

ENGINEERING DRAWING

Chapter I Introduction

1.1 Definition of engineering drawing

Engineering drawing is a formal and precise way of communicating information about the size, shape, features and precision of physical object. It is a universal language of engineers and technicians.

Engineering drawing is divided in to two main categories. These are geometrical drawing and machine drawing.

- **Geometrical drawing:** - is the representation of geometrical objects on pieces of paper. This is also divided in to *plane geometrical drawing* (representation of geometrical figures having only two dimensions, length and breath) and *solid geometrical drawing* (representation of objects having 3-dimensiona, length, breadth and thickness)

- **Machine drawing:** - is the representation of engineering objects such as machines and machine parts with practical solid geometries on apices of paper

1.2 Area of application of engineering drawing

- *Aeronautical drafters* prepare engineering drawings detailing plans and specifications used in the manufacture of aircraft, missiles, and related parts.
- *Architectural drafters* draw architectural and structural features of buildings and other structures. These workers may specialize in a type of structure, such as residential or commercial, or in a kind of material used, such as reinforced concrete, masonry, steel, or timber.
- *Civil drafters* prepare drawings and topographical and relief maps used in major construction or civil engineering projects, such as highways, bridges, pipelines, flood control projects, and water and sewage systems.
- *Electrical drafters* prepare wiring and layout diagrams used by workers who erect, install, and repair electrical equipment and wiring in communication centers, power plants, electrical distribution systems, and buildings.
- *Electronics drafters* draw wiring diagrams, circuit board assembly diagrams, schematics, and layout drawings used in the manufacture, installation, and repair of electronic devices and components.
- *Mechanical drafters* prepare drawings showing the detail and assembly of a wide variety of machinery and mechanical devices, indicating dimensions, fastening methods, and other requirements.
- *Process piping or pipeline drafters* prepare drawings used in the layout, construction, and operation of oil and gas fields, refineries, chemical plants, and process piping systems.

Additional list

Aeronautical or Astronautically engineers- Study jet engines and aircraft design. They may also work on applications for space missions.

Agricultural engineers- Design farm equipment, animal shelters, crop systems, and product processing systems.

Chemical engineers- Develop processes and products made with chemicals perhaps in the food, petroleum, or pharmaceutical industries.

Civil engineers- Design roads, buildings, transportation systems, and other large-scale construction projects. Categories within this area may include structural, environmental, geological, hydraulic, transportation and construction engineering.

Electrical and computer engineers- Design, construct, and maintain electronic systems, which may include working with computer chips, circuits and electronic communications.

Geological engineers- Solve earth-related technical problems while at the same time protecting the environment.

Industrial engineers: - Plan and design industrial and business facilities for the best product quality and employee working conditions.

1.3 Drawing instruments

Preparation of good quality drawing is primarily based on the proper selection and utilization of drawing instruments. Basic drawing equipments and their uses are:

- Paper (working media).
- Drafting tape (attaching the drawing paper with the table).
- Erasers(rub out fault from the paper),
- Erasing shield (covering for well done areas not to be erased),
- Drawing board (the bed of the paper, provide smooth drawing sheet),
- T-square(paper fixing and guides for triangles),
- Set squares (to make line at different angles),
- Scales (measurements of lengths),
- Irregular curves(drawing of irregular configurations)
- Protractor(angle measurement),
- Compass(drawing circles and arcs),
- Pencils (drawing maker); the grade of the pencil is marked by a

number and letter at its one end. The number before the letter indicates the degree of hardness or softness. Pencils are divided in to three groups.

1) Soft grade pencils: B, 2B, 3B,.....7B

2) Hard grade pencils: H, 2H, 3H,....9H

3) Medium grade pencils: HB

NB: - As the no increases the hardness or softness of the pencils increases.

- Special equipments: drafting machines, templates, adjusting curves, ruling pens, proportional dividers, beam compass, electric eraser, rail road and etc.

1.4 Drawing sheet

- o Drawing paper: is the working media for the drawing
- o Paper should be tough, strong, uniform in thickness
- o Paper sizes:
 - ✓ Paper sizes can be A series, B series, C series
 - ✓ A series papers are widely used for daily office use, especially A4
 - ✓ A series papers can vary from A4 to A0
 - ✓ Dimensions of A series papers in metric standard are as follow
 - A4=297mm*210mm
 - A3=420mm*297mm
 - A2=594mm*420mm
 - A1=841mm*594mm
 - A0=1189mm*841mm

