Mechanics Level-I

Based on March 2022, Curriculum Version 1

Module Title: - Interpreting Drawings and Sketches

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Table of Content

Acknowledgment

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Acronym

- TTLM-Teaching, Training and Learning Material.
- TVT – Technical Vocational Training.
- LAP- Learning Activity Performance.
- CAD- Computer Aided Design.

Introduction to the Module

Drawing' is an entry-level module on the fundamentals of technical drawing used in some forms of Technical Trainings in TVT Institutions. It is a short briefing on the basics of drawing, the instruments involved, drawing views and the proper use of dimensions. This module is designed to meet the industry requirement under Mechanics Occupational Standard, particularly for the unit of competency: **Interpret Drawings and Sketches.**

This module covers the units:-

- Basic of Technical Drawings
- Drawing views, standard symbols and lines
- Interpretation of Technical Drawing
- Drawing Quality

Learning Objective of the Module:-

- Identify technical drawing
- Identify views, standard symbols and lines
- Interpret technical drawing
- Assess Drawing quality

Module Instruction

For effective use this modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit.
2. Accomplish the Self-checks at the end of each unit.
3. Perform Operation Sheets which were provided at the end of units.
4. Do the “LAP test” given at the end of each unit.
5. Read the identified reference book for examples and exercise.

Unit One: Basic of Technical Drawings

This unit is developed to provide you the necessary information regarding the following content coverage and topics:-

- Introduction to Technical Drawing
- Drawing Tools/instrument and Equipment
- Alphabet of lines
- Lettering
- Freehand sketches
- Geometric Construction
- Drawing Version Validation
- Drawing Instructions

This unit will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify and use Drawing Tools/instrument and Equipment
- Identify alphabet of lines
- Write Lettering
- Perform freehand sketches
- Perform geometric construction
- Validate drawing versions and instruction

1.1 Introduction to Technical Drawing

1.1.1 Definitions of drawing

Drawing:-is a graphic representation of a real thing, an idea, or a proposed design for later manufacture or construction.

- **A graphic** that represents an idea, a concept, or an entity which actually or potentially exists in life by using points, lines or planes.

- A way of communicating all necessary information about an abstraction such as an idea or a concept.

1.2,2 Types of Drawing

There are two basic types of drawings: **Artistic** and **Technical** drawings.

A. Artistic Drawings :

Artistic Drawings range in scope from the simplest line drawing to the most famous paintings. Regardless of their complexity, artistic drawings are used to express the feelings, beliefs, philosophies, and ideas of the artist. In order to understand an artistic drawing, it is sometimes necessary to first understand the artist. Artists often take a subtle or abstract approach in communicating through their drawings, which in turn gives rise to various interpretations.

B. Technical Drawings

The Technical Drawing, on the other hand, is not subtle, or abstract. It does not require an understanding of its creator, only an understanding of technical drawings.

A technical drawing is a means of clearly and concisely communicating all of the information necessary to transform an idea or a concept in to reality. Therefore, a technical drawing often contains more than just a graphic representation of its subject. It also contains dimensions, notes and specifications

1.2 Drawing Tools/instrument and Equipment

The preparation of technical drawing is possible only through knowledge and skill in the use of a variety instruments. With the aid of knowledge and skill practice will bring perfection. The following listed drawing instruments are the basic ones.

1.2.1 Drawing Tools/Instrument

Drawing tools/instrument like T-square, Drawing Board or binder, Set Squares, Compasses, Protractors, French Curves, Templates, Eraser, Dividers etc….

1. T-square

T-square is provides a parallel straight edge for the beginning drawing drafter.

It is composed of two parts:

- The head and
- The blade.

The two parts are fastened together at an exact right angle. The blade must be straight and free of any necks and imperfections. Used to draw horizontal lines on the drawing sheet Used to draw vertical lines and slanted lines with the help of additional equipment basically $45^0$and 60^0 set- squares. Draw lines only against the upper edge of the blade. Make sure the head is held against the left edge of the drawing board to guarantee parallel lines.

The uses of T-square are to align the drawing paper to the drawing board, and to draw parallel horizontal lines on the paper.

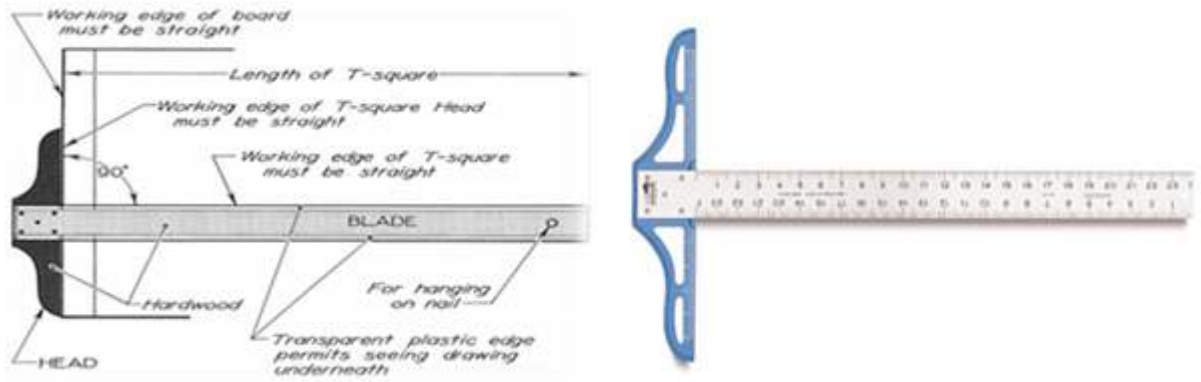


Figure 1.1 T-square

2. Drawing Board

Drawing Board; is Available in a variety of styles and sizes. Most are adjustable up and down, and can tilt to almost any angle from vertical 90^o to horizontal. The drawing surface must be clean, flat, smooth, and large enough to accommodate the drawing and some drafting equipment. If a T-square is to be used, at least one edge on the board must be absolutely true. Most quality boards have a metal edge to ensure against warping and to hold the T-square securely.

Figure 1.2 Drawing Boards

3. Triangles (Set- square)

Triangles (setsquares):- They are used to construct the most common angles (i.e. 30^o, 45^o, and 60^o) in technical drawings. The 45^o x 45^o and 30^o x 60^o triangles are the most commonly used for ordinary work.

Triangles are used in combination with the T square or straightedge to draw vertical and inclined lines. They are usually made of transparent plastic, which allows you to see your work underneath the triangles.

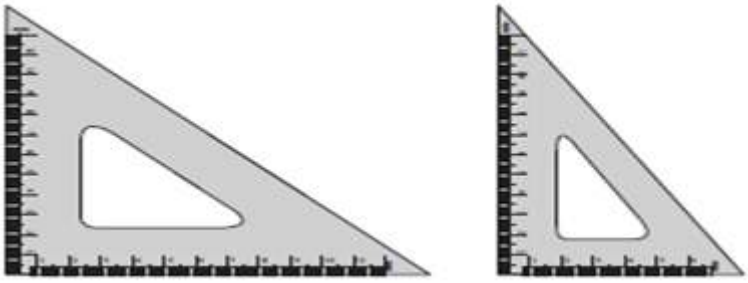


Figure 1.3 (a) 30|60 Set Square (b) 45 Set Square

4. Compass

Drawing compass has two parts connected by a hinge so the radius of the circle that is drawn can be adjusted and changed. Usually at the end of one part is a needle and at the end of another is a pencil.

Figure 1.4 Compasses

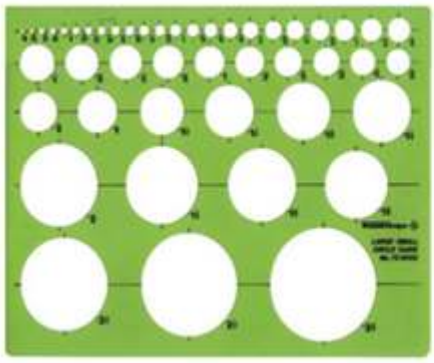
5. Divider

Dividers are similar to compasses, except that both legs are provided with needle points. As with compasses, dividers are available in large and small sizes, Dividers are used to transfer measurements. To step off a series of equal distances, and to divide lines into a number of equal parts A divider is similar to a compass, except that it has a metal point on each leg. It is used to lay off distances and to transfer measurements

Figure 1.4 Divider

6. Drawing Templates

A template is a thin, flat piece of plastic containing various cutout shapes. It is designed to increase the speed and accuracy of the Drafter. Templates are available for drawing standard figures like circles, ellipses.



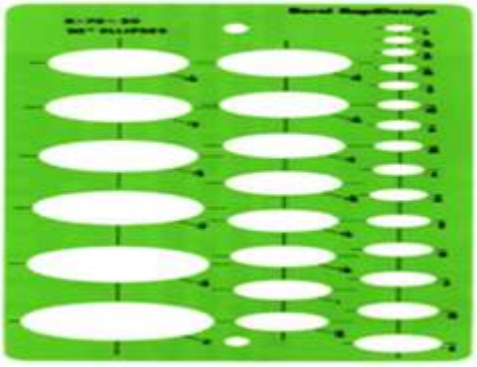


Figure 1.5 a) circle Template b) Ellipse Template

7. French curves

French curves are thin plastic tools that come in assortment of curved surfaces. They are used to produce curved lines that cannot be made by a compass. Most common French curves are actually segments of ellipses, **parabolas** and **hyperbolas**.

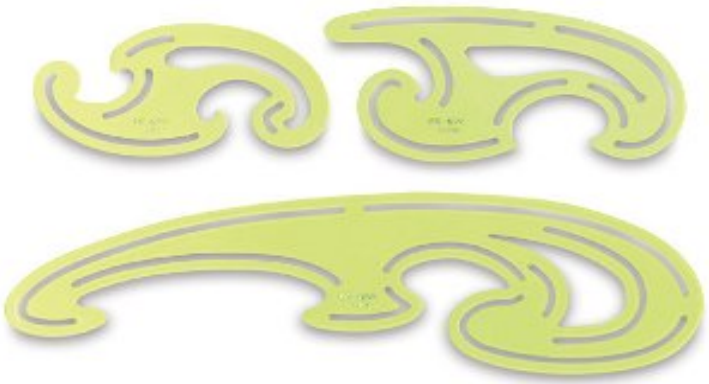


Figure 1.7 French curves

8. Protractor

Protractors used to mark or measure angles between 0 and 180°. They are semicircular in shape (of diameter 100mm) and are made of Plastic or celluloid which has more life. Protractors with circular shape capable of marking and measuring 0 to 360° are also available in the market.

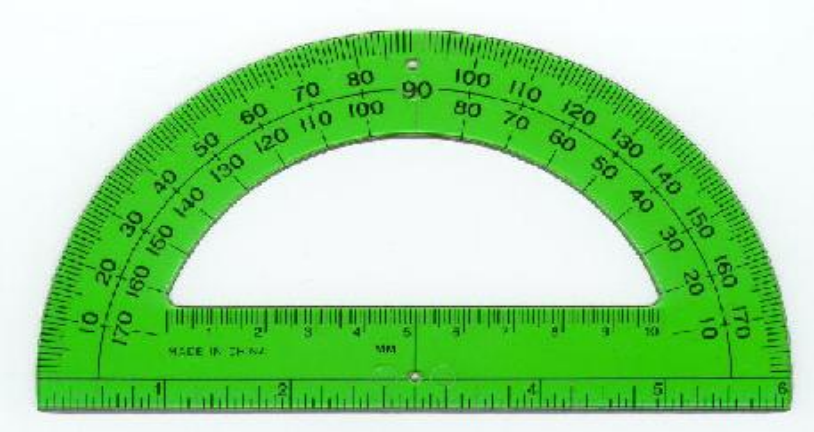


Figure.1.8 Protractor

1.2.2 Drawing Materials

Drawing Materials are consumable materials that can be used to represent drawings by the help of drawing instruments.

1. Drawing Paper

They are available in many varieties and good quality paper with smooth surface should be selected for Drawings which are to be preserved for longer time. Recommended Standard size of drawing sheet.

Table 1.1 Designation Size (mm) of standard paper.

Designation	Designation mm Trimmed Size
A0	1189 × 841(1 m^2)
A1	841 × 594
A2	594 × 420
A3	420 × 297
A4	297 × 210
A5	210 ×148

2. Drawing Pencils:

The accuracy and appearance of a Drawing depends on the quality of Pencil used to make Drawing.

The grade of a Pencil lead is marked on the Pencil. HB denotes medium grade. Increase in hardness is shown by value put in front of H such as 2H, 3H etc., Softer pencils are marked as 2B, 3B, and 4B etc. A Pencil marked 3B is softer than 2B and Pencil marked 4B is softer than 3B and so on. Beginning of a Drawing may be made with H or 2H. For lettering and dimensioning, H and HB Pencils are used.

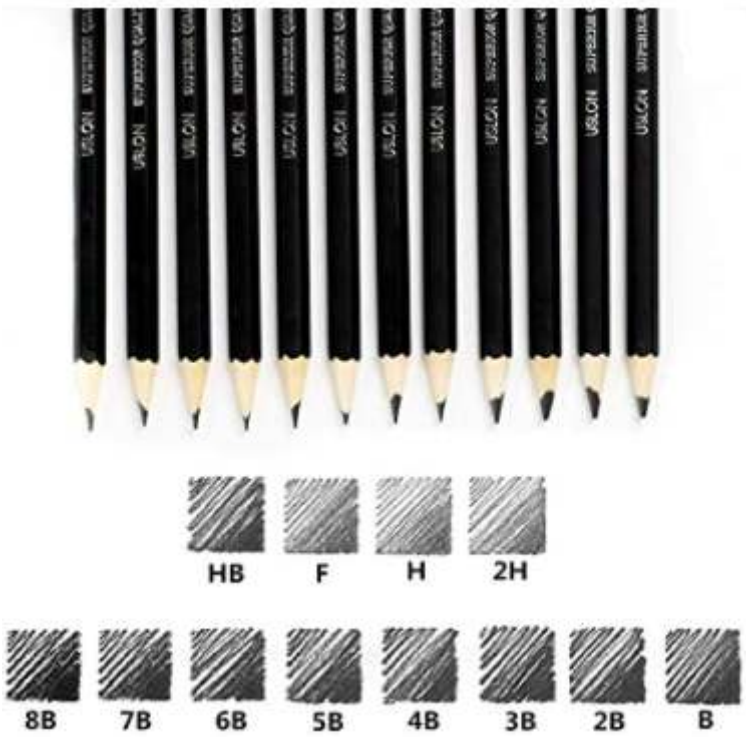


Figure.1.9 Drawing Pencils

3. Eraser

Erasers are made of plastic rubber and used to correct drawings drawn by drawing pencils.

Figure.1.9 Erasers

4. Masking tape

Masking tape are used to fix drawing paper on drawing board and made of sticky materials.

