

Machining

Level-I

Based on March 2022, Curriculum Version 1



Module Title: - Draw and Interpret Drawing

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Acronym

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Introduction to the Module

In machining field; the **Draw and Interpret Drawing** project helps to prepare for drawing; to perform simple drawing; to perform multi-view; to Performing freehand sketch and to perform details sketches and drawings

This module is designed to meet the industry requirement under the machining occupational standard, particularly for the unit of competency: **Draw and Interpret Drawing**

This module covers the units:

- Prepare for drawing
- Draw simple drawing
- Construct multi-view
- Prepare freehand sketch
- Interpret sketches and drawings

Learning Objective of the Module

- Preparing for drawing
- Perform simple drawing
- Perform multi-view
- Performing freehand sketch
- Perform details sketches and drawings

Module Instruction

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

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

Unit one: Prepare for drawing

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

- Drawing instruments.
- lines and alphabet
- Measurements and scales
- Lettering.

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

- Identifying and selecting drawing instruments
- Identifying alphabet and lines
- Performing Measurements using appropriate scales
- Write lettering.

1.1. Introduction drawing

Exchange of ideas needs means of communication. As the idea becomes technical the usual means of communication (talk or listen, read or write) will be less exact. For this reason visual language is developed to be technical and accurate means communication. This visual language in broad term is called graphic language.

Technical drawing is concerned mainly with using lines, circles, arcs etc., to illustrate general Configuration of an object. It is a language of communication between architects and engineers, usually to convey information about the object. However, it is very important that the drawing produced to be accurate and clear.

The ability to read and understand drawings is a skill that is very crucial for technical education students; this text aims at helping students to gain this skill in a simple and realistic way, and gradually progress through drawing and interpreting different level of engineering drawings.

Types of Drawing

❖ Sketches

- describe the concept in general

❖ Layout

- show the relationships of parts and defines key dimensions

❖ Production Drawings

- **Used to:**
 - Transmit and communicate information for the production of objects and assemblies (critical in concurrent engineering environment!)
- **Classified in two major categories:**
 - detail drawings
 - assembly drawings

❖ Detail drawing

- Drawings of single parts
- May be drawn one part per sheet
- May be several parts detailed on a large sheet
- Include info such as dimensions and notes relating to material, finish, weight, or tolerance
- Includes all of the information needed to fabricate the part.

❖ Assembly Drawings

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- Show how parts fit together or are functionally related
- Dimensions typically refer to relationships among the parts
- Often a bill of materials (listing of all parts necessary to make up the total assembly) is included.
- An assembly drawing is handy for a technician servicing a machinery or machinery component.
- By studying an assembly drawing and keeping it handy as the part is repaired, you can be sure that all parts are installed in their proper place.

❖ Exploded pictorial drawings

- Represent several parts assembled according to the axes of their assembly
- Parts are not shown assembled but are moved apart along the principal axes of the product
- Typically not dimensioned
- Helpful for assembly purposed on the production line
- Shows all of the components spread out, or exploded. so you can see what each part looks like.
- Frequently used in illustrated parts manuals and service bulletins.

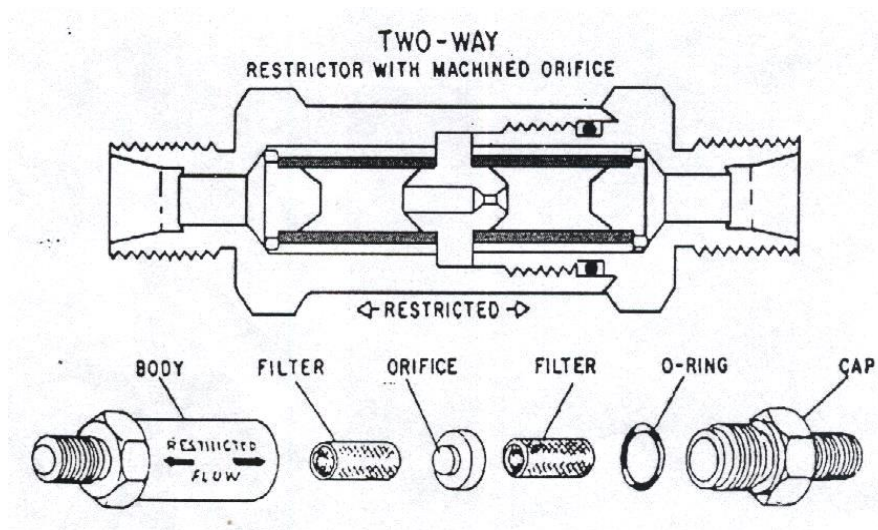


Fig. 1.1. Exploded pictorial drawings

❖ Schematic diagram

- Shows the relative location of all of the parts in a system, but does not give the location of the parts in the machinery.
- Schematic drawing is of great help when troubleshooting a system.

❖ Installation Drawing

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- Required when an assembly or group of assemblies is installed in a power plant
- An installation drawing shows the location of the parts and assemblies the completed machinery and identifies all of the detail parts used in the installation.
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- An installation drawing shows the location of the parts and assemblies the completed machinery and identifies all of the detail parts used in the installation.