See the following figure

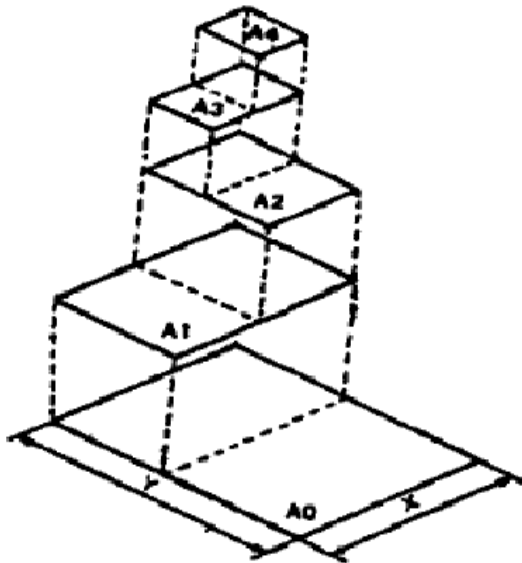


Fig. Drawing Sheet Formats

1.5 Title Block and Drawing Sheet Layout

Title Block

- The title block should lie within the drawing space at the bottom right hand corner of the sheet
- It is the information center for our drawing
- It is composed of

- Drawer name
- Checker name
- Date that the drawing prepared
- Scale of the drawing
- Type of projection
- Company
- Title of the drawing
- Drawing number
- And other information required by the company.

Drawing Sheet Layout

- The lay out the paper for drawing purpose is very necessary
- The lay out shows the areas to be covered through our paper
- It shows the drawing area, border line ,page border and title block
- FIG (paper lay out)

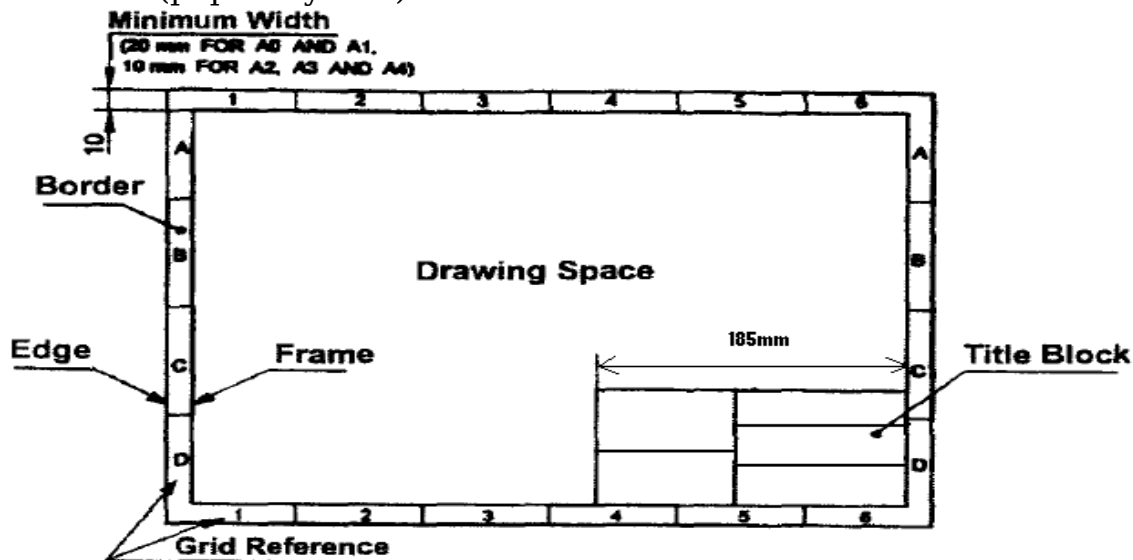


Fig General features of a drawing sheet

1.6 Lettering

Lettering: The art of writing alphabets A, B, C....Z, a, b, c z and numbers such as 0, 1, 2, 3.... etc or combination of these (Words) is called as Lettering. It is the talk of drawing that explains the part of the drawing that can't be shown by lines.

It is used in Engineering drawing for writing titles, dimensions, notes and other important particulars on the drawing. It is an important part of a drawing. Sometimes poor lettering spoiled appearance of a good drawing.

Lettering should, therefore, be done properly, is clear, legible and uniform style. It should be in plain and simple style so that it could be done *freehand* and

speedily. Efficiency in the art of lettering can be achieved by *careful and continuous practice*.

Single -stroke letters: It is the simplest form of letters and usually employed in most of the engineering drawings. *The word single-stroke should not be taken to mean that the letter should be made in one stroke without lifting the pencil.* It actually means that the thickness of the line of the letter should be such as is obtained in one stroke of the pencil.

The horizontal lines of letters should be drawn from left to right and vertical or inclined lines, from top to bottom.

Single -stroke letters are of **two** types:-

Depending on the relation between lettering height(h) and thickness of lines(d), we have two types of lettering, lettering A & lettering B

1) Lettering Type A ($d=h/14$): (I) Vertical and (II) Sloped (at 75° to the horizontal)

2) Lettering Type B ($d=h/10$): (I) Vertical and (II) Sloped (at 75° to the horizontal)

Type B is preferred for easy and fast execution, because of the division of height into 10 equal parts. And also Vertical letters are preferred for easy and fast execution, instead of sloped letters.

