HIGHER SECONDARY-FIRST YEAR

VOCATIONAL EDUCATION

BASIC MECHANICAL ENGINEERING

ENGINEERING DRAWING & FITTING

PRACTICAL

Untouchability is Inhuman and a Crime

A publication under Free Textbook Programme of Government of Tamil Nadu

Department of School Education
This book “BASIC MECHANICAL ENGINEERING ” Practical has been written entirely based on new syllabus framed by TNSCERT. The subject matter is explained in a simple manner and simple language, lightened by sufficient colourful diagrams,3D projectional views like Isometric and Orthographic projection with practical learning objectives.

“BASIC MECHANICAL ENGINEERING ” Practical subject is which helps the students to understand the subject further in detail and quickly. Line diagrams as well as 3Dimension views are given for easy understanding, of Engineering Drawing and Engineering Workshop fitting practical.

I sincerely convey my thanks to the Director, Joint Director and Staff members whose patronage on this book to come out successfully and the committee of experienced Teachers who bear the responsibility of the book to come out in good shape.

In spite of all our efforts, some errors and mistakes might have crept in. Any error or misprint, if pointed out and any suggestion for the improvement of the book will be thankfully acknowledged.
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INTRODUCTION

The oldest form of communication among human beings is sharing of ideas through some sort of graphical language. They might have put into use a peculiar equipment to make out images. We can even imagine that ancient men used a stick to scratch messages on sand. Early Egyptians used paint and brushes to make pictures to be used as a form of communication. In the field of Engineering drawing, some special equipment (or) tools are required to make images. At present we use pencil, sketch pad and even computer controlled plotting devices for making drawings.

ENGINEERING DRAWING

Engineering drawing is an effective method of communication between engineers belonging to various disciplines of engineering. All necessary features of an object are mentioned on the drawing with proper dimensioning and important remarks. The entire community of engineers can analyze the object for its correctness, accuracy of the object’s design and modifications. As all the production related remarks and instructions are graphically expressed in the drawing, it is easy for the production process to be carried out.

Engineering drawing is the language engineers. This language is spoken, read and written in its own way. It is used as a means of communicating ideas, concepts and designs to all the others involved in the process of production. Engineering drawing is drawn by an engineer having engineering knowledge for engineering purposes. Engineering drawing is the starting point for all engineering disciplines—Mechanical, Automobiles, Production, Civil, Architectural, Computer, Science, Communication, Instrumentation, Aeronautical, Marine, Agricultural, Mining, Chemical, Textile etc.

The view of an objects are drawn initially on a tracking paper and this drawing is known as original drawing. Additional copies of the original drawings are taken according to the need and they are called as Blue prints or Ferro prints.
**Importance of Engineering drawing**

It is not possible to explain all the details of objects orally irrespective of the size of the object (very small to large). Some of the details may be left out, misrepresented or misunderstood.

There may be some difficulty in understanding oral communication because of the languages spoken by the individuals. Considering such difficulties, drawings are used to communicate with people from different levels in the field of engineering (from engineers to workers). The can understand the drawing and help manufacture new components. Another distinct advantage is that the details are protected for further reference.

As there is a define grammar for a language and rules and regulations for games and sports, there is definition for a drawing.

Each and every symbol, line, letter and numbers has its unique meaning. Drawing should be made with these definitions in mind. Same methods are to be followed in making drawings for them to be accepted and understood all over the world.
INTRODUCTION

The necessity of proper equipments and instruments for making drawings was discussed in the previous lesson. Good quality of drawing instruments are needed to make accurate drawings. However, these instruments should be handled correctly and accurately. Following are the instruments required for preparing drawings.

1. Drawing board
2. T-square
3. Drafter
4. Pencils and pencil leads
5. Scales
6. Set squares
7. Protractor
8. French curves
9. Instrument Box
   a) Compass
   b) Divider
   c) Inking pen
   d) Lengthening bar
10. Drawing sheets

DRAWING BOARD

A drawing board is made of four or five strips of soft wood with approximate thickness of 20mm. The wood should be well-seasoned and soft and made of Pine, Oak or Fir. The strips are cleated at the back by battens with screw to prevent them from warping.
A straight ebony strip is fitted on the left edge of the board. This enables the movements of T-square on the board. The drawing board is illustrated in figure.

The top surface of the drawing board should be flat and smooth and the thickness uniform B.I.S (Bureau of Indian Standards) has standardized the sizes of drawing board as follows.

<table>
<thead>
<tr>
<th>SI.NO</th>
<th>Designation</th>
<th>Size in mm</th>
<th>Size of sheet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L X W X T</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>D₀</td>
<td>1500 X 1000 X 25</td>
<td>A₀</td>
</tr>
<tr>
<td>2</td>
<td>D₁</td>
<td>1000 X 700 X 25</td>
<td>A₁</td>
</tr>
<tr>
<td>3</td>
<td>D₂</td>
<td>700 X 500 X 15</td>
<td>A₂</td>
</tr>
<tr>
<td>4</td>
<td>D₃</td>
<td>500 X 350 X 15</td>
<td>A₃</td>
</tr>
</tbody>
</table>

### T-SQUARE

T-square is made of hard quality of wood like teak or mahogany. There are two parts of a T-square namely stock and blade. The working edge is formed by an ebony piece attached to the blade. The stock slides along the abony piece attached to the drawing board. These two parts are connected at right angles to each other by means of screw or dowel pins. The working length of the T-square is approximately equal to the length of the drawing board. T-square is illustrate in figure.

<table>
<thead>
<tr>
<th>SI.No</th>
<th>Designation</th>
<th>Length of the working edge of the blade in mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>T₀</td>
<td>1500 x 10</td>
</tr>
<tr>
<td>2</td>
<td>T₁</td>
<td>1000 x 10</td>
</tr>
<tr>
<td>3</td>
<td>T₂</td>
<td>700 x 5</td>
</tr>
<tr>
<td>4</td>
<td>T₃</td>
<td>500 x 5</td>
</tr>
</tbody>
</table>
T-square are used to draw horizontal lines parallel to each other. When used along with set-square, it is used as a base to draw various angles.

**DRAFTER**

It comprises of a pair of steel strips hinged at the center. At one end, a clamp is provided. This clamp is useful in clamping the drafter at the left side top corner of the drawing board. The other end is known as working end which consists of the two perpendicular scales and circular base. The perpendicular scales are graduated in millimeters whereas circular scale is graduated in degrees up to 360°. The working end can be oriented to any angle and fixed at the position with help of knob.

When the clamping end is fitted to the drawing board, the working end can be made to slide over the board. After the perpendicular scales are set at the desired angle, parallel or perpendicular lines can be drawn. Taking reference from the circular scale, line at any desired can also be drawn drafter is illustrated in figure.