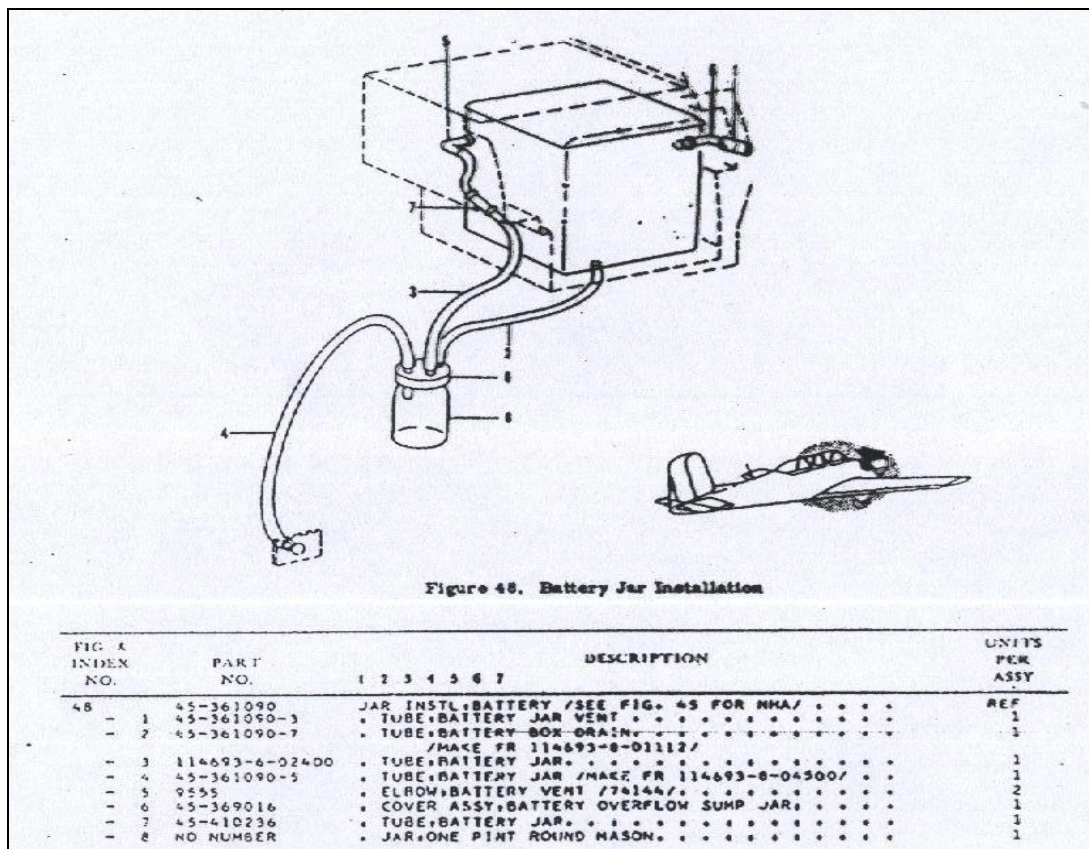


Fig. 1.2. Installation Drawing

I. There are two principles in drawing

➤ Visualization

- The ability to see what an object looks like in the mind of eye.

➤ Implementation

- Drawing of an object that has been visualized

II. Study of drawing can be categorized as

➤ Plane geometry

- Representation of an object having two dimensions

➤ Solid geometry

- Representing three dimensions of objects

III. Mechanical drawing for Engineer

➤ Advantage

- It is technical
- Exact
- Clearest way to communicate
- It is a universal language

➤ Disadvantage

- Time consuming to produce
- It needs skill

1.2. Drawing Instruments

Some basic equipment is necessary in order to learn drawing effectively, here are the main Ones.

- I. Drawing Board:** - Drawing board is used for fixing the drawing sheet by means of a tape as shown in Fig. 1.1. Its surface should be perfectly smooth. Drawing boards are available in different sizes in the market. As per IS 1444:1989 the sizes of drawing boards are given in Table 1.1

Table 1.1 Drawing Board Size

S.No.	Designation	Size (in mm)
1.	B ₀	1500 × 1000 × 25
2.	B ₁	1000 × 700 × 25
3.	B ₂	700 × 500 × 15
4.	B ₃	500 × 350 × 15
5.	B ₄	350 × 250 × 15

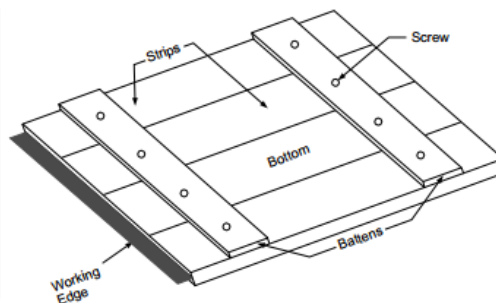


Fig. 1.3 Drawing Board

For the use in engineering colleges, B₂ (700 × 500 × 15) size drawing board is recommended.

- II. Drawing Sheet:** - A variety of drawing sheets are available in the market. Generally drawing sheets are of A0 size and the other sizes can be obtained by cutting the A0 size sheet as shown in Fig 1.2. The preferred sizes of the sheet as selected from IS 10711:1983 are given in Table 1.2.

Table 1.2 Drawing Sheet Size

S.No.	Designation	size (in mm)
1.	A ₀	841 × 1189
2.	A ₁	594 × 841
3.	A ₂	420 × 594
4.	A ₃	297 × 420
5.	A ₄	210 × 297
6.	A ₅	148 × 210

Fig. 1.4 Drawing Sheet

For the practice of engineering students, A2 (420 × 594) size drawing sheet is recommended.

Mini Drafter: - The function of mini drafter has the combined advantages of tee-square, set square, scale and protractor as shown in Fig. 1.3. It is mounted at the left end of the drawing board by means of a knob. It consists of two blades always parallel to their original position, fixed on a circular disc in such a way that they can be moved freely on circular disc, which acts as a protractor. The bigger version of this mini drafter is known as drafting machine, which is permanently fixed on a large drawing board, as shown in Fig. 1.4. Mini drafter is commonly used by the college students and drafting machine by draftsmen in the design department.

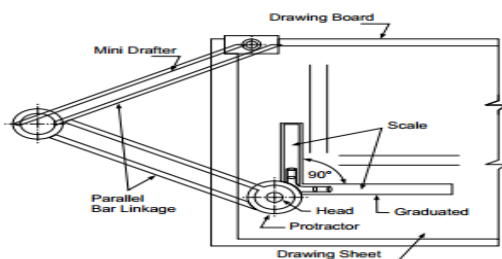


Fig. 1.5 Mini Drafter

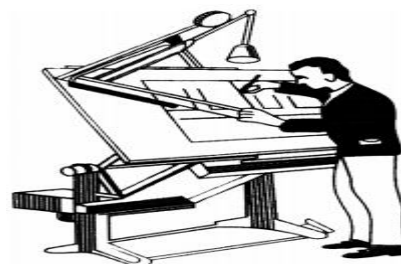


Fig. 1.6: Drafting Machine

III. T-square:

A T-square is a technical drawing instrument primarily used for drawing horizontal lines on a drafting table; it is also used to guide the triangle that is used to draw vertical lines. The name “T-square” comes from the general shape of the instrument where the horizontal member of the T (blade) slides on the side of the drafting table.

- The head is fixed at 90° to the blade
- The cleanness of your T –square greatly affects your drawing quality and cleanliness.

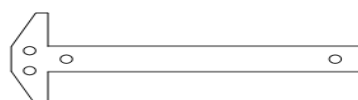


Figure 1.7. Tee-Square

IV. Scale (ruler):- A number of kinds of scales are available for varied types of engineering design. Figure fig 1.6 Scales with beveled edges graduated in mm is usually used.

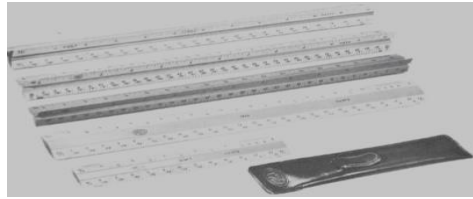


Fig 1.8 Scales

V. Set- square:

A set square or triangle is a tool used to draw straight vertical lines at a particular planar angle to a baseline. The most common form of Set Square is a triangular piece of transparent plastic with the centre removed. The outer edges are typically beveled. These set squares come in two forms, both right triangles: one with 90-45-45 degree angles, and the other with 90-60-30 degree angles.

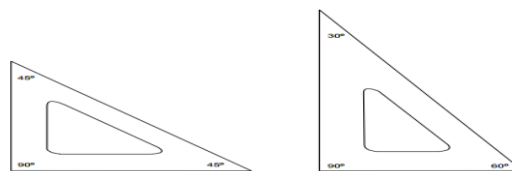


Figure 1.9 Set- square:

VI. Drawing Instrument Box: - A standard set of drawing instrument box is used by engineering students, containing large compass, bow compass, large divider, bow divider, inking pen and pencil lead etc. as shown in Fig. 1.8.