Size of Letter for Lettering Type B

Characteristics	Ratio	dimension					
Height of capital letters (h)	h	2.5	3.5	5	7	10	14
Height of lower case letters(c)	$7^*h/10$	-	2.4	3.5	5	7	10
Spacing b/n characters(a)	$2^*h/10$	0.5	0.7	1	1.4	2	2.8
Minimum spacing of base lines(b)	$14^*h/10$	3.5	5	7	10	14	20
Minimum spacing b/n words (e)	$6^*h/10$	1.5	2.1	3	4.2	6	8.4
Thickness of words (d)	$h/10$	.25	.35	.5	.7	1	1.4

NB; all dimensions are in mm

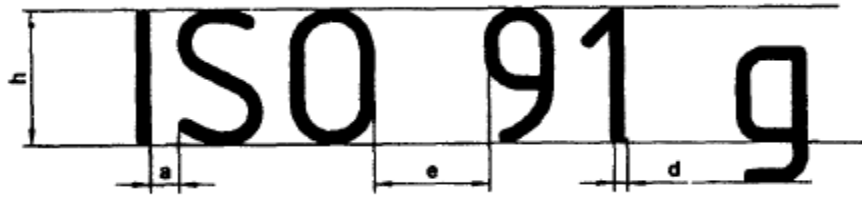
The selection of h is depending on a typical application.

Example $h=5\text{mm}$, 7mm , 10mm , for main title of the drg, heading, sheet no., item

$h=3.5\text{mm}$, 5mm , for sub titles or sub headings

$h=3.5\text{mm}$ 5mm , for notes, legends, schedules, materials and dimensions

$h=2.5\text{mm}$, for tolerances



Guide lines: USED TO REGULATE THE height and inclination of letters

- ✓ Capital letters have two guide lines (i.e upper and lower(base) line)
- ✓ Lowercase letters contain four lines (i.e cap line, waist line (next from the top), base line and drop line (bottom most line)).
- ✓ All guide lines should be done with light lines
- ✓ Those lines may be erased so that they will not be seen

Spacing:

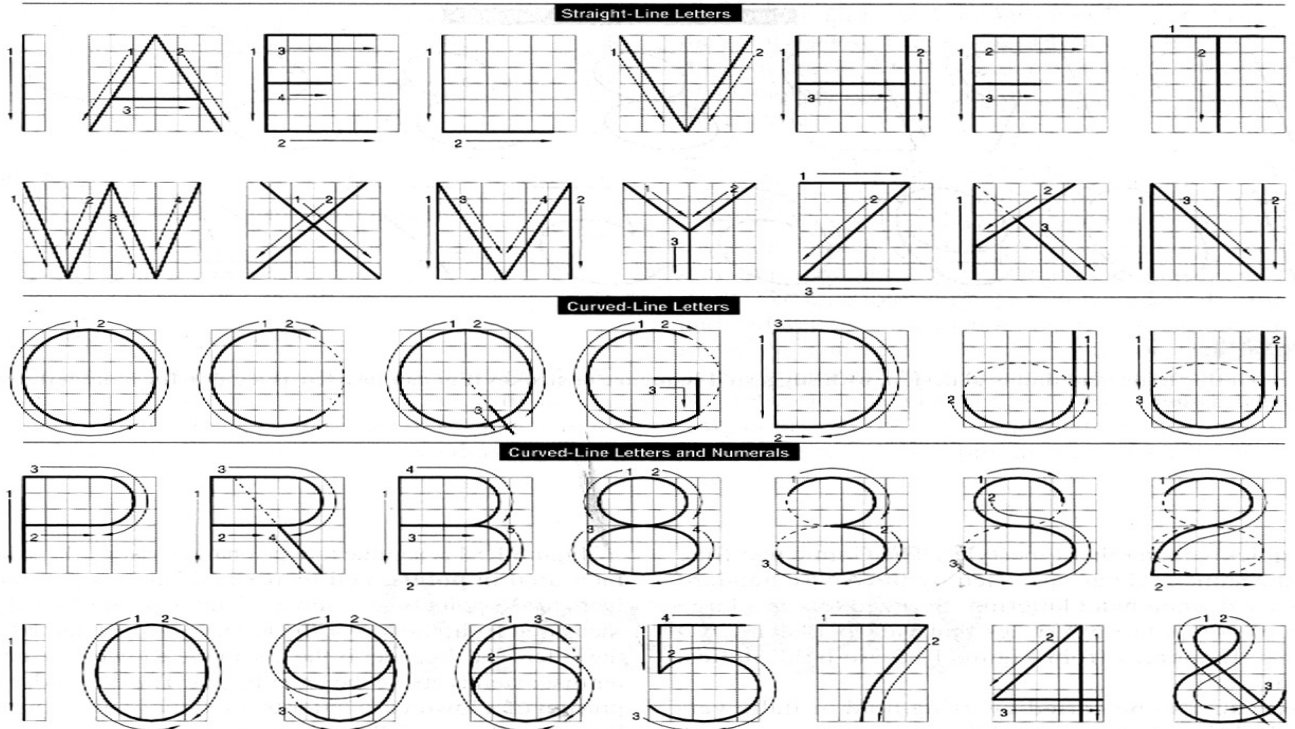
- Spacing must appear equal between each letter
- More space is allowed for having tall vertical parts like H&I
- More space is also allowed if letters have open space around them like V and A