Figure.1.10 Masking tape

1.3 Elements of Technical Drawing

Technical drawing is made up of **graphics language** and **word language**.

- **Graphics language:** Describe a shape (mainly).
- **Word language**: Describe name, an exact size, location and specification of the object.

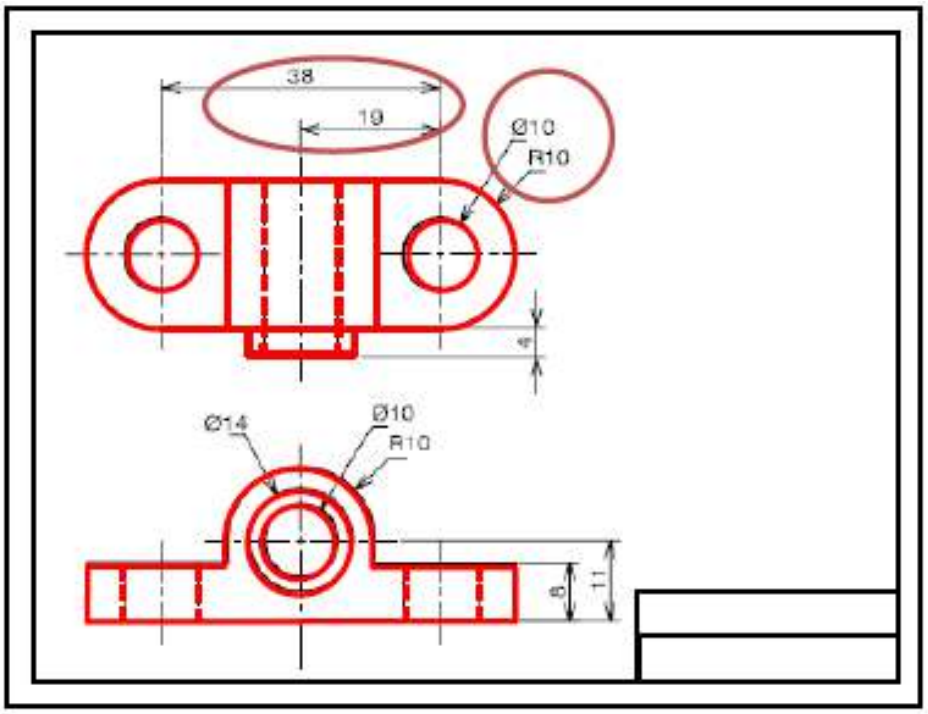


Figure.1.11 Graphic and word language

1.4 Lettering

Lettering is the process of writing an alphabet A, B,C…Z/a,b,c…z or a number 0.1, 2, 3…9. Lettering is used to provide easy to read and understand information to supplement a drawing in the form of notes and annotations. Lettering is an essential element in both traditional

drawing and Computer Aided Design (CAD) drawing. Name, notes and dimensions are all lettered.

Thus, it must be written with:

Legibility – shape & space between letters and words.

Uniformity – size & line thickness.

Types of Lettering

The two types of lettering are:

1. **Double Stroke Lettering**: In Double Stroke Lettering the line width is greater than that of Single Stroke Lettering.

Double Stroke Lettering is further divided into: a) Double Stroke Vertical Gothic Lettering.

b) Double Stroke Inclined Gothic Lettering.

A stencil is mostly used when hand drawing double stroked letters.

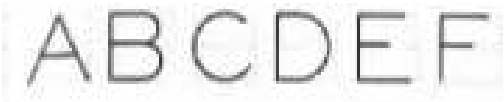
Example

2. **Single Stroke Lettering:** Thickness in single stroke lettering is obtained by a single stroke of pencil or ink pen. It is further divided into:

(a) Single Stroke Vertical Gothic Lettering.

b) Single Stroke Inclined Gothic Lettering

Example



1.5 Alphabet of Lines

Lines in technical drawings are part of a specialized graphic language that is standardized throughout industry. Each type of line has a very precise symbolic meaning. Correct usage of this "alphabet of lines" is essential whether you use traditional drafting methods or CAD.

Line weight is the thickness of the line. Construction lines and guide lines are very light,

easily erased lines used to block in the main layout. Visible lines are the edges or "outlines" of an object. They are drawn as solid lines with a thick/heavy weight.

Line	Appearance
Construction	
Visible/Object	
Hidden	
Center	
Dimension	
Extension	
Phantom	
Long Break	
Short Break	
Cutting-plane/ Viewing-plane	
Section	
Chain	

Figure.1.12 Line Types

1.6 Free Hand Sketching

Sketching is as much a thinking process as it is a communication technique and it is a rapid method of drawing. In addition to gaining speed freehand sketches have the following uses;

- Transferring information, obtained in the field or shop, to the engineering office.
- Conveying the ideas of the designer to the draftsman.
- Making studies of the layout of the views required in an instrumental drawing.
- A means of making preliminary studies of a design to show how it functions.
- Furnishing a three-dimensional picture of an object; this will help to interpret the orthographic views

1.7 Drawing Version Validation

Drafting standard and drawing management system has been established, a drawing validation process must exist to ensure compliance with corporate standards.

Oftentimes this consists of one or more drafters or checkers performing drawing audits from within AutoCAD software using various tools like Check Standards,

This process can be time-consuming and costly especially when a large amount of drawings must be processed within a short time period.

Several third-party applications exist to assist with this process but most require an extensive setup and an external database.

Validation should take place from the early to the final stages of our product lifecycle and even after the release of the final solution.

The most commonly used methods are surveys/questionnaires, usability tests, card sorting, eye-tracking, A/B tests and a continuous monitoring of how users are responding and interacting with your product even after every release.

1.8 Drawing Instructions

The Title block is a boxed area containing general information about the part in the drawing. The main purpose of the title block is that it contains important text information about the part such as company name, drawing number, part number and other pertinent information. Different companies may have somewhat different formats for their title blocks, but most of the time the title block is located in the lower right corner of the drawing sheet

The drawing should also include a symbol identifying the projection. The main scale and the linear dimension units if other than "mm" Mechanical drawings should list the standards use for: indicating the surface texture.

1.9 Geometric Construction

This unit 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.

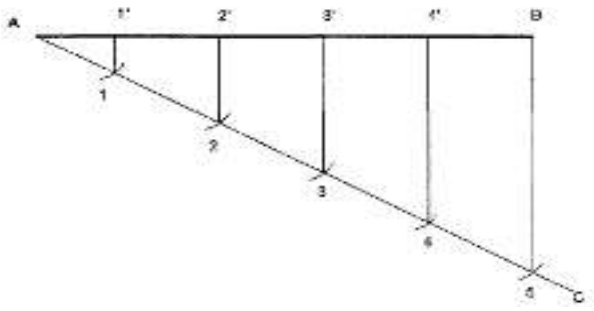
There are an endless number of plane figures but we will concern ourselves only with the more common ones – the triangle, the quadrilateral and the better known polygons.

1.9.1 Lines and angles

In a field of mathematics, a line is defined as a set of continuous points that extend indefinitely in either direction. In technical drawing terminology, a line is a segment defined by two points, the start point and the end point. These end points are defined with coordinates.

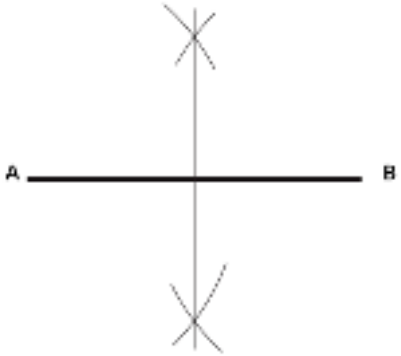
An angle is formed when two non-collinear lines share the same end point. The common point where the two lines meet is called Vertex.

1. To divide a straight line into a given number of equal parts say 5.



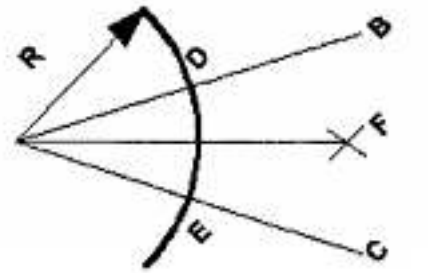
1. Draw AC at any angle e to AB.
2. Construct the required number of equal parts of convenient length on AC like 1,2,3.
3. Join the last point 5 to B.
4. Through 4, 3, 2, 1 draw lines parallel to 5B to Intersect AB at 4', 3', 2' and 1'

2. To bisect a given line in to two equal parts,



1. Draw a given line AB.
2. With center at A and B, strike an arc that intersect at two points
3. Join the two points by straight line.
4. The line that joins two points bisect the give line AB

3. To bisect a given angle,



1. Draw a line AB and AC making the given angle.
2. With center A and any convenient radius R draw an arc intersecting the sides at D and E.
3. With centers D and E and radius larger than half the chord length DE, draw arcs intersecting at F
4. Join AF, <BAF = <PAC.

1.9.2 Polygon

A polygon is a plane figure bounded by straight lines/sides. Polygons that are frequently referred to have particular names. Some of these are listed below.

- A triangle a plane figure bounded by three sides
- A quadrilateral is a plane figure bounded by four sides.
- A pentagon is a plane figure bounded by five sides.
- A hexagon is a plane figure bounded by six sides.
- A heptagon is a plane figure bounded by seven sides.
- An octagon is a plane figure bounded by eight sides.
- A nonagon is a plane figure bounded by nine sides.
- A decagon is a plane figure bounded by ten sides.

A regular polygon is one that has all its sides equal and therefore all its exterior angles equal and all its interior angles equal.

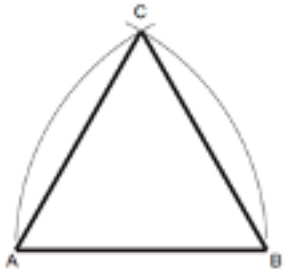
Example: Equilateral triangle, square, Regular heptagon, Regular hexagon etc…
It is possible to construct a circle within a regular polygon so that all the sides of the polygon are tangential to that circle. The diameter of that circle is called the 'diameter of the polygon' . If the polygon has an even number of sides, the diameter is the distance between two diametrically opposed faces. This dimension is often called the ' across-flats ' dimension.
The diagonal of a polygon is the distance from one corner to the corner furthest away from it. If the polygon has an even number of sides, then this distance is the dimension between two diametrically opposed corners.

- Inscribed regular polygon-a polygon is inside a circle.
- Circumscribed regular polygon-a polygon is outside the circle.

1. To construct an equilateral triangle, given one of the sides.

1. Draw a line AB, equal to the length of the side.
2. With compass point on A and radius AB, draw an arc as shown.
3. With compass point on B, and with the same radius, draw another arc to cut the first arc at C.

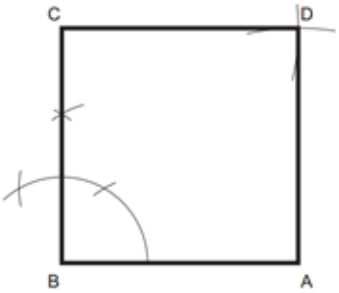
Triangle ABC is equilateral.



2. To construct a square given the length of the side,

1. Draw the side AB.
2. From B erect a perpendicular.
3. Mark off the length of side BC.
4. With centers A and C draw arcs, radius equal to the length of the side of the square, to intersect at D.

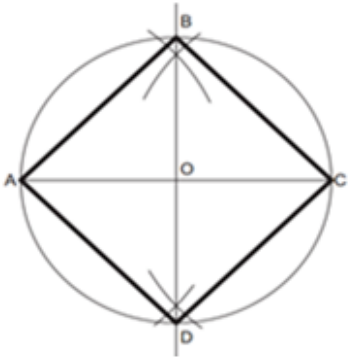
ABCD is the required square.



2. To construct a square given the diagonal,

1. Draw the Diagonal AC.
2. Bisect AC.
3. With center O and radius OA and OC, draw a circle to cut the bisecting line in B and D.

ABCD is the required square



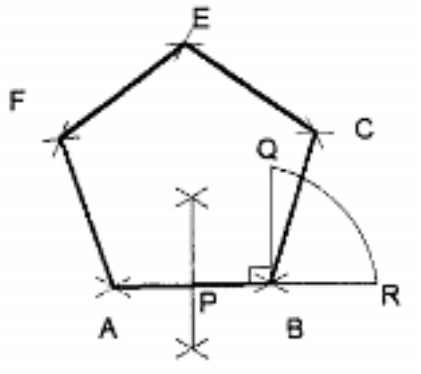
4. To construct a regular pentagon, given the length of side,

1. Draw a line AB equal to the given length of side.
2. Bisect AB at P.
3. Draw a line BQ equal to AB in length and perpendicular to AB.
4. With center P and radius PQ, draw an arc intersecting AB produced at R. AR is equal to

the diagonal length of the pentagon.

5. With centers A and B and radii AR and AB respectively draw arcs intersecting at C.
6. With centers A and B and radius AR draw arcs intersecting at D.
7. With centers A and B and radii AB and AR respectively draw arcs intersecting at E.

ABCDE is the required pentagon.



Self-check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided by your trainers:

A) Choose the correct answer from the following Questions

1. _____is a kind of technical drawing instruments used to prepare drawings

A. set squares B. French curve

C. T-square D. all

2. Which one is used to mark or measure angles between 0 and 180

A. Protractor B. Divide

C. Ellipse template D. Circle Template

3. _____is a thin, flat piece of plastic containing various cutout shapes

A. Template B. French curve set squares

C. T-square D. curve set squares

4. Which one of the following is the largest size of drawing sheets

A. A4 B. A0

C. A5 D. all

5._____ is used to provide easy to read and understand information to supplement a drawing in the form of notes and annotations.

A. Dimensioning B. Drawing

C. Lettering D. Sketching

B) Match column 'B' with Column 'A'

A	**B**
_____ 1. Polygon is outside the circle	A) Bisecting
_____ 2. Bounded by straight line	B) Square
_____ 3 Divide it two equal parts	C) Inscribed
_____4. Regular polygon	D) Circumscribed
_____5. Polygon is inside the circle	E) Polygon

C) Answer the following Questions

1. Mention types drawing and explain each with example.
2. List at least 3 drawing instrument and write its purposes.
3. Mention two classification of lettering.
4. List some alphabets of line in technical drawing.
5. List all types drawing materials.

Operation sheet-1

Operation title: Methods of Using Drawing instruments

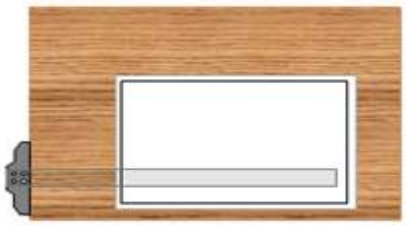
Purpose: To practice fastening paper to drafting board and draw boarder line and title block using drawing instrument.