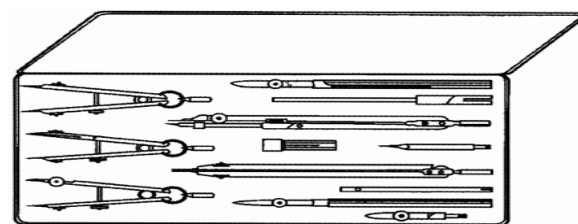


Fig. 1.10 Instrument Box

Drawing instruments are made of nickel, silver with a silvery luster on the surface and are corrosion resistant. The other parts like divider point, ruling pen, nibs and spring parts are made of hard steel.

Large Compass: - The large compass is used to draw circles and circular arcs. It consists of two legs pivoted at the top. A pointed needle is fitted at the lower end of one leg, while the other leg a pencil lead is inserted. A large compass can draw a circle up to 120mm diameter.

For drawing larger circles, both the legs of the compass are bent at the knee joints as shown in Fig. 1.11(I).

Bow Compass: - A bow compass is used for drawing small circles and arcs up to 25 mm diameter. This compass is used by structural engineers when a large number of small circles of the same diameter are to be drawn as shown in Fig. 1.11(II).

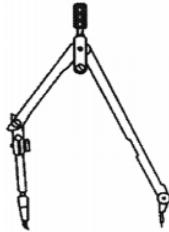


Fig. 1.11(I) Large Compass

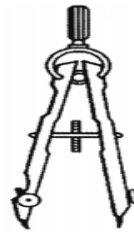


Fig. 1.11(II) Bow Compass

Large Divider: - The divider is used for dividing straight lines and circles into desired number of equal parts as shown in Fig. 1.12(iii). It is also used for transferring distance from one part of drawing to another part of the drawing. It has two legs, with steel points at both the lower ends instead of pencil point.

Bow Divider: - The bow divider is used for dividing small circles or arcs and number of small equal distances as shown in Fig. 1.12(iv).

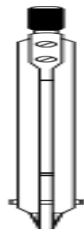


Fig. 1.12(III) Large Divider

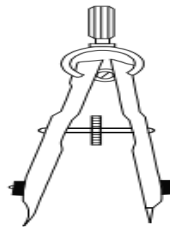


Fig. 1.12(IV) Bow Divider

VII. Other Miscellaneous Instruments:

The following instruments are used in engineering drawing are as:

- i. **Drawing Pencils:** - Drawing pencils are used for preparing the drawing of an object. The quality and neatness of the drawing depends upon the quality of the pencil used. Pencils are made of graphite, mixed with varying quantities of clay to produce different degree of hardness covering with ordinary wood. It is available in a variety of grades such as 9H, 8H, 7H and 6H (hard) 5H and 4H (medium hard) 3H and 2H (medium), H and F (medium soft), HB, B, 2B to 6B (very soft). Engineering students uses HB pencil to draw extra thick lines e.g. border line, title block lines etc. H pencil is used to draw thick lines e.g., visible lines, cutting plane lines, short break lines and lettering or dimensioning. 2H pencil is used to draw thin lines e.g., centre line, hidden lines etc. and 3H pencil is used to

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draw faint lines, or guide lines. There are two ways for using the pencil to prepare the drawing:

1. **Chisel edge pencil**
2. **Conical pointed pencil.**

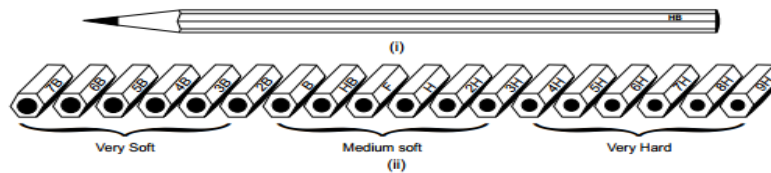


Fig. 1.13 Different Grades of Pencils

3. **Chisel edge pencil:** The chisel edge pencil is used to draw straight lines. It is used to obtain uniform thickness of line as shown in Fig. 1.14 (I).
4. **Conical pointed pencil:** The conical pointed pencil is used for general work e.g.: lettering, dimensioning and drawing circles and arcs. Do not use a pencil less than 75 mm and cut the wood of pencil at the opposite end of grade marking as shown in Fig. 1.14(II).



Fig. 1.14: Chisel Edge

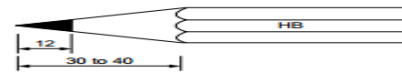


Fig. 1.14: Conical Pointed

- ii. **Eraser:** - A soft colorless and good quality rubber is used for erasing or rubbing unnecessary lines in the drawing. Frequent use of rubber should be avoided and rubbing should be dusted off by dusting cloth as shown in Fig. 1.15(I).



Fig. 1.15: Eraser

- iii. **French curve:** - French curve is used to draw irregular curves and arcs in the drawing. It is made of transparent plastic material and available in different shapes and sizes. Its edge must be perfectly smooth as shown in Fig. 1.16(II).



Fig. 1.16: French curve

- iv. **Circle Master:** - Circle master is used to draw of small size circles which are not possible to draw by compass. It consists of different size of circles. It is also used to increase the speed of drafting. It is made of plastic material in various sizes as shown in Fig. 1.17 (III).

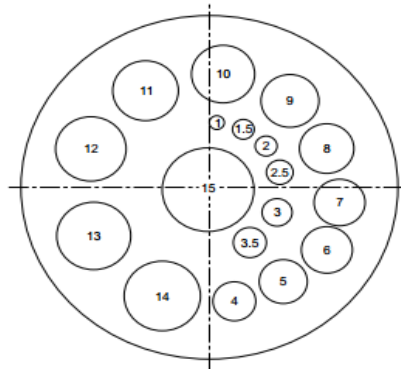


Fig. 1.17: Circle Master

Duster: - Duster is used for cleaning of drawing sheet as well as drawing instruments etc. Preferably it should be a towel cloth or a handkerchief. The eraser crumbs formed after the use of eraser should be removed with the help of duster.

Layout of Drawing Sheet: - The layout of drawing sheet is an important function of engineering drawing. The engineering student must know the standard rules for the selection of suitable scale, margin space, title block and part list etc. on the drawing sheet as shown in Fig. 1.18(I) and Fig. 1.18(II), according to IS 46: 2003. The border line is drawn around a sheet by HB pencil. It is usually drawn at a distance of 30 mm from left hand side and 20 mm for the other three sides. The extra space which is kept on the left hand side is used for filing and binding purpose. For engineering students practice purpose, layout of drawing sheet is given below.