**PENCILS**

Pencils are used for making drawings on drawing sheets. The quality of the pencil determines the accuracy and appearance of the drawing. The grades of pencil are designated by marking made on each of them. The grade of pencil describes the hardness of the graphite lead used. The grades of pencil range from 9H to 7B, where 9H is the hardest and 7B is the softest. Hard pencils such as 2H, H are used for making engineering drawing and for lettering and dimensioning, softer pencils like HB pencils are used, also used for making freehand sketches.
The grades of the pencil may be categorized as

- **Soft** 7B to 2B
- **Medium** B to 3H
- **Hard** 4H to 9H

---

**SET-SQUARE**

Set-square are useful in drawing perpendicular lines and lines at 30°, 45°, 60° and 90° to the horizontal lines drawn with T-square. By the combined use of two Set-square, we can also draw lines at 15°, 75° and 105° to the horizontal line.

- **30°-60° Set-square** has edges having 30 degree and 60 degrees apart from an edge which is right angled. The 45° Set-square also has a right angled edges besides two edges having 45° and is the form of an isosceles triangle. They are made of transparent celluloid to enable us to see the lines underneath them. Figure illustrates Set-squares.

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**PROTRACTOR**

Protractor are used to measure or construct angles which cannot be done by Set-square. The shape of the protractor may be circular or semi-circular. They are made of celluloid, wood or ivory.
**French Curves**

French curves are the templates made of plastic or celluloid sheet. Profiles and contours of different shapes and sizes are cut on the edges of French curves. Curve lines and circular arcs which cannot be drawn with a compass can quickly be drawn with French curve. Figure illustrate French curves.

**Instrument Box**

The instrument box contains different drawing instruments for drawing different types of drawings. The instruments are:

1. Large Size Compass
2. Small Bow Compass
3. Small Ink Bow Compass
4. Large Size Divider
5. Small Bow Divider
6. Lengthening Bar
7. Inking Pen
8. Pin Point
9. Ink Pot
10. Lead Case
COMPASS

Compass are used for the drawing circles and arcs of required sizes. It has two metals legs joined at the top with help of a knee joint. One of the two legs is fitted with an adjustable needle. The other leg has an attachment which can hold an inking device (or) a pencil lead tip.

DIVIDER

Straight lines or curved lines are divided into required number of equal parts with help of dividers. (Divider is also useful in transferring dimensions from a part to another part in the drawing and set off given distances from the scale to the drawing) It is very similar in construction to a compass but for the fact that both the legs of the divider are provided with steel points.
Inking pen is used to draw straight lines and curved lines in ink. It consists of a metal nib fitted to an ivory or metal holder. Pin point and ink point are used as attachment to a large compass. Lead case is useful in holding lead sticks of different grades.

**DRAWING SHEETS**

**Drawing Sheet: Standard size**

- Trimmed paper of a size A₀-A₄.
- Standard sheet size

<table>
<thead>
<tr>
<th>Size</th>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₀</td>
<td>841 x 1189</td>
</tr>
<tr>
<td>A₁</td>
<td>594 x 841</td>
</tr>
<tr>
<td>A₂</td>
<td>420 x 594</td>
</tr>
<tr>
<td>A₃</td>
<td>297 x 420</td>
</tr>
<tr>
<td>A₄</td>
<td>210 x 297</td>
</tr>
</tbody>
</table>

(Dimensions in millimeters)

Different qualities of drawing sheets used for making drawings. The quality of the sheet depends upon the nature of drawing. It should be tough, strong and uniform thickness. The effect of erasing should not be felt and ink should not spread out. The smooth side of the sheet should always be used for drawing.

The standards sizes of trimmed drawing sheets recommended by ISO (International Organisation for Standardization) and adopted by BIS (Bureau of Indian Standards)- BIS: 10711-1983 are as follow.
Different sizes of drawing sheet

\[
\begin{array}{ccc}
A_0 & A_1 & A_2 \\
1189 \times 841 & 594 \times 841 & 594 \times 420 \\
A_3 & A_4 & A_5 \\
297 \times 420 & 297 \times 210 & 210 \times 148 \\
\end{array}
\]
INTRODUCTION

The field of engineering and Technology is fast evolving day by day to set newer trends in the world community. The arrival of foreign technologies, technical tie-ups between different countries, and exchange of new technologies have made it mandatory to set specific international standards in the field. This need is most felt in preparing and understanding of engineering drawing. Indian Standards Institution (ISI) established in the year 1947, formulated the code of practice for general engineering drawing in the year 1955. ISI was taken over and renamed as Bureau of Indian Standards (B.I.S.) in the year 1987 by an Act in the Indian Parliament.

In the year 1987, B.I.S. has adopted the standards of ISO (Indian Standards Organization for Standardization) in full. The following are the topics adopted by B.I.S in the field of Engineering drawing (latest version).

<table>
<thead>
<tr>
<th>Sl.No</th>
<th>Standard</th>
<th>Indian Status</th>
<th>Corresponding ISO standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drawing sheet(sizes, layout etc.)</td>
<td>IS: 10711-2001</td>
<td>ISO:5457-1999</td>
</tr>
</tbody>
</table>

(Note: In the standards mentioned above, either the whole topic or certain parts(s) of the topic may have been withdrawn and new standards introduced)

LAY OUT OF DRAWING SHEET

The Lay out of drawing sheets make it easy for the readers to locate all important references of the drawing. For this a standard arrangement should be followed in which all the informations are included. The Lay out of drawing sheet should have the following features.

1. Margin
2. Title block
3. Parts list
4. Revision panel
5. Zone system
6. Folding marks
Margin

Margin is provided in a drawing sheet to enable it to be trimmed. After trimming, the sizes of the standard drawing sheets should be equal to the sizes of trimmed sheets recommended by B.I.S.

Apart from margins, border lines are drawn to get a complete working space. Drawing of border lines should also facilitate easy filing or binding.

Title Block

Provision of title block in a drawing is necessary as it gives all informations regarding the drawing. It is placed at the bottom right hard corner of the drawing sheet. B.I.S has recommended the size of the title block to be 185mm x 65mm. The size is the same for all designated sizes of the sheet (i.e. from A0-A5). The title block should contain the following informations. A0-A5 A sample title block is given below:

<table>
<thead>
<tr>
<th>NAME OF THE ORGANISATION</th>
<th>NAME</th>
<th>DATE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DESIGNED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DRAWN</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CHECKED</td>
<td></td>
<td></td>
</tr>
<tr>
<td>STANDARD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APPROVED</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCALE</th>
<th>TITLE</th>
<th>DRAWING NUMBER</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>TITLE OF DRAWING</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Drawing Number</td>
</tr>
<tr>
<td>2. Title of the Drawing</td>
</tr>
<tr>
<td>3. Projection</td>
</tr>
<tr>
<td>4. Material Details</td>
</tr>
<tr>
<td>5. Scale of Drawing</td>
</tr>
<tr>
<td>6. Surface Finish</td>
</tr>
<tr>
<td>7. Tolerance</td>
</tr>
</tbody>
</table>
INTRODUCTION

Lettering is an important feature in Engineering drawings. Writing of titles and subtitles of drawings, dimensioning the parts of the objects drawn, writing the scale and other details is called dimensioning. As the use of instrument for lettering will consume more time, it is very essential to do lettering free hand with speed, neatness, and beauty of form.

