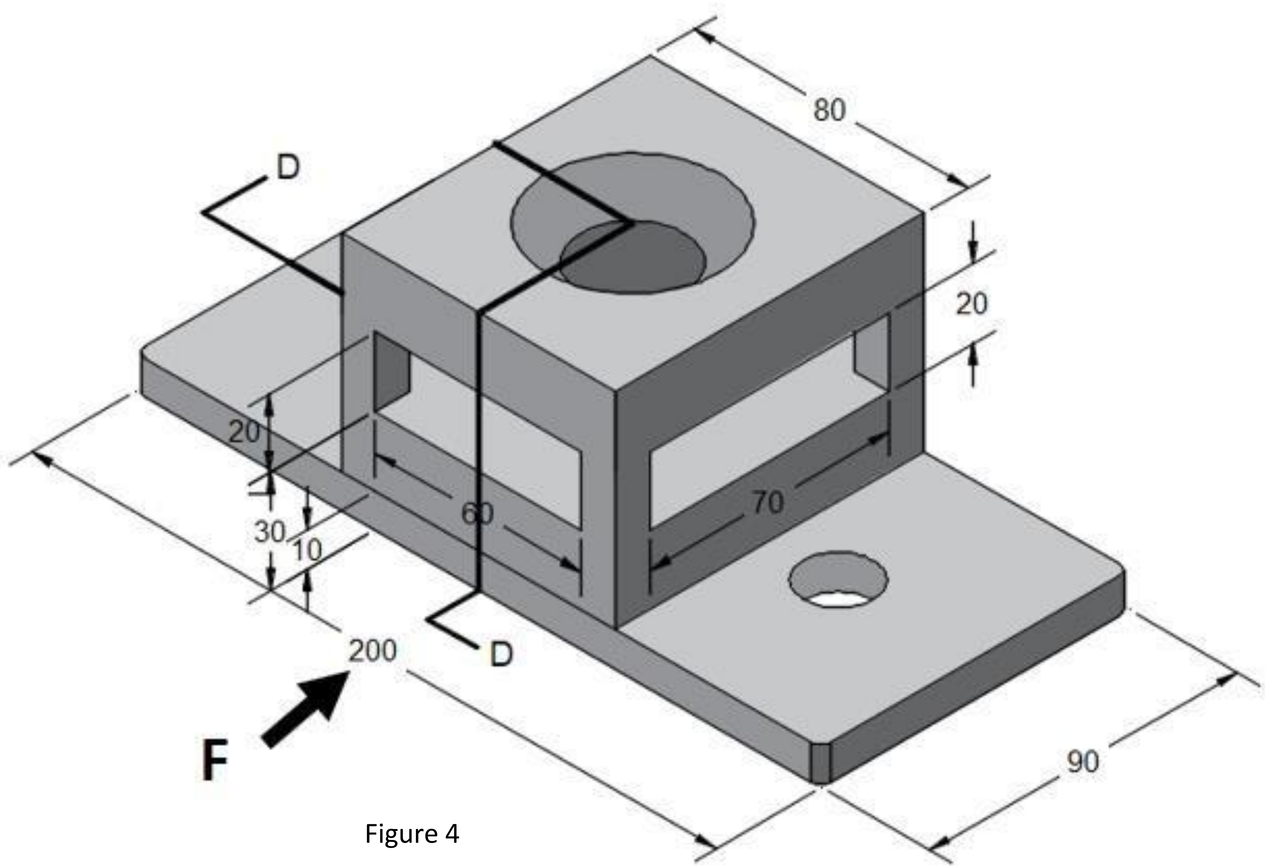


Figure 4

EXERCISE 2:

Isometric Views of a machine part are shown in Figure 5. Draw the Orthographic projection for the:

- **Top View**
- **Offset Sectional E-E Front View**
- **Side View**

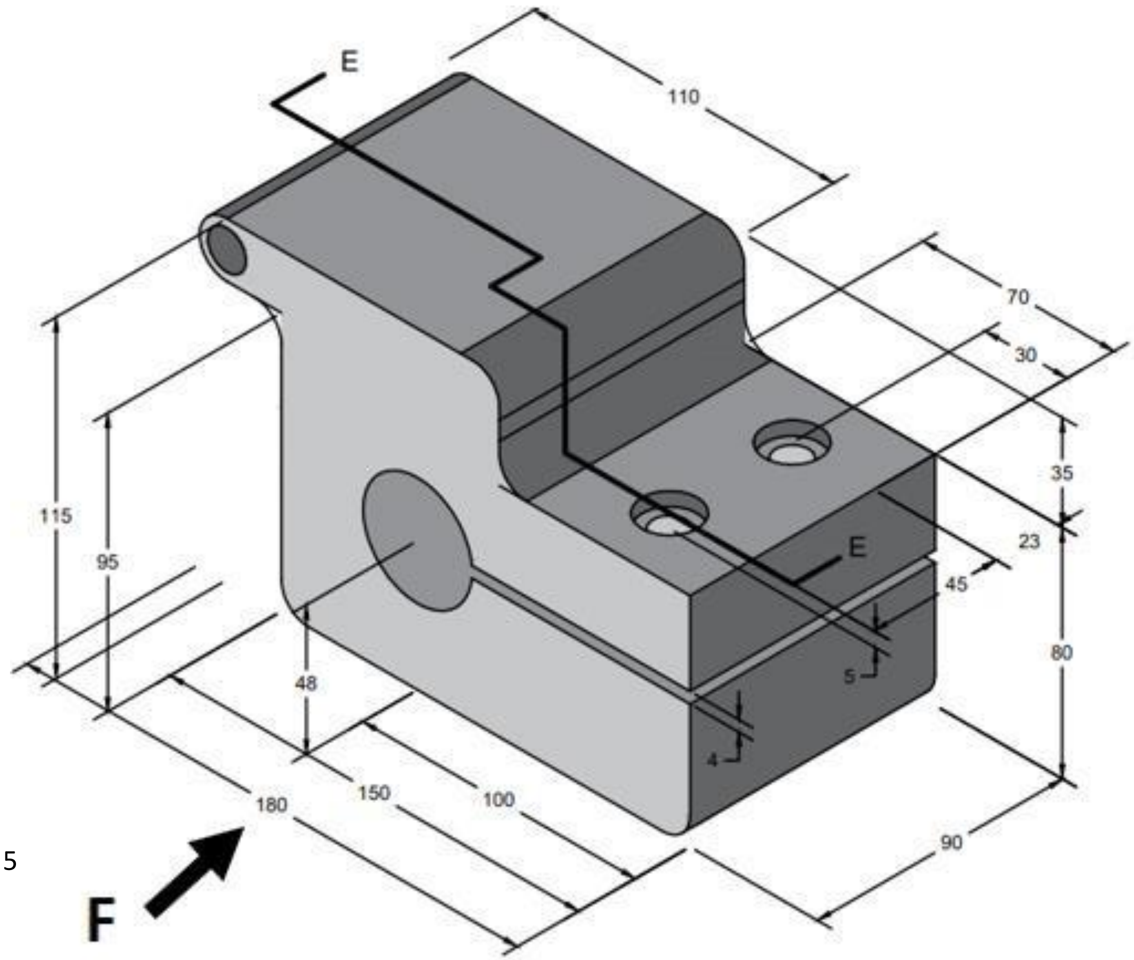


Figure 5

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1. N. S. Parthasarathy, Vela Murali (2015). *Engineering Drawing*. Tamil Naidu State: Oxford University
2. K.C.John (2013). *Textbook of Machine Drawing*. Delhi: PHI Learning.
3. Ajeet Singh (2012). *Machine Drawing (Second Edition)*. New Delhi: Tata McGraw-Hill Education
4. Basant Agrawal (2014). *Engineering Drawing.* India: *McGraw Hill Education.*

Book Engineering Drawing (Technical Drawing) focus on technical drawing following the order of in the syllabus Polytechnic. Each chapter provided examples and practical exercises that can aid comprehension and suitable for polytechnic student.

FIRST EDITION 2021

Politeknik Nilai
Kompleks Pendidikan Bandar Enstek
71760 Bandar Enstek
Negeri Sembilan
No.Tel : 013-7069535

e ISBN 978-967-19793-6-5

Harga : RM20.00