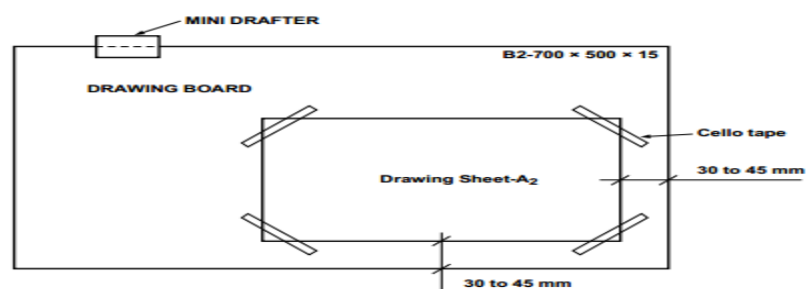


Fig. 1.18: Layout of Drawing Sheet

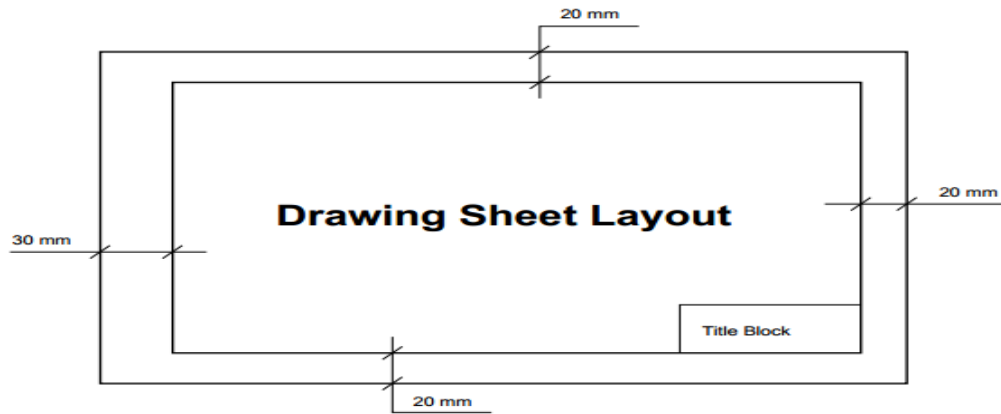


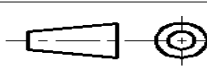
Fig. 1.18: Layout of Drawing Sheet

Title Block: - Different types of title blocks are used in industrial as well as in engineering colleges. For all sizes of drawing sheets 65×185 mm size of title block is commonly used.

The title block provides the following information:

- Name of the institute or firm:
- Title of drawing:
- Class:
- Sheet No:
- Roll No:
- Scale:
- Starting date:
- Symbol (1st angle or 3rd angle projection):
- Completion date:
- Drawn by/Name:
- Checked by:

From different types of title blocks one example are shown in Fig. 1.14.

	50	50	50
20	Name: Student Title of drawing: Engineering Drawing III		
10	Class Std X	Sheet No. 1	Scale: 1:1
10	Class No. 55	Valued by:	
10	Date: 25/02/17	Grade:	

Care and use of drawing instrument

In engineering drawing any object is represented by straight lines and/or curves. These lines should be drawn as accurate as possible by the help of drawing instruments.

Quality of a drawing depends to a large extent on the **quality, adjustment, proper use and care of drawing instruments.**

A Skilled Draftsman Uses Principal Usage A Combination of T. Square and Set Square

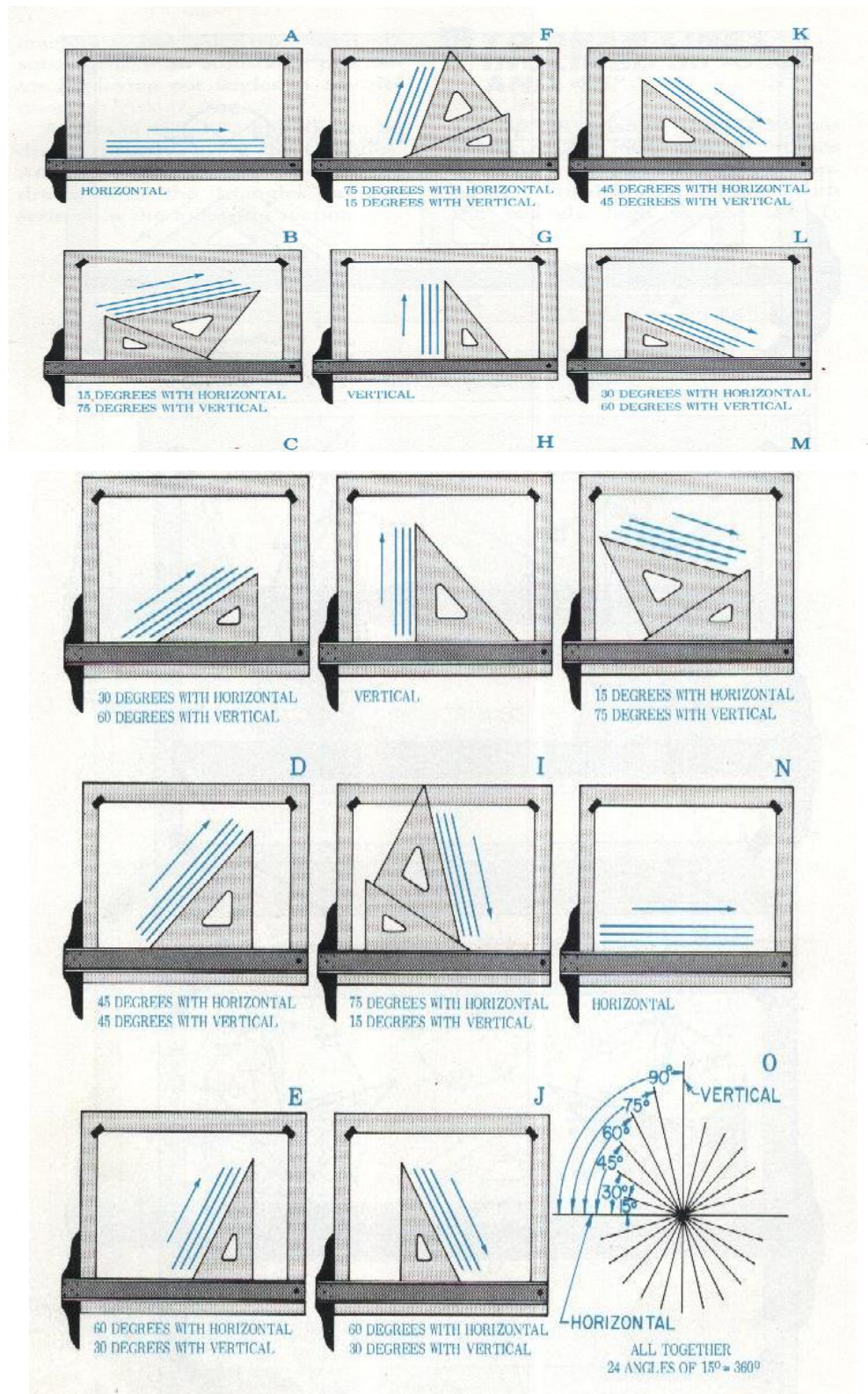


Fig. 1.19: Combination usage of T. Square and Set Square

1.3. Read And Interpreted Lines :

Lines: - Lines are predominant and fundamental drawing element in every drawing. Various types of lines are used to represent different objects like:-





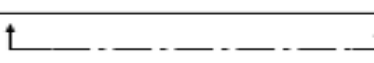


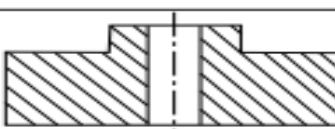

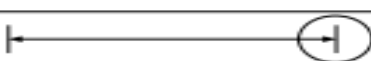

Visible lines are used for drawing outlines of visible edges and surface line which represent the object. These are drawn in bold dark and continuous lines.