Space between letters equals the size of the letter

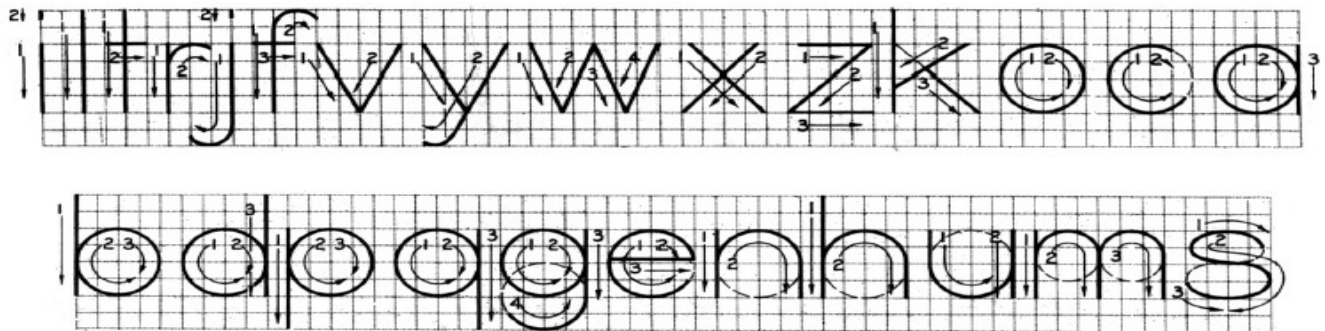
Procedure for Lettering

1. Thin horizontal guide lines are drawn first at a distance ' h' apart.
2. Lettering Technique: Horizontal lines of the letters are drawn from left to right. Vertical, inclined and curved lines are drawn from top to bottom.
3. After lettering has been completed, the guidelines are not erased.

Upper-case letters & Numerals



Lower-case letters



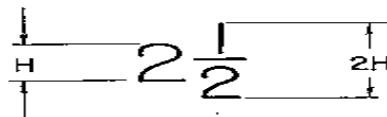
- The text's body height is about $\frac{2}{3}$ the height of a capital letter.

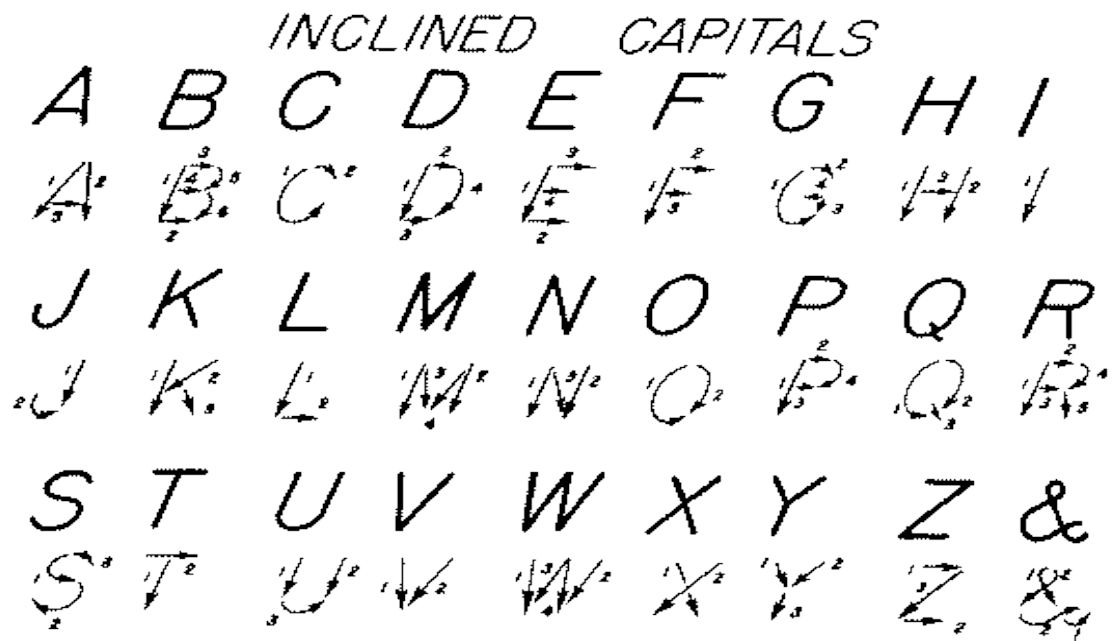
VERTICAL CAPITALS

A	B	C	D	E	F	G	H	I
A	B	C	D	E	F	G	H	I
J	K	L	M	N	O	P	Q	R
J	K	L	M	N	O	P	Q	R
S	T	U	V	W	X	Y	Z	&
S	T	U	V	W	X	Y	Z	&

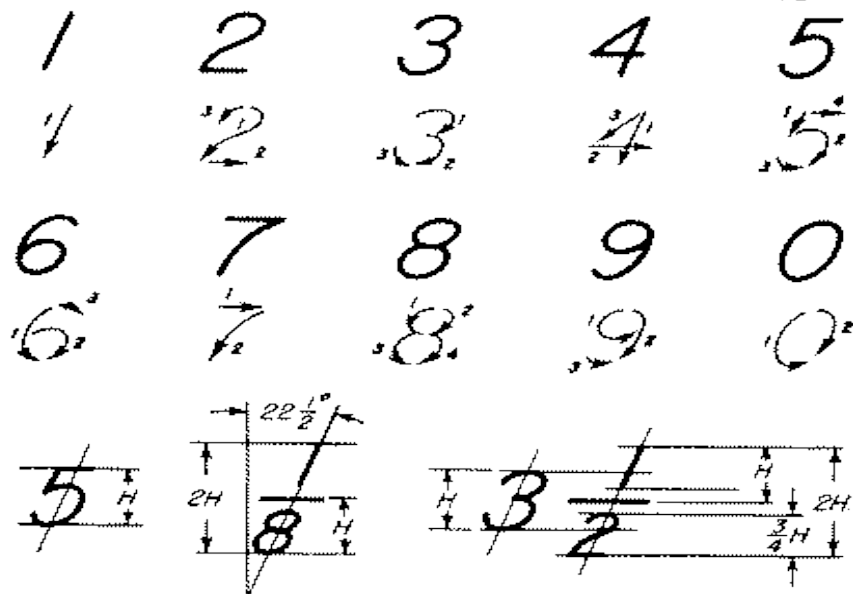
NUMERALS AND FRACTIONS

1	2	3	4	5	6	7	8	9	0
1	2	3	4	5	6	7	8	9	0





INCLINED NUMERALS AND FRACTIONS



Notes

- ✚ Dimensions and notes in drawing will be best performed by knowing different lettering techniques
- ✚ Poor lettering will decrease the quality of the drawing
- ✚ For good lettering the hand must hold the pencil firmly
- ✚ Art of good lettering depends on the uniformity of shape, style, size slope Weight and spacing
- ✚ Good drawer realizes the importance of neat and attractive lettering

1.7 Alphabet of Lines:

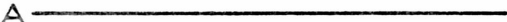
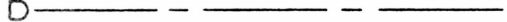
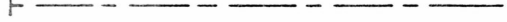
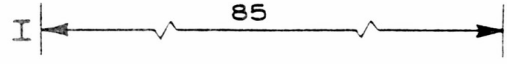
- Object (out line) visible line
 - To draw visible edge and surface boundaries of objects.
 - They are thick and continuous.
- Hidden lines:
 - To show hidden edges.
 - Are shown in a drawing by dotted lines.
 - These are made up of short dashes approximately equal.
 - Approximate length 3 mm and equal spacing 1 mm.
- Section lines:
 - Thin continuous lines at 45°.
 - Spaced uniformly about 1.5 mm apart.
 - Used to show sectional parts.
- Center line:
 - Indicate the folding line of symmetric objects.
 - They are thin lines drawn with medium hard pencils.
 - Composed of alternating long and short dashes.
 - Equally spaced approximately 1.5 mm apart.
 - Short dashes are about 3mm long and long dashes are about 6 to 8 times the short dashes.
- Dimension lines:
 - Are thin continuous lines.
 - Indicate length of dimensions.
 - Are terminated by pointed arrow heads.
- Extension lines:
 - Are thin continuous lines.
 - 1.5mm is kept between these lines and object lines.
 - Extended about 3mm beyond the dimension line.
- Leader lines:
 - Are thin lines.
 - Used to connect a specific note to a feature.
 - Arrow headed to the feature.
 - Inclined 30°, 45°, or 60° from the horizontal.
- Cutting plane lines:
 - Are thick lines.
 - Alternately long and two short dashes in the ratio of about 1:8.
 - Uniformly spaced 1.5mm apart and the short dashes are about 3mm long.
 - These are used for indicating the location of sectioning plane.
- Break lines:
 - Are short and long break lines.
 - The thick short break is very common although the thin long break may be used for long distances.

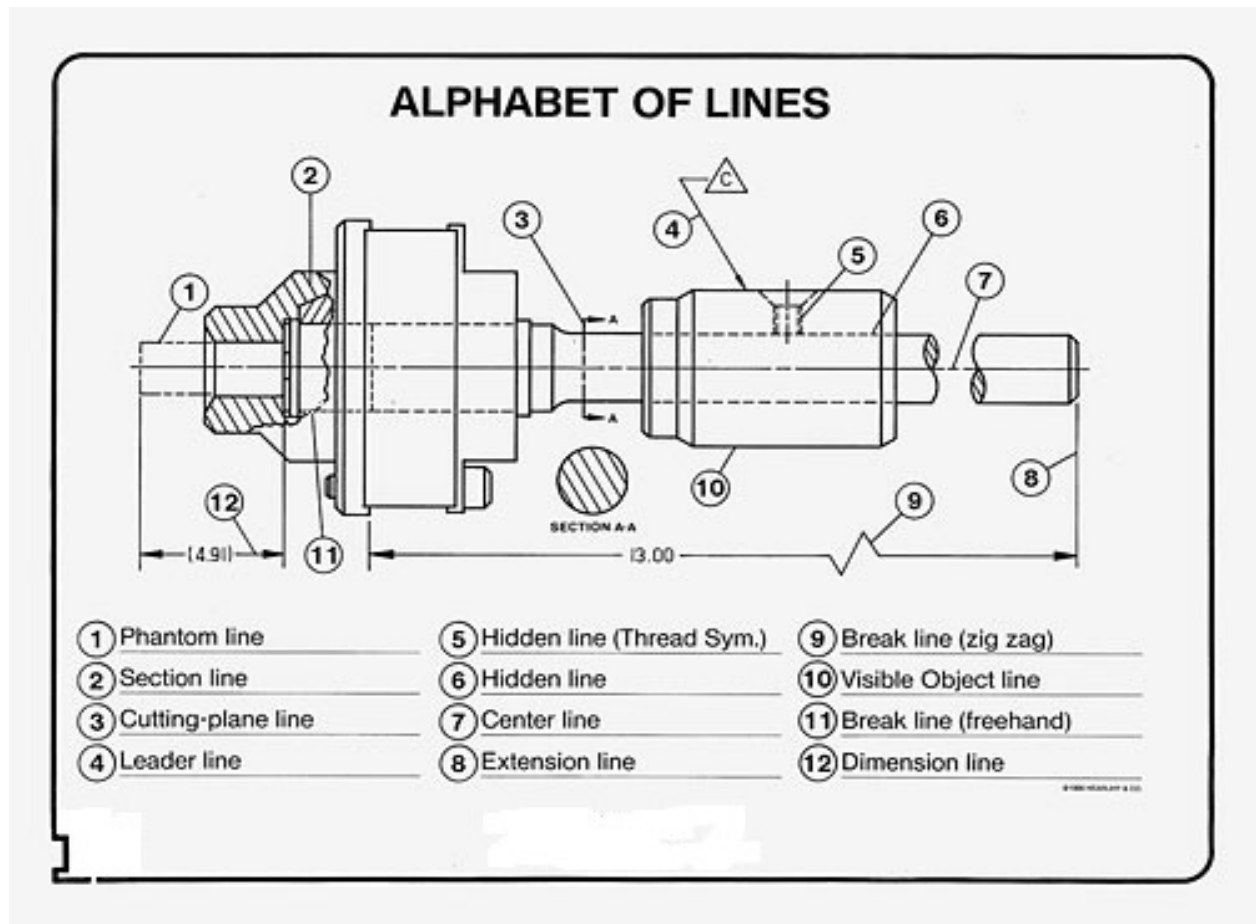
➤ Phantom lines:

- Are thin lines made of long and two short dashes alternately.
- They are used to identify alternate positions of moving parts, adjacent positions of related parts or repetitive details.

Summary for alphabet of lines

Each line on a drawing represents specific precise information regarding the components design.

<u>Type:</u> (Thickness)	<u>Example:</u>	<u>Application:</u>
Continuous Visible 0.7mm	A 	outlines
Continuous (thin) 0.3mm	B 	Dimension lines
Short dashes 0.3mm	C 	Hidden detail
Long chain Center 0.3mm	D 	lines
Chain, thick at ends 0.7 - 0.3mm	E 	Section cutting planes
Short chain 0.3mm	F 	Developed views
Continuous wavy Boundaries 0.3mm	G 	Broken
Straight zigzag 0.3mm	H 	Break lines
Straight lines with Two short zigzags 0.3mm	I 	Dimension lines



Precedence of Lines

1. When a Visible Line coincides with a Hidden Line or Center Line, draw the Visible Line.

Also, extend the Center Line beyond the outlines of the view.

2. When a Hidden Line coincides with a Center Line, draw the Hidden Line.

3. When a Visible Line coincides with a Cutting Plane, draw the Visible Line.

4. When a Center line coincides with a Cutting Plane, draw the Center Line and show the cutting Plane line outside the outlines of the view at the ends of the Center Line by thick dashes.

➡ **ASSIGNMENTS**

Prepare a guide line and write the following in **BOTH CAPITAL AND LOWER CASE** letter and numbers by keeping appropriate space between characters, words as well as sentences. Use a text height of **8mm**.