The requirements of lettering, namely types and sizes of letters and techniques of lettering are specified in IS 9609-1983 (Lettering for technical Drawings).

IMPORTANCE OF LETTERING

Neatness, legibility, uniformity, suitability for microfilming and photocopying are the main feature of lettering. Poor lettering will spoil the appearance of a drawing and lead to wrong results. Lettering is the talk of the drawing and so it very important that it is done correctly to finish the drawing completely.

PROPORTIONS OF LETTERING

There is no specified proportions for each letter of alphabets lettering. Considering uniformity, a proportions between the height and the width is to be followed. There are three proportions by which lettering can be done best. They are

1. NORMAL LETTERING
2. CONDENSED LETTERING
3. EXTENDED LETTERING

Normal lettering will have normal height and width and finds application in general use. Condensed lettering has shortened width with respect to its height and is used where space available is limited. Extended lettering will have more width and normal height.

SPACING OF LETTERS

The distance left between two adjacent letters while lettering is known as spacing of letters. Equal spaces have to be left between letters for better appearance. Spacing is judged by observation and done by practice.
A distance equal to the $\frac{3}{5}$th of the height of the letters has to be left between two successive words. The space between two lines should be equal to $1\frac{1}{2}$ times the height of the letters.

### SIZE OF LETTERS

The size of letters in engineering drawing is the height of the letters. B.S.I recommends standard sizes of lettering for various features and they are listed below.

<table>
<thead>
<tr>
<th>SI. No</th>
<th>Features</th>
<th>Size (Height in mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Drawing Numbers, Letters indicating cutting plane section</td>
<td>10, 12</td>
</tr>
<tr>
<td>2</td>
<td>Title of the drawing</td>
<td>6, 8</td>
</tr>
<tr>
<td>3</td>
<td>Sub-titles and headings</td>
<td>3, 4, 5 &amp; 6</td>
</tr>
<tr>
<td>4</td>
<td>Material List, Dimensioning, Schedules, notes</td>
<td>3, 4 &amp; 5</td>
</tr>
<tr>
<td>5</td>
<td>Tolerances Alteration entries</td>
<td>2 &amp; 3</td>
</tr>
</tbody>
</table>

### TYPES OF LETTERS

The lettering in which the alphabets are written with uniform thickness is known as Gothic lettering. Gothic lettering may be done on single stroke and double stroke. Double stroke letters are thicker than single stroke letters.

**ITALIC PRINTING IS**

free hand gothic

OR ROMAN LETTERING

**Types of letters**

1. Vertical letters
   a) Upper case letters (capital)
   b) Lower case letters

2. Inclined letters
   a) Upper case letters (capital)
   b) Lower case letters

**Vertical Letters**

If the direction of alphabets and numerals is vertical, the letters are know as vertical letters, Both upper case and lower case letters are written in this fashion.
**Inclined Letters**

When the letters are written inclined to the horizontal line, they are called inclined letters. The angle of inclination is approximately 75° from right to left.

**Vertical Upper Case Letters**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
<th>M</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>P</td>
<td>Q</td>
<td>R</td>
<td>S</td>
<td>T</td>
<td>U</td>
<td>V</td>
<td>W</td>
<td>X</td>
<td>Y</td>
<td>Z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
<td>IX</td>
<td>X</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Vertical Lower Case Letters**

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
<th>k</th>
<th>l</th>
<th>m</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>o</td>
<td>p</td>
<td>q</td>
<td>r</td>
<td>s</td>
<td>t</td>
<td>u</td>
<td>v</td>
<td>w</td>
<td>x</td>
<td>y</td>
<td>z</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>0</td>
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<td></td>
</tr>
</tbody>
</table>

**Inclined Upper Case Letters**

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
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<th>N</th>
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<td>O</td>
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<td>S</td>
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<td>V</td>
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<tr>
<td>I</td>
<td>II</td>
<td>III</td>
<td>IV</td>
<td>V</td>
<td>VI</td>
<td>VII</td>
<td>VIII</td>
<td>IX</td>
<td>X</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

**Inclined Lower Case Letters**

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
<th>f</th>
<th>g</th>
<th>h</th>
<th>i</th>
<th>j</th>
<th>k</th>
<th>l</th>
<th>m</th>
<th>n</th>
</tr>
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<tr>
<td>o</td>
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<td>q</td>
<td>r</td>
<td>s</td>
<td>t</td>
<td>u</td>
<td>v</td>
<td>w</td>
<td>x</td>
<td>y</td>
<td>z</td>
<td></td>
<td></td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DIMENSIONING

Drawings are made to represent the actual shape and size of the objects to be produced. So it is necessary to place proper dimensions and related informations regarding different parts of the object. In case the dimensioning is not done properly, there will be great loss in materials, labour and time.

Dimensioning is known as the method of writing various sizes (or) measurements of an object and other important informations such as tolerances on a finished drawing. It should be done with great care that no information is left out in describing the object completely.

TYPES OF DIMENSIONS

System of Dimensions

According to B.I.S., there are two system of placing dimensions on drawing and they are

1. Aligned system
2. Unidirectional system

Aligned system (for A2 to A5 sheet size)

Unidirectional system (for large sized sheets)

Aligned system

In this system, the dimensions are placed in a manner to read them from the bottom or from the right side of the drawing. All the dimensions are placed above the dimension lines. Aligned system dimensioning is commonly used in engineering drawing.

Unidirectional system

In this system, the dimensions are placed so that they may be read from the bottom of the drawing only. The dimensions are placed approximately at the middle of the dimension line by breaking it. There is no restriction in controlling the direction of the dimension lines.
Notation of dimensioning
The dimension lines, extension lines, leader lines, arrow head, dimension figures, notes and symbols make up the notation of dimensioning.

Dimension line
Dimension lines are used to indicate the measurement in numbers at a space above them or at a space created by breaking them approximately at their center. Dimension line is drawn as thin continuous line.

Extension line
It is the line that extends from the outline of the object on a drawing. It is a continuous thin line extending at least about 2mm beyond the dimension line.

Leader line
When some notes are to be made regarding a specific feature of a drawing, leader lines are used. They extend from where the notes have to be applied to a point where the notes are actually written. Leader line has an arrow at one end which touches the particular feature. It is drawn at any convenient angle between 30° to 60°

Arrow head
Arrow head are placed at both ends of a dimension line. They touch the extension lines drawn from the outline of the part and indicates the extent of a dimension. The length and width of the arrow should be in the ratio 3:1

Dimension figure
The size of a specific feature is indicated by the dimension figure either as a numerical or as symbols like Ø, R followed by numerals.

TYPES OF LINES
Engineering drawing is made by the combination of different types of lines. Each line shown in the drawing is meant to represent a separate meaning. So it necessary to understand the types of lines and their meaning to make or read a drawing successfully.
**Continuous thick line**

A continuous thick line in a drawing represents a visible edge or outline. It is drawn with a H or HB grade pencil.

**Continuous thin line**

Continuous thin lines are used for construction of a drawing. These lines are also used for drawing dimension lines, extension lines, leader lines, and sectional lines (hatching line). When used as construction lines, they do not appear on the finished drawing. But in geometrical drawings, they are removed. Continuous thin lines are drawn with 2H pencils.

**Short dashes**

Short dashes represent hidden features or outlines in a drawing. The dashes should be of uniform length and the spacing equal. They are drawn with H pencils.

**Long chain (thin)**

Long chain lines are drawn as an alternative combination of a long dash and a short dash. The lengths of both long dashes, short dashes are to be maintained uniform and they are equispaced. They represent centre lines, extreme positions movable parts and pitch circles in drawings. This type of line is drawn with a 2H pencil.

**Long chain (Thick at ends)**

It is very similar to a long chain line expect that the terminal long dashes are drawn thick. Cutting plane lines are represented by this type of line. The terminal dashes are drawn with H pencil and others with 2H pencils.
**Long chain (Thick)**
A long chain line is drawn thick completely for this type of line. The surfaces which are to receive additional treatment are represented by a long chain (thick) line. It is drawn with a HB pencil.

**Continuous thin (Wavy)**
Irregular boundary lines and short break lines are drawn as wavy continuous thin lines. They are with 2H pencils.

**Ruled line and short zigzag (thin)**
These lines indicate long break lines. When a long structure of uniform shape is to be shown on a drawing, its view is intercepted by this line and it is drawn with 2H pencil.
General rules for dimensioning

1. Dimension should be placed outside the view as far as possible.
2. Dimension lines should not intersect each other.
3. Dimension lines should not be placed cutting an extension line.
4. Dimension lines should be given on the view which shows the relevant feature most clearly.
5. Dimension should never be crowded. If the spaces is not sufficient, arrow heads may be replaced by dots or inclined lines.
6. The distance between the outline of the object and first dimension line should be at least 10mm.
7. A distance of atleast 8mm should be kept between two adjacent dimension lines.
8. The extension line should not project beyond 2mm from the dimension line.
9. Leader lines should be constructed at an angle to the horizontal (30°, 45° and 60°).
10. Center lines should not be used as dimension line.
11. Dimensions with smaller sizes should be placed near the drawing than those with bigger sizes.
12. Dimensions marked in one view need not be repeated in other views.
13. While dimensioning angles, their values are placed outside the view.
14. Remarks, instructions and foot notes should be written horizontally.
15. Dimensions of part which are not drawn to scale should be underlined. If the whole drawing is not drawn to scale, a note should be made in the drawings as ‘NOT TO SCALE’.
16. When all the dimensions are in same unit, there is no need to mention the unit. Instead a foot note should be written as ‘ALL DIMENSIONS ARE IN mm’.
17. The size of the datum plane should be written within brackets.
18. While dimensioning external threads, the type, size and length should be marked.
19. The size of the arcs should be indicated by its radius.
20. The diameter of the circle is always specified as follows
21. While marking the dimension of an arc, the dimension should be proceeded by a mark ‘R’.

22. The dimensions of holes may be made in the following methods

(i) It should be understood that the four holes are of 8mm diameter. The hole at the centre is 20 mm deep and the diameter is 20 mm.
(ii) The hole on the left is 50 mm deep and is of diameter 12 mm. The other hole is a through hole of diameter 20 mm.

Chamfering is done at the ends of cylindrical parts and parts having cylindrical holes. Chamfering is dimensioned as shown following diagrams.
Incorrect and correct methods of dimensioning

In the previous section, guidelines are given regarding proper dimensioning of some important profiles. However, there are chances that dimensions may not be represented in a correct way. Some examples are given in the next few pages to highlight the situations where dimensions are misrepresented frequently and to correct them.

Incorrect

Correct

Incorrect

Correct
INTRODUCTION

It is now our knowledge that drawings are made to show all the details of objects clearly. But, it is not always possible to show the objects on a drawing sheet in actual sizes. For example, large machine parts cannot be represented on a drawing sheet in its original size. Hence, it is necessary to reduce the size of the object in affixed proportion to show it in a drawing. At the same time, it is necessary to increase the size of the object in some cases to give a clear description of the object.

In both cases, a proportion is used either to reduce or increases the dimensions of the object. So the proportion by which the actual size of the object is reduced or increased on a drawing is known as Scale of a drawing.

Scales are usually made of celluloid, card board, wood or metal. They are actually rulers on which different proportions are represented to make drawings of objects having different range of dimensions. As far as possible, standard scales are adopted in making drawings. The standard scales are designated as M1, M2, M3 --------- M8. When standard scales are not suitable for making a particular drawing, scales in required proportion can be constructed.

Uses of Scales

The important uses of scales are

1. Scales are useful in making reduced size and enlarged size drawings.
2. The dimensions of various parts can be measured directly.

Types of Scales

There are three types of scales according to the proportions made on them.

1. Full size scale
2. Reducing scale
3. Enlarging scale
**Full size scale**

When the dimensions of objects are shown on a drawings in its actual sizes, the scale used in the drawings is full size scale. *Full size scale is indicated as 1:1*

**Reducing scale**

When the size of the object is too large to be accommodated on a drawing sheet, the dimensions of the object are reduced in a particular proportion and represented in the drawing. This scale is known as reducing scale. Eg: 1:2, 1:5, 1:10

**Enlarging scale**

When the size of the object to be shown on the drawing sheet is very small to give clear description about the object, the dimensions of the object are enlarged in a particular proportion. This scale is called enlarging scale. Eg: 2:1, 5:1, 10:1.

<table>
<thead>
<tr>
<th>Full size scale</th>
<th>Reducing scale</th>
<th>Enlarging scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>1:1</td>
<td>1:2 1:5 1:10</td>
<td>10:1 5:1 2:1</td>
</tr>
<tr>
<td></td>
<td>1:20 1:50</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1:100 1:200</td>
<td></td>
</tr>
</tbody>
</table>
INTRODUCTION

In the introductory chapter, it was explained that the need of the drawing is to communicate the ideas and informations regarding an object between a number of engineers and operators in the field of designing, developing, manufacturing and marketing. As regards to solid geometric drawing, there is the necessity of presenting the informations about a three dimensional object on a two dimensional plane of paper. In overcoming this difficulty, the views of the objects are represented pictorially. Apart from pictorially, the information about the object can be represented in more than one view arranged in a specified order. In general, obtaining the views of the object on a drawing sheet is known as Projection and procedures and rules involved in the process are known as Theory of projection.