Hidden lines are shown with medium thick lines consisting of short dashes and use to represent invisible ages and surface boundary.

Centre lines are thin lines drawn with ultimate long dashes and dots and are used for representing symmetrical objects. Then there are dimension and cutting lines.

Different types of lines are used for different purposes in engineering drawing as described by S.P. 46-1988 which are known as an “ALPHABET OF LINES”. The following types of lines should be used as given below in Table 1.3.

Table 1.3 types of line:

S. No.	TYPES OF LINES	DESCRIPTION	THICKNESS OF LINE IN MM	GRADE OF PENCIL
1.		Border line	0.8	HB
2.		Visible line	0.6	H
3.		Center line	0.3	2H
4.		Hidden line	0.3	2H
5.		Cutting plane line	0.6	H
6.		Short break line	0.6	H
7.		Long break line	0.4	2H
8.		Section line	0.4	2H
9.		Dimension line	0.4	2H
10.		Extension line	0.4	2H
11.		Leader line	0.4	2H

Types of lines:

Border Line: - It is a thick continuous line used to draw boundary lines on the drawing sheet and title block lines at the bottom of drawing sheet, as shown in Table 1.3.

Visible Line: - Outlines of parts in finished drawing is represented by thick lines. It is a continuous line which is also known as objects line.

Centre Line: - Centre line is used to locate the centre of arcs, circles and cylindrical objects. It should be thin, long and short dashes are evenly spaced in a proportion of 4: 1 to 6: 1.

Hidden Line: - Hidden lines are used, where viewing surface of an object is not visible. Hidden line is represented by short dashes evenly spaced.

Cutting Plane Line: - Cutting plane line is thin and long chain line which is thick at the ends. Cutting planes are designated by capital letters, with arrows indicating the direction for viewing section. It is just like a centre line.

Short Break Line: - Short break line is drawn free hand for short breaks. It may be used on both details and assembly drawing. It is a thick curved line.

Long Break Line: - Long break line represented by thin ruled straight lines with evenly spaced free hand zigzag, is used to shortening of long parts, which are the same throughout.

Section Line: - Section line indicates plane cut in section view. These lines are usually drawn at angles of 45° to the axis, with a spacing of 2 mm for small size drawing and 3 mm for large size drawings.

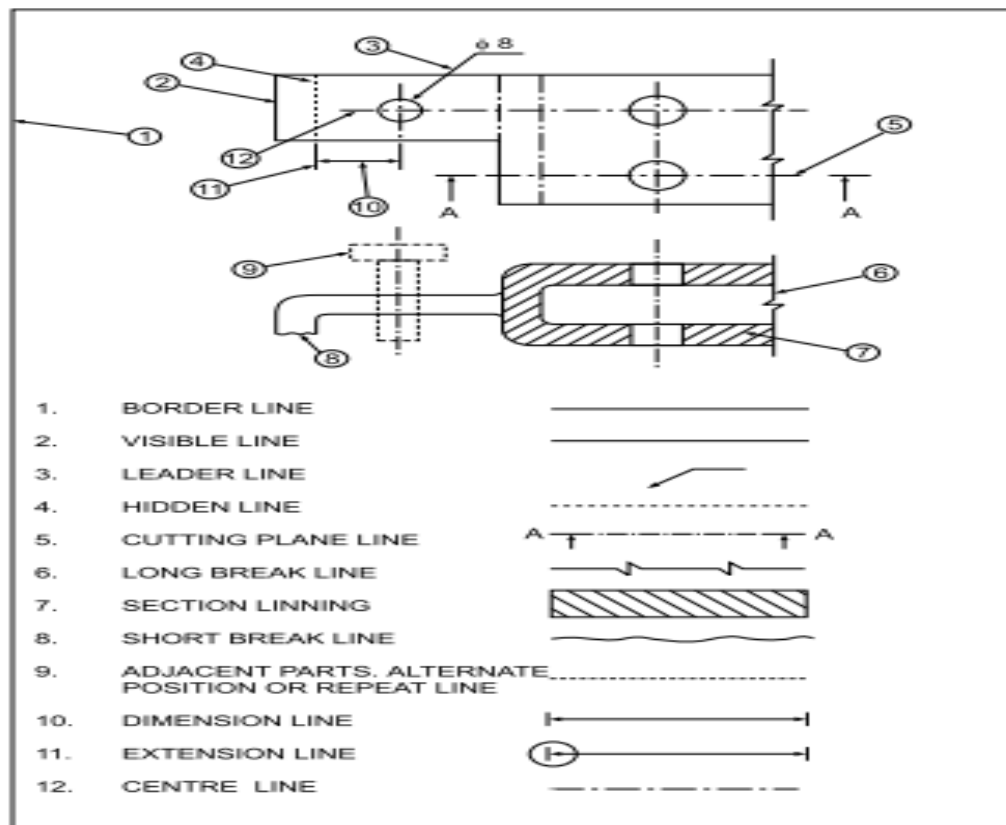
Dimension Line: - Dimension line should be terminated by arrow head touching the extension lines on both ends. It is thin continuous line broken in the centre to insert the dimension.

Extension Line: - Extension lines are projected from the outlines of the object and are usually perpendicular to the dimension line at a distance 2 mm from the outline of the object.

Leader Line: - Leader lines contain numerals and indicate size of objects, and are generally 3 mm long. The angle of the leader line is not less than 30° .

Detailed description and uses of various lines are given in table 1.4.

Table 1.4 different types of lines



Line Thickness

For most engineering drawings two thicknesses of lines are mainly required, a thick and thin one. The general recommendations are that thick lines to be twice as thick as the thin lines.

————— A thick line is used for visible leader edges and outline

————— A thin line is used for hatching, lines, short centre lines, dimensions and projections.

1.4. Measurements and scales

1.4.1. Drawing Standards

An engineering drawing should be well specified and universally acceptable. That's why there are some specified rules for engineering drawing. These rules may vary slightly for different regions. There are some drawing standards or drawing codes that accumulates the rules of engineering drawing for a certain region.

Well known drawing codes and their application region is expressed below:

Table 1.5 Drawing Standards:

Country/Region	Code/Standard	Full Meaning
Worldwide	ISO	International Organization for Standardization

USA	ANSI	American National Standards Institute
JAPAN	JIS	Japanese Industrial Standards
UK	BS	British Standards

Units of Measure:

International systems of units (SI) – which is based on the meter.

Millimeter (mm):- The common SI unit of measure on engineering drawing. Individual identification of linear units is not required if all dimensions on a drawing are in the same unit (mm). The drawing shall however contain a note: all dimensions are in mm. (Bottom left corner outside the title box).