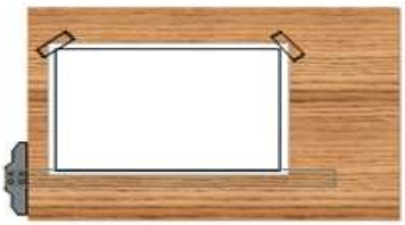
Instruction: Use the given tools and equipment, perform the tasks given below. For this operation you have given 3Hour and you are expected to provide the answer on the given table.

Tools and requirement:

- Drawing board
- Drawing paper
- T-square
- Set square
- Drawing pencil
- Eraser

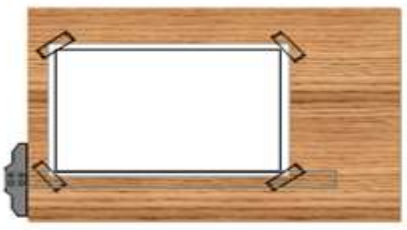
Precautions: For every practice use the required tools and neatness of your work is mandatory.





Procedures 1

The steps of fastening Paper to Drafting Board are as follows:

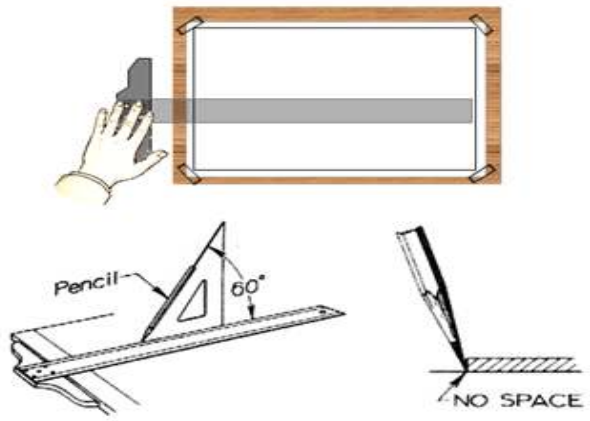


1. Place the paper close to the table's left edge.
2. Move the paper until its lower edge place about the top edge of T-square.
3. Align the top edge of the paper with T-square blade.
4. Attach the paper's corners with tape
5. Move T-square down to smooth the paper
6. Attach the remaining paper's corners with tape

Procedures 2

The steps to use T-square and set square are as follows:

1. Press the T-square head against the left edge of the table.
2. Smooth the blade to the right.
3. Lean the pencil at an angle about 60^{o} with the paper in the direction of the line and slightly "toed in".
4. Draw the line from left to right while rotating the pencil slowly

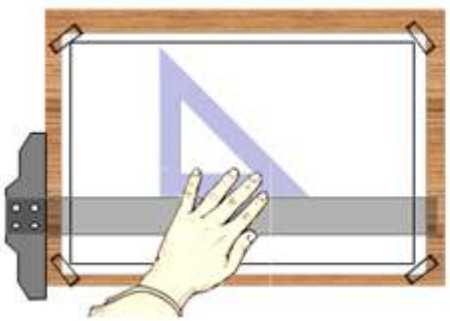


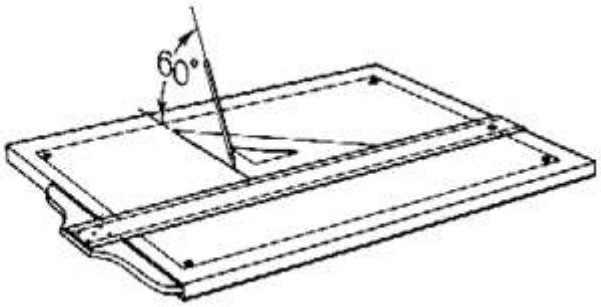
Procedures 3

The steps to draw a vertical, parallel, perpendicular Line are:

1. Set T-square as before Place any triangle on T-square edge.
2. Slide your left hand to hold both T-square and triangle in position.

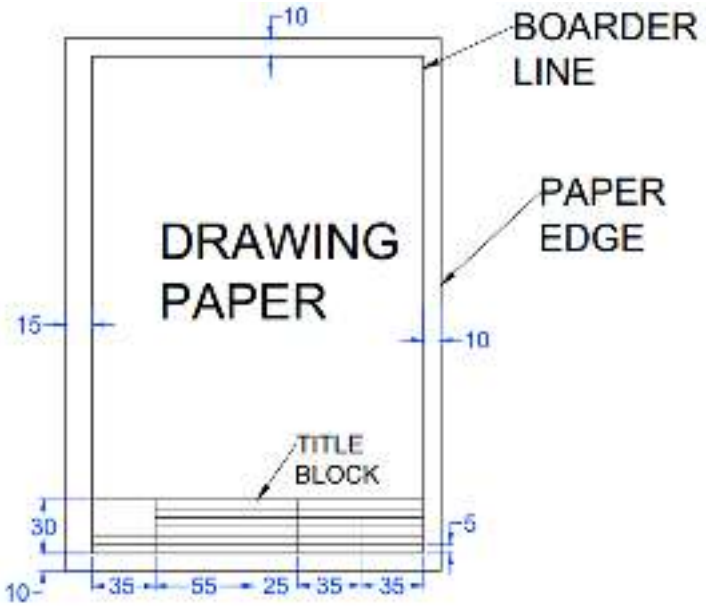
3. Lean the pencil to the triangle.
4. Draw the line upward while rotating the pencil slowly..





LAP Test 1

Task: Create the drawing template (Title Block), shown with the following dimensions



Request from your trainer the following materials.

- HB drawing pencil lead
- 4H drawing pencil lead
- 45º x 90º triangle
- 30º x 60º triangle
- Eraser
- T-square
- Drafting pens
- Drawing table
- Drawing papers

Operation Sheet-2

Operation title: Lettering and Free Hand Sketching

Purpose: To practice the way of writing different letters on drawing and free hand sketching.

Instruction: Use the given tools and equipment, perform the tasks given below. Before starting lettering and free hand sketching prepare boarder line and title block.

Tools and requirement:

- Drawing board
- Drawing paper
- T-square
- Set square
- Drawing pencil
- Eraser

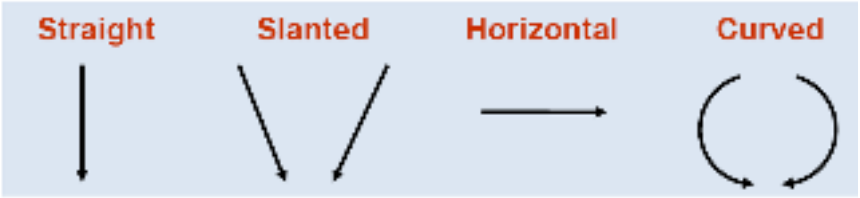
Precautions: For every practice use the required tools and neatness of your work is mandatory.

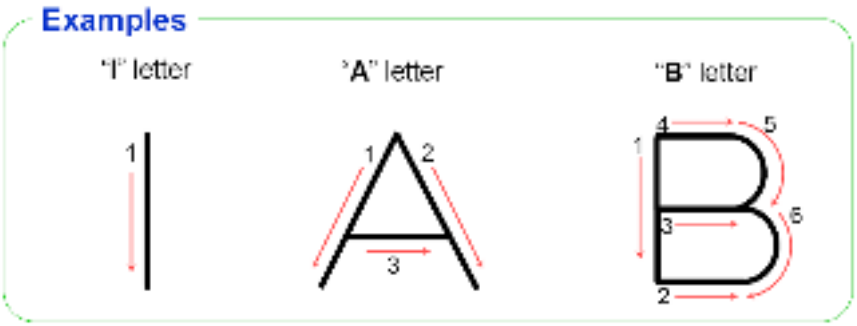
Procedures 1

The steps to write lettering and free hand sketching are as follows:

To write a letter,

1. Prepare guide lines as required height of a letter.
2. Use the stroke as given below to write each letters.





To do Free Hand Sketching,

1. Mark the end points
2. Make a few trial motions between the marked points to adjust the eye and hand to the contemplated line.
3. Sketch a very light line between the points by moving the pencil in two or three sweeps.

When sketching the trial line, the eye should be on the point toward which the movement

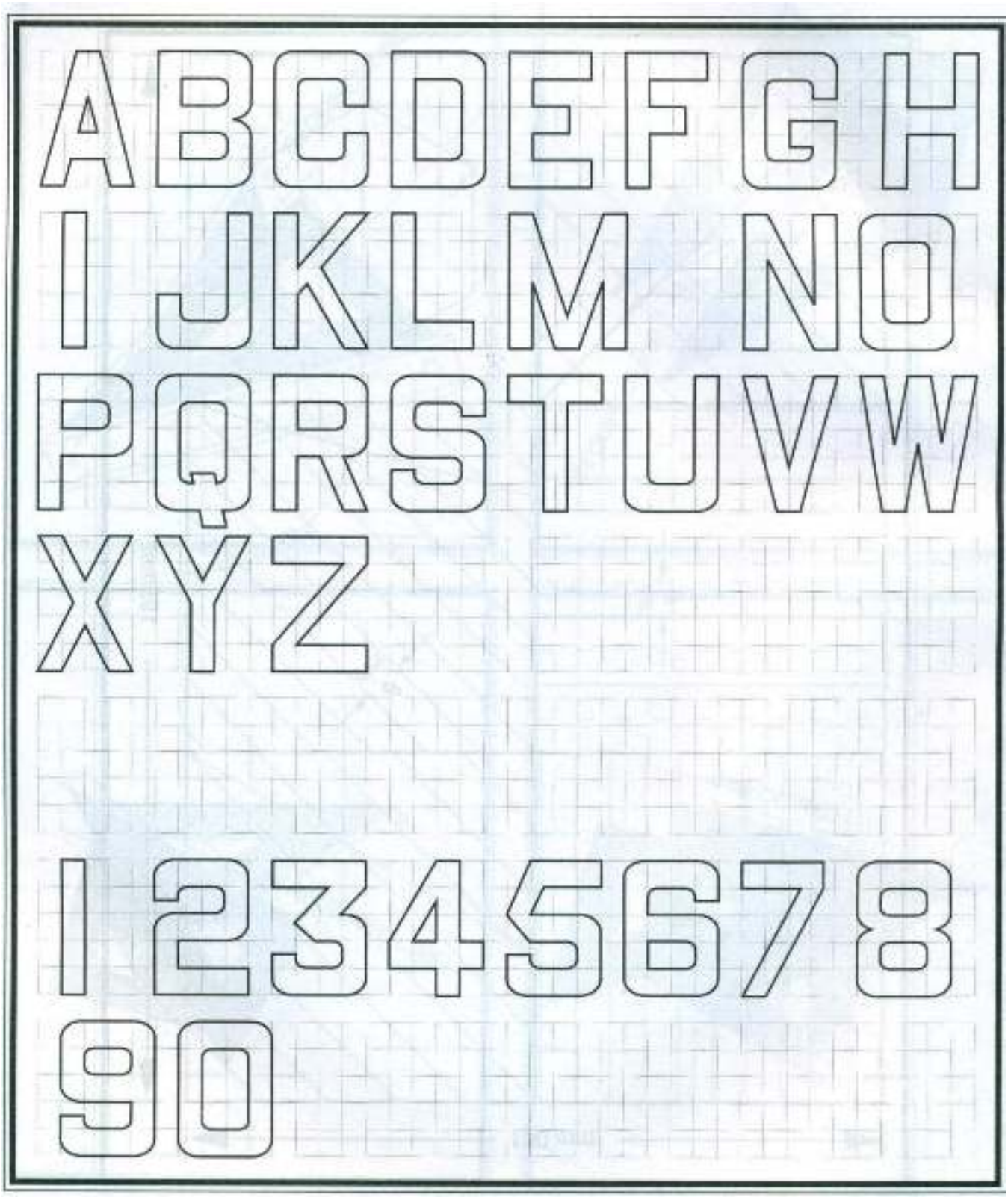
is directed.

4. Darken the finished line, keeping the eye on the pencil point on the trial line. The final

line, replacing the trial line, should be distinct, black, uniform, and straight

LAP Test 2

Task 1:- Perform/drawing Lettering A to Z and 0 to 9 on the required paper



Task 2:- Perform free hand sketching of the given line on required paper

a. Horizontal Lines

b. Vertical Lines

c. Inclined lines

d. Curved lines

Operation Sheet-3

Operation title: Constructing Geometric figures,

Purpose: To practice the way of constructing different geometric figure

Instruction: Use the given tools and equipment, construct the geometric figures given below.

Before starting constructing geometric figures, prepare boarder line and title block.

Tools and requirement:

- Drawing board

- Drawing paper
- T-square
- Set square
- Drawing pencil
- Eraser

Precautions: For every practice use the required tools and neatness of your work is mandatory.

Procedures:

The steps to construct the geometric figures are as follows:

1. Set up your drawing paper on top of the drawing board.
2. Construct boarder line and title block as required.
3. Be sure to show all construction lines, arcs on your drawing and object line should be darkened.
4. Using the basic drawing instruments and materials, perform the drawing task in the given following problems given in the Lap test below.
5. Use appropriate pencil lead in your drafting works.
6. You may submit your finish work once you are true but should be within the time specified for submission

LAP Test 3

Direction: Solve the following questions on A4 paper.

1. Draw straight line AB=65mm and divide it in to 8 equal parts.
2. Draw straight line CD=70mm and bisect it.
3. Draw angle <ACB=75^{o} and bisect it.
4. Draw equilateral triangle given that one side AB=30mm.
5. Draw square given that one side AB=40mm.
6. Draw regular polygon given that one side AB=40mm.
7. Draw regular hexagon given that distance across corner is 45mm.

8. Draw regular hexagon given that distance across flat is 50mm
9. Draw regular heptagon, regular octagon and regular nonagon on common side length of 30mm.(Use general method)

Unit Two: Drawing Views and Standard Symbols

This unit to provide you the necessary information regarding the following content coverage and topics:-

- Definition and Purpose of Multi view drawing
- Type of projection
- Plane of projection
- Method of projection
- Isometric Views
- Sectional views
- Drawing symbols & Codes

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify of Multi view drawing
- Identify type of projection
- Perform orthographic projection
- Apply method of projection
- Perform Isometric Views
- Identify sectional views
- Identify Drawing symbols & Codes

2.1 Multi View Drawing

2.1.1 Type of Projection

A projection is a drawing or representation of an entity on an imaginary plane or planes. It consist four components: The actual object that the drawing or projection represents.
The eye of the viewer looking at the object. The imaginary projection plane (Viewers drawing paper Imaginary lines of sight called **projectors.**
Two broad projection types are viable with different further classifications. These are:

- Parallel projection
- Perspective projection

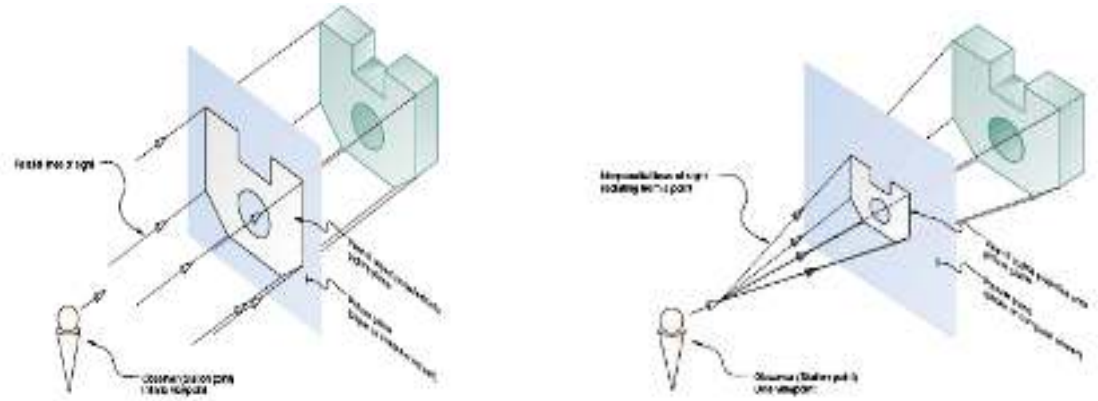


Figure 2.1 Type of projections (Parallel and perspective projection)

Parallel projection is a projection where imaginary projection lines will not converge as a point on the viewer's eye. This implies that, all projection lines are either parallel or perpendicular to each other. There are three main types of parallel projection system illustrated below:

- Orthographic projection
- Axonometric projection.
- Oblique projections

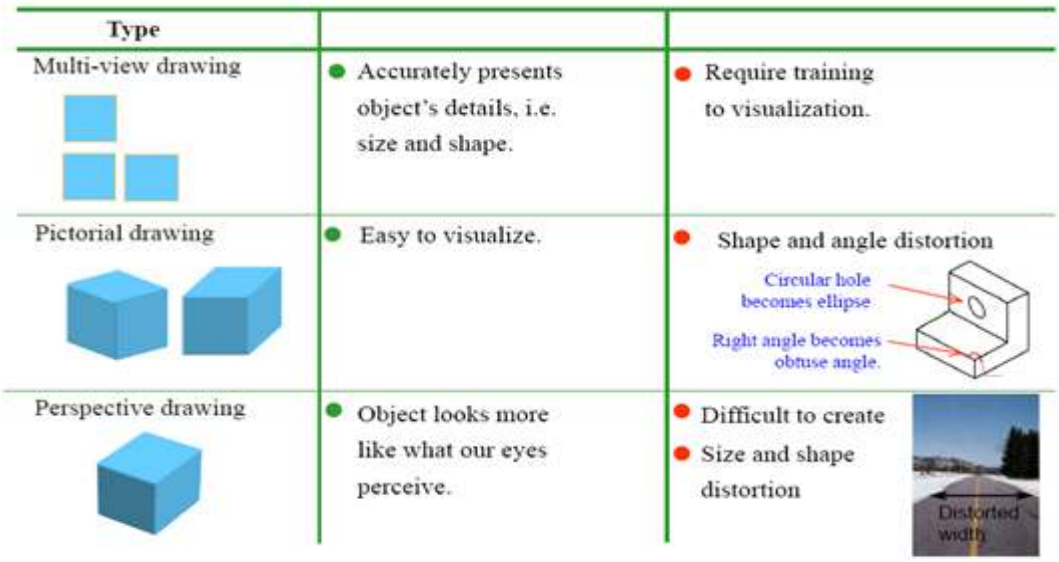


Figure 2.2 Comparison of views

2.1.2. Orthographic Projection

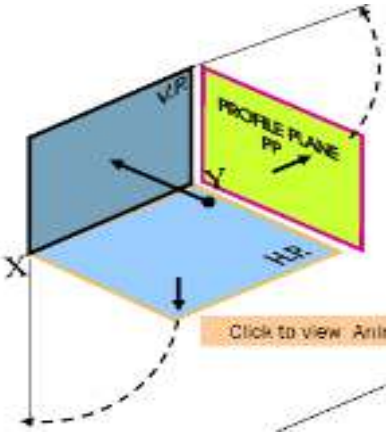
Orthographic is a system of views of an object formed by projectors from the object perpendicular to the desired planes of projection. Orthographic Projections are a technical

drawing in which different views of an object are projected on different reference planes observing perpendicular to respective reference plane.

2.1.2.1 Plane of projection

There are 3 Reference planes of projection:

- Horizontal Plane (HP) - in which the top view of an object is projected.
- Vertical Plane (VP) - in which the front view of an object is projected.
- Side or Profile Plane (PP) - in which the side view of an object is projected.



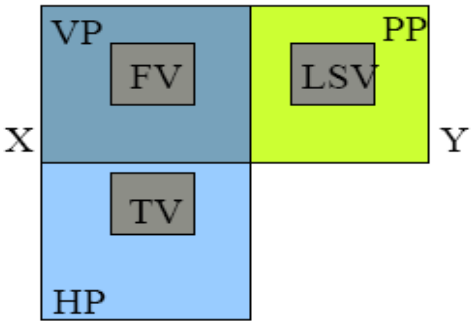


Figure 2.3 Plane of projection

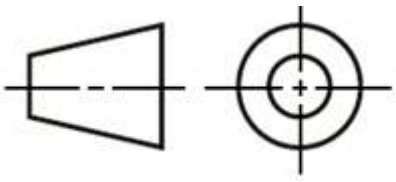
2.1.2.2 -Method of projection

There are two methods of projections:

1. First-Angle Projection

- An object is placed in a first quadrant.
- An object is between line of sight/observer and plane of projection.

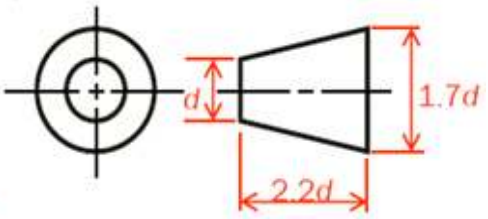
Symbol

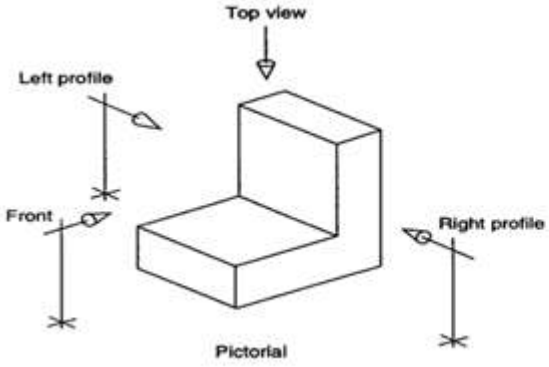


2. Third-Angle Projection

- An object is placed in a third quadrant.
- Plane of projection is between an object and line of sight/observer.

Symbol





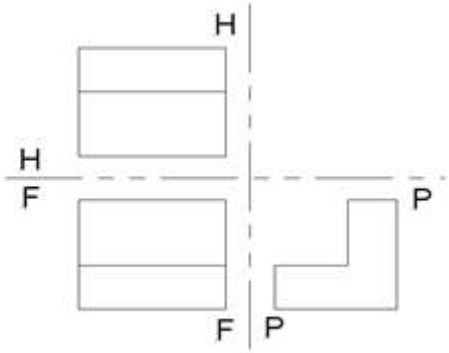


Figure 2.3 a) pictorial view b) multi-view drawing

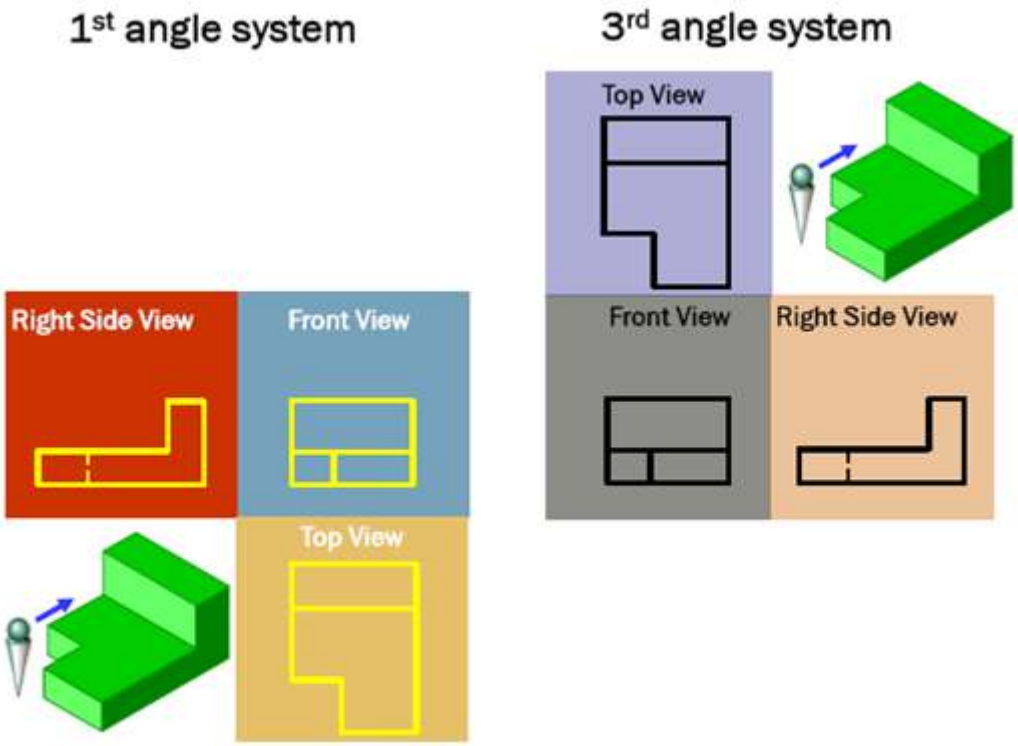
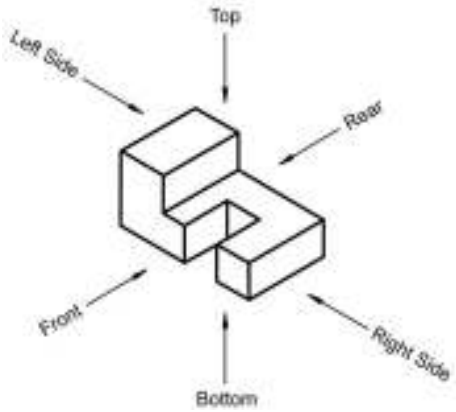


Figure 2.4 View arrangements in First and third angle projection

2.1.2.3 The Six Principal Views

Let us surround the object entirely by asset of six planes, each at right angles to each other. On these planes, views of the object can be obtained as is seen from the top, front, and right side, left side, bottom and rear. Think now of the six sides, or the plane of the paper. The front is already in the plane of the paper, and the other sides are, as it were, hinged and rotated in position as shown.



The 6 principal views are created by looking at the object, straight on, in the directions indicated.

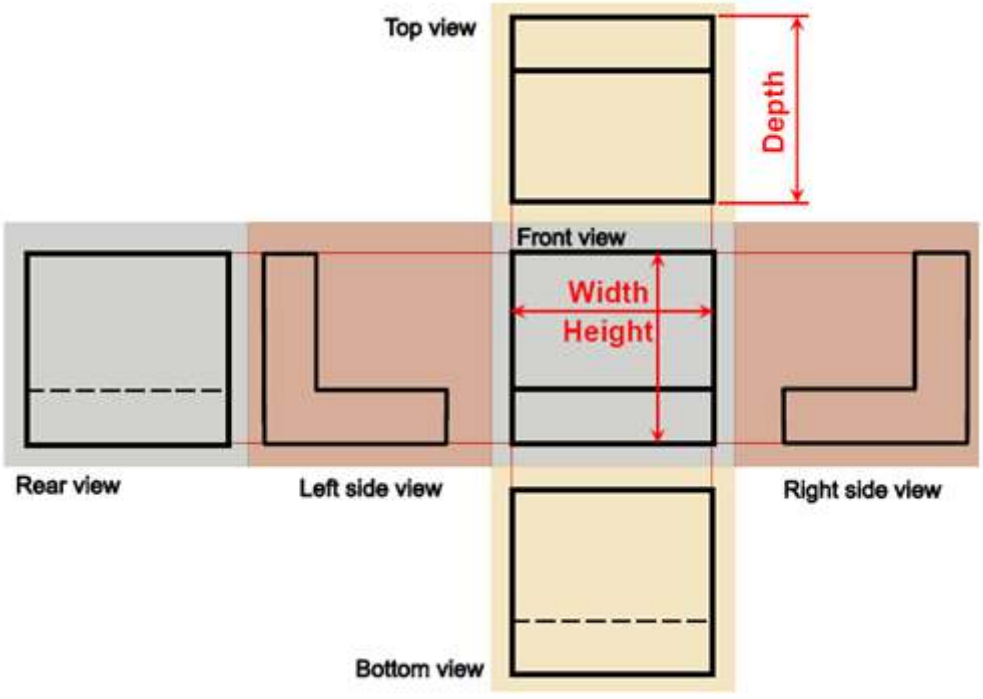


Figure 2.5 The six principal Views

Selection of views

- The number of orthographic views required for clear description of the object is taken as the criteria to select the views. As far as possible least number of views is drawn.

- While selecting the views; the object is placed in such a way the numbers of hidden lines are kept to minimum.
- Front view is drawn seeing the object in a direction is which its length is seen. It is also chosen such that the shape of the object is revealed. The direction of the view is indicated by arrows.

2.2 Isometric Views

The representation of isometric drawing is one of a family of three-dimensional views called pictorial drawings. In an isometric drawing, the object's vertical lines are drawn vertically, and the horizontal lines in the width and depth planes are shown at 30 degrees to the horizontal. When drawn under these guidelines, the lines parallel to these three axes are at their true scale) lengths. (Lines that are not parallel to these axes will not be of their true length. Any engineering drawing should show everything: a complete understanding of the object should be possible from the drawing. If the isometric drawing can show all details and all dimensions on one drawing, when all three angles are equal the drawing is classified as a isometric. For example angles A, B and C are equal and are 120^0.

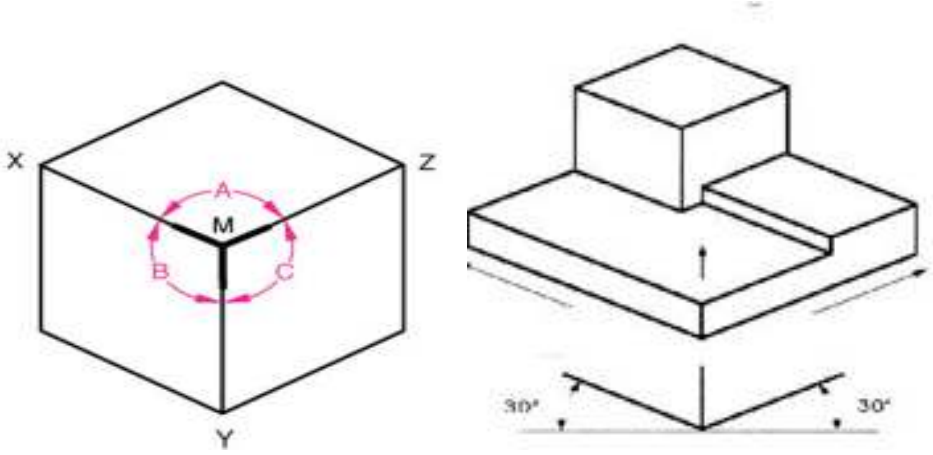


Figure 2.4. Isometric and Isometric drawing

2.3 Perspective drawing

Pictorial drawings used to represent 3-D forms on 2-D media in a manner closest to how we perceive the objects with our eyes. Terms to be familiar with include horizon line (HL), ground line (GL), station point (SP), picture plane (projection plane), and vanishing point (VP). Perspective projections are drawings which attempt to replicate what the human eye actually sees when it views an object. There are three types of perspective projections: One point, Two-point and Three-point Projections.

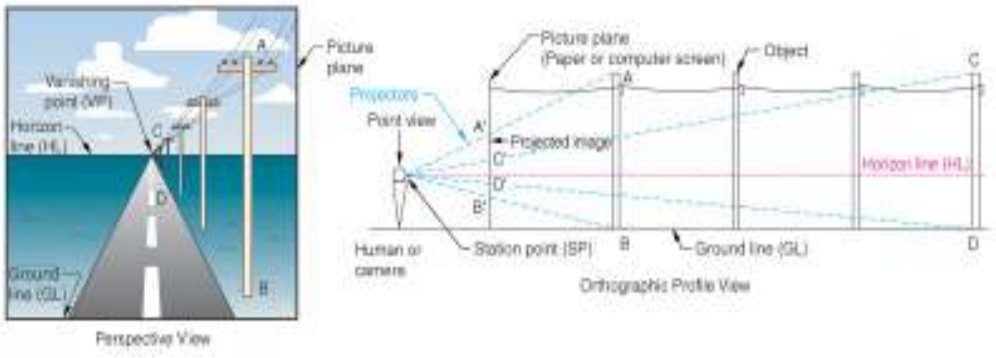


Figure 2.5. Perspective drawing

1. One point Perspective projection

In one point Perspective projection all projectors none parallel to each other. When drawing use one point perspective all objects vanish to a common point somewhere on the horizon.

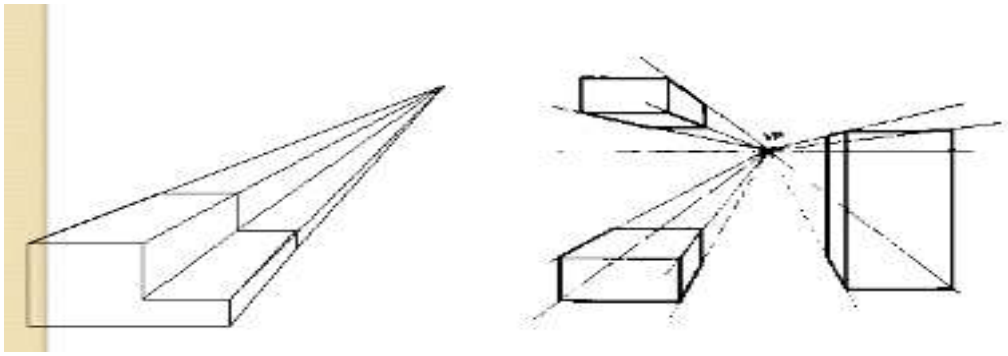


Figure 2.6.One point Perspective

2. Two Point perspective projection

The object is placed so that one set of parallel edges is vertical and has no vanishing point, while the two other sets each have vanishing points two point perspective represents a turning or moving aside, a glance to the left or right, an approach to the primary form that is more informal, idiosyncratic and complex, composed as it is two adjacent sides of every object woven into a single perspective view. This view is usually associated with the orientation of the objects, which are simply turned at an angle to the image plane. The two direction points are used for two of the directions it is pointing away from us, giving us **two point perspectives.**

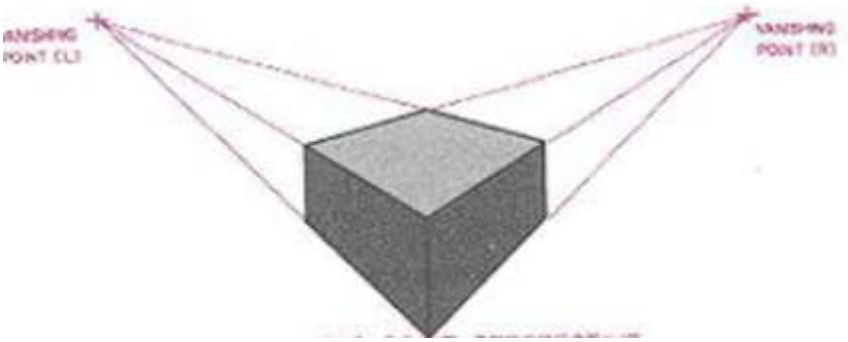


Figure 2.7 Two Point perspective projections

3. Three point perspective projection:

The object is placed so that none of its principal edges is parallel to the picture plane. Hence, each of the three sets of principal edges will have a separate vanishing point.

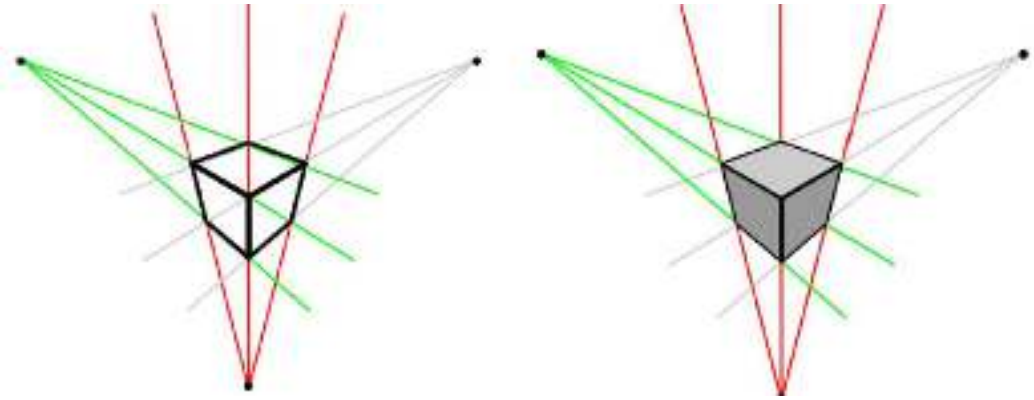


Figure 2.8 Three point perspective projection

2.4 Exploded drawing

Exploded drawing is a diagram, picture, schematic or technical drawing of an object, that shows the relationship or order of assembly of various parts.

It shows the components of an object slightly separated by distance, or suspended in surrounding space in the case of a three-dimensional exploded diagram. An object is represented as if there had been a small controlled explosion emanating from the middle of the object, causing the object's parts to be separated an equal distance away from their original locations.

The exploded view drawing is used in parts catalogs, assembly and maintenance manuals and other instructional material.

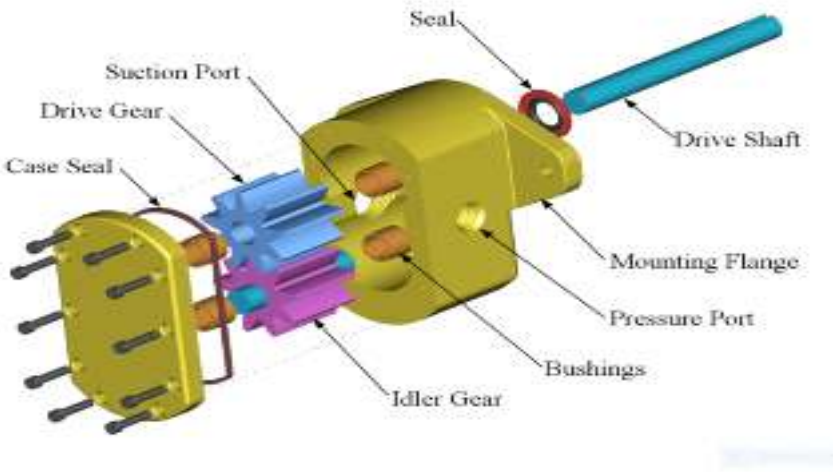


Figure 2.9 Exploded drawing

2.5 Hidden view technique

Hidden lines are not usually shown in isometric sketches unless they are needed to show a feature that would be unclear. Usually the orientation for the isometric drawing should be chosen so that hidden lines aren't needed. Holes are assumed to go completely through the object unless their depth is indicated with a note or with hidden lines.

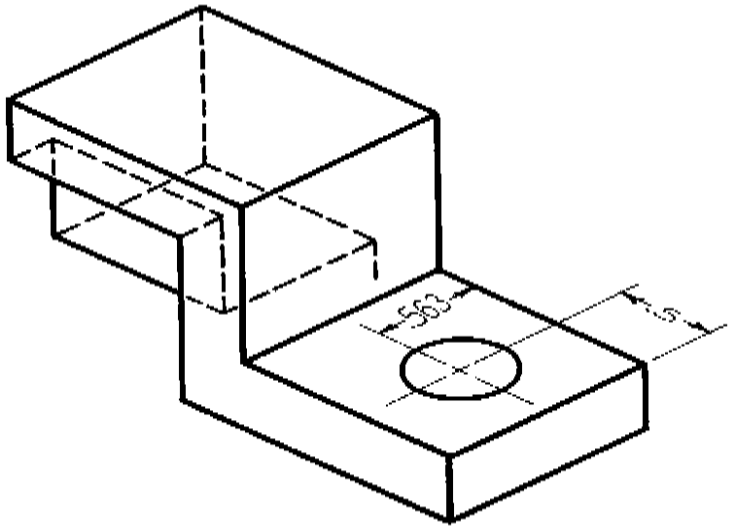


Figure 2.10 Hidden view technique

2.6 Sectional views

Sectional views are multi-view technical drawings that contain special views of a part or parts, which reveal interior features. Sectioning uses a technique that is based on passing an imaginary cutting plane through a part.

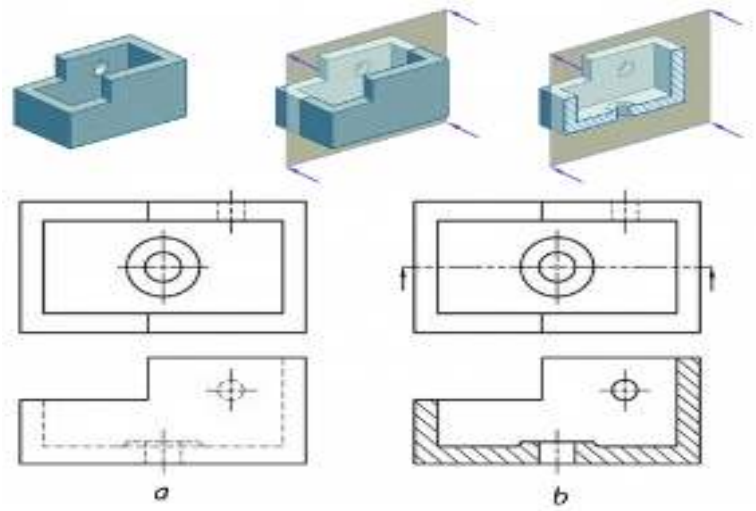


Figure 2.11 Sectional views

General principles

- A sectional view represents the part of an object remaining after a portion is assumed to have been cut and removed.
- The exposed cut surface is then indicated by section lines.
- Hidden features behind the cutting plane are omitted, unless required for dimensioning or for definition of the part.

If the section lines appear to be parallel, or nearly so, to one of the sides or features of the part, you should choose other than 45^o angle. Section lines should not run parallel or perpendicular to the visible outline.

- In all sections of a single component, section lines should be similar in direction and spacing, but adjacent parts should be section-lined in different directions, angles, or spacing.
- Section lines should be thinner than visible lines.
- Do not run section lines beyond the visible outlines or stop them too short.

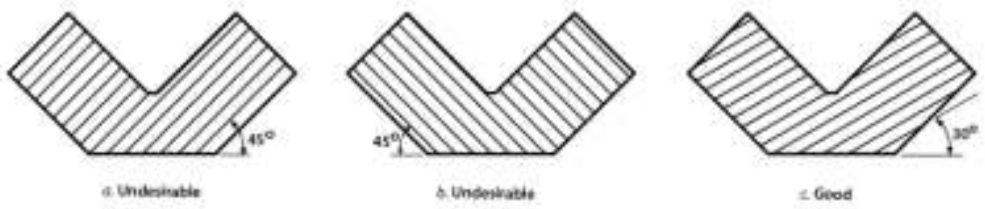


Figure 2.12 Section lines alignment

2.6.1 Cutting plane lines

A cutting plane is represented on a drawing by a cutting plane line. This is a heavy long-short-short-long kind of line terminated with arrows. The arrows in show the direction of view.

The long dash can be lengthened for large section drawings to save time and create a more readable drawing.

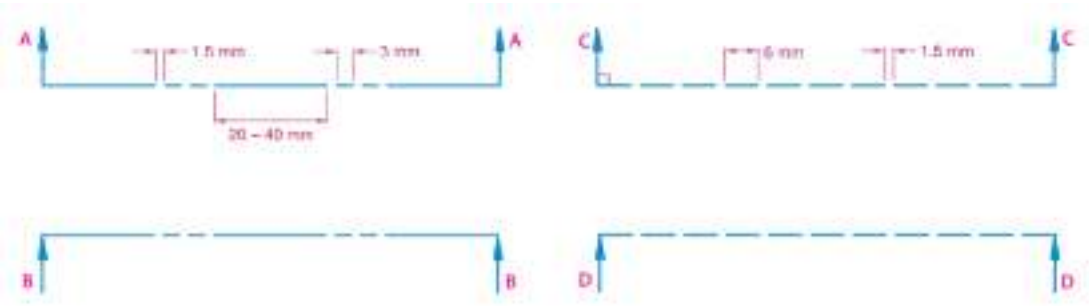


Figure 2.13 cutting plane lines

2.6.2 Types of sectioning

1. Full section

When a cutting plane line passes entirely through an object, the resulting section is called a full section .

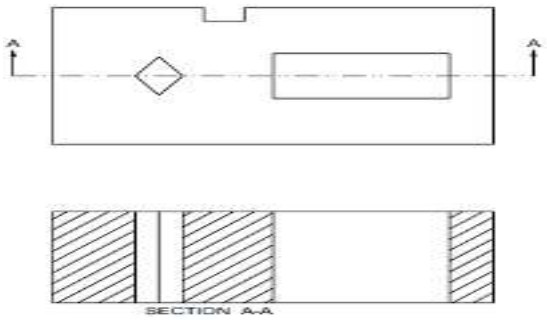


Figure 2.14 Full section

2. Half Sections

If the cutting plane is passed halfway through an object, and one-quarter of the object is removed, the resulting section is a half section. A half section has the advantage of showing both inside and outside configurations. It is frequently used for symmetrical objects.

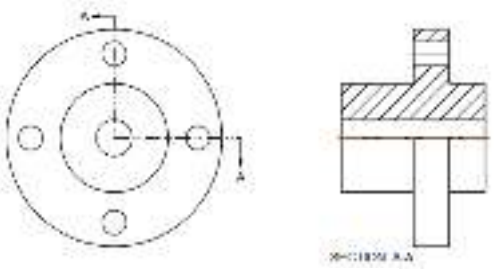


Figure 2.15 Half section

3. Offset Sections

An offset section is a means of including in a single section several features of an object that are not in a straight line. To do this, the cutting plane line is bent, or “OFFSET” to pass through the features of the part.

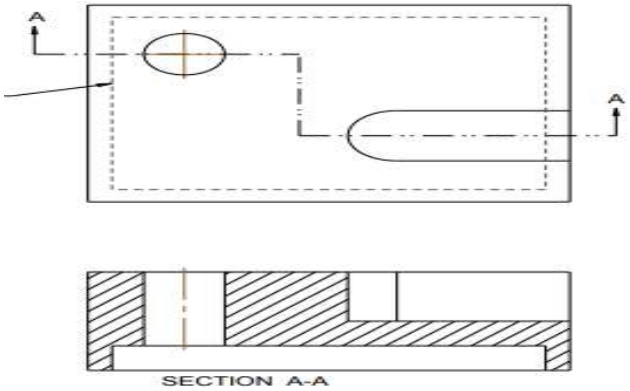


Figure 2.16 Off set section

2.7 Drawing Symbols & Codes

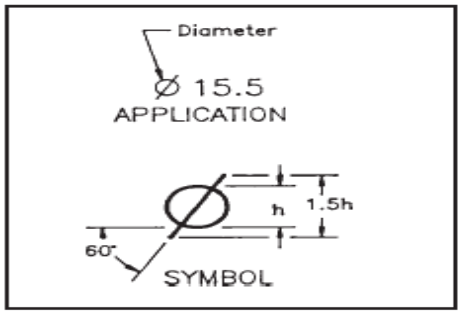
The symbols are presented in two groups for easier use of this section as a reference. General dimensioning symbols are shown first. Some of these symbols are also used in tolerance specifications. The second sets of symbols are used for tolerances.

Symbols are not generally used in text or notes lists. Abbreviations and symbol names are used in text or notes.

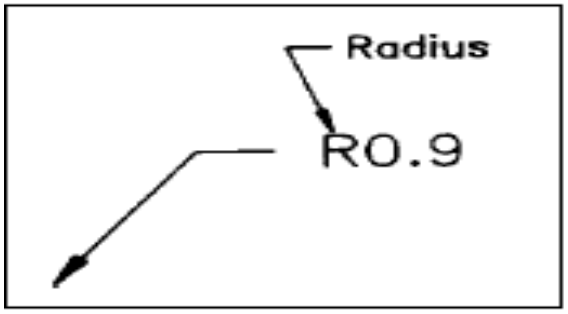
General symbols are used with dimensions to clarify the requirement defined by a dimension value and to minimize the number of words or abbreviations placed on a drawing.

Examples

1. **Diameter**: - A diameter symbol is placed in front of any dimension value that is a diameter.



2. **Radius**:- The letter **R** is placed in front of any value that indicates a radius dimension.



Self-check-1

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

A) Choose the correct answer from the following Questions

1 .One of the following views gives length and width of dimensions

A. side view C. Front view

B. top view D. none

2. Which one of common standards used in orthographic projection of drawings

A. First Angle Projection B. European projection

C. Third Angle Projection D. A and C

3. Which orthographic views principles are correct in making drawing In first angle projection

A. Front view on the above and the Top view at the bottom

B. front view and the side view are always in line horizontally

C. Front view is drawn seeing the object in a direction is which its length is seen.

D. All above answer are correct

4. Which orthographic projection is **not** correct about third angle projection methods.

A. Object is placed in 3rd quadrant B. Object is placed in 1st quadrant

C. Plane of projection is b/n observer and object D. None of the above

5. _____ is a diagram, picture, schematic or technical drawing of an object, that shows the relationship or order of assembly of various parts.

A. Perspective drawing B. Exploded drawing

C. Isometric Drawing D. Axonometric drawing

B) Write <u>True</u> if the Statement is Correct Write <u>False</u> if not Correct

1. A diameter symbol is always placed after any dimension value.

2. In first angle projection plane of projection is between an object and line of sight/observer.

3. Vertical Plane (VP) is the plane in which the front view of an object is projected.

4. Hidden lines are not usually shown in isometric sketches unless they are needed to show a feature that would be unclear.
5. In one point Perspective projection all projectors are none parallel to each other.

C) Answer the following questions.

1. Write the difference between Orthographic and Pictorial drawings.
2. Mention two methods of projections.
3. What are the three reference planes of projection? Explain them.
4. What are the uses of Exploded view in an industry?
5. How you select the three principal from the given six views of an object.
6. Mention 6 types of sectional views and explain each.

Operation Sheet 1

Operation title: Constructing One Point Perspective, Isometric view and Multi view drawing.

Purpose: To practice the way of constructing different views of an object.

Instruction: Construct the views of different features given below. Before starting constructing the views, prepare boarder line and title block and remember using of construction lines in every drawings.

Tools and requirement:

- Drawing board
- Drawing paper
- T-square
- Set square
- Drawing pencil
- Eraser

Precautions: For every practice use the required tools and neatness of your work is mandatory.

Procedures:

The steps to construct the views are as follows:

1. Set up the drawing paper on top of the drawing board.
2. Check to see that the paper edges are parallel to the left and bottom edges of the board respectively.
3. Properly secure the paper on top of the table by using masking tape or tacks or the likes.
4. Using the set of triangles and T-square, draw the border line around the drawing paper, and title block at the bottom part.
5. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.
6. For normal drawing or lettering use the soft lead pencil (**HB**) for final results. Use the harder lead pencil (**4H**) for guidelines drawing only.
7. Use the set of triangles, T-square and lead pencil this activity.
8. Always remember that construction lines and guidelines are necessary in sketching and drafting, so utilize this knowledge.
9. Apply the knowledge on line quality in your work.
10. Accuracy and aesthetics always go hand in hand with drawing, so do your work with quality.

11. You may submit your finish work once you are true but should be within the time specified for submission.

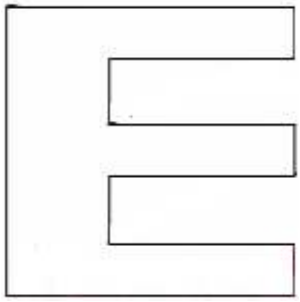
Lap Test- 1

Practical Demonstration

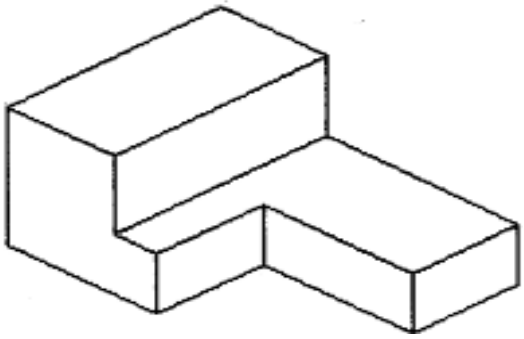
Instructions: Given necessary tools and materials you are required to perform the following tasks.

1. **You are required to do the following activities as required in the problem.**

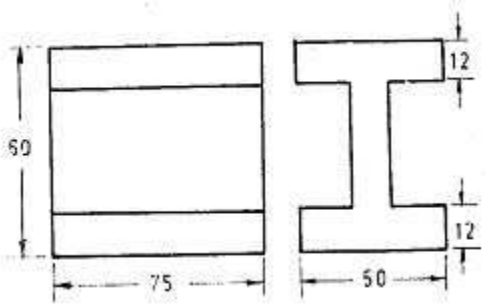
Task 1: Draw the **one point** perspective view of letter " E " below.



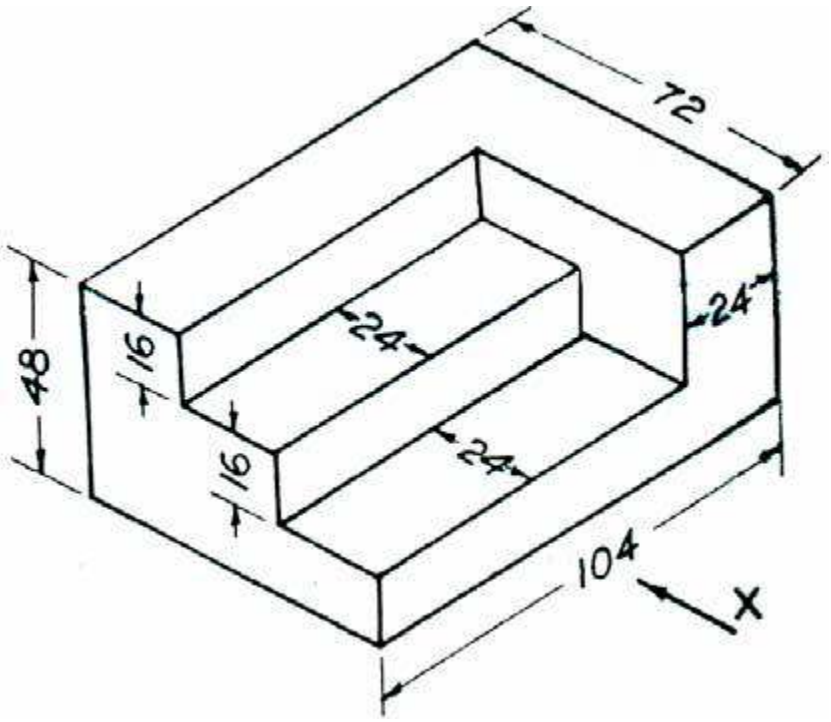
Task 2: Draw the **two point** perspective view of the isometric figure below.(one to one scale)



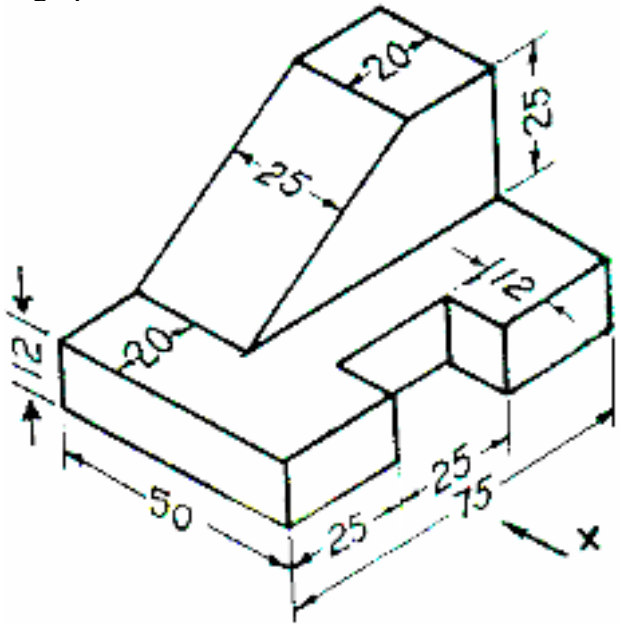
Task 3: - Draw the isometric view of the object whose orthographic projections are given in figure. All dimensions are in mm.



Task 4:- Draw front view, top view and side view of the model shown below by **first** and **third angle** projection respectively.

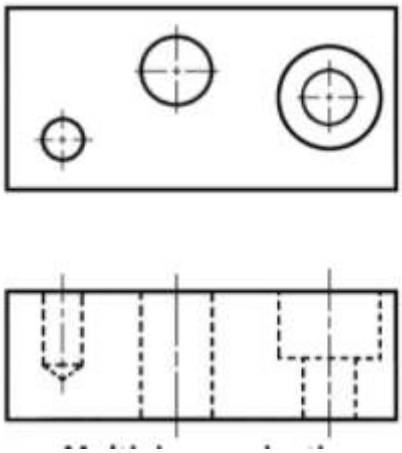


Task 4:- Draw the Orthographic views of the Isometric view shown in the following figure:

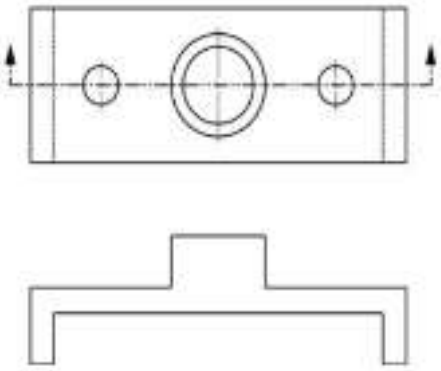


Task 4:- Draw the sectional views for the views shown in the following figure:

1.



2.



Unit Three: Interpretation of Technical Drawing

This unit to provide you the necessary information regarding the following content coverage and topics:-

- Type of drawing (Detail and Assembly drawing)
- Dimensioning Technique
- Elements of dimensioning

- Size dimensioning
- Location dimensioning
- Dimensioning tolerance and notation

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Identify Type of drawing
- Perform dimensioning of an object
- Identify dimension tolerances

3.1 Type of Drawing

A production drawing, also known as **working drawing**, supplies information and instructions for the manufacture or construction of machines or structures. A production drawing should provide all the dimensions, limits, special finishing processes, surface quality, etc. The particulars of material, the number of components required for the assembly, etc., are given in the title block.