- I. TECHNICAL DRAWING IS A GRAPHICAL LANGUAGE. IT USES GRAPHICAL OBJECTS LIKE POINTS, LINES, CIRCLES AND DIFFERENT TYPES OF NON CIRCULAR CURVES FOR COMMUNICATION.
- II. THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG.
- III.

$$1\frac{1}{2} , 2\frac{3}{4} , 3\frac{4}{5} , 6\frac{9}{17}$$

NB: - All should be with a proper border line and title block and **on the same drawing sheet**

Chapter two

Orthographic Projection

Any object has three dimensions, viz., length, width and thickness. A projection is defined as a representation of an object on a two dimensional plane. The projections of an object should convey all the three dimensions, along with other details of the object on a sheet of paper.

The elements to be considered while obtaining a projection are:

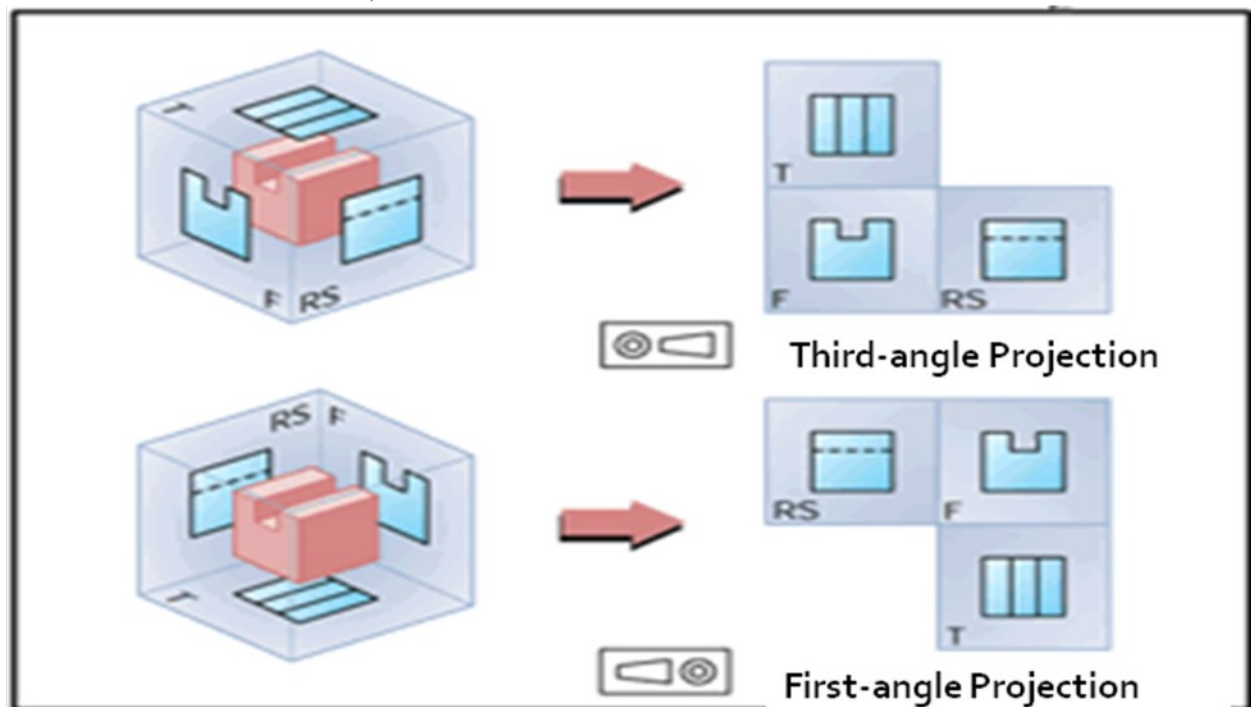
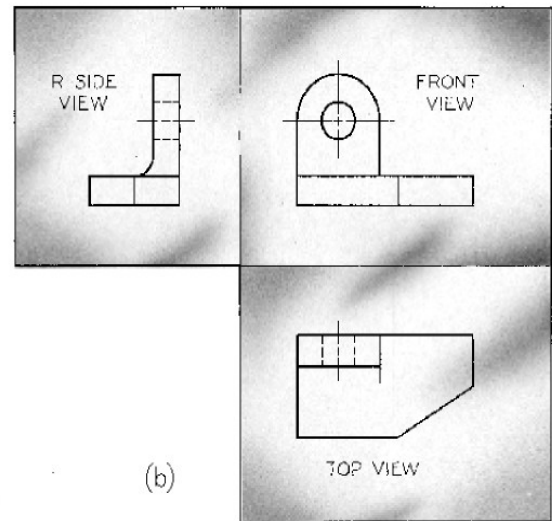
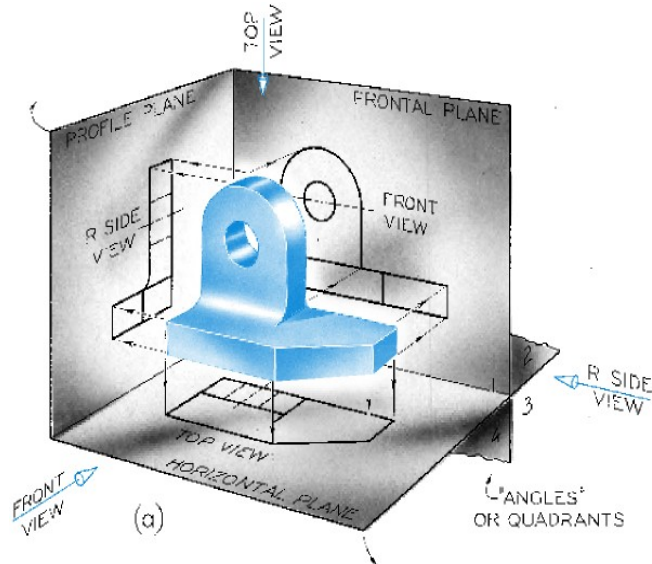
- (i) The object
- (ii) The plane of projection
- (iii) The point of sight
- (iv) The rays of sight

A projection may be obtained by viewing the object from the point of sight and tracing in correct sequence, the points of intersection between the rays of sight and the plane on to which the object is projected. A projection is called orthographic projection when the point of sight is imagined to be located at infinity so that the rays of sight are parallel to each other and intersect the plane of projection at right angle to it.

The principles of orthographic projection may be followed in four different angles or systems, viz., first, second, third and fourth angle projections. A projection is said to be first, second, third or fourth angle when the object is imagined to be in the first, second, third or fourth quadrant respectively. However, the Bureau of Indian Standards (SP-46:1988) prefers first angle projection and throughout this book, first angle projection is followed.

Principle of First angle projection

In first angle projection, the object is imagined to be positioned in the first quadrant. The view from the front of the object is obtained by looking at the object from the right side of the quadrant and tracing in correct sequence, the points of intersection between the projection plane and the rays of sight extended. The object is between the observer and the plane of projection (vertical plane). Here, the object is imagined to be transparent and the projection lines are extended from various points of the object to intersect the projection plane. Hence, in first angle projection, any view is so placed that it represents the side of the object away from it.

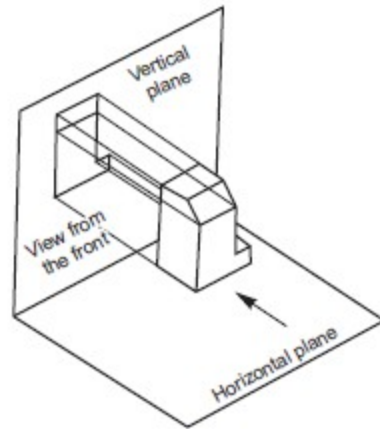


Methods of obtaining Orthographic views

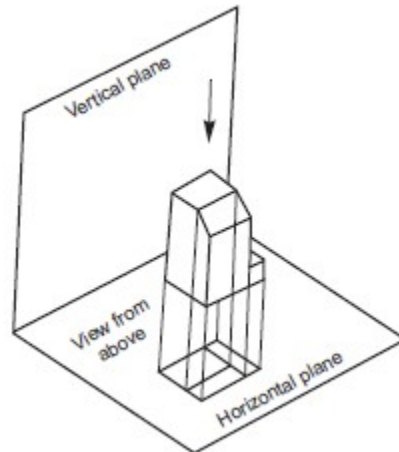
View from the front:-

The view from the front of an object is defined as the view that is obtained as projection on the vertical plane by looking at the object normal to its front surface. It is the usual practice to position the object such that its view from the front reveals most of the important features.

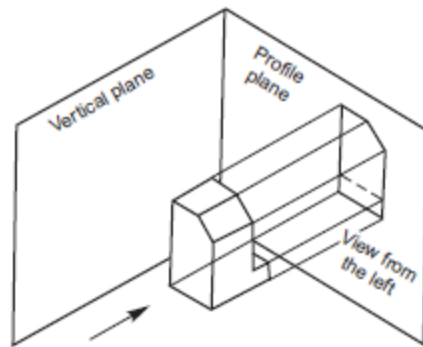
Figure below shows the method of obtaining the view from the front of an object.

**View from top**

The view from above of an object is defined as the view that is obtained as projection on the horizontal plane, by looking the object normal to its top surface. Figure 3.2 shows the method of obtaining the view from above of an object.

**View from side**

The view from the side of an object is defined as the view that is obtained as projection on the profile plane by looking the object, normal to its side surface. As there are two sides for an object, viz., left side and right side, two possible views from the side, viz., view from the left and view from the right may be obtained for any object. Figure below shows the method of obtaining the view from the left of an object.



Example: - Draw the front, top and side views of the following picture