Measurement for Engineering Design

• Systems of units

- British imperial system used throughout North America
- Metric system (SI) became universal worldwide system

✓ The Real World of Variability

- **Variation** Measure of the extent to which the dimension can be expected to vary in magnitude
 - All dimensions have variability
 - Example: box through a hole

Accuracy and Precision

✓ Accuracy

– Degree of conformity of a measured or calculated value to its actual value

✓ Precision

- Degree to which several measurements or calculations show the same result
- Also known as repeatability or reproducibility

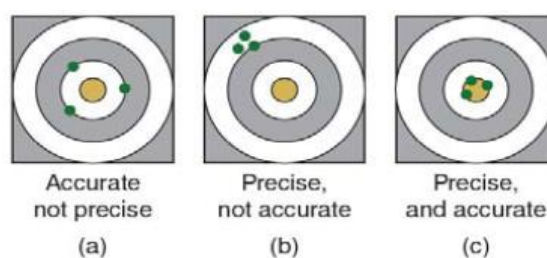


Fig.1.13 Accuracy and Precision

Simple Rules for Variability of Measurement

- ✓ Variability typically referred to as tolerance
- ✓ When using a physical measuring device:
 - Take a fraction of the smallest viewable dimension as the variability
- ✓ When using a commercial instrument:
 - Use the published accuracy

1.4.2. Scale (ruler):

A number of kinds of scales are available for varied types of engineering design. Scales with beveled edges graduated in mm are usually used. The proportion by which we either reduce or increase the actual size of the object on a drawing is known as scale. It is not possible always to make drawings of an object to its actual size as the extent of drawing paper is limited and also sometimes the objects are too small to make it clearly understandable by drawing its actual size in drawing paper. Scale is the technique by which one can represent an object comfortably as well as precisely within the extent of drawing paper. In other words, a scale is a measuring stick, graduated with different divisions to represent the corresponding actual distance according to some proportion. Numerically scales indicate the relation between the dimensions on drawing and actual dimensions of the objects.

Uses of scale:

- To prepare reduced or enlarged size drawings.
- To set off dimensions.
- To measure distances directly.

Sizes of Scales:

- Full size scale
- Reducing scale
- Enlarging scale

Full Size Scale:

The scale in which the actual measurements of the object are drawn to the same size on the drawing is known as full size scale. It is represented as 1:1 scale. If possible, drawing should be done in full scale.

Reducing Scale:

The scale in which the actual measurements of the object are reduced to some proportion is known as reducing scale. The standard formats of reducing proportions are:

1:2 - drawing made to one - half of the actual size

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- 1:5 - drawing made to one - fifth of the actual size
- 1:10 - drawing made to one-tenth of the actual size
- 1:50 - drawing made to one-fiftieth of the actual size
- 1:100 - drawing made to one - hundredth of the actual size

Enlarging Scale:

The scale in which the actual measurements of the object are increased to some proportion is known as reducing scale. The standard formats of enlarging proportions are:

- 2:1 - drawing made to twice the actual size
- 5:1 - drawing made to five times the actual size
- 10:1 - drawing made to ten times the actual size

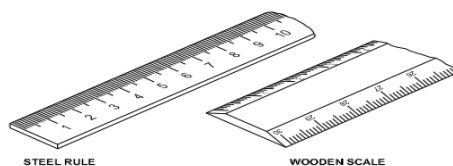


Fig.1.14 ruler

Protractor:

It is used for laying out and measuring angle.

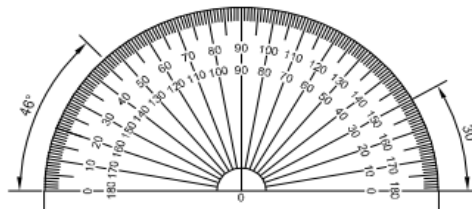


Fig. 1.15 protractor

The scale is the ratio between the size represented on the drawing and the true size of the object.

Scale= Dimension to carry on the drawing ÷ True Dimension of the object.

Examples:

1. Dimension carried on the drawing = 4mm.

True dimension= 40mm

Scale = $4 \div 40 = 1:10$

2. Calculating drawing dimension of a line having a true dimension of 543 mm to a scale of 1/10.

- If a true dimension of 10mm is represented as 1mm, a true dimension of 543mm is represented as X

- Then 10 mm -----→ 1 mm
- 543 mm-----→ X mm
- We have $1/10 = x \div 543$ or $X = 54.3\text{mm}$.

Therefore, a true dimension of 543mm is represented to a scale of 1/10 by a length of 54.3mm.

1.5. Lettering:

Lettering is an important part of engineering drawing which provides the complete information about size of an object and appearance required. Writing of titles, sub-titles, dimensions and other relative details on drawing should be lettered with freehand. A good practice of freehand lettering improves the quality of drawing and is also executed neatly, uniformly and rapidly. The use of instruments for lettering consumes more time as compared with freehand lettering. Both the vertical (up-right) and sloping (italic) letters can be lettered freehand as well as by instruments. Capital letters should be used for all purpose except where lower case letters are accepted in international usage for abbreviations. A good practice of lettering is required which may be achieved by continuous efforts. Normally two types of lettering are commonly used by engineers who are:

1. Single stroke letters
2. Double stroke letters.

But another important type of lettering is the gothic style of lettering which is commonly used by draftsmen as well as the engineering students for writing title block and other features. It may be performed with single stroke without lifting the pencil.

Single Stroke Letters:

Single stroke letters are used universally in engineering drawing. The Bureau of Indian Standards ISO 9609: 2001/ ISO 3098-0: 1997 replaced by SP: 46-2003 also recommended the use of single stroke letters. The term “Single stroke” means the uniform width of letter is obtained in single stroke of pencil. Single stroke letters are of two types.

Single Stroke Vertical Letter:

Single stroke vertical letters and numerals are written in a vertically upward direction without the use of drawing instruments as shown in Fig. 1.16. For writing the single stroke vertical letters and numerals, first draw the faint guide lines at a distance equal to the height of letters. These guide lines should be drawn by light grade pencil (2H). The height of letters and numerals are written in 1.8, 2.5, 3.5, 5, 7, 10, 14 and 20 mm. The ratio of height to width is 7:

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4 for single stroke vertical letters except M and W which is of 7: 5 ratios. The ratios of height to width of all the numerals are also written in 7: 4 except 1. There is no hard and fast rule for spacing between two letters. Generally the gap between two letters is taken as one unit. The spacing between two words is generally taken as 1 to 1.5 times their height and spacing in between two sentences is twice the height of letters as shown in Fig. 1.17.

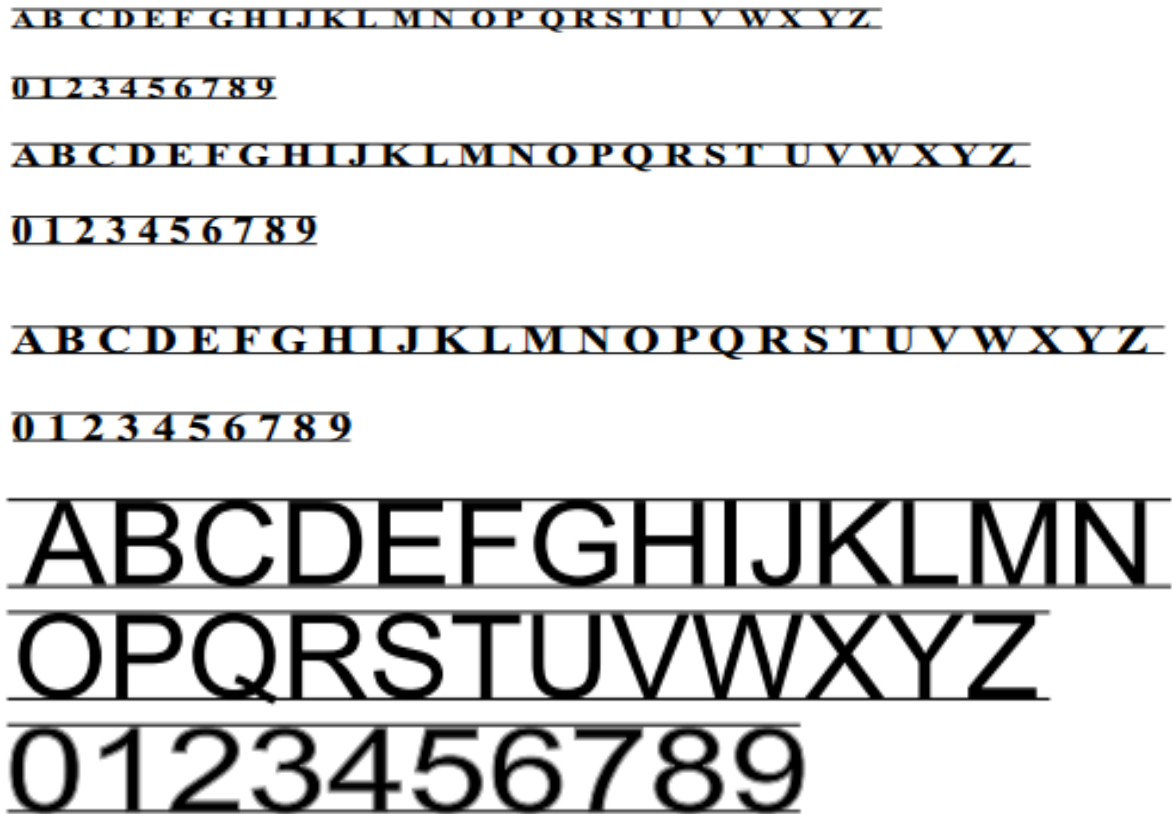


Fig.1.16: Vertical Letter

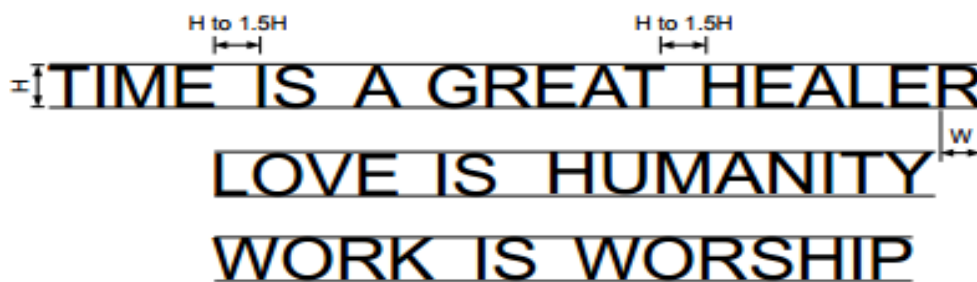


Fig.1.17: Vertical Letter

Single Stroke Inclined Lettering:

Many draftsmen use the inclined letters in preference to the vertical letters. The order and direction of the strokes are the same as in the vertical form. These inclined letters and numerals are written at an inclination of 75° from right towards left as recommended by SP

46 : 2003 as shown in Fig. 1.18. H grade pencil is preferred for freehand inclined lettering and numerals. The height of letters and numerals are same as described in single stroke vertical letters. The same ratio of height to the width and spacing are used as we used in single stroke vertical letters.

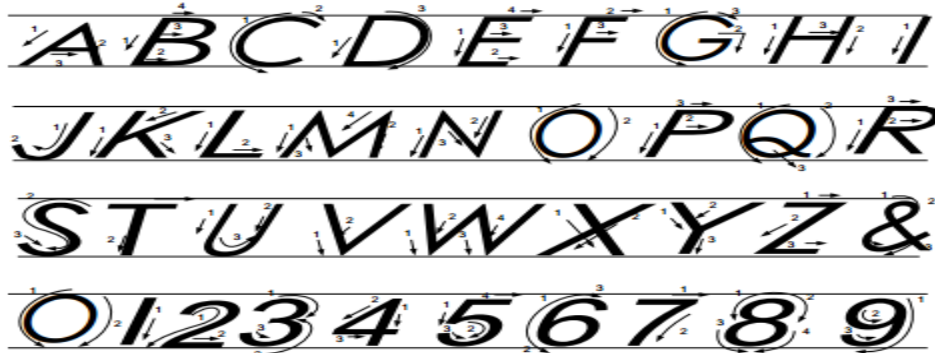


Fig.1.18 Inclined Lettering

Double Stroke Letters:

The letters and numerals which are completed in double stroke of the pencil with a uniform thickness in between the strokes is known as double stroke letters and numerals. For drawing double stroke gothic letters and numerals, a square grid is constructed with light lines. The height of the grid is taken equal to the height of letters as shown in Fig. 1.19. The ratio of height to width is 7: 5 for double stroke letters.



Fig. 1.19: Double Stroke Letters

Lower Case Letters

The lettering in which the alphabets are small uniform letters is called as a lower case gothic letters, such as a, b, c, d, e... z. These letters are written free hand. The method of writing the vertical and inclined type's lower case letters are shown in Fig. 1.20.

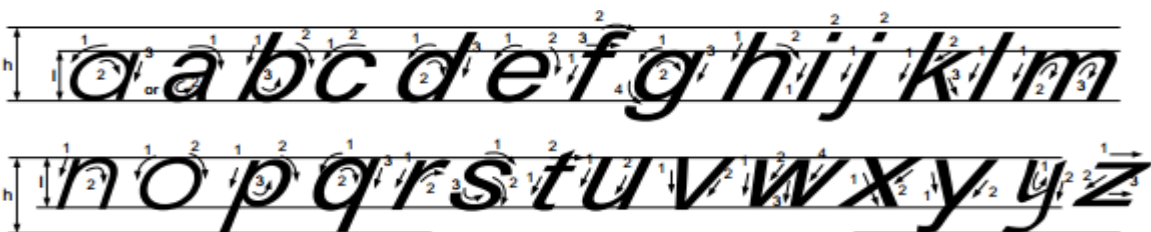


Fig. 1.20: Lower Case Letters

For writing the lower case letters, three horizontal lines are drawn and dividing the desired height in the ratio 2 : 5, keeping the upper division 2 and the lower on 5. The lower case letters are extensively used in architectural drawing and in map drawing etc. The standard height for lower lettering and numerals are 3.5, 7, 10 and 20 mm according to B.I.S.

The Height of Letters and Numerals:

The height of letters and numerals recommended by IS 9609 (Part O): 2001/ISO 3098-0:1997 for different purposes according to drawing size are shown in Table 1.3.