Theory of projection

In the engineering drawing, the exact shape and size of an object should be shown on a two dimensional plane and paper. For doing so, the object is imagined to be located between the observer and the plane on which the view is going to be obtained. Straight lines are drawn from different points on the contour of the object to meet the plane of paper. The points obtained on the sheet of paper are joined in proper sequence to form the image or view of the object.
**Pictorial projection**

Pictorial projection is a projection in which the description of the object is presented completely in one view. These projections give an immediate impression of the general shape and details of the object. But the exact size of the object is not exhibited.

**Isometric View**

If the length, breadth and height of an object are drawn and shown in a single view which is called Isometric view.

**The method of drawing of Isometric View**

Isometric projection is the representation of an object in pictorial form. In isometric projection, there are three pictorial axes namely X,Y and Z which are $120^\circ$ apart. The length, breadth and height of the object are drawn on these axes.

**Oblique projection**

It is the projection of an object on a plane when one face of the object is kept parallel to the plane and the other adjacent face is inclined at $45^\circ$ to the plane, i.e. the projectors make an angle of $45^\circ$ with the plane of projection. Here two axes are perpendicular to each other. But the third axis is drawn either at $30^\circ$ or at $45^\circ$ to the horizontal. The main types of oblique drawings are

1. Cavalier Drawing
2. Cabinet Drawing
Cavalier Drawing

In this type of drawing, two axes are drawn perpendicular to each other and the third is inclined at 45°. It is made of the exact dimensions of the object. However, in many instances, this projections makes the view appear distorted.

Cabinet Drawing

To reduce distortion, the dimensions of the object along the receding axis is drawn to half scale. The resulting view is called cabinet drawing.

Perspective projection

It is the projection of an object obtained on a plane when the projectors converge to a point. This projection does not represent the actual size of the object.

Orthographic Projections

It is the projection in which different views of an object are obtained on planes of projection when the projectors are parallel to each other and perpendicular to the plane on which the view is projected.

There are some assumptions to be made for obtaining orthographic projection:

1. The observer looks at the object from an infinite distance.
2. The lines drawn from various points on the contour of the object (projectors) are parallel to each other.
3. On projection from the object, these lines meet the plane (of projection) at right angles (the Projectors are perpendicular to the plane of projection)
4. The plane of projection is transparent.
Types of orthographic projection

The object can be placed in any of the four quadrants to obtain the projections (or) views. In convention. The practice of getting views by placing the object either in the first or in the third quadrant is followed. So, the types of orthographic projections are

1. First angle projection
2. Third angle projection

First Angle Projection

When the object is placed in the first quadrant in front of the vertical plane and above the horizontal plane, the method of obtaining the projections on these planes is called First Angle Projection.

In this method of projection, the object lies between the observer and the planes of projection. The front view is obtained above the ground line (or) reference line and the top view is obtained below the ground line. When the horizontal plane and auxiliary vertical plane are rotated after obtaining the projections, the views will be arranged as follows:

1. The top view is placed below the front view
2. The left side view is placed at the right side of the front view
3. The right side view is positional at the left side of the front view.

Third Angle Projection

The method of obtaining projections on vertical plane and above the horizontal planes by placing the object in the third quadrant is known as Third Angle Projection. Here, the object is placed behind the vertical plane and below the horizontal plane.

In this method of projection, the planes of projection lie between the observer and the object. The front view is obtained below the ground line and the top view is obtained above the ground line.
When the horizontal plane and auxiliary vertical plane are rotated after obtaining the projections, the views will be arranged as follows:

1. The top view is placed above the front view  
2. The left side view is placed at the left side of the front view  
3. The right side view is placed at the right side of the front view.

**Views obtained in orthographic projection**

Different views are obtained on different planes in orthographic projection. They are

1. Front View (or) Elevation  
2. Top view (or) Plan  
3. Right Side View  
4. Left side View  
5. View from Below  
6. View form the Rear  
7. Cut Section View  
8. Auxiliary view

**Front view**: when the object is viewed from its front, the projection (or) view of the object obtained on the vertical plane, is known as front view. It is also known as Elevation. The details of length and height are found in this view.

**Top view**: when the object is viewed from its top, the projection (or) view of the object obtained on the horizontal plane, is known as top view. It is also known as Plan. Length and width details of the object are found in this view.

**Side view**: When the object is viewed from its side, the projection (or) view of the object obtained on the auxiliary vertical plane is known as side view. It can also be called as side elevation.

**Auxiliary view**: when the object is viewed from a direction which is not parallel to any of the three major axes, the projection (or) view obtained on a auxiliary plane is known as auxiliary view. When a specific detail which cannot be shown in any of the above three views is necessary to be shown, it is done so on auxiliary view.

**Making orthographic projection from isometric view**

The isometric view helps us in understanding the shape of the object but does not give the dimensional and inner details of the object. But these details are necessary for designing and manufacturing purposes. So, the need of orthographic projection becomes essential.

The object is viewed from the direction of arrow to obtain the front view. If the arrow is not given, the most prominent views is taken as front view. The other views are obtained by viewing the object in direction that are perpendicular to the one utilized for front view.
The following illustrations are given to make orthographic projections from the given isometric views.
The following illustrations are given to make Orthographic Projections from the given Isometric Views.

**Isometric view**
PRACTICAL 1

ISOMETRIC VIEW

ORTHOGRAPHIC PROJECTION

PLAN

ELEVATION

SIDE VIEW

ALL DIMENSIONS ARE IN mm.
PRACTICAL 2

ISOMETRIC VIEW

ORTHOGRAPHIC PROJECTION

PLAN

ELEVATION

SIDE VIEW

ALL DIMENSIONS ARE IN mm
PRACTICAL 3

ALL DIMENSIONS ARE IN mm

PRACTICAL 4

ALL DIMENSIONS ARE IN mm.
PRACTICAL 5

ALL DIMENSIONS ARE IN mm.

PRACTICAL 6

The following illustrations are given to make Isometric Views from the given Orthographic Projections.

PLAN

ALL DIMENSIONS ARE IN mm.

ELEVATION

SIDE VIEW
PRACTICAL 7

ALL DIMENSIONS ARE IN mm.

PRACTICAL 8

ALL DIMENSIONS ARE IN mm.
PRACTICAL 9

Plan

All dimensions are in mm.

Elevation

Side View

PRACTICAL 10

Plan

All dimensions are in mm.

Elevation

Side View
Blueprint is the common name given to the copies taken from an original drawing. The name has nothing to do with the colour of the paper or the colour of the drawing lines.

Blue print reading is an essential skill for any technical persons to perform his job in industry satisfactorily for manufacturing a component accurately and correctly. Proper interpretation of the drawing is essential. Blue print reading involves the following aspects.

1. Visualization of the object from the given orthographic views.
2. Interpretation of the dimensions, notes and symbols.

For blue print reading, one must have a through knowledge of principles of drawing and orthographic projections & also various manufacturing processes.

### ABBREVIATIONS FOR MATERIALS

#### FERROUS MATERIALS

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Ferrous material</th>
<th>Abbreviation</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Cast Iron</td>
<td>CI</td>
</tr>
<tr>
<td>2</td>
<td>Cast Steel</td>
<td>CS</td>
</tr>
<tr>
<td>3</td>
<td>Forged Steel</td>
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</tr>
<tr>
<td>4</td>
<td>Mild Steel</td>
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</tr>
<tr>
<td>5</td>
<td>Spring Steel</td>
<td>Sp.S</td>
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#### NON - FERROUS MATERIALS

<table>
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<th>Abbreviation</th>
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<tbody>
<tr>
<td>1</td>
<td>Aluminium</td>
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<tr>
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<tr>
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<td>Bronze</td>
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<td>4</td>
<td>Copper</td>
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</tr>
<tr>
<td>5</td>
<td>Gun Metal</td>
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</tr>
<tr>
<td>6</td>
<td>White Metal</td>
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</tr>
<tr>
<td>7</td>
<td>Zinc</td>
<td>Zn</td>
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# DRAWING ABBREVIATIONS

<table>
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<tr>
<th>Sl.No.</th>
<th>Term</th>
<th>Abbreviations</th>
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<tr>
<td>1</td>
<td>Across corners</td>
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</tr>
<tr>
<td>2</td>
<td>Across flats</td>
<td>A/F</td>
</tr>
<tr>
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<td>Alt</td>
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<td>4</td>
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<td>APPD</td>
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<tr>
<td>5</td>
<td>Approximate</td>
<td>APPROX</td>
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<td>6</td>
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<td>External</td>
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<td>24</td>
<td>Figure</td>
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<tr>
<td>25</td>
<td>Ground level</td>
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<td>26</td>
<td>Hexagon</td>
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<td>31</td>
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<td>Left hand</td>
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<td>Machine</td>
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<td>Metres per second</td>
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<tr>
<td>38</td>
<td>Mechanical</td>
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</table>
### REPRESENTATION OF VARIOUS FEATURES IN DRAWINGS

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<th>Title</th>
<th>Actual Projection/Section</th>
<th>Convention</th>
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</thead>
<tbody>
<tr>
<td>External Threads</td>
<td></td>
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<tr>
<td>Internal Threads</td>
<td></td>
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<tr>
<td>Slotted Head</td>
<td></td>
<td></td>
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<tr>
<td>Square End and flat</td>
<td></td>
<td></td>
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<tr>
<td>Radial Ribs</td>
<td></td>
<td></td>
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<tr>
<td>Bearing</td>
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<tr>
<td>Knurling</td>
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<tr>
<td>Holes on Linear Pitch</td>
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<td>Holes on Circular Pitch</td>
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<tr>
<td>Leaf Spring</td>
<td></td>
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<tr>
<td>Ratchet and Pawl</td>
<td></td>
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<tr>
<td>Splined Shaft</td>
<td></td>
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<tr>
<td>Springs</td>
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<tr>
<td>Repeated Parts</td>
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<tr>
<td>SI.No.</td>
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<tr>
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<tr>
<td>01.</td>
<td>Round section</td>
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<tr>
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<td>I - beam section</td>
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<td>11.</td>
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<td>12.</td>
<td>Z section</td>
<td>![Z section symbol]</td>
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<td>13.</td>
<td>Rail section</td>
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<tr>
<td>14.</td>
<td>Bulb Angle section</td>
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<tr>
<td>15.</td>
<td>Bulb plate section</td>
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### Title

<table>
<thead>
<tr>
<th>Actual Projection/Section</th>
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<tr>
<td><strong>External Threads</strong></td>
<td>![External Threads diagram]</td>
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<tr>
<td><strong>Internal Threads</strong></td>
<td>![Internal Threads diagram]</td>
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<tr>
<td><strong>Slotted Head</strong></td>
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<td>Title</td>
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<td>Square End and Flat</td>
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<tr>
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</tbody>
</table>
Some drawing are given as exercises to read them correctly and answer the questions given below each of them

Answer the questions given below with reference to the above diagram

1. What are the two views drawn in the diagram?
2. What are the types of lines indicated by the letters E,F,G,H, & I ?
3. What is the total width of the part (B) ?
4. How many holes are there in the part ?
5. What is the thickness of the plate ?
6. What are the diameters of the holes?
7. What is the radius of the arc in the top of the object ?
8. What is the distance between the top two holes (C) ?

Answers
1. Plan, Elevation
3. 122 mm
4. 3 Holes
5. 4 mm
6. 12 mm
7. 16 mm
8. 90 mm
Answer the given questions with reference to the diagram

1. What is the name of the part?

2. Mention the use of the part

3. What is the outer diameter of the part?

4. What is the length of the part?

5. What is the size of the thread?

6. What is the angle of the V-groove?

7. What is the diameter of the central hole?

8. What is the depth of the V-groove?
Answer the given questions with reference to the diagram

1. What is the name of the part?

2. What is the pitch circle diameter?

3. How many holes are there in the part?

4. What is the outer diameter of the part?

5. What is the thickness of the part?

6. What is the angle between two adjacent holes?
FIG 4

Answer the questions given below with references to the above diagram

1. What is the name of the part?

2. How many holes are tapped?

3. What is the radius of the groove?

4. What is the length of the part?

5. What is the width of the part?

6. What is the height of the part?

7. What are the dimensions represented by A, B & C?
Answer the questions given below with reference to the above diagram

1. What are the overall dimensions of the bracket shown?

2. What is the shape and size of the base of the bracket?

3. What is the size of the hole in the bracket?

4. What is the radius of the curved top?
GENERAL GUIDELINES FOR FITTING WORK

In this modern era, automatic machines are used for manufacturing in small, medium and heavy industries. But fitting and bench work finds an important place in completing and finishing a job to the desired accuracy. Some components that come out after machining processes require some minor operations to be performed by hand tools. Fitting work is an important method in doing this. Fitting is the assembling of parts together and removing them for necessary fit. Both these types of work require many number of hand tools, devices and equipments.

Fitting of parts are made with different kinds of fits. It may be arranged where the fit is tight, loose or very loose. The parts may be arranged to move together with no relative movement or rotational and sliding relative movement.

OBSERVATION EXERCISE FOR STUDENTS

We happen to see various machine tools in engineering shops. We see the sliding and rotating parts are made to fit into each other by Dovetail joints, T – joints, L – joints triangular joints and as holes and shafts. These joints should be closely watched to understand their nature and their respective uses.

For example, in a lathe – the parts of the assembly of carriage – saddle, cross – slide and compound slide. Observe these joints for their shape and purpose.

Observe the top of the table of a shaping machine – What is the shape of the slots made on it? What is its purpose?

Again in the shaping machine, the ram reciprocates on the column. Observe the joint between the top of the column and bottom of the ram for their shape and purpose.

Observe the method of joining of the parts column, Knee, Saddle and table of a milling machine. These parts are joined by different methods of joining and for different purposes.

Likewise different parts of different machine tools are joined by different methods for obtaining different utilities.

We can also observe some house – hold articles are also joined by different methods.

1. The cap and the body of the bottles that we use daily. How are they joined?
2. The tiffin – carrier. How are the set of dishes held together?
3. Hot – cases. How is the lid joined with the base?
4. The base vessel and the lid of the pressure cooker. What are the methods by which they are joined? Why?
5. The regulator of the L.P.G cylinder. How is it fitted with the cylinder?
6. The frames and the doors of the windows. How are they fitted?
7. Day – to day usages of waist belts, pen caps, cell phone panels and wrist watch straps. Observe how they are fastened?

8. Observe the domestic water line taps. How are they opened and closed?

9. The water pipelines made out in our localities for distribution. How are they connected?

10. The drums and the tyres of automobiles. How are they fitted?

By observation we find that different parts are connected or fitted or joined by different methods. Taking these examples in mind we should realise that the manufacturing processes involve joining of various components to accomplish different purposes.

### TOOLS USED IN FITTING WORKSHOP

There are different types of tools used in fitting shop and they are classified as

<table>
<thead>
<tr>
<th>1. Marking tools</th>
<th>Steel rule, protractor, divider, trammel, punches, try square, surface gauge etc.,</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Measuring devices and instruments</td>
<td>Different types of Gauges, Vernier caliper, Micro Meter, Combination Set, Sine Bar etc.,</td>
</tr>
<tr>
<td>3. Holding and supporting tools</td>
<td>Different types of vices, V block, marking table, surface plate etc.,</td>
</tr>
<tr>
<td>4. Striking tools</td>
<td>Different types of hammers</td>
</tr>
<tr>
<td>5. Cutting tools</td>
<td>Files, Scrapers, Chisels and hacksaw blades</td>
</tr>
<tr>
<td>6. Tightening tools</td>
<td>Pliers, spanners and wrenches.</td>
</tr>
</tbody>
</table>

### Some of the tools used in fitting shop are illustrated here:

#### 1. STEEL RULE

![Steel Rule Image]

It is one of the most useful tools in a workshop for taking linear measurements and scribing straight lines.
2. SURFACE PLATE

The flatness of a surface of a work can be tested with the help of a surface plate. It is also used for marking-out work.

3. SCRIBERS

Scribers are used to mark dimensions and to scribe lines on the workpieces.

4. PUNCHES

Punches are used to make permanent marks on the lines already scribed on the workpieces. The punch marks make the line appear clearly. Punches are also used to make marks on exact locations on the workpieces where drilling is to be performed. Punch marks are made at regular intervals on the lines (interval may be 6mm for straight lines and 3mm for curved lines).

5. TRY SQUARE

Try square is used to check the perpendicularity of surfaces (both external and internal). It is also useful in scribing parallel lines perpendicular to a particular surface and to check flatness of surfaces.
6. HACKSAW

It is used for sawing all metals except hardened steel. It consists of a frame and a blade.

7. FILES

A files is a hardened steel tool having slanted and parallel rows of cutting edges or Teeth on its surfaces. It is used to cut, smooth or fit metal parts. It cuts all materials except hardened steel. Small quantities of unrequired metal can be removed with files. Metal burrs left out after chiseling and hacksaw cutting are removed with the help of files.

8. VICE

Vice is generally used to hold workpieces when operations like drilling, filing, chiseling and hacksaw cutting are performed on them.

The different types of vices used in shop are Bench vice, Hand vice, Leg vice, Pipe vice, Pin vice, Tool maker’s vice, Machine vice, Swivel vice, Universal vice.
### GENERAL WORKSHOP SAFETY PRECAUTIONS

1. The layout of machines in the workshop should be suitably done considering proper lighting and ventilation.
2. First-aid box containing proper medicine and instruments should be kept always ready in a workshop.
3. Inflammable materials should be kept in safe places with proper precautions.
4. Round and Cylindrical objects, sharps articles and tools should not be found in pathways for it may cause injuries to the workers.
5. Oil and grease should not be found spilled inside the workshop.
6. Hot objects should be kept separately wherein message like “HOT”, “DO NOT TOUCH” are displayed.

### SAFETY PRECAUTIONS REGARDING OPERATORS

1. Operators should wear tight clothings. They should avoid wearing loose dresses.
2. Operators should not wear ties and bows while working.
3. The dress code of the operator does not allow him to wear small towel or clothes around his neck or on shoulders.
4. Operators should wear only leather footwear.
5. While performing operations like grinding, welding and chiseling, the operator should wear safety goggles.
6. Metal chips should not be cleaned with bare hands but with proper brushes.
7. Safety plates and equipments should be installed before the machine is set on for operation.
8. Operators should wear gloves while handling hot and sharp articles.
9. The Operators should resist himself from changing the speed, marking or lubricating on functioning machines.
10. Then Operators should seek the help of others while handling heavy and fragile materials.
11. Strict code of discipline should be followed in the workshop. Running, playing and chatting with others are to be avoided in the workshop.
12. The Operators should not rest his body on the machines at any time, when working on them.
13. The Operators should prefer working on machines which are familiar to him.
14. The Operators should not touch unsafe and un-installed electrical wires.
MARKING, PUNCHING & FILING

AIM:

To perform the operation of filing, marking and punching

Tools required:

1. Bench vice
2. Try square
3. Hacksaw frame
4. Scriber
5. Steel rule
6. Punches
7. Flat file-rough
8. Flat file-medium
9. Flat file-smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape.
2. The given piece of metal is checked for size whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try-square.
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The given design is scribed on the chalked surface using steel rule, divider and scribe.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined 60° so that they are filed off later.
CONCLUSION

The operations of square filing, marking and punching are performed according to the given design on the given M.S plate.
AIM

To perform the hacksaw cutting on the given M.S plate according to the given design

Tools required

1. Bench vice  
2. Try square  
3. Hacksaw frame  
4. Scriber  
5. Steel rule  
6. Punches  
7. Flat file-rough  
8. Flat file-medium  
9. Flat file-smooth  
10. Triangular file  
11. Hammer  
12. Divider  
13. Chalk paste  
14. Vernier caliper  
15. Surface plate

PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try-square.
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. Lines are scribed on the chalked surface using steel rule, divider and scriber.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined 60° so that they are filled off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Hacksaw cuts are made on the metal piece at marked locations.
14. The cuts should be made by making the hacksaw frame stroke for the full length at a medium speed.
Conclusion

The operations of square filing, marking and punching and hacksaw cutting are performed according to the given design on the given M.S plate.
**AIM**

To perform ‘L’ cutting on the given M.S plate according to the given designs.

**Tools required**

1. Bench vice
2. Try square
3. Hacksaw frame
4. Scriber
5. Steel rule
6. Punches
7. Flat file-rough
8. Flat file-medium
9. Flat file-smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

**PROCEDURE**

1. The design of the given model is studied completely to understand the features like its size and shape
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides=90 degrees). The same is checked with help of a try-square.
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The design for ‘L’ shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions.
10. Punch marks are made at required points on the surface using dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60° so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm
13. Thin auxiliary lines are made at a distance 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting from hacksaw cutting is filed with the help of flat files(rough, medium, and smooth)
16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corner of the ‘L’ shape is filed with the help of triangular file.
18. The edge surface of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

Conclusion

The operations of square filing, marking and punching and hacksaw cutting and finish filing (for ‘L’ shape) are performed according to the given design on the given M.S plate.
‘T’ CUTTING

AIM

To perform ‘T’ cutting on the given M.S. plate according to the given design.

Tools Required:

1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate

PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square.
6. The piece of work is checked for $90^\circ$ on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The design for ‘T’ shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at $60^\circ$ so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting from hacksaw cutting is filed with the help of flat files (rough, medium and smooth).
16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corner of the ‘T’ shape is filed with the help of triangular file.
18. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

**Conclusion**

The operation of square filing, marking, punching, hacksaw cutting and finish filing (for ‘T’ shape) are performed according to the given design on the given M.S plate.
**AIM**

To perform ‘V’ cutting on the given M.S. plate according to the given design.

**Tools Required:**

1. Bench vice  
2. Try square  
3. Hacksaw cutting  
4. Scribe  
5. Steel rule  
6. Punches  
7. Flat file – Rough  
8. Flat file – medium  
9. Flat file – smooth  
10. Triangular file  
11. Hammer  
12. Divider  
13. Chalk paste  
14. Vernier caliper  
15. Surface plate

**PROCEDURE**

1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square.
6. The piece of work is checked for 90\(^\circ\) on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The given design in the form of steps is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scribe as per the given dimensions. The angular lines are scribed with the help of the protractor head of a combination set.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60\(^\circ\) so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6 mm.
13. Thin auxiliary lines are made at a distance of 1.5 mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting form hacksaw cutting is filed with the help of flat files (rough, medium and smooth).
16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corners of the steps are filed with the help of triangular file.
18. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

**Conclusion**

The operation of square filing, marking, punching hacksaw cutting and finish filing (for step cutting) are performed according to the given design on the given M.S plate.
‘V’ CUTTING

AIM

To perform ‘V’ cutting on the given M.S. plate according to the given design.

Tools Required:

1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate
16. Combination Set

PROCEDURE

1. The design of the given model is studied completely to understand the features like its size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness. (The angle between adjacent sides = 90°) The same is checked with the help of a try – square.
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece.
8. Chalk is allowed to dry.
9. The design for ‘V’ shape is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions. The angular lines are scribed with the help of the protractor head of a combination set.
10. Punch marks are made at required points on the surface using a dot punch and a hammer.
11. Punch marks are made by keeping the punch inclined at 60° so that they are filed off later.
12. The spacing between adjacent punch marks should be at least 6mm.
13. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
14. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
15. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting from hacksaw cutting is filed with the help of flat files (rough, medium and smooth).
16. When filing, care is taken that half of the punch mark is retained on the workpiece.
17. The sharp corner of the ‘V’ shape is filed with the help of triangular file.
18. The edge surface of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

**Conclusion:**

The operation of square filing, marking, punching hacksaw cutting and finish filing (for ‘V’ shape) are performed according to the given design on the given M.S plate.
**AIM:**

To perform Dovetail Cutting on the given M.S. plate according to the given design.

**Tools Required:**

1. Bench vice
2. Try square
3. Hacksaw cutting
4. Scriber
5. Steel rule
6. Punches
7. Flat file – Rough
8. Flat file – medium
9. Flat file – smooth
10. Triangular file
11. Hammer
12. Divider
13. Chalk paste
14. Vernier caliper
15. Surface plate
16. Protractor
17. Combination Set

**PROCEDURE**

1. The design of the given model is studied completely to understand the features like its Size and shape.
2. The given piece of metal is checked for sizes whether it is sufficient for the design.
3. Hand tools and measuring instruments are selected suitably to perform the required operations.
4. The piece of metal (Mild Steel) is held in the bench vice and two adjacent sides are filed for squareness using a flat file. These two sides are considered prime sides.
5. The remaining two sides are also filed for squareness (The angle between adjacent sides = 90 degrees). The same is checked with the help of a try – square.
6. The piece of work is checked for 90° on all four sides.
7. A thin layer of chalk paste is applied on the flat surface of the metal piece. Chalk is allowed to dry.
8. The design of dovetail cutting (Single side) is clearly scribed on the flat chalked surface with the help of steel rule, divider, try square and scriber as per the given dimensions. The angular lines are scribed with the help of a protractor or the protractor head of a combination set.
9. Punch marks are made at required points on the surface using a dot punch and a hammer.
10. Punch marks are made by keeping the punch inclined at 60°so that they are filed off later.
11. The spacing between adjacent punch marks should be at least 6mm.
12. Thin auxiliary lines are made at a distance of 1.5mm from the punched line.
13. Hacksaw cuts are made on these auxiliary lines. The unwanted portion of the metal piece is removed.
14. The remaining portion of the metal piece is fitted on the bench vice. The rough surface resulting form hacksaw cutting is filed with the help of flat files (rough, medium and smooth).
15. When filing, care is taken that half of the punch mark is retained on the workpiece.
16. The sharp corner of the dovetail cutting (single side) is filed with the help of triangular file.
17. The edge surfaces of the workpiece are checked frequently for perpendicularity and parallelism with the help of a try-square.

**Conclusion:**

The operations of square filing, marking, punching hacksaw cutting (for dovetail cutting – single side) are performed according to the given design on the given M.S plate.
Higher Secondary – Class XI – Basic Mechanical Engineering
List of Authors and Reviewers

Authors
C.Ravivarman, Vocational Teacher,
Govt. Boys Hr. Sec. School,
Nattrampalli, Vellore District.

B.Prabakaran, Vocational Teacher,
Govt. Boys Hr. Sec. School,
Vandavasi, Thiruvannamalai District.

N.Palanivelu, Vocational Teacher,
Govt. Boys Hr. Sec. School,
Arni, Thiruvannamalai District.

R.Arumugam, Vocational Teacher,
Govt. Boys Hr. Sec. School,
Ondipudur, Coimbatore District.

A.Maduraimuthu, Vocational Teacher,
Govt. Boys Hr. Sec. School,
Magudanchavadi, Salem District.

Academic Coordinators
A.Ilangovan, Lecturer,
DIET, Thirur,
Thiruvallur District.

K.Ravichandran, PG Assistant,
Thanthai Periyar Govt. Hr. Sec. School,
Puzhuthivakkam, Kancheepuram District.

P.Malarvizhi, FT Assistant,
PUMS, Padiyanallur,
Thiruvallur District.

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