Working drawings may be classified into two groups: Detail or part drawings and Assembly drawings

3.1.1 Detail or Part Drawings

A detail or part drawing is nothing but a production or component drawing, furnishing complete

information for the construction or manufacture of the part. This information may be classified

as:

- Shape description
- Size description
- Specifications
- Additional information

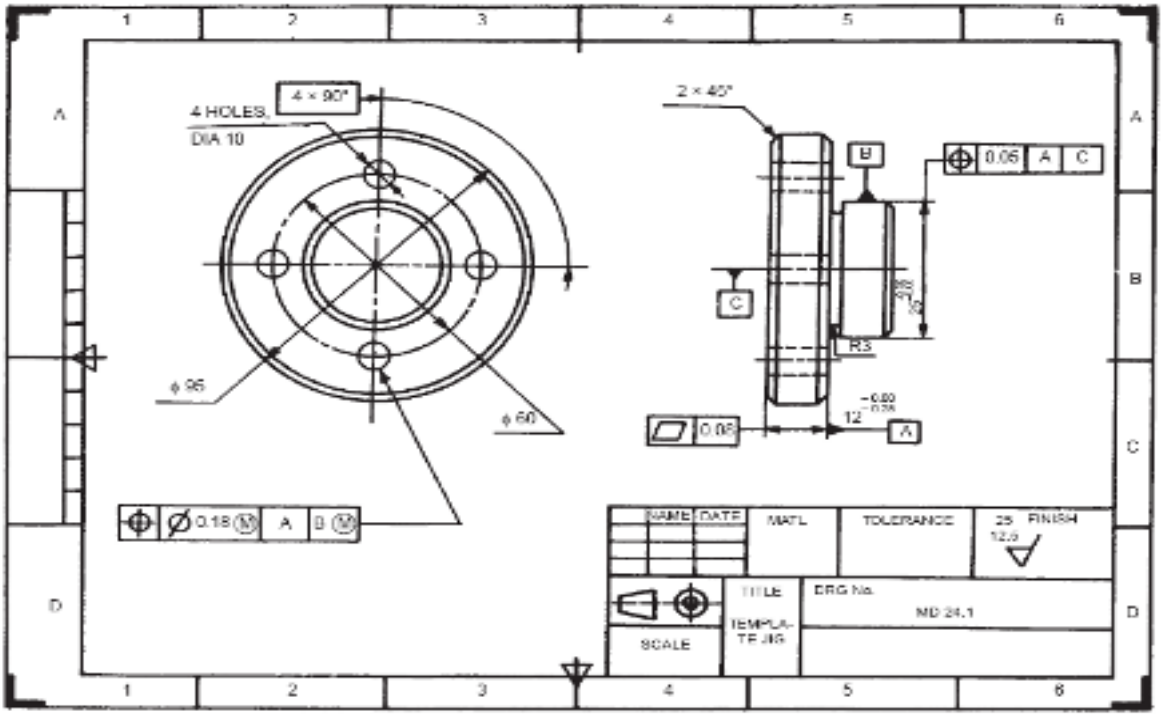


Figure 3.1 Detail or Part drawing

3.1.2 Assembly Drawing

An assembly drawing is one which represents various parts of a machine in their working position. A complete assembly drawing is presentation of the product or structure put together, showing all parts in their operational positions. The separate parts come to the assembly department after their manufacturing processes are finished and in this department they are put together according the assembly drawings.

The final assembly drawings are prepared from design assembly drawings or from the working drawings (component drawings).

Assembly drawings should include reference letters and numbers representing the different parts.

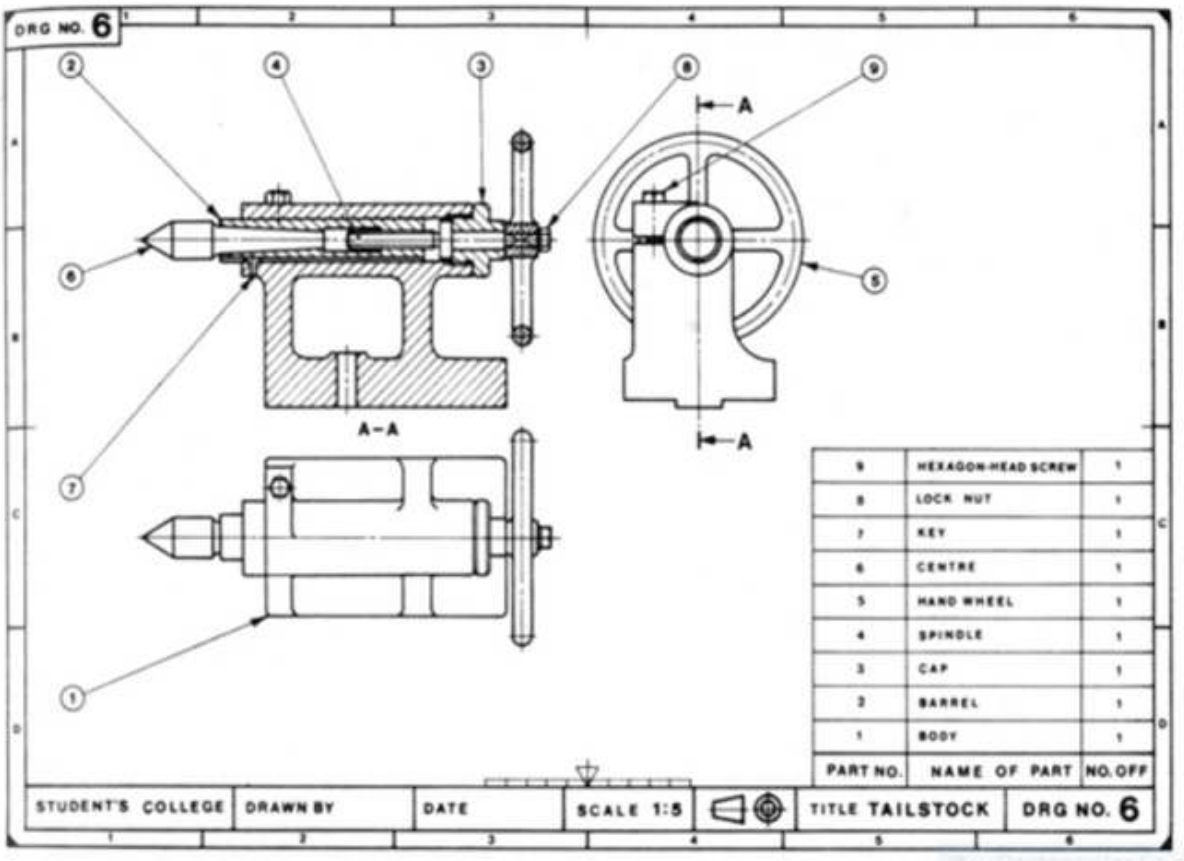


Figure 3.2 Assembly drawing

3.2 Dimensioning Technique

Detail drawing is expected to provide not only the complete shape description of the part, but also furnish size description. This is provided in the form of distance between the surfaces, location of holes, kind of finish, type of material, etc. These features are illustrated on a drawing by the use of lines, symbols, figures, and notes, called dimensioning. Proper dimensioning requires engineering judgment and thorough knowledge of the practices and requirement of the production department. Dimension is a numerical value expressed in appropriate units of measurement and used to define the size, location, orientation, form or other geometric characteristics of a part.

3.2.1 Elements of Dimensioning

Dimension Line:- is a thin line, broken in the middle to allow the placement of the dimension value, with arrowheads at each end.

Arrowhead is approximately 3mm long and 1 mm wide That is, the length is roughly three times the width.

An extension line extends a line on the object to the dimension line. The first dimension line should be approximately 12 mm (0.6 in) from the object. Extension lines begin 1.5mm from the object and extend 3 from the last dimension line.

A leader is a thin line used to connect a dimension with particular area.

Dimension figure a number that indicates the size or locations of features on an object,

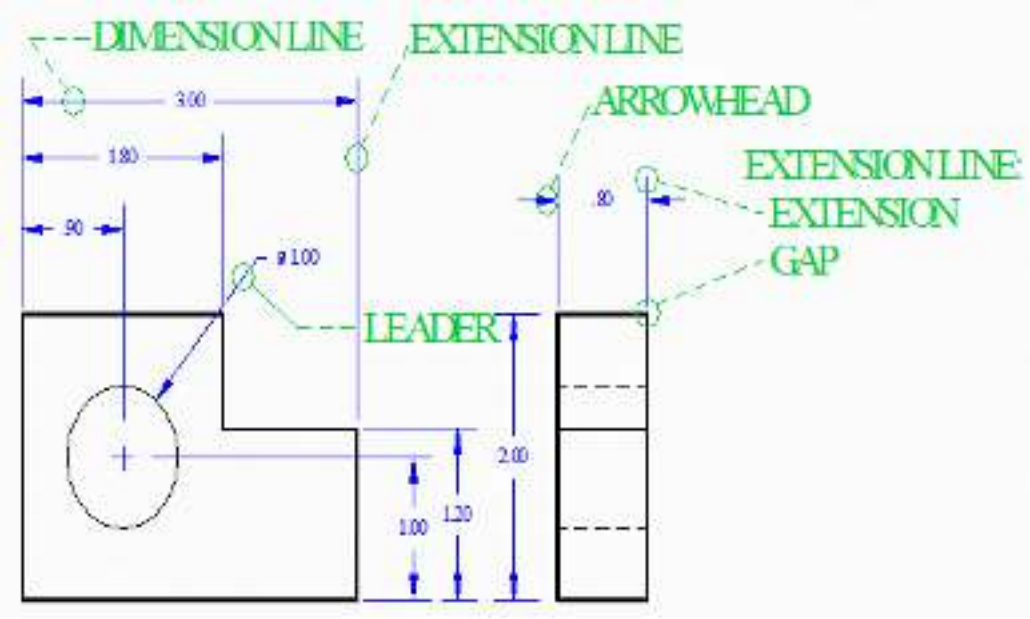


Figure 3.3 Elements of Dimensioning

3.2.2 Size and Location Dimensions

Size dimensions represent the geometric size of an object from datum/reference edges; It indicates either length, width or height of an object

A location dimension indicates the location of different features on an object. It represents the location of holes, grooves, flanges on an object.

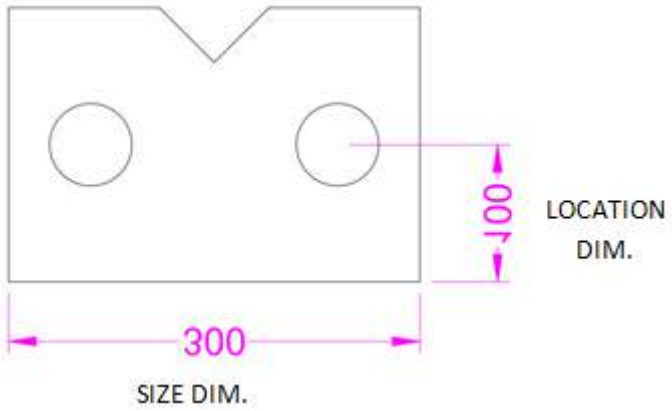


Figure 3.4 Size and location Dimension

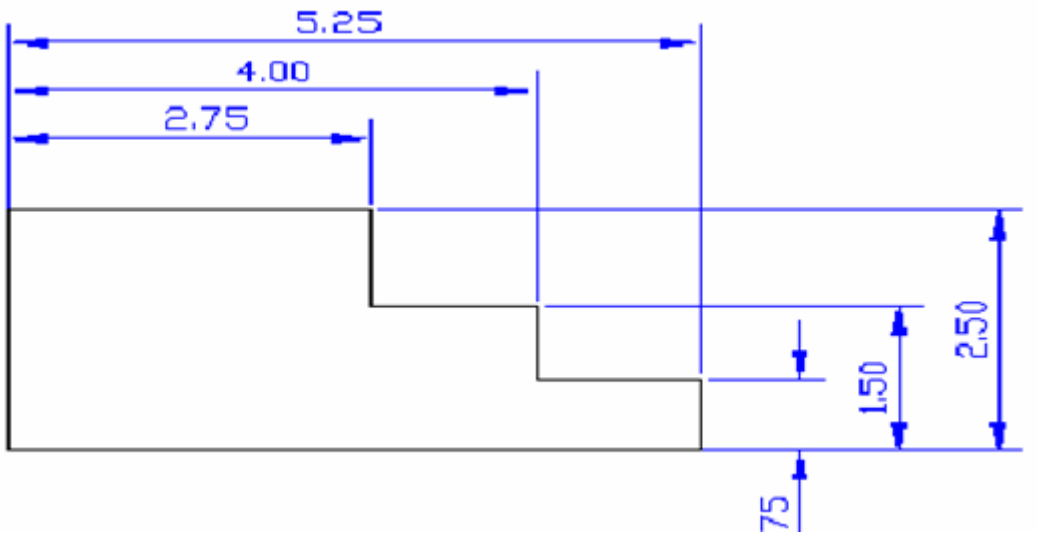


Figure 3.5 Datum plane Dimensioning

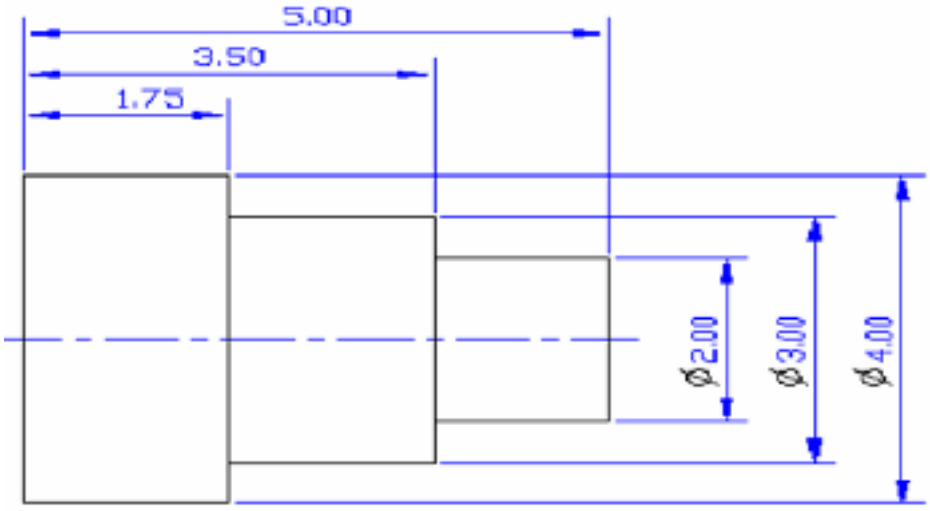


Figure 3.6 Cylindrical Dimensioning

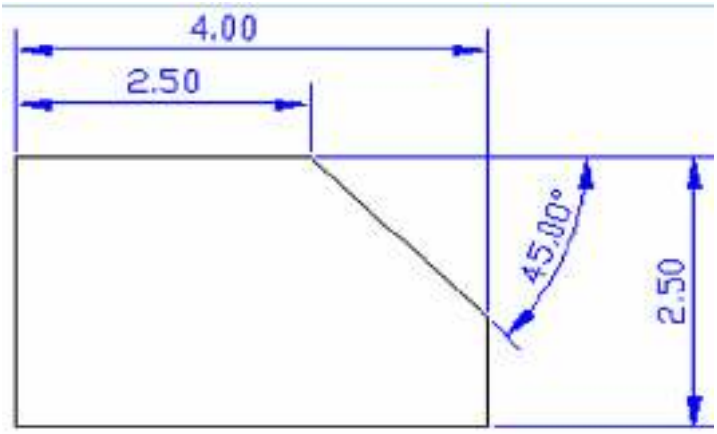


Figure 3.6 Angular Dimensioning

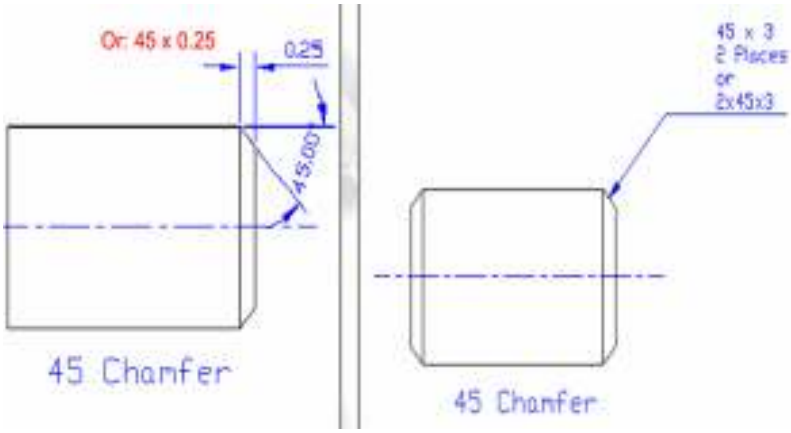


Figure 3.7 Chamfer Dimensioning

3.3 Dimensioning Tolerance and Notation

The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. Dimensioning should follow these guidelines.

- **Accuracy:** correct values must be given.
- **Clearness:** dimensions must be placed in appropriate positions.
- **Completeness:** nothing must be left out, and nothing duplicated.
- **Readability:** the appropriate line quality must be used or legibility

Type of tolerances

1. **General Tolerance**

If no tolerances are specified at the dimension level, then general tolerances may be applied by deliberately controlling the number of values past the decimal point on each dimension.

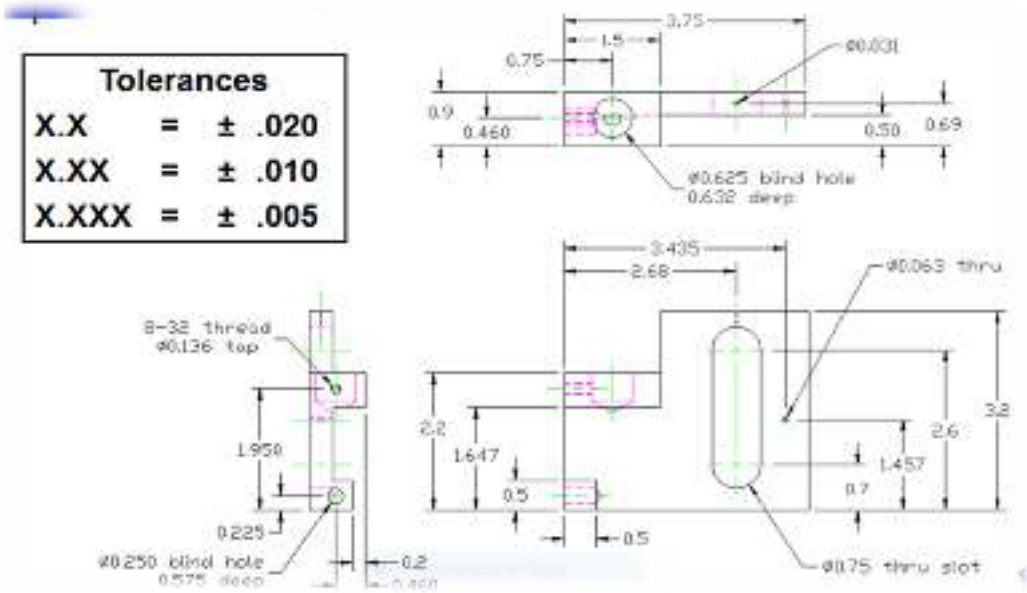


Figure 3.8 General Tolerances

2. **Geometric tolerance**

In a typical engineering design and production environment, the designer of a part rarely follows the design to the shop floor, and consequently the only means of communication of the design intent are the design drawings. Problems of validation and interpretation of design arise when the drawings do not clearly reflect what the designer intended, when they do not communicate to manufacturing how the design should be implemented and when the drawings are subjected to a number of different interpretations.

The use of linear tolerances when dimensioning the part can control the size of a product. It is however possible for limits of size to be maintained while the shape of a part or feature deviates significantly from the intended form. To control this deviation, a method of specifying the acceptable tolerance of form is required and this is done using geometric

dimensioning and tolerance symbols. These enable the designer to specify on the drawing, the geometry or shape of a component and they provide a precise definition of what constitutes a functionally good part.

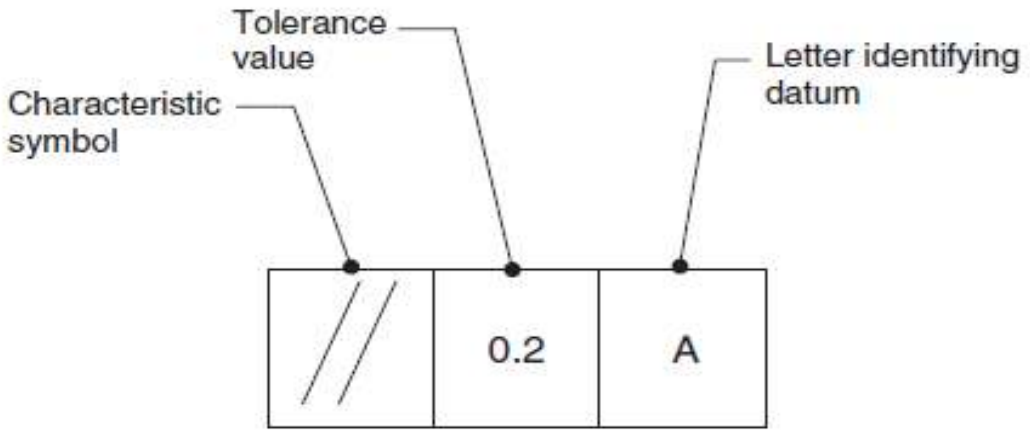


Figure 3.9 Representing Geometric Tolerances

3. Angular tolerance

In a mechanical drawing of a part, angularity tolerance allows the designer to specify the degree to which the orientation of an angled part feature may vary. The angularity symbol is often used to insure that the part can properly mate with another.

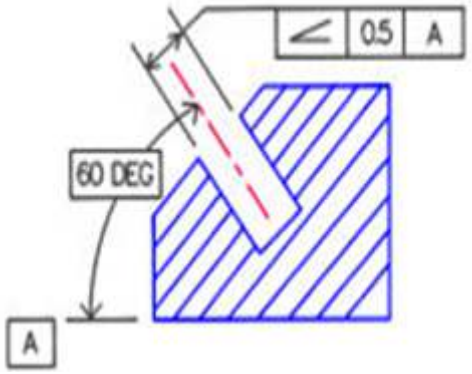


Figure 3.10 Angular Tolerances

Tolerance Characteristic Symbol:

The straightness of an axis, the flatness of a face, etc, are characteristics of features and these are indicated on drawings using the symbols shown in bellows.

Features and tolerances		Toleranced characteristics	Symbols
Single features	Form tolerances	Straightness	—
		Flatness	▱
		Circularity	○
		Cylindricity	⌭
Single or related features		Profile of any line	⌒
		Profile of any surface	⌓
Related features	Orientation tolerances	Parallelism	//
		Perpendicularity	⊥
		Angularity	∠
	Location tolerances	Position	⌖
		Concentricity and coaxiality	◎
		Symmetry	⌯
	Run-out tolerances	Circular run-out	↗
		Total run-out	⌰

Figure 3.10 Geometric Tolerance Characteristic Symbols

Self-Check -1

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

A) Write <u>True</u> if the Statement is correct and <u>False</u> if not Correct.

1. The purpose of dimensioning is to provide a clear and complete description of an object.

2. Complete set of dimensions will permit only different interpretation needed to construct the part.
3. Geometrical tolerances should be specifying for all requirements critical to functioning and interchangeability.
4. Suitable locations on the part, called datum targets.
5. The use of linear tolerances when dimensioning the part can control the size of a product.

B) Match column "B" with Column "A"

A	**B**
_____ 1. Completeness	A) The appropriate line quality must be used or legibility
_____ 2. Leader	B) Represent allowable size on an object.
_____ 3.Dimension	C) a thin line used to connect a dimension with particular area.
_____ 4. Readability	D) Represent size of an object.
_____ 5. Tolerances	E) Nothing must be left out, and nothing duplicated.

C) Explain the following terms.

1. General tolerance
2, Angular tolerance
3. Dimensioning
4. Tolerance symbols
5. Dimensioning figure

Operation Sheet 1

Operation title: To perform dimensioning of different features of Views.

Purpose: To practice how to dimension different views of an object by using elements of dimensioning.

Instruction: Draw the orthographic projections needed to fully describe the part. Choose the best view for the front view. Use a scale of 1:1 with 50 mm spacing between the views. Apply all dimensioning style.

Tools and requirement:

- Drawing board
- Drawing paper
- T-square
- Set square
- Drawing pencil
- Eraser

Precautions: For every practice use the required tools and neatness of your work is mandatory.

Procedures:

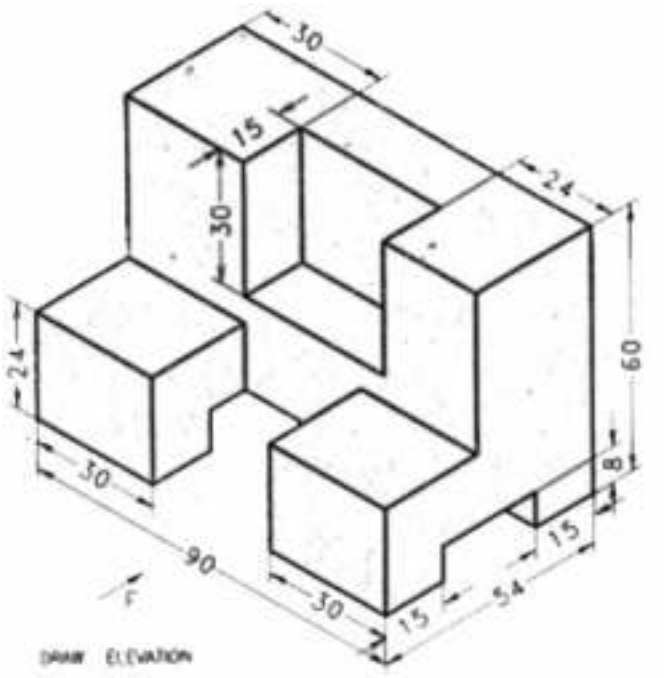
The steps to construct the geometric figures are as follows:

1. Set up your drawing paper on top of the drawing board.
2. Use the drawing template format given to you by your teacher.
3. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.
4. Using the basic drawing instruments and materials, perform the drawing task in the given following task 1 to 2 below under LAP test 3.
5. Use appropriate pencil lead in your drafting works.
6. Provide the 3 basic orthographic views (top, front and side/end views) given the isometric view.
7. Provide appropriate dimension for each views accordingly.
8. You may submit your finish work once you are complete but should be within the time specified for submission.

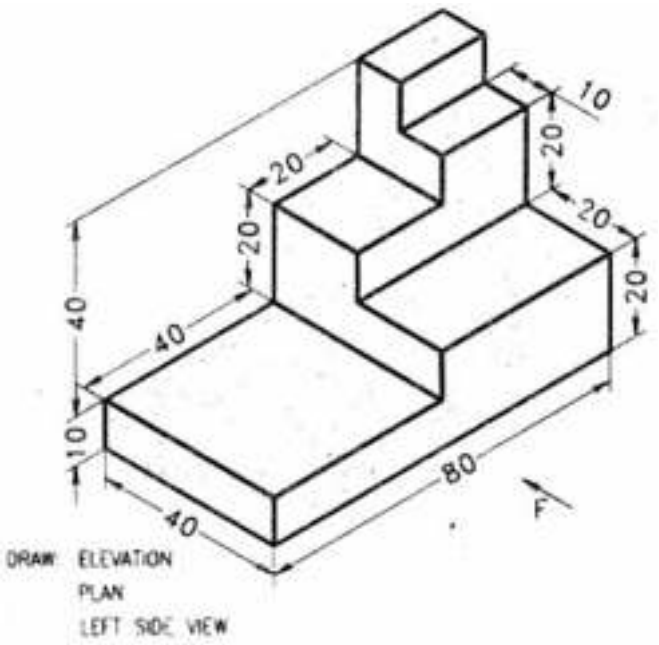
Lap Test-1

Practical Demonstration

Task 1:


30
15
30
24
24
60
8
30
90
30
15
15
54
F
DRAW ELEVATION

Task 2:


10
20
20
20
20
20
40
40
10
40
80
F
DRAW ELEVATION
PLAN
LEFT SIDE VIEW

Unit Four: Drawing Quality

This unit to provide you the necessary information regarding the following content coverage and topics:-

- Drawing and its Quality
- Drawing Evaluation
- Faults and its Corrective Actions

This guide will also assist you to attain the learning outcomes stated in the cover page. Specifically, upon completion of this learning guide, you will be able to:

- Checking Drawing Quality
- Evaluating Drawings
- Identifying causes of Faults and its Corrective Actions

4.1 Quality of Drawing

Drawing is the primary medium through which a consultant directs the people on site. So it is absolutely necessary that the drawing is complete in all respects and all the relevant

information is furnished explicitly and clearly on the drawing by way of illustration or otherwise. A thorough process of reviewing, rechecking, communicating and improving of each and every drawing is a part of our continuous endeavor to enhance the quality of service rendered and guarantee customer satisfaction, professional standards and safety requirements.

4.2 Drawing Evaluation

Drawing a picture or diagram provides an alternative to writing. Sometimes it is more efficient to show ideas in a picture than in writing a lengthy explanation. So drawing techniques for Accuracy and understanding relationships of components of a finished work when put together. The evaluation is concerned about appropriate use of drawing materials and overall neatness and presentation of finished drawings.

4.3 Faults and its Corrective Actions

Drawing fault is encounter where unwanted line is drawn and makes a drawing wrong interpretation. Such fault is correct by approving a drawing before it's offered to the stakeholder.

Self-Check -1

Directions: Answer all the questions listed below.

1. How drawing fault is minimized?
2. Why quality of drawing is concerned?
3. What are drawing evaluation concerned about?
4. _____ is concerned about appropriate use of drawing materials and overall neatness and presentation of finished drawings.
5. _____ Drawing is the primary medium through which a consultant directs the people on site.