Table 3.1 Height of Letters:

S.No.	Purpose	Height of Letters and Numerals in MM
1.	Title of drawing and drawing number in title block	6, 8, 10, 12
2.	Sub-titles and headings	3, 4, 5, 6
3.	Notes, material list, dimensioning and the tolerances	2, 3, 4, 5

Self check-1

Part –I: Say true if the statement is true and false if the statement is false.

1. A technical person uses the graphic language.
2. Words are clumsy with respect to transmitting information about an engineering artifact.
3. Engineering drawing hasn't a set of rules and regulations for it to operate correctly.
4. Lines of different types and thicknesses are used for graphical representation of objects.
5. Objects lines are not visible.

Part –II: Choose the correct answer from the following Questions

1. The T-square is used for drawing lines.
A. Vertical B. Curve C. Horizontal.
2. Angles in multiples of 15° are constructed by the combined use of _____ and _____.
A. T-square B. set-squares C. Protractor.
3. To draw or measure angles, _____ is used.
A. Set-squares B. T-square C. Protractor.
4. For drawing large-size circles, is attached to the compass.
A. Straight bar B. Bow compass C. Lengthening bar.
5. Measurements from the scale to the drawing are transferred with the aid of a _____.
A. Scale B. Compass C. Divider.
6. The scale should never be used as a _____ for drawing straight lines.
A. Set-squares B. Working edge C. Straight edge.
7. To remove unnecessary lines _ is used.
A. Duster B. Chalk C. Sand box D. Eraser.
8. Circles and arcs of circles are drawn by means of a _____.
A. Lengthening bar B. Divider C. compass.
9. Set-squares are used for drawing and lines.
A. Horizontal B. Vertical C. Inclined D. Parallel.

Part –III: short Answer writing

1. Write Basic Instruments and Materials of drawing
2. List measuring instruments of drawing
3. List Sizes drawing paper
4. List different types and thicknesses of lines

Operation sheet-1.1.practice using drawing instruments

- **Operation title:** lay out lines
- **Purpose:** To develop drawing skill
- **Instruction:** Using the figure below and use drawing equipments to each line. You have given 20 Minut for the task and you are expected draw properly in a neat sketch.

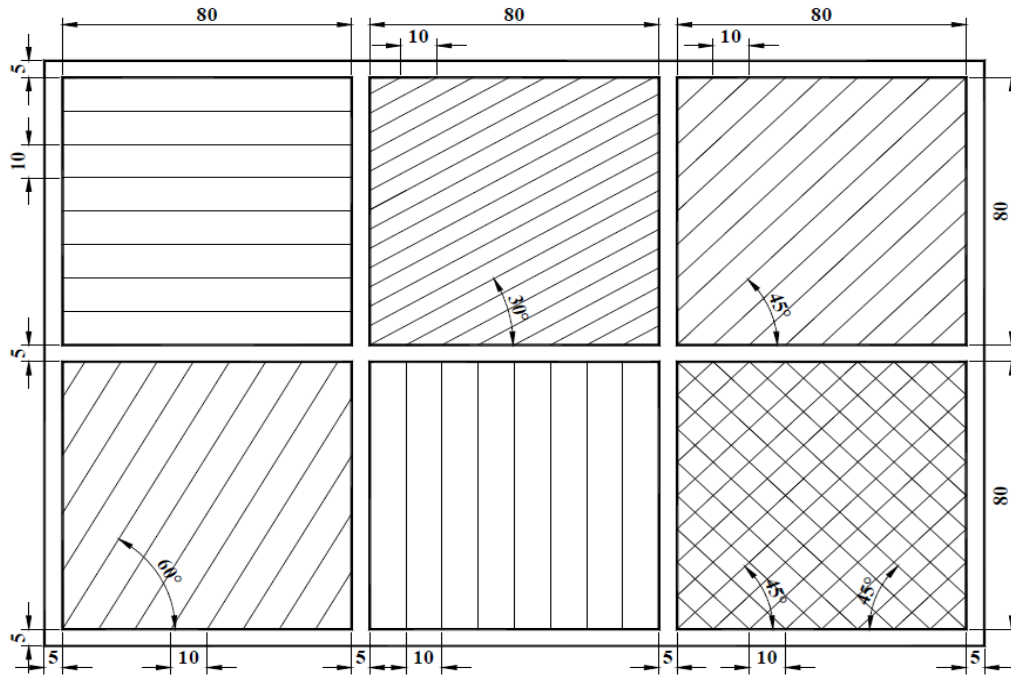


Figure 1.21: Figure given for operation sheet 1.1

- **Tools and requirement:**
 1. Paper,
 2. T-square,
 3. Pencil.
 4. Scale
 5. Set square 30/60 and 45
 6. Plaster
- **Steps in doing the task**
 1. Attach a paper in drawing board using T-square to the right angle.
 2. Draw border lines and other all requirements
 3. Set your T-square at right angle of drawing bored coincide them at the age of each other.
 4. Draw horizontal line using T-square to its length and divided equally.
 5. Then use 30/60 or 45 set square draw set vertical ,inclined on its angle
 6. Complete all four drawings and Your work submit to your assistant

Quality Criteria: copy the given drawing accurately and neat and clean.

Precautions: use the given ruler.

Operation sheet-1.2. Scale

- **Operation title:** scale
- **Purpose:** To apply and identify scaling
- **Instruction:** Using the figure below and use free hand sketch. You have given 20 Minut for the task and you are expected draw properly in a neat sketch and correct scale.

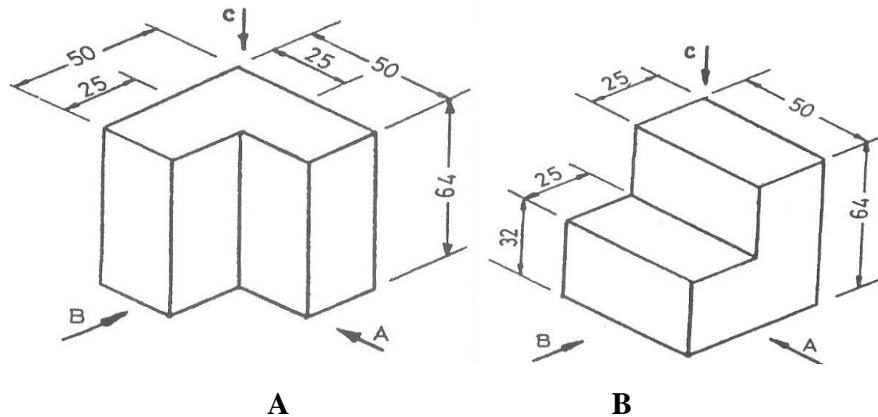


Figure 1.22: Figure given for operation sheet 1.2

- **Tools and requirement:**

Paper, Pencil, T-square, Set square 30/60 and 45, Plaster

- **Precautions:** Measure and calculate accurately
- **Procedures in doing the task**

Step-1: Use the given figure

Step-2: Measure the length and width of each component on drawing with mm

Step-3: Covert a scale to Reproduce 1:5 and of Redraw 3:1 the given drawing respectively.

Step-4: measure and set freely within what we show weight of the drawing and calculated dimension

Operation sheet-1.3: Template and Title Block

- **Operation title:** Title Block
- **Purpose:** To draw title Block
- **Instruction:** Using the figure below and use drawing instruