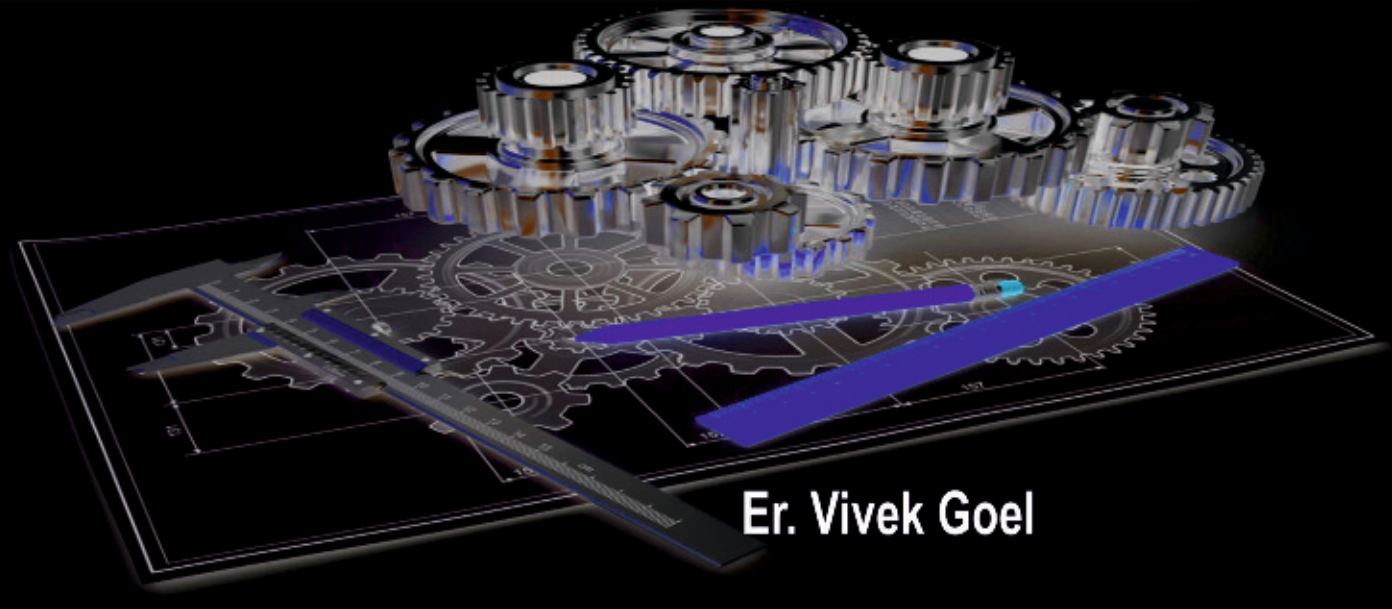
VIRAM SERIES

ENGINEERING GRAPHICS-I

For First Semester Diploma Students



Er. Vivek Goel

As per AICTE and UBTER, Uttarakhand Syllabus

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Investing in Learning

Engineering Graphics-I

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for

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by
Er. Vivek Goel

KHANNA PUBLISHERS
Operational Office:
4575/15, Onkar House, Ground Floor,
Darya Ganj, New Delhi 110 002
Phones : 011-23243042, 011-23243043 & Mob. 09811541460
email : contactus@khannapublishers.in

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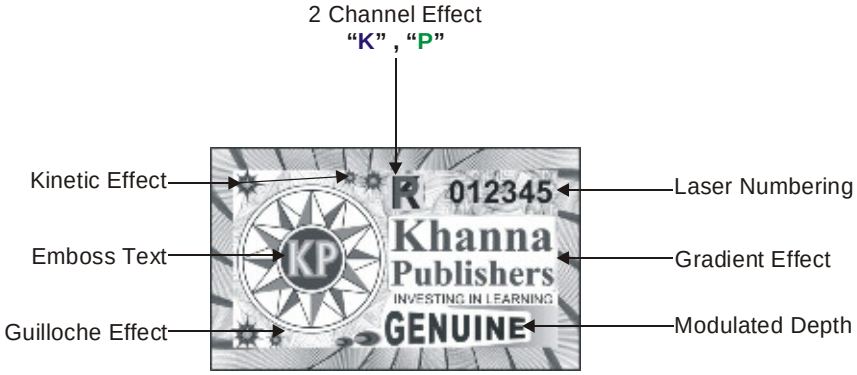

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Preface

The book "Engineering Graphics—I", has been written for the Diploma students of UBTER, Uttarakhand as per AICTE syllabus for their first semester diploma course. This textbook is the universal language of engineering community and machine drawing is the media through which technical people can convey information to get the desired results. This book will not only help the engineering students but will also be useful for practicing engineers.

Each chapter covered compressively topics have been arranged as per syllabus—illustrations are clearly drawn. The book highlights the topics like Drawing Office Practices, Lines and Lettering, Dimensioning, Geometrical Constructions, Scale, Principle of Projections, Symbols and Conventions.

Each topic has been supported by solved questions and answers alongwith review questions for practice.

Every attempt has been made to make this book student friendly. Any suggestion made by the students to improve the usefulness of the book are welcomed.

—Publishers

Contents

CHAPTER

1 Drawing Office Practices, Lines & Lettering

Objectives

After reading this chapter, students should be able to :

- *Understand drawing*
- *Know about drawing instruments and their uses*
- *Learn about different types of line and free-hand lettering.*

1.1 INTRODUCTION

Drawing plays an important role in the engineering and construction works. It requires no language, any one can read it. So, drawings improve the imagination, and new inventions can be developed. The estimate for the project can be done using the details provided in the drawing.

Engineering Graphics is a two-dimensional representation of three-dimensional objects. In general, it provides essential information about the shape, size, surface quality, material, manufacturing process, etc., of the object. It is the graphic language from which a trained person can visualise objects. Drawings prepared in one country may be utilised in any other country irrespective of the language spoken.

Hence, Engineering Graphics is called the universal language of Engineers. Any language to be communicative, should follow certain rules so that it conveys the same meaning to every one. Similarly, graphics practice must follow certain rules, if it is to serve as a means of communication.

Structures

For this purpose, Bureau of Indian Standards (BIS) adapted the International Standards on code of practice for drawing. The other foreign standards are: DIN of Germany, BS of Britain and ANSI of America.

☛ **Remember!**

- Engineering graphics is the language of engineers.
- It is a graphical language.
- It has its own alphabets and grammar.
- It is useful in representing three-dimensional objects on a paper by means of two-dimensional drawings.
- It provides relevant information about the shape, size, tolerances, surface quality, material, manufacturing process, etc., of the object.
- Drawings, photographs, slides, transparencies, and sketches are all forms of graphic communication.
- Any medium that uses a graphic image to aid in conveying a message, instructions, or an idea is involved in graphic communication.

Hence, we can say that the most widely used forms of graphic communication is the drawing. Technically, it can be defined as "a graphic representation of an idea", a concept or an entity which actually or potentially exists in life. Drawing is one of the oldest forms of communication, dating back even farther than verbal communication.

The drawing itself is a way of communicating all necessary information about an abstract, such as an idea or concept or a graphic representation of some real entity, such as a machine part, house or tools. It is used to fully and clearly define requirements for engineered items. It produces Engineering graphics (the documents).

More than merely the drawing of pictures, it is also a Language—a graphical language that communicates ideas and information from one mind to another.

Engineering Graphics convey the following critical information:

- ***Geometry*** **:** the shape of the object; represented as views; how the object will look when it is viewed from various angles, such as front, top, side, etc.
- ***Dimensions*****:** the size of the object is captured in accepted units.
- ***Tolerances*****:** the allowable variations for each dimension.
- ***Material*****:** represents what the item is made of.
- ***Finish*****:** specifies the surface quality of the item, functional or cosmetic. For example, a mass-marketed product usually requires a much higher surface quality than, say, a component that goes inside industrial machinery.

In this chapter, we shall study Graphics instruments and their uses, sizes and layout of Standard Graphics sheets and graphic boards, different types of lines, Letters and Numbers as per BIS : SP46-2003 specifications.

1.2 GRAPHICS: A TOOL TO COMMUNICATE IDEAS

The "Graphics" or "Drawing" can be expressed as art of representation of an object by systematic lines on a drawing paper or sheet. It can be broadly classified as :

- Artistic drawing and
- Engineering drawing.

An artistic drawing deals with the representation of painting, advertisement, pictures etc., whereas engineering drawing deals with the representation of engineering objects such as machine components, dams, roads, buildings, electronic components, computers, motors, generators etc.

Engineering graphics or drawing is the universal language of Engineers. An Engineer communicate his idea to others with the help of this language. Before actual construction of buildings, bridges, machines components etc., it is required to design them in order to meet technical requirements such as strength, safety etc.

After designing, the next step is to prepare detailed drawings which are required during manufacturing or actual construction. A good drawing communicate the message very fast among the people who use it.

For example, workers or artisans in the factory, perform manufacturing operations only after understanding the drawing of particular object. This method of communicating ideas is not new. The ancient man also used pictures and symbols to communicate among each other. The engineering graphics helps to provide clear idea about size, shape, internal details of any object.

Internal and complicated details of an object or machine parts can be understood easily. Looking to its high importance, the Engineering Graphics is taught to students of almost all branches of Engineering.

Let us consider some examples where its uses are important. The drawing of a machine component is important for mechanical and electrical engineers. Drawings of maps of buildings, bridges, roads, dams etc., are useful for civil engineers. Drawings of electronic devices are of great importance for electronic engineers.

An ideal and good drawing should have neat and clean, accurate and beautiful presentation. For such drawing, it is important to use good quality of instruments, pencils, sheets by the skilled draftsman.

1.3 ROLE OF ENGINEERING GRAPHICS

Engineering Graphics/Drawing is the most important requirement of all technical people in any profession. When we compare to verbal or written description, this method is brief and more clear.

Some of the applications are:

- building drawing for civil engineers,
- machine drawing for mechanical engineers,
- circuit diagrams for electrical and electronics engineers, computer graphics for one and all.

The subject in general is designed to impart :

1. Ability to read and prepare engineering drawings.
2. Ability to make free-hand sketching of objects.
3. Power to imagine, analyse and communicate, and
4. Capacity to understand other subjects.

1.4 GRAPHIC INSTRUMENTS AND THEIR USES

Knowledge of graphic instruments and other accessories is important for Engineers and students. Proper technique for using them is an another aspect to be considered for production of a good drawing. Following is the list of common instruments and accessories/items required by an engineering student.

1. Drawing sheet
2. Drawing board
3. Mini drafter
4. Instrument box
5. Drawing pencils
6. Drawing clips/pins
7. Sand Paper block
8. T square
9. Compass
10. Divider
11. Set squares
12. Clinograph
13. Protractor
14. French curves
15. Drawing templates
16. Set of scales
17. Ten plates
18. Pencils
19. Eraser
20. Paper holders
21. Engineer's scale
22. Pencils
23. Eraser

1.4.1 Drawing Sheet

Drawing sheet is a white paper on which an object is drawn which is available in various sizes. The sheet used for engineering should be of good quality. It should be white in colour with uniform thickness with must resist the easy torn of paper.

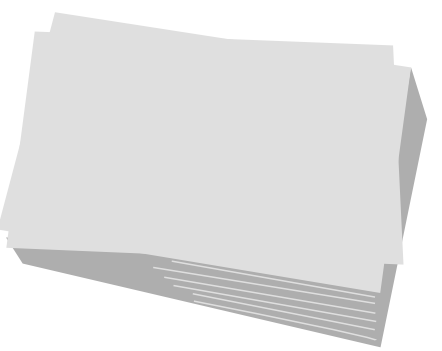


Fig. 1 : Drawing Sheet

The surface of sheet must be smooth. Now-a-days, drawing sheet/paper is available in different quality and sizes.

The quality of drawing work and its appearance depends on the quality of drawing sheet. A good quality sheet will not leave black marks while erasing. An ideal drawing sheet should meet the following requirements:

(a) It should be tough and strong.

(b) It should have good erasing quality so that, if eraser is used its fibres should not come out.

(c) It should be super white in colour.

As per recommendation of Bureau of Indian Standards (BIS), standard size of drawing sheets can be designated as shown as follows:

Drawing Sheet Type	Dimensions (Length × Width) (mm)
A_0	841 × 1189
A_1	594 × 841
A_2	420 × 594
A_3	297 × 420
A_4	210 × 297
A_5	148 × 210

1.4.2 Drawing Board

Drawing board is generally made of soft wood and it is in rectangular shape. It is used to support drawing sheet, so, the size of board is made according the size of the drawing sheet.

The wood portions are joined by tongue and grove type joint to prevent cracks. At the edge of board, straight ebony edge is provided for the T-square usage.

Different types of drawing boards and their sizes according to IS classification are listed below.

Fig. 2 : Drawing Board

Type of Drawing Board	Length × Width × Thickness (mm)
D0	1500 × 1000 × 25
D1	1000 × 700 × 25
D2	700 × 500 × 15
D3	500 × 350 × 15

Until recently drawing boards used are made of well seasoned softwood of about 25 mm thick with a working edge for T-square. Nowadays mini-drafter are used instead of T-squares which can be fixed on any board. The standard size of board depends on the size of drawing sheet size required.

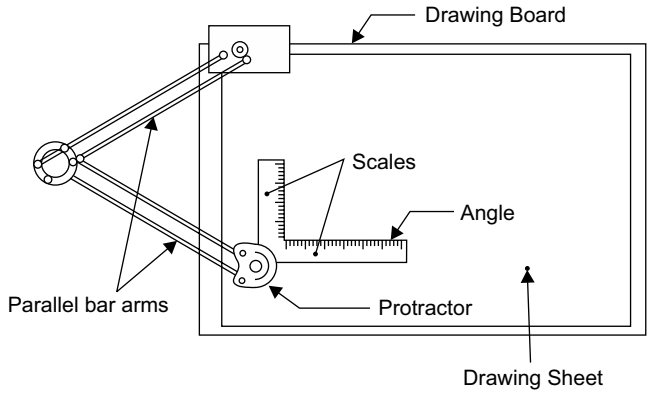


Fig. 3 : Mini-drafter

1.4.3 Mini Drafter

A drafting machine is a tool used in Engineering Graphics, consisting of a pair of scales mounted to form a right angle on an articulated protractor head that allows an angular rotation. Mini drafter is used to draw :

- horizontal,
- inclined or vertical lines on drawing paper or sheet.

It is an instrument which can be used for multiple functions in drawing. It contains two arms which is adjustable to required angle and at the end of the lower arm a scale set is attached. It has eliminated the use of T-square, set square, scales and protractors.

Now-a-days, it has gained wide popularity and is being used by majority of engineering students. The scale set contains two scales connected perpendicular to each which cannot be separated. This instrument is fixed to the drawing board at one edge with the help of screw provided for the drafter.

Mini drafter is used for drawing horizontal lines, vertical lines, inclined lines, angles, parallel lines, perpendicular lines etc.

Fig. 4 : Mini Drafter

1.4.4 Instrument Box

Instrument box contains various instruments for specific work. Usually following instruments are found in a typical instrument box.

(a) Large size compass (b) Large size divider
(c) Small size bow compass (d) Small size bow divider
(e) Inking pen (f) Lengthening bar

(a) Large Size Compass: This compass is used to draw circles, semi circles or arcs of required radius. It consists of two metal legs hinged together at upper end. One leg is fitted with a pointed needle whereas other end has a provision/clamp to hold pencil lead. This pencil leg is detachable and can be interchanged with linking pen.

(b) Large Size Divider: It consists of two legs hinged at the upper end. Both the ends of legs are fitted with steel pins. It is used to divide straight lines into required number of equal parts. It can also be used to transfer dimensions from one part to other part of the drawing.

(c) Small Size Bow Compass: This compass is used for drawing circles, semi circles, arcs etc., of small radius (less than 25 mm radius). It is also convenient to use when large number of circles with the same radius are required to be drawn. It has one leg with a steel pin while another leg with a clamp for inserting pencil lead. Small bow compass may be of central adjustment type and side adjustment type. A knurled nut is used to adjust the distance between two legs.

(d) Small Size Bow Divider: This divider is used to divide a line and transfer the distance from one part of the drawing to another part. The distance between legs can be adjusted with the help of knurled nut. This is very convenient for working over small distances.

(e) Inking Pen: This is used to draw lines in ink. It consists of two steel nibs fitted together in a holder. The distance between two steel nibs can be adjusted with the help of a knurled nut.

(f) Lengthening Bar: Lengthening bar is used as an extension bar with large size compass for making circles or arcs of large radius (more than 75 mm). For using this, pencil leg is first

detached from large compass and then lengthening bar is attached. The pencil leg is now attached to lengthening bar.

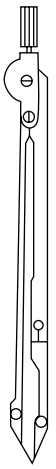


Fig. 5 : Large compass

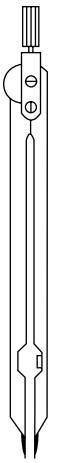


Fig. 6 : Large divider

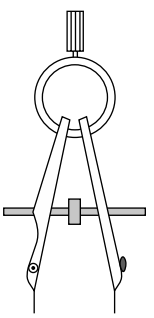


Fig. 7: Small size bow compass

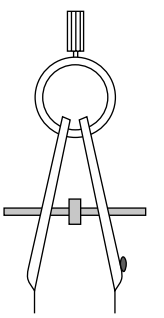


Fig. 8 : Small size bow divider

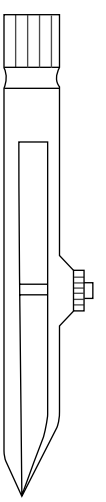


Fig. 9 : Inking Pen

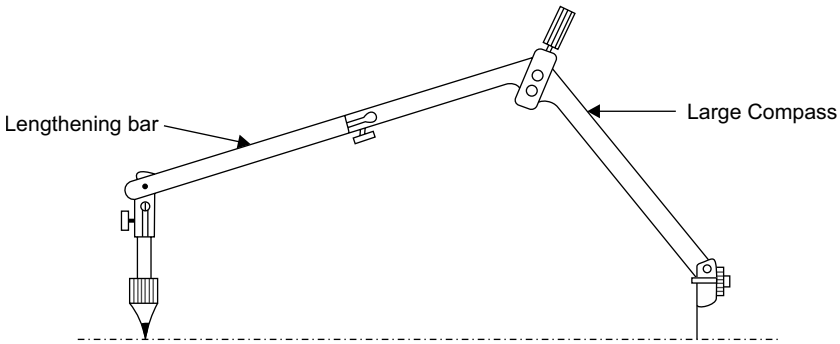
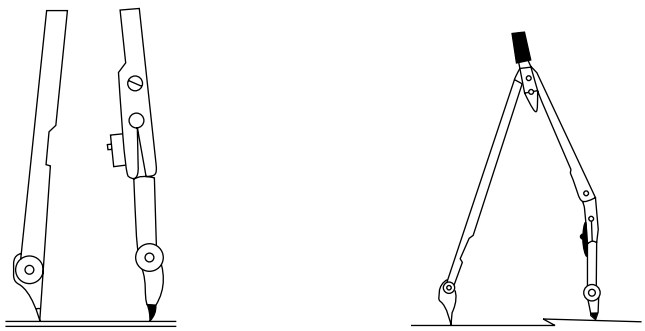


Fig. 10: Lengthening bar



(a) Sharpening and position of compass lead

(b) Position of the lead leg to draw larger circles

Fig. 11 :

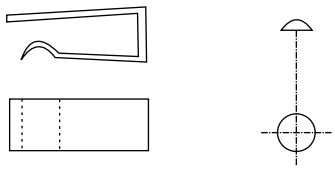
1.4.5 Drawing Pencils

Drawing pencils are important tool for any students. Students need drawing pencils for any kind of drawing work. Selection of proper grade of pencil for various components of a drawing is very important in order to achieve accurate and good appearance.

- To identify pencil, grade is marked on it. Standard way of designating grade is to use some numeral followed by some letter or some letter only e.g., 2H, 3H, B etc.
- Depending upon hardness of graphite lead, pencils of different grades have been recommended by BIS.
- Such grades (from hard to soft) are 9H, 8H, 7H, 6H, 5H, 4H, 3H, 2H, H, F, HB, B, 2B, 3B, 4B, 5B, 6B and 7B. Pencils with 9H and B grades are considered as hardest and softest respectively.
- Hard pencil produces light and thin line whereas soft pencil produces dark and thick line. Pencils with H and 2H grades are most commonly used for drawing various objects. Soft pencils such as H or HB may be used for darkening of outlines, title, lettering etc.

1.4.6 Drawing Clips/Pins

Drawing sheet is placed on the drawing and is fixed using drawing clips or drawing pins. Drawing clips are available in stainless steel or plastic material. Typical drawing clip and drawing pin is shown in Fig. 12 (a) and (b) respectively.



(a) (b)

Fig. 12 : Drawing clip and pin

1.4.7 Sand Paper Block

Sand paper block (Fig. 13) is used to sharpen the pencil lead to conical point. A piece of sand paper is pasted on a wooden block. The pencil lead is rub on the surface of sand paper to get the required level of sharpness. To draw smooth lines of uniform thickness, it is important to maintain the sharpness of pencil during drawing work because dull pencil always produces fuzzy and unsmooth lines.

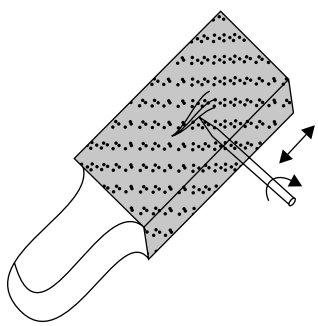
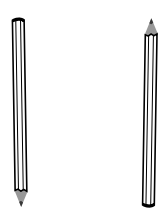


Fig. 13 : Sand paper block

Pencil can be sharpened to following two types (Fig. 14):

(a) Conical point and (b) Chisel edge

Conical point is suitable for drawing lines, dimensioning and general purpose work whereas chisel edge is used to draw straight line of uniform thickness.



(a) (b)

Fig. 14: Conical Point and chisel edge

1.4.8 T-Square

T square is used to draw horizontal and vertical lines on drawing sheet. It made of wood or plastic and in T shape. The vertical part of T is called as blade and horizontal part of T is called as head.

The edge of head is uniform level and attached to the edge of the board. The working edge is used to draw lines anywhere on the sheet by moving the instrument top to bottom.

Fig. 15 : T-Square

1.4.9 Compass

Compass is used to draw an arc or circle with known dimensions on engineering graphics. It is generally made of steel and consists of two legs. One leg contains needle at the bottom and other leg contains a ring in which a pencil is placed.

The needle tip is placed at the respected point and pencil tip is adjusted to the height at least 1 mm just above the tip of the needle. The gap is nothing but the paper thickness.

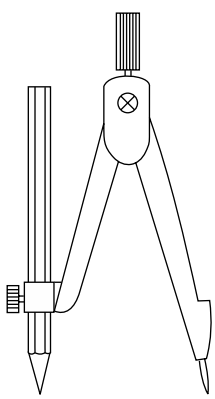


Fig. 16 : Compass

1.4.10 Divider

The divider looks like a compass, but the difference is the two legs of divider are provided with needles. This is used to divide a line or curve into equal parts. It is also used to check the measurements.

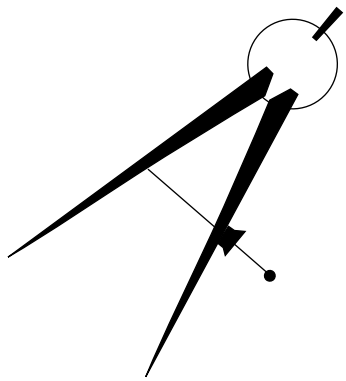


Fig. 17: Divider

1.4.11 Set Square

Set squares are used to draw lines with an angle between them. In most of the structures, 30, 45, 60 and 90-degree lines are most common. So, set squares make the work easier for this type of drawings.

Generally, set squares are of two types. One is 45 degree set square and another one is called as 30 – 60 degree set square. Both are required in the drawing. 45 set square has a side of 25 cm while 30-60 set square has 25 cm length on one side.

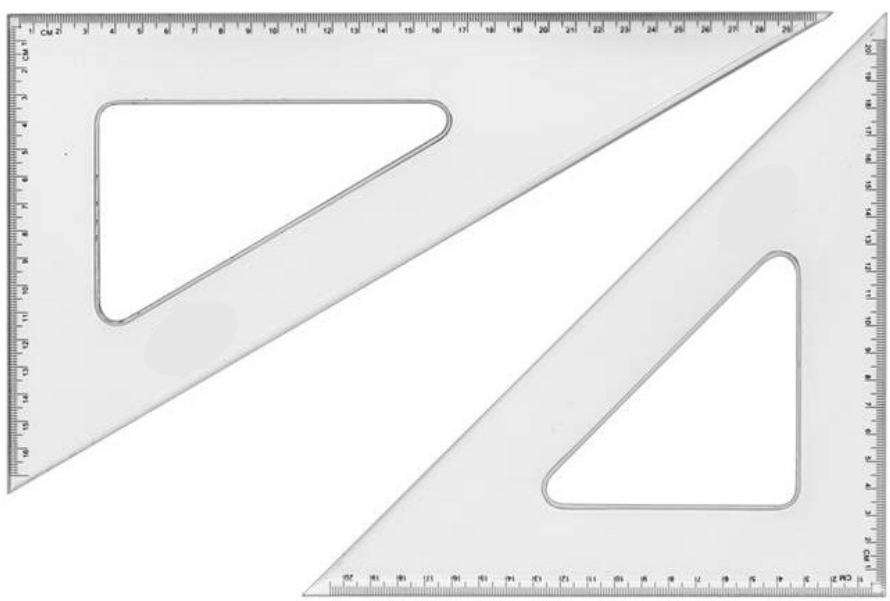


Fig. 18 : Set Square

1.4.12 Clinograph

Clinograph is an instrument used to draw parallel lines to the inclined lines. It contains one adjustable wing or strip which can be adjusted to required angle. So, it can be termed as adjustable set square.

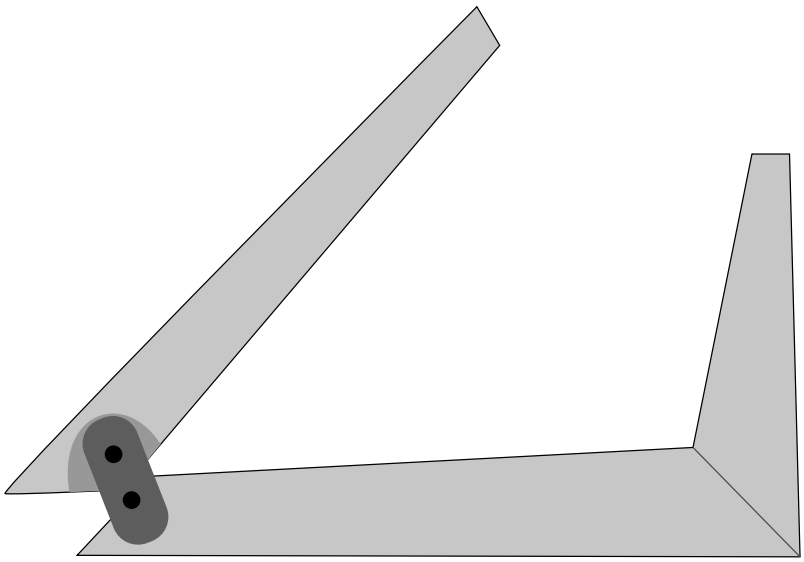


Fig. 19 : Clinograph

1.4.13 Protractor

Protractor is used to draw and measure the angles of lines in the drawing. It is transparent and made of plastic. It is in the shape of semi-circle, and the edge of semi-circle part consists reading with one-degree accuracy.

The bottom line joins the 0^o to the 180^o. The center of this bottom line is marked as "O" or "C" from which the angles are measured.

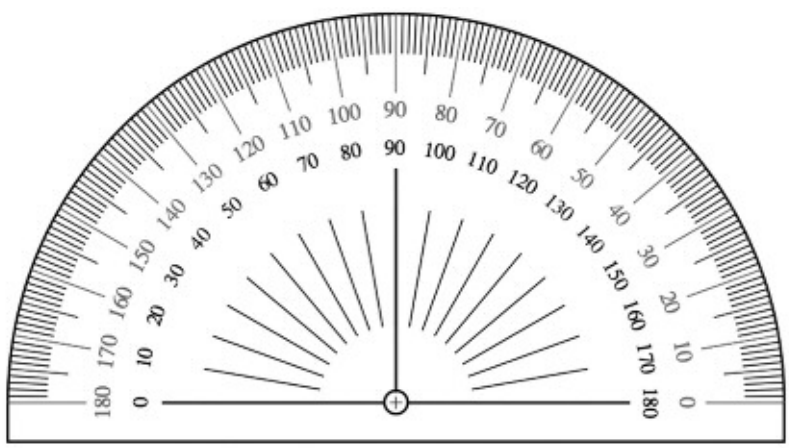


Fig. 20 : Protractor

1.4.14 French Curves

French curves are made of plastic and they are in irregular shapes. Sometimes the drawing requires irregular curves or shapes or arcs which cannot be drawn using compass. In that case French curves are used for drawing smooth curves, or shapes or arcs.

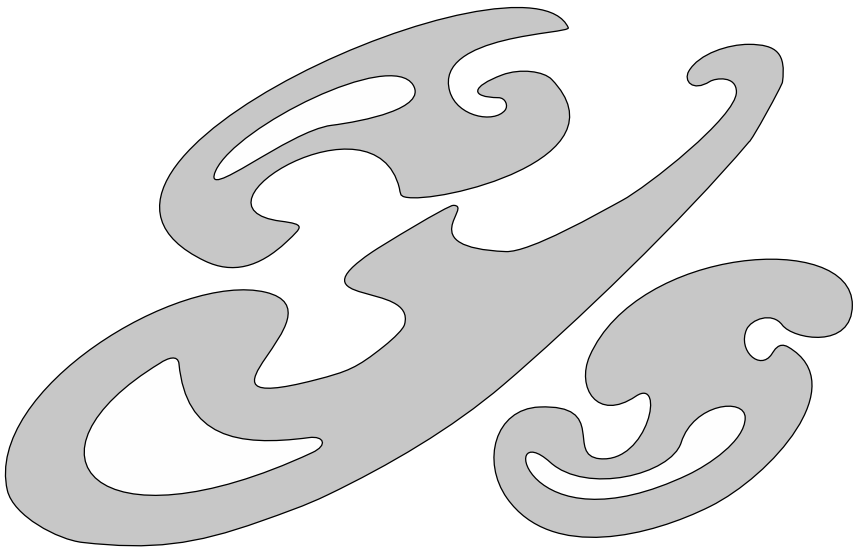
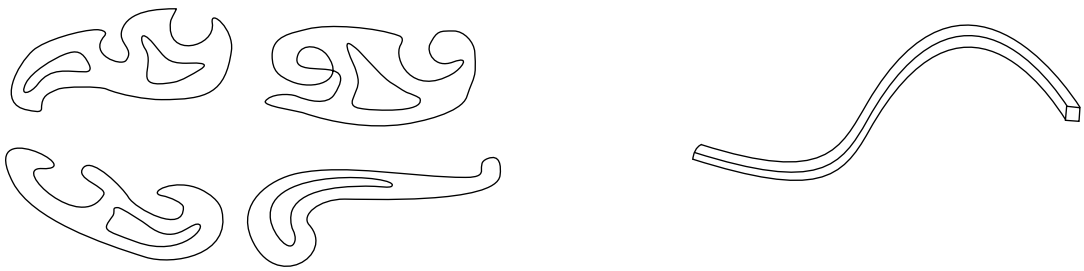


Fig. 21 : French curves

Generally French curves are more suitable for small curves and for long curves splines are used. French curves are available in different shapes (Fig. 22-a). First a series of points are plotted along the desired path and then the most suitable curve is made along the edge of the curve. A flexible curve (Fig. 22-b) consists of a lead bar inside rubber which bends conveniently to draw a smooth curve through any set of points.



(a) French curves (b) Flexible curves

Fig. 22 : French Curves

1.4.15 Drawing Templates

Templates are nothing but plastic or wooden boards which contains spaces of several shapes or letters. Non-dimensional shapes or variety font letters are drawn by using templates which makes drawing easier and perfect.

1.4.16 Set of Scales

Scales are used to make drawing of the objects to proportionate size desired. These are made of wood, steel or plastic (Fig. 23). BIS recommends eight set-scales in plastic/cardboard with designations M_1, M_2 and so on as shown in Table Set of scales

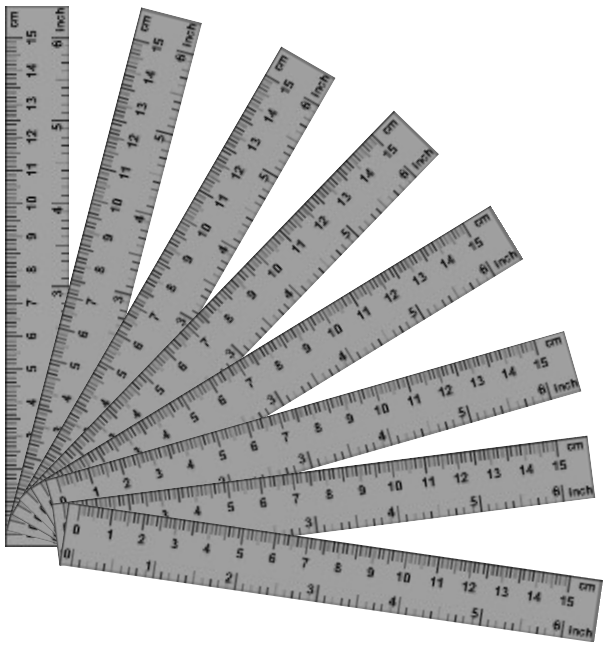


Fig. 23 : Set of Scales

	M_1	M_2	M_3	M_4	M_5	M_6	M_7	M_8
Scale on one edge	1:1	1:2.5	1:10	1:50	1:200	1:300	1:400	1: 1000
Scale on other edge	1:2	1 :5	1:20	1:100	1:500	1.600	1:800	1:2000

Note: Do not use the scales as a straight edge for drawing straight lines.

Scales for use on Technical drawings (IS: 46-1988)			
Category	**Recommended scales**		
Enlargement scales	50 : 1 5: 1	20 : 1 2: 1	10 : 1
Full size	1 : 1	—	—
Reduction scales	1 : 2 1 : 20 1 : 200 1 : 2000	1 : 5 1 : 50 1 : 500 1 : 5000	1 : 10 1 : 100 1 : 1000 1 : 10000

1.4.17 Tern Plates

These are aids used for drawing small features such as circles, arcs, triangular, square and other shapes and symbols used in various science and engineering fields (Fig. 24).

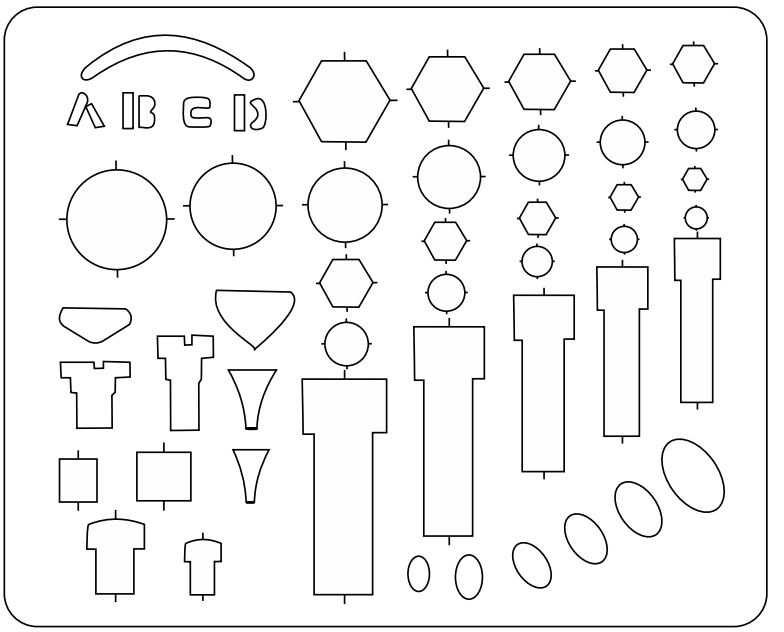


Fig. 24 : Tern Plates

1.4.18 Pencils

Pencil is used to draw on the paper. Any type of pencil is not suitable for drawing. There are some limitations, the drawing appearance should be very neat and understandable. Every line of the drawing indicates its importance. It depends upon the hardness of pencil.

Based on the hardness quality pencils are classified into 18 grades and they are:

Grade of Pencil	Hardness of Pencil
9H	Hardest
6H, 5H, 4H	Extremely Hard
3H	Very hard
2H	Hard
H	Moderately hard
F	Firm
HB	Medium hard
B	Moderately soft and black
2B	Soft and black
3B	Very soft and black

4B, 5B, 6B	Very soft and very black
7B	Softest

Out of the above 18 grades of pencils, following grades are used in engineering drawings.

Grade of Pencil	**Used to Draw**
3H	Construction lines
2H	Dimension lines, center lines, sectional lines, hidden lines
H	Object lines, lettering
HB	Dimensioning, boundary lines

Pencils with leads of different degrees of hardness or grades are available in the market. The hardness or softness of the lead is indicated by 3H, 2H, H, HB, B, 2B, 3B, etc. The grade HB denotes medium hardness of lead used for general purpose. The hardness increases as the value of the numeral before the letter H increases. The lead becomes softer, as the value of the numeral before B increases (Fig. 25).

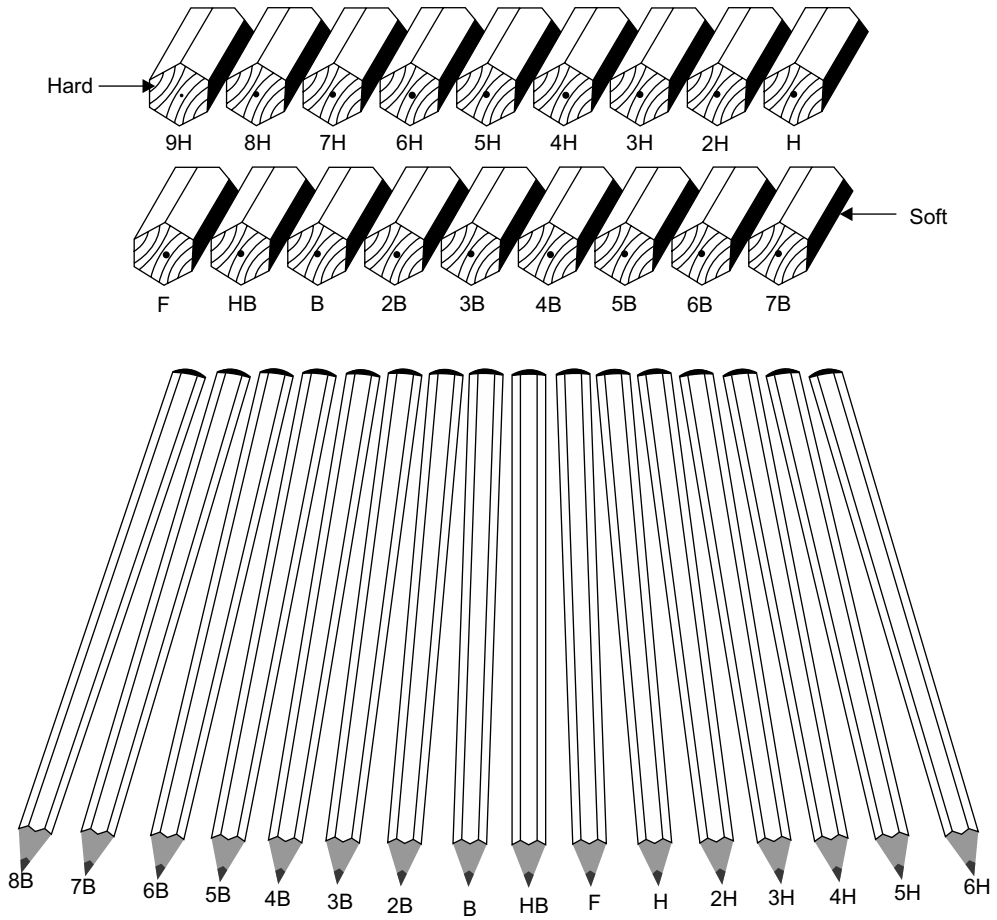


Fig. 25 : Pencil Leads

The selection of the grade depends on the line quality desired for the drawing. Pencils of grades H or 2H may be used for finishing as these give a sharp black line. Softer grade pencils are used for sketching work. HB grade is recommended for lettering and dimensioning.

Nowadays mechanical pencils are widely used in place of wooden pencils. When these are used, much of the sharpening time can be saved. The number 0.5, 0.70 of the pencil indicates the thickness of the line obtained with the lead and the size of the lead diameter. Micro-tip pencils with 0.5 mm thick leads with the following grades are recommended.

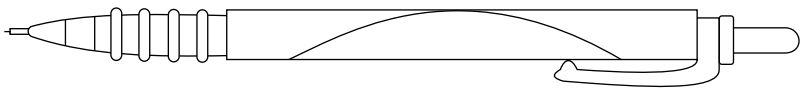


Fig. 26 : Mechanical Pencil

HB Soft grade for Boundary lines, Dimensioning and Free sketching. H Medium grade for visible outlines, object lines and lettering. 2H Hard grade for Dimension lines, Leader lines, Extension lines, Centre lines, Hatching lines and Hidden lines. 3H very hard grade for construction lines.

1.4.19 Eraser

Eraser is used to remove the lines or spots which drawn by mistake or with wrong measurements. The eraser used should be of good quality and soft. It should not damage the paper while erasing. (Fig. 27).

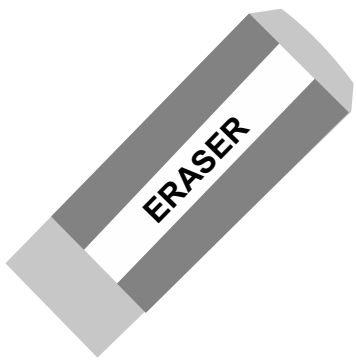


Fig. 27 : Eraser

1.4.20 Paper Holders

When the drawing sheet is placed on the board it may not be in fixed position. To fix the drawing sheet to the board paper holders are used.

Generally used paper holders are thumb pins, spring clips, stick tapes etc. Care should be taken while removing the clips or tapes otherwise the sheet may tore. (Fig. 28)

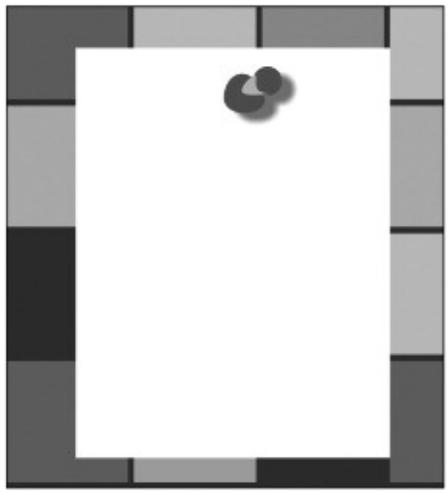


Fig. 28 : Paper Holder

1.4.21 Engineer's Scale

Drawing of bigger objects can not be prepared with true dimensions. It is always required to reduce the actual dimensions to fit the normal paper size. However, full scale drawing can also be prepared for smaller objects such as watch components, small electronic circuits etc. Engineer's scale can be made from wood, celluloid, card board or metal.

On both sides divisions are marked with the reduced or enlarged lengths in a particular ratio. For example, full size scale (1:1) on one side and half size scale (2:1) on other side. As per BIS standard full size scale is designated as 1:1. Reducing scales may be with 1:2, 1:5, 1:10, 1:20, 1:25, 1:50, 1:100 and enlarging scale may be with 10:1, 5:1 and 2:1. The ratio 1:10 means that 1 cm on drawing will represent 10 cm actual distance. Engineer's scales are used to prepare drawings with either enlarging or reducing size.

1.5 SIZES AND LAYOUT OF STANDARD GRAPHICS SHEETS AND GRAPHIC BOARDS

Engineering students generally use A2 or A3 size drawing sheets. After fixing the drawing sheet on to the drawing board, the "Border lines" and the "Title block" are first drawn.

An ideal working space for drawing is obtained by drawing the borderlines. Use on HB pencil for drawing the Borderlines. The following steps are involved in drawing the borderlines:

- Draw a filing margin of 30 mm width at the left-hand edge of the drawing sheet for taking perforations.
- Draw margins of a minimum of 10 mm each at the top, bottom and right side of the drawing sheet.

The standard sizes of the drawing sheet recommended by Indian Standard Institution, IS: 696-1972 are given in Table.

Designation	A_0	A_1	A_2	A_3	A_4
Dimensions in mm	841 × 1189	594 × 841	420 × 594	297 × 420	210 × 297

1.5.1 Sizes of Graphic Sheets

Paper sizes seem to always bring confusion, and the bottom line is that exact measurements make a difference. I have had commercial jobs come to me and the clients say "well it's off half an inch, but that won't make that much of a difference" and fact is that a half an inch could make a very big difference.

The printer will then need to resize the document to fit, and if it is not proportionate it will be either stretched or squished to fit. It is extra work for the printer, most likely a bigger charge for the client in the end, and poor quality in most cases. There are several projects that different sizes can be used for, but I have included a few examples. Below are a few basic paper sizes:

- **Letter Size - 8.5" × 11":** This is the most common size in the United States used in most commercial communication aids such as fax machines and copy machines, as well as being the standard print size for home inkjet printers.
- **Legal Size – 8.5" × 14":** This size is offered on some printers, most likely any printer that is built to handle 8.5" × 11" paper can handle this size because the width is the same. This size is used for larger flyers, brochures and works well with Microsoft Excel projects.
- **Tabloid Size - 11" × 17":** Some home printers can handle this size, but you will find these printers are much larger than other at home ink jet printers. This size is great for flyers, brochures, signs and 4 pages flyers as well. When you fold the 11" × 17" paper in half it will create 4 (8.5" × 11") panels which is great for announcements, programs and small booklets.
- **Letter Half Size – 5.5" × 8.5" :** This size is the US standard letter size (8.5" × 11") cut in half. This is a common size for direct mail pieces and inserts for magazines and booklets. There are several sizes for direct mail pieces, so you will need to check with your printer to find out the sizes that they offer.
- **A4 – 8.2677" × 11.6929":** This is the common "letter" size outside of North America, primarily used in Europe.
- **A3 – 11.6929" × 16.5354":** This is a size used outside of North America and it commonly used when you want to output two A4 documents on the same spread.
- **Compact Disc – 4.7222" × 4.75":** This size is specific for CD covers and inserts.

Postcards

- **Standard:** 5.47 × 4.21
- **Oversized:** 8.5 × 5.47

Business Cards

- **No Bleed Horizontal:** 3.43” × 1.93”
- **No Bleed Vertical:** 1.93” × 3.43”
- **Bleed Horizontal:** 3.54” × 2.05”
- **Bleed Vertical:** 2.05” × 3.54”

Posters

- **Small:** 11.25” × 17.3”
- **Medium:** 18” × 24”
- **Large:** 24” × 36”

There a few other topics that go hand-in-hand with document size, such as the bleed. A bleed is primarily used for flyers, magazine covers, advertisements and mailing pieces. A bleed is when your final printed price does not have a border around the image; it goes right to the edge of the paper.

You can achieve this by giving extra room to the printer to be able to trim excess paper that doesn’t contain pertinent information. Primarily a standard bleed in the US is .125”, meaning if your page size was 8.5”× 11” you would then add .125” to each side.

The final product size would still be 8.5” × 11”, but your image would go right to the edge of the paper. This also means that it is important that you leave a margin to ensure that nothing important is cut off or cropped too close to the edge of the piece.

A margin is the space that you leave in between the final trim area and the image size area. This space ensures that after the product is trimmed, the content is not cut off or too close to the outer edges. A standard size margin is .25” on all four sides of the document. The margin space will print, unlike the bleed, so make sure that the information that is contained in the margin is something that you want included.

1.5.2 Layout of Graphic Sheets

Drawing sheets may be used with their longer size positioned either horizontally or vertically (Figs. 29 (a) and (b))

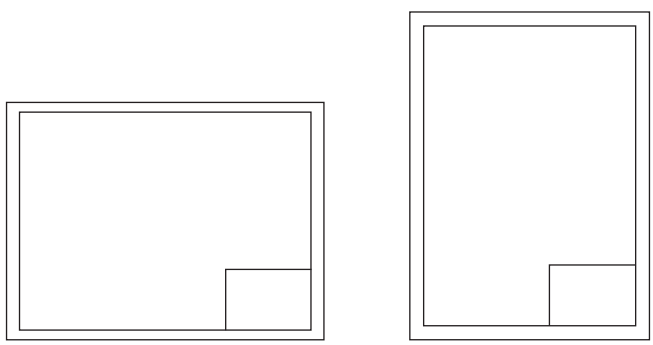


Fig. 29 : Layout of Drawing Sheets

• *Borders*

An ideal working space for drawing is obtained by drawing the Borderlines. It is recommended that these borders have a minimum width of 20 mm for the sizes A0 and A1 and a minimum of 10 mm width for the sizes A2, A3 and A4 (Fig. 30). Use an HB pencil for drawing the Borderlines.

The following steps are involved in drawing the border lines.

(a) Draw margins of a minimum 10 mm each at the top, bottom and right side of the drawing sheet.

(b) Draw a filing margin for taking perforations at the left-hand edge of the drawing sheet. This margin shall have a minimum width of 20 mm (the border included therein).

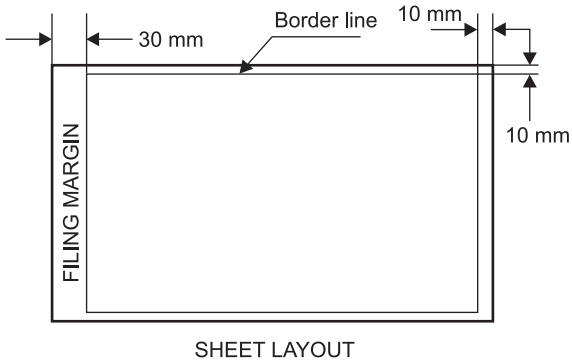


Fig. 30 : Borderlines

• *Title block*

The title block is positioned in accordance with the recommendation of ISO-5457, normally at the right hand side bottom corner of the drawing space. The title block should lie within the drawing space at the bottom right hand comer of the sheet.

The title block can have a maximum length of 170 mm providing the following information:

1. Title of the drawing.
2. Drawing number.
3. Scale.
4. Symbol denoting the method of projection.
5. Name of the firm, and
6. Initials of staff, who have designed, checked and approved.

The title block used on shop floor and one suggested for students class work is shown in an example of the arrangements in Fig. 31.

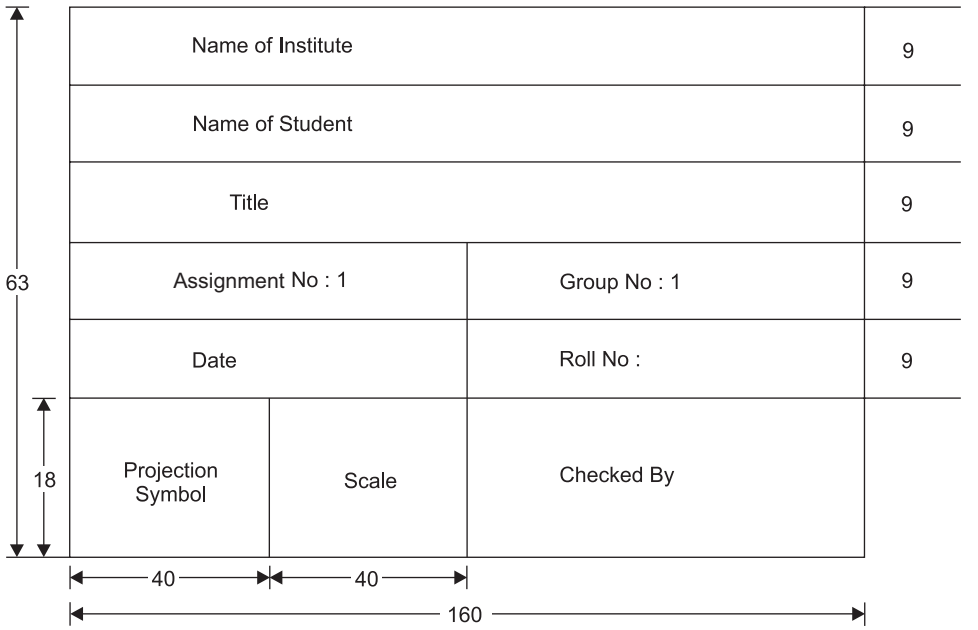


Fig. 31 : Title block

1.6. DIFFERENT TYPES OF LINES IN ENGINEERING GRAPHICS AS PER BIS SPECIFICATIONS

Engineering Graphics of any object is systematic combination of lines of different types. Different types of lines are considered as alphabet of this language, each line used in some specific sense.

1.6.1 Types of Lines

The basis of any drawing is a line. The use of a right type of line results in a correct drawing. The Bureau of Indian Standard BIS (SP46:2003) has prescribed the types of lines and their General applications as given in Table 1.

The various types of lines are shown in Fig. 32 and their uses are described below:

- **Outlines (A)** : An outline is a line or set of lines enclosing or indicating the shape of an object in a sketch or diagram. Outlines are drawn to represent visible edges and surface boundaries of objects are called outlines or principal lines. These are continuous thick lines.
- **Margin Lines (A):** These are continuous thick lines along which the prints are trimmed.
- **Dimension Lines (B):** These lines are continuous thin lines. These are terminated at the outer ends by pointed arrow heads touching the outlines, extension lines or centre lines.

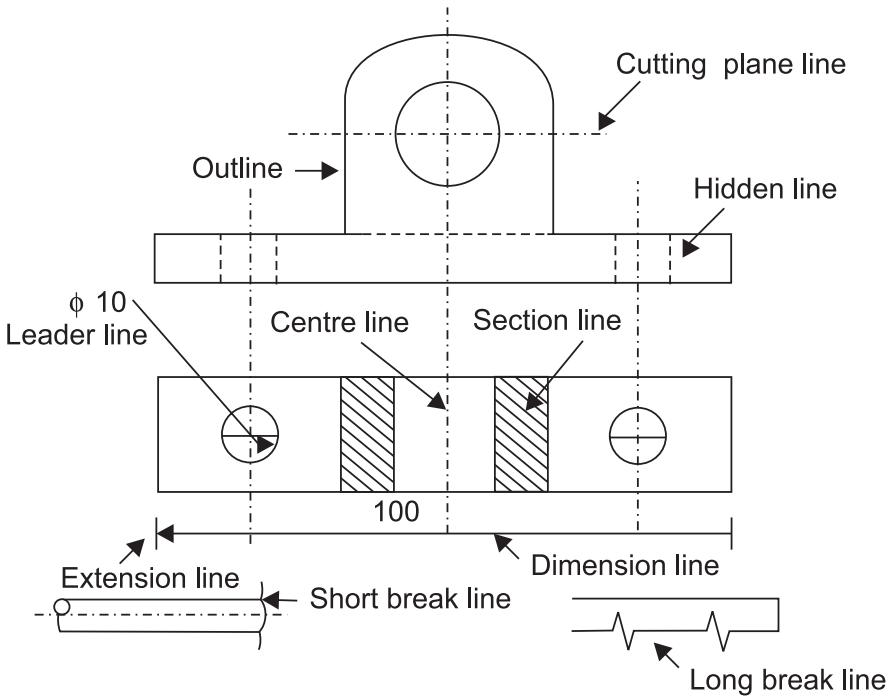
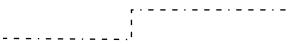


Fig. 32 : Use of various lines

Table 1. The types and thickness of lines used for various purposes as per BIS (SP46:2003).

	Line	Description	General Application
A	———	Continuous thick	A1 Visible outlines. A2 Visible edges.
B	———	Continuous thin (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines. B3 Projection lines. B4 Leader lines. B5 Hatching lines. B6 Outlines of revolved sections in place. B7 Short centre lines.
C	~~~	Continuous thin free hand	C1 Limits of partial or interrupted views and sections, if the limit is not a chain thin.

D		Continuous thin (straight) with zigzags	D1 Long break line.
E		Dashed thick	E1 Hidden outlines. E2 Hidden edges.
F		Dashed thin	F1 Hidden outlines. F2 Hidden edges.
G		Chain thin	G1 Center lines. G2 Lines of symmetry. G3 Trajectories.
H		Chain thin, thick at ends and changes of direction	H1 Cutting planes.
J		Chain thick	J1 Indication of lines or surfaces to which a special requirement applies.
K		chain thin double dashed	K1 Outlines of adjacent parts. K2 Alternative or extreme position of movable parts. K3 Centroidal lines K4 Initial outlines prior to forming K5 Parts situated in front of the cutting plane.

- **Extension or Projection Lines (B):** These lines are also continuous thin lines. They extend by about 3 mm beyond the dimension lines.
- **Construction Lines (B):** These lines are drawn for constructing figures. These are shown in geometrical drawings only. These are continuous thin light lines.
- **Hatching or Section Lines (B)**: These lines are drawn to make the section evident. These are continuous thin lines and are drawn generally at an angle of 45^{o} to the main outline of the section. These are uniformly spaced about 1 mm to 2 mm apart.
- **Leader or Pointer Lines (B):** Leader line is drawn to connect a note with the feature to which it applies. It is a continuous thin line.
- **Border Lines (B)**: Perfectly rectangular working space is determined by drawing the border lines. These are continuous thin lines.
- **Short-Break Lines (C):** These lines are continuous, thin and wavy. These are drawn freehand and are used to show a short break, or irregular boundaries.

- **Long-Break Lines (D):** These lines are thin ruled lines with short zigzags within them. These are drawn to show long breaks.
- **Hidden or Dotted Lines (E or F):** Interior or hidden edges and surfaces are shown by hidden lines. These are also called dashed lines or dotted lines. These are of medium thickness and made up of short dashes of approximately equal lengths of about 2 mm spaced at equal distances of about 1 mm. When a hidden line meets or intersects another hidden line or an outline, their point of intersection or meeting should be clearly shown.
- **Centre Lines (G):** Centre lines are drawn to indicate the axes of cylindrical, conical or spherical objects or details, and also to show the centers of circles and arcs. These are thin, long, chain lines composed of alternately long and short dashes spaced approximately 1 mm apart. The longer dashes are about 6 to 8 times the short dashes which are about 1.5 mm long. Centre lines should extend for a short distance beyond the outlines to which these refer. For the purpose of dimensioning or to correlate the views these may be extended as required. The point of intersection between two centre lines must always be indicated. Locus lines, extreme positions of movable parts and pitch circles are also shown by this type of line.
- **Cutting-Plane Lines (H):** The location of a cutting plane is shown by this line. It is a long, thin chain line, thick at ends only.
- **Chain Thick (J):** These lines are used to indicate special treatment on the surface.
- **Chain Thick Double Dashed (K):** This chain thin double dashed is used for outline for adjacent parts, alternative and extreme, position of movable part, centroidal lines, initial outlines prior to forming and part suited in front of the cutting plane.

The thickness of lines are varied depending on whether the drawing is drawn by ink or pencil. The thickness of lines of various groups is shown in Table 2. The line group is designated according to the thickness of the thickest line. For any particular drawing, a line-group is selected according to its size and type. All lines should be sharp and dense so that good prints can be reproduced.

Table 2 : Thickness of Lines (Ink Drawing)

Line Group mm	Types of Lines						
	A	B	C	D	E	F	G
1.2	1.2	0.6	0.4	0.4	1.2	0.4	0.4
0.8	0.8	0.4	0.3	0.3	0.8	0.3	0.3
0.5	0.5	0.3	0.2	0.2	0.5	0.2	0.2
0.3	0.3	0.2	0.1	0.1	0.3	0.1	0.1

For drawing finalised with pencil, the lines can be divided into two line groups as shown in Table 3. It is important to note that in the finished drawing, all lines except construction line should be dense, clean and uniform. Construction line should be drawn very thin and faint and should be hardly visible in the finished drawing.

Table 3 : Thickness of Lines (Pencil Drawing)

Line Group mm	Thickness	Lines
0.2	Medium	Out lines, dotted lines, cutting plane- lines
0.1	Thin line	Center-lines, section-lines, dimension-lines, extension lines, construction lines, leader lines, short break lines and long break lines.

There are only two types of lines used in drawing, e.g. thick and thin lines. The ratio between the thick line and thin line should not be less than 2:1. If the thickness of thin line is 0.25 mm, then the thickness of the thick line will be 0.5 mm.

Similarly the distance between two parallel thin lines (Hatching lines) is twice the thickness of the heaviest line. If the thickness of the heaviest line is 0.7 mm, then the distance between two hatching lines will be1.4 mm. The thickness of lines depends upon the size and type of drawing.

1.7 FREE HAND LETTERING (ALPHABET AND NUMERALS)

Lettering is an important part of engineering graphics. It gives information regarding size, and instructions, in the form of notes and dimension. It is used to write titles, sub-titles, dimensions, and other necessary information on a drawing. The Indian Standard followed for lettering is BIS9609.

All letters should have uniform height and width and should be legible, simple and easy to write. Lettering should be done with dark pencil such as H or HB.

The lettering should be done in such a manner that it should take minimum time without the use of drawing instruments. Letters used for engineering graphics may broadly be classified into two types i.e., single stroke letters and gothic letters.

On a drawing, whole of the written information is always in the form of lettering. It is not hand written. Also, it may be added here, that Lettering is appropriate and correct words but not printing (Printing means production of printed material on a printing press).

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 commonly used in engineering drawing viz. Gothic Lettering and Roman Lettering.

1.7.1 Single Stroke Letters

Single stroke letters are simplest form of letters and are used to write titles, dimensions, notes and other information on a drawing. Lettering using single stroke letters has been recommended by Bureau of Indian Standards (BIS) and described in IS:9609-1990. The word “single stroke” indicates that the thickness of lines used in letters should be such as obtained in single stroke of pencil. It does not mean that letter written in single stroke without lifting the pencil. The single stroke letters may be of two types e.g., vertical and inclined letters.

Fig. 33 : Single stroke vertical letters and numerals

The vertical letters are used for general purpose lettering in engineering drawing. Height to width ratio of such letters varies. But for all practical purposes the letters with height to width ratio may be taken as 7:5 or 6:5 for all capital letters except I, J, L, M and W. For M and W the suitable ratio is 10:8 and for I, this ratio is taken as 10:2.

For numerals such ratio may be taken as 7:4 or 6:3. Single stroke vertical upper and lower case letters and numerals are shown in Fig. 34. The inclined/italics letters are written at an angle of 75º from horizontal towards right. Fig. 35 illustrates typical inclined letters and numerals. The size of letters and numerals is specified by their heights 'h'.

The standard heights of letters and numerals for practical use are 1.8, 2.5, 3.5, 5.7, 10, 14 and 20 mm as recommended by BIS. The letters size 5 mm-10 mm may be used for main title of drawing.

For sub-titles, letter size of 3.5 mm or 5 mm may be used conveniently. The letters and numerals having size 2.5, 3.5 or 5 mm are suitable for writing notes, dimensions etc. The single stroke letters may be of A type or B type.

In A type letter, height of letter is divided into fourteen parts whereas in B type letter, the height is divided into 10 parts. The recommended ratio, spacing between letters and thickness of lines (stems) of letters are summarized in Table and are explained in Fig. 35.

Fig. 34 : Single stroke inclined letters and numerals

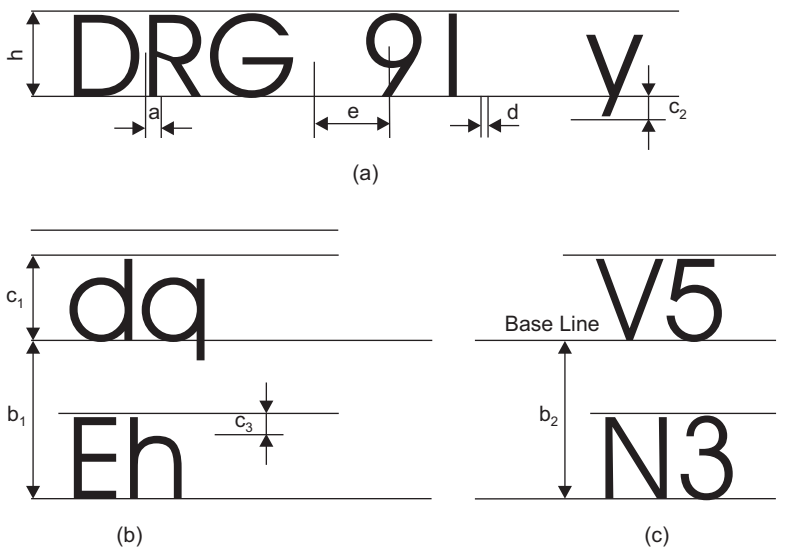


Fig. 35 : Standard dimensions for A and B letters

1.7.2 Gothic Lettering

When the stem of letters are given more thickness, such letters are called as gothic letters. These letters are used for writing the main title for working drawings. Thickness of stem may be taken as 1/5th to 1/10th of the height of letters.

Lettering having all the alphabets or numerals of uniform thickness is called Gothic Lettering.

1. Vertical Gothic Lettering
2. Italic or Inclined Gothic Lettering.

☛ *General Rules for Lettering*

- ❍ Select the size of letters suitable to given drawing.
- ❍ Draw horizontal guidelines keeping the distance between them equal to the height of letters.
- ❍ Width of letters may be taken equal to the height of the letter. Complete the lettering with the standard dimensions.
- ❍ Do not erase the guidelines.

1.7.3 Vertical Gothic Lettering

These are vertical letter having thickness of each line of alphabet or numerals etc. same as the single stroke of a pencil. Since Stroke means that the letter is written with one or more stems or curves and each made with single stroke.

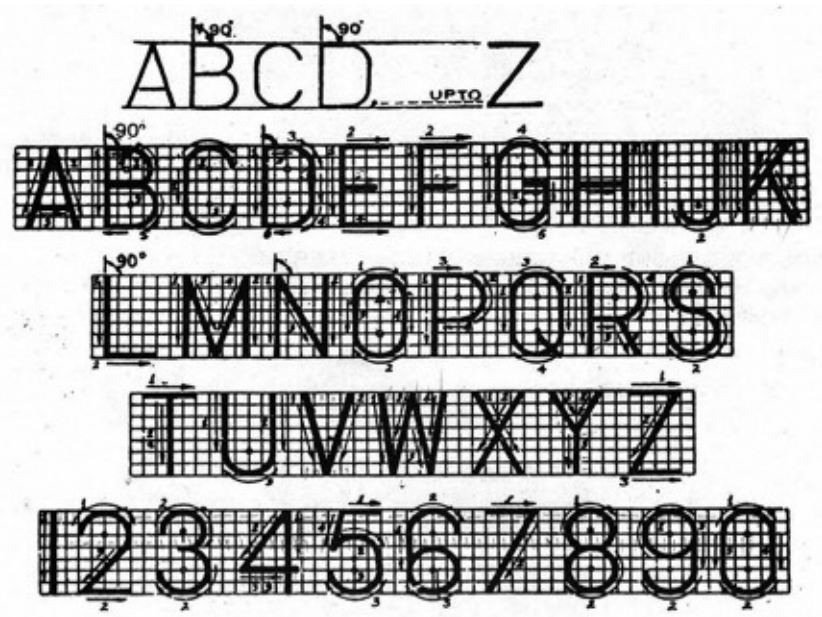


Fig. 36:

1.7.4 Single Stroke Inclined Gothic Lettering

These are single stroke letter inclined at 75′ to the Horizontal.

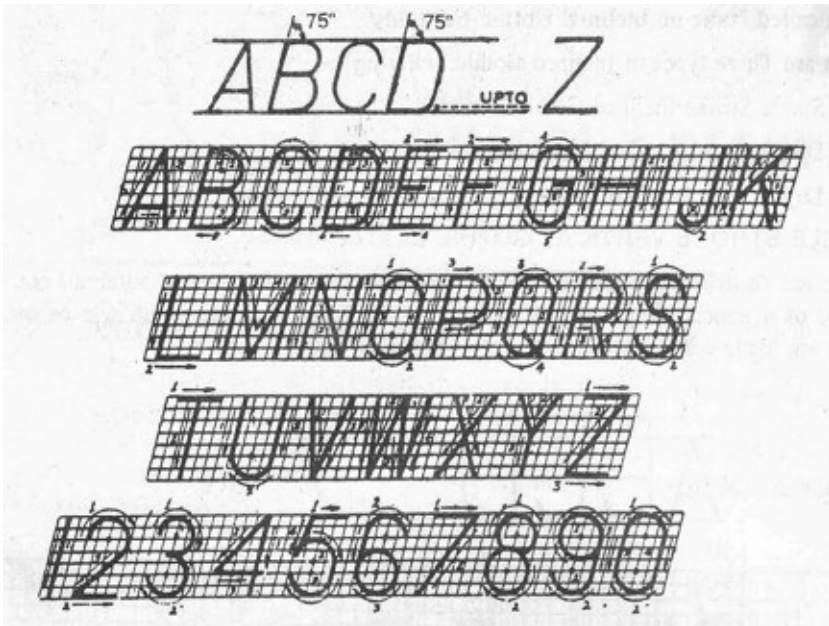


Fig. 37 :

1.7.5 Double Stroke Vertical Gothic Lettering

Vertical letter drawn by double Stroke of pencil with uniform thickness between these strokes are called Double Stroke Vertical Gothic Lettering.

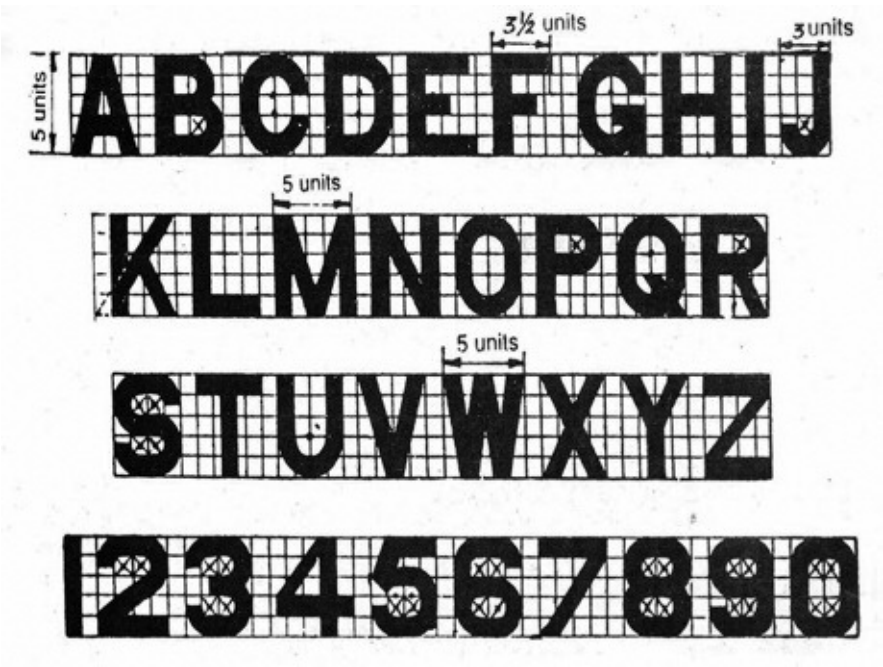


Fig. 38 :

1.7.6 Double Stroke Inclined Gothic Lettering

Double stroke gothic when inclined at an angle of 75′ is called Double Stroke Inclined Gothic Lettering.

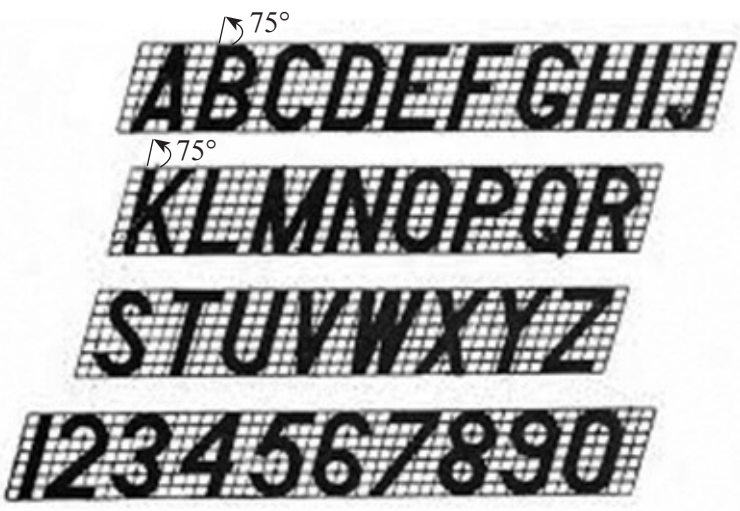


Fig. 39 :

1.7.7 Lower Case Vertical Single Stroke Gothic Lettering

Lower case vertical gothic lettering is shown along with its sizes. Which is quite self explanatory.

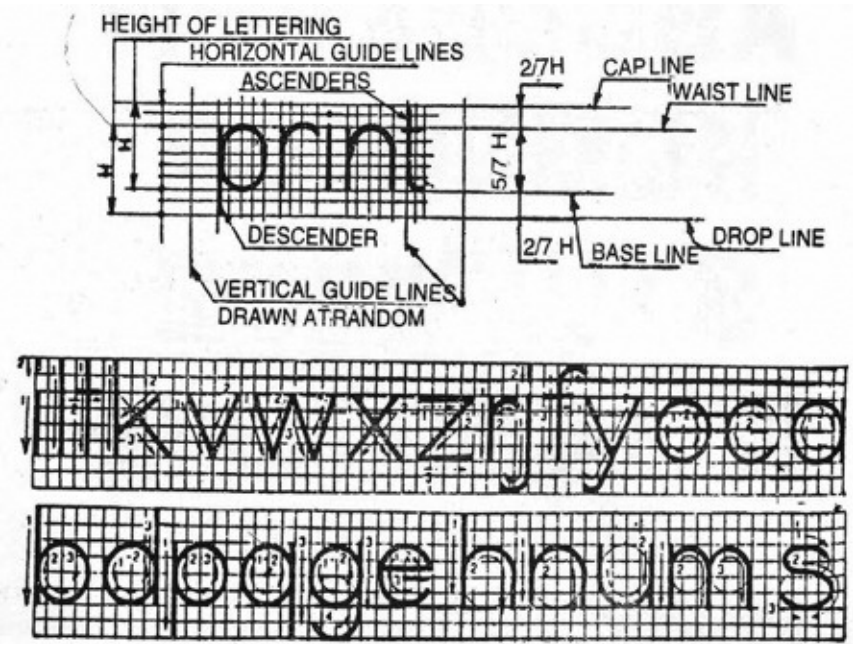


Fig. 40 :

1.7.8 Lower Case Vertical Double Stroke Gothic Lettering

It is shown along with its size which is quite self explanatory.

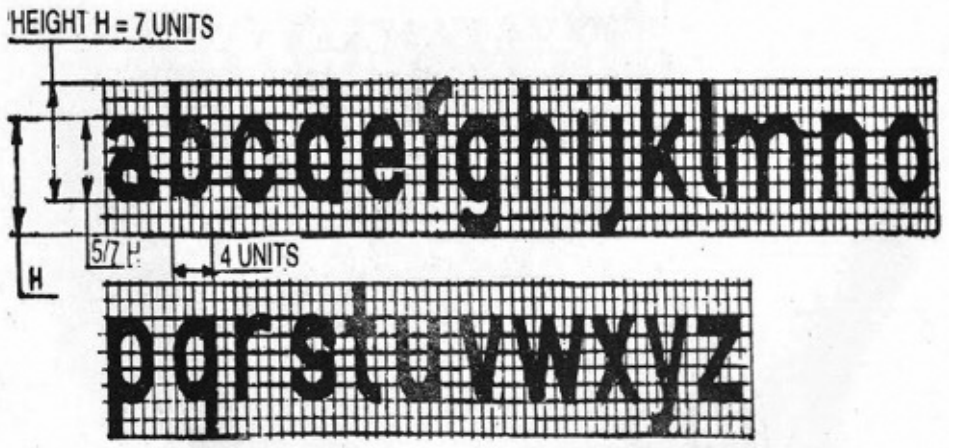


Fig. 41 :

1.7.9 Lower Case Inclined Single Stroke Gothic Lettering

It is shown with its sizes which is self explanatory.

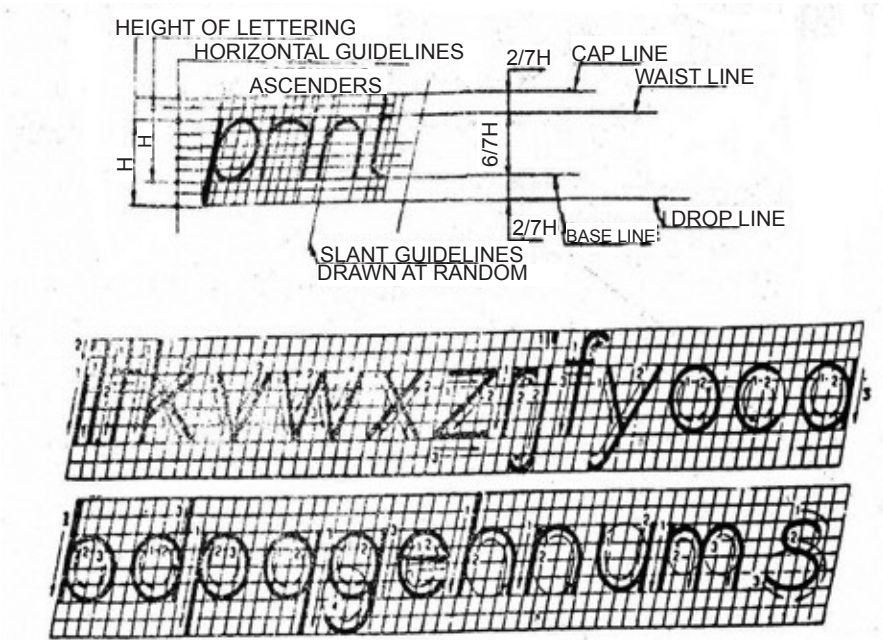


Fig. 42:

1.7.10 Roman Lettering

The lettering in which all the letters are formed by thick and thin elements is called Roman Lettering. It may be vertical or inclined or inclined. It can be written with a chisel pointed Pencil or D-3 type Speed Ball Pen.

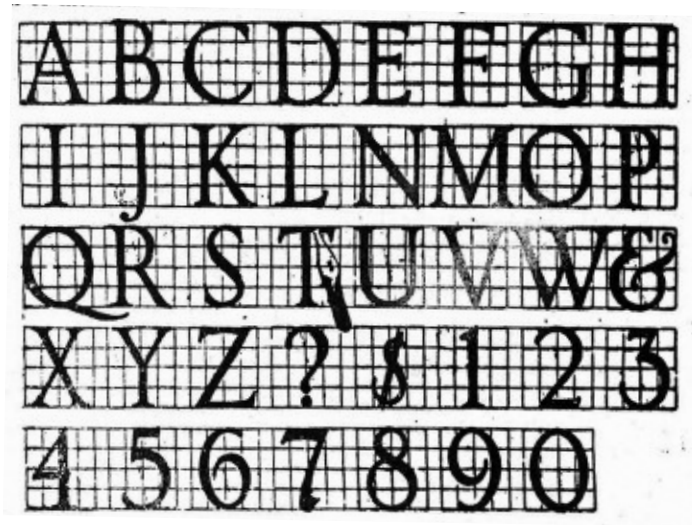


Fig. 43 :

1.7.11 Free Hand Lettering

The writing of alphabets without the use of drawing instruments and in free hand is called Free Hand Lettering. It may be vertical or Inclined Gothic Lettering.

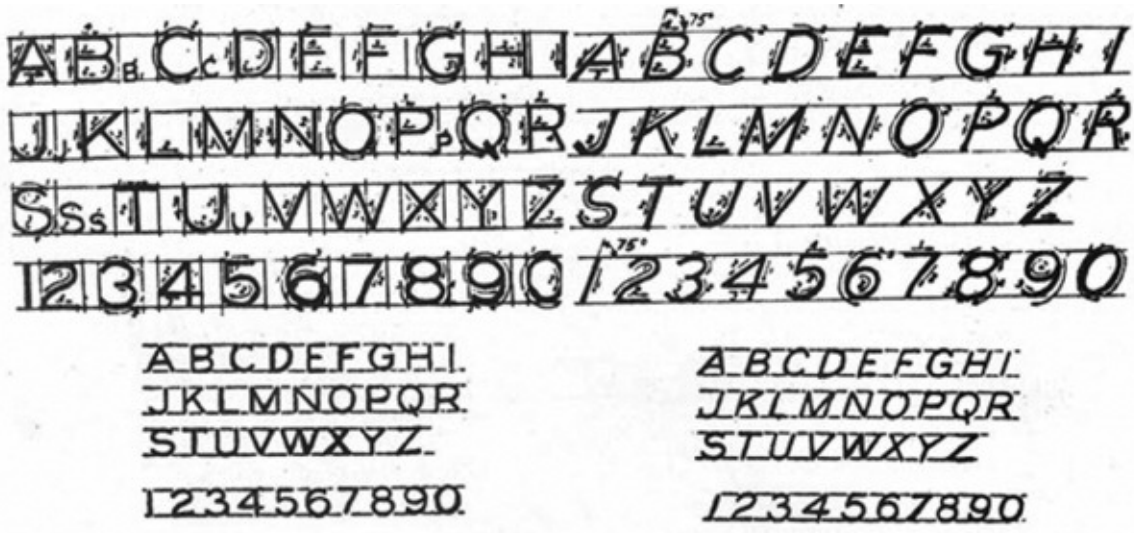


Fig. 44 :

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

[(!?:;"=+x:.%&)] 0123456789IVX

ABCDEFGHIJKLMNOPQRSTUVWXYZ

abcdefghijklmnopqrstuvwxyz

[(!?:;"=+x:.%&)] 0123456789IVX

Fig. 45 :

1.7.12 Height Of Lettering

The height "h" of the capital letter is taken as the base of dimensioning. The main requirement of lettering on engineering graphics are legibility, uniformity, ease and rapidity in execution.

Both upright and inclined letter are suitable for general use. All letters should be capital, except where lower case letters are accepted internationally for abbreviations.

The recommended size of lettering is as under :

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 etc.)	3, 4, 5
Alteration, Enteries and Tolerances	2, 3

1.7.13 Guidelines

The light thin lines drawn to obtain uniform and correct height of letters are called Guidelines.

Guide line should be drawn very light and thin, so that, they need not be erased after the lettering is finished. To erase guide lines after finishing the lettering is not easily possible. Guide line for capital and lower case lettering.

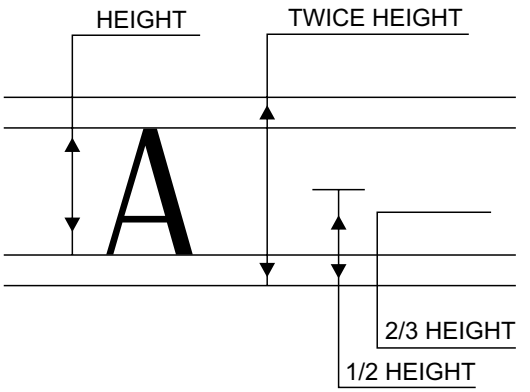


Fig. 46 :

Drawing Graph For Lettering

The letters are drawn in a graph. Before drawing the alphabets or numerals of 7:4, 5:4 or any other ratio, a graph is needed.

- First of all take the height of the lettering and draw two parallel horizontal lines.

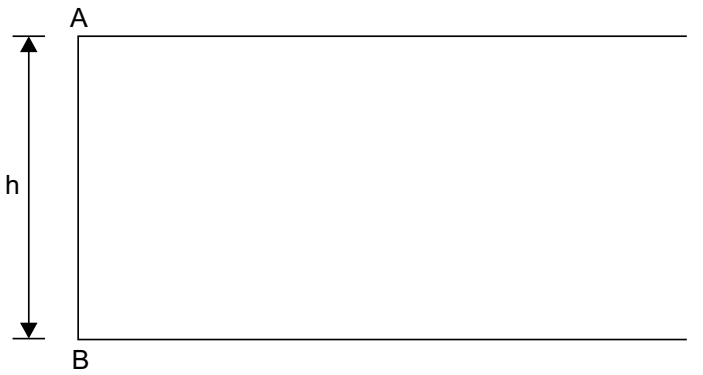


Fig. 47 :

- Draw an inclined line at A and mark, 7 or 5 or as required number of vertical squares or rhombii, parts of any suitable size. Join B_1 with B.

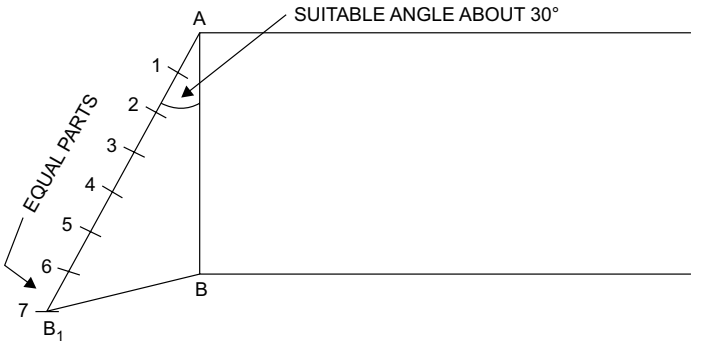


Fig. 48 :

1.8 SUM UP

- Engineering Graphics plays an important role in the engineering and construction works. It requires no language, any one can read it.
- Engineering Graphics improve the imagination, and new inventions can be developed. The estimate for the project can be done using the details provided in the graphics.
- Engineering Graphics is a two-dimensional representation of three-dimensional objects.
- In general, it provides essential information about the shape, size, surface quality, material, manufacturing process, etc., of the object. It is the graphic language from which a trained person can visualise objects.
- Drawings prepared in one country may be utilised in any other country irrespective of the language spoken.
- Hence, engineering graphics is called the universal language of engineers. Any language to be communicative, should follow certain rules so that it conveys the same meaning

to every one. Similarly, drawing practice must follow certain rules, if it is to serve as a means of communication.

- The drawing itself is a way of communicating all necessary information about an abstract, such as an idea or concept or a graphic representation of some real entity, such as a machine part, house or tools. It is used to fully and clearly define requirements for engineered items. It produces engineering graphics (the documents).
- Engineering graphics or drawing is the universal language of engineers. An engineer communicate his idea to others with the help of this language. Before actual construction of buildings, bridges, machines components etc., it is required to design them in order to meet technical requirements such as strength, safety etc.
- A good drawing communicate the message very fast among the people who use it.
- The engineering graphics helps to provide clear idea about size, shape, internal details of any object.
- Internal and complicated details of an object or machine parts can be understood easily. Looking to its high importance, the engineering graphics is taught to students of almost all branches of engineering.
- Drawings of maps of buildings, bridges, roads, dams etc., are useful for civil engineers. Drawings of electronic devices are of great importance for electronic engineers.
- An ideal and good drawing should have neat and clean, accurate and beautiful presentation. For such drawing, it is important to use good quality of instruments, pencils, sheets by the skilled draft man.
- Drawing board is generally made of soft wood and it is in rectangular shape. It is used to support drawing sheet, so, the size of board is made according the size of the drawing sheet.
- The wood portions are joined by tongue and grove type joint to prevent cracks. At the edge of board, straight ebony edge is provided for the T-square usage.

SOLVED QUESTIONS AND ANSWERS

1. *What is engineering graphics?*

Ans. Engineering graphics, most commonly referred to as engineering drawing, is the art of graphic representation of designs of a variety of components, especially those related to engineering. It primarily consists of sketching the actual component, for example a machine, with its exact dimensions. The scale of dimensions is suitably adjusted so as to properly fit within the contours of the drawing sheet.

Engineering drawing, is the most important aspect of mechanical engineering, as it is the fundamental need to develop the design and assembly of a machine. While the interpretation of a component in terms of sketching can be done in various methods, the three most necessary techniques of drawing/projection are:

Orthographic Projection: In this method the object is placed in space in such a way that the front view of it is captured in the vertical plane, and the top view of the same, is captured in the horizontal plane. The projections of the object are perpendicular with the planar screen, and hence, the name 'orthographic'.

Perspective Projection: This is a simple technique of drawing an object as how one views it. The observer's eye position, height, and the distance from the object, all influence the outcome of the drawing. Two sub-methods are adopted for this projection technique, namely, Visual Ray Method and Vanishing Point Method.

Isometric Projection: This form of projection gives the total detail of the component under consideration. The basic principle behind isometric projection is that it involves the consideration of three axes that are inclined to each other making equal angles (thus the name since iso- means equal) with each other (120 deg). This is followed by transfer of actual dimensions to the isometric scale involving some basic trigonometric calculations.

2. *What role Engineering graphics does play ?*

Ans. Engineering graphics plays a vital role both in manufacture and design, as it not only explains the string of arrangement in a machine, but also tells us about the method to be employed to manufacture the individual blocks.

An engineering graphics not only helps convey ideas and convert concepts into reality, an engineering drawing follows criteria and conventions to eliminate confusion by the the standardization of nomenclature and practices, as a way to clearly relay the information to the individual who understands it when it is read, and very importantly, it indicates or hints how something is going to be manufactured.

3. *What is Computer graphics*

Ans. Computer graphic is the discipline of producing picture or images using a computer include modeling—creation, manipulation, and storage of geometric objects and rendering—converting a scene to an image, or the process of transformations, rasterization, shading, illumination, and animation of the image.

4. *What do you mean by visualization?*

Ans. Visualization is the representation of an object, situation, or set of information as a chart or other. It is the process of rendering data as images in order to enhance our understanding.

5. *What is the use of T-Square in engineering graphics? Explain.*

Ans. T-square is used to draw horizontal lines on graphics sheet.

- It is also used to guide the set square for drawing vertical or inclined lines at 30°, 45° or 60°.
- It is usually made from hard wood. Two wooden strips
- e.g., stock and blades are joined together at right angles with the help of screw and pins. Stock slides over the working edge of drawing board and blade moves up and down horizontally.

6. *What are Set Squares?*

Ans. Set squares are used to draw vertical and inclined lines at $30^{o,}$ 45^{o}, 60^{o} etc. Set squares are used with T-square. Set squares are usually made of plastic, wood, etc. A 45^{o} set square and a 30^{o}-60^{o} set square.

7. *What is the use of Drawing Board?*

Ans. It is considered as one of the essential instruments. Its top surface should be flat and smooth and edges should be at right angle to each other. Drawing board is usually made of well seasoned soft wood. Five to six narrow strips of soft wood are joined together with the help of suitable glue.

8. *What does an Instrument Box contain?*

Ans. Instrument box contains various instruments for specific work. Usually following instruments are found in a typical instrument box.

(a) Large size compass
(b) Large size divider
(c) Small size bow compass
(d) Small size bow divider
(e) Inking pen
(f) Lengthening bar

9. *What do you mean by Mini Drafter or Drafting Machine?*

Ans. Mini drafter is used to draw horizontal, inclined or vertical lines on drawing paper or sheet. It has eliminated the use of T-square, set square, scales and protractors. Now-a-days, it has gained wide popularity and is being used by majority of engineering students. Its one end is provided with clamping screw and clamp. This end can be fixed on one of the edges/corners of drawing board. Other end is fitted with L-type scale and a protractor which can be set at any desired angle.

10. *What is Sand Paper Block?*

Ans. Sand paper block is used to sharpen the pencil lead to conical point. A piece of sand paper is pasted on a wooden block. The pencil lead is rub on the surface of sand paper to get the required level of sharpness. To draw smooth lines of uniform thickness, it is important to maintain the sharpness of pencil during drawing work because dull pencil always produces fuzzy and unsmooth lines. Pencil can be sharpened to following two types.

(a) Conical point and (b) Chisel edge

Conical point is suitable for drawing lines, dimensioning and general purpose work whereas chisel edge is used to draw straight line of uniform thickness.

11. *Briefly explain Graphics as a Tool to Communicate Ideas.*

Ans. Engineering graphics or drawing is the universal language of engineers. An engineer communicate his idea to others with the help of this language. Before actual construction of buildings, bridges, machines components etc., it is required to design them in order to meet technical requirements such as strength, safety etc.

After designing, the next step is to prepare detailed drawing which is required during manufacturing or actual construction. A good drawing communicate the message very fast among the people who use it. For example, workers or artisans in the factory, perform manufacturing operations only after understanding the drawing of particular object. This method of communicating ideas is not new. The ancient man also used pictures and symbols to communicate among each other. The engineering drawing helps to provide clear idea about size, shape, internal details of any object.

Internal and complicated details of an object or machine parts can be understood easily. Looking to its high importance, the engineering graphics/drawing is taught to students of almost all branches of engineering. Let us consider some examples where its uses are important. The drawing of a machine component is important for mechanical and electrical engineers. Drawings of maps of buildings, bridges, roads, dams etc., are useful for civil engineers. Drawings of electronic devices are of great importance for electronic engineers.

The "drawing" or "graphics" can be expressed as art of representation of an object by systematic lines on a drawing paper or sheet. It can be broadly classified as artistic drawing and engineering drawing. An artistic drawing deals with the representation of painting, advertisement, pictures etc., whereas engineering drawing deals with the representation of engineering objects such as machine components, dams, roads, buildings, electronic components, computers, motors, generators etc.

12. *What are Drawing Clips/Pins?*

Ans. Drawing sheet is placed on the drawing and is fixed using drawing clips or pins. Drawing clips are available in stainless steel or plastic material.

13. *What is Eraser?*

Ans. It is usually made up of rubber and is used to remove pencil lines or marks. It should be made from good quality soft rubber to prevent residue after erasing a drawing.

14. *What is Scale (Ruler) ?*

Ans. A scale is used to measure the distances and to draw straight lines. Scales can be made from wood, plastic or metal. One long edge is marked with divisions of centimetres and millimetres and the other long edge may be marked with division of inches and its sub units.

15. *What is the use of Protractor?*

Ans. Protractor is also made of transparent celluloid material. It is used to measure angles or to construct angles of any required degree.

16. *What are French Curves?*

Ans. French curves are made of transparent plastic or celluloid and are used to draw curved lines or arcs of any irregular shape or of desired curvature.

17. *What are called Gothic Letters?*

Ans. When the stem of letters are given more thickness, such letters are called as gothic letters. These letters are used for writing the main title for ink drawing. Thickness of stem may be taken as 1/5th to 1/10th of the height of letters.

18. *Describe the General Rules for Lettering*

Ans. (a) Select the size of letters suitable to given drawing.

(b) Draw horizontal guide lines keeping the distance between them equal to the height of letters.

(c) Width of letters may be taken equal to the height of the letter. Complete the lettering with the standard dimensions.

(d) Do not erase the guide lines.

19. *What do you mean by Single Stroke Letters? Explain.*

Ans. Single stroke letters are simplest form of letters and are used to write titles, dimensions, notes and other information on a drawing. Lettering using single stroke letters has been recommended by Bureau of Indian Standards (BIS) and described in IS:9609-1990. The word "single stroke" indicates that the thickness of lines used in letters should be such as obtained in single stroke of pencil. It does not mean that letter written in single stroke without lifting the pencil. The single stroke letters may be of two types e.g., vertical and inclined letters.

The vertical letters are used for general purpose lettering in engineering drawing. Height to width ratio of such letters varies. But for all practical purposes the letters with height to width ratio may be taken as 7:5 or 6:5 for all capital letters except I, J, L, M and W. For M and W the suitable ratio is 10:8 and for I, this ratio is taken as 10:2. For numerals such ratio may be taken as 7:4 or 6:3. Single stroke vertical upper and lower case letters and numerals.

20. *What is Lettering?*

Ans. Lettering is used to write titles, dimensions and other necessary information on a drawing. All letters should have uniform height and width and should be legible, simple and easy to write. Lettering should be done with dark pencil such as 2H or HB. The lettering should be done in such a manner that it should take minimum time without the use of drawing instruments. Letters used for engineering drawing may broadly be classified into two types i.e., single stroke letters and gothic letters.

21. *What are the uses of Pencil Sharpener?*

Ans. Pencil sharpener is used to sharpen the pencil. It consists of a cutting blade, fitted inside its body. It removes the wood around the lead and produces conical end leaving the lead exposed. The lead can be prepared as conical point or chisel edge.

22. *Describe the use of handkerchief or Towel Cloth.*

Ans. Handkerchief or towel cloth of suitable size is used as a duster. Before starting the drawing work, all the instruments and accessories should be cleaned thoroughly using duster or towel cloth. This can also be used for sweeping away the crumbs which are formed due to erasing with rubber or eraser.

23. *What is Drawing Sheet?*

Ans. Now-a-days, drawing sheet/paper is available in different quality and sizes. The quality of drawing work and its appearance depends on the quality of drawing sheet. A good quality sheet will not leave black marks while erasing. An ideal drawing sheet should meet the following requirements:

(a) It should be tough and strong.

(b) It should have good erasing quality so that, if eraser is used its fibres should not come out.

(c) It should be super white in colour.

24. *What are Engineering drawing instruments?*

Ans. Following is the list of drawing instruments that required making engineering drawings on paper with perfection.

- Drawing board
- Mini drafter
- Set-squares (45° – 45° & 60° – 90°)
- T-square
- Protractor (180°, 360°)
- Scales
- Roll & draw
- Compass (drafting)
- Circle Master
- French Curves
- Drawing paper & drawing sheet
- Drawing pencil (lead pencil [mechanical pencil], wooden pencil)
- Sharpener
- Eraser
- Drawing pins & clips
- Duster or handkerchief

REVIEW QUESTIONS

1. Describe the important instrument of Engineering Graphics.
2. Rewrite the following in free hand vertical up right printing. Take height of letters = 10 mm. "GROW MORE FOOD"?
3. Print free hand 10 mm height in capital up right letters the following:
   DIFFERENT MATERIALS SHOULD BE INDICATED BY NOTES ON DRAWING?
4. Write your name and the name of your institution in free hand single stroke vertical lettering, taking height of letters as 3 mm, 5 mm, 8 mm, 10 mm and 12 mm?
5. Rewrite the following in free hand vertical upright and inclined lettering.
   I AM PROUD OF MY COUNTRY,
   take height of letters = 3 mm,4 mm,6 mm, 8 mm and 12 mm?

6. Print the following in vertical capital letters free hand only :
   GOD HELPS THOSE WHO HELP THEMSELVES?
7. Write alphabets A to Z and numerals 1 to 9 and "0" vertical upright and inclined lettering, free hand, single stroke. Height of letters = 3 mm, 45 mm, 6 mm, 8 mm,10 mm and 12 mm?
8. Draw single stroke vertical capital letters of ratio 7 : 4 and 6 : 5,
   INDIAN STANDARD INSTITUTIONS?
9. Print the single stroke vertical letters in height 28 mm in 7 : 4 ratio,
   BUY NATIONAL SAVING CERTIFICATES?
10. Draw double stroke vertical lettering. A to Z ratio = 5 :4, Height =25 mm,
    ENGINEERING DRAWING?
11. What is the purpose of lettering on a drawing sheet?
12. What is the purpose of Guideline in lettering?
13. What is the inclination of inclined lettering?
14. What is the height of lettering for lower case lettering?
15. What do you mean by drawing board?

ENGINEERING GRAPHICS-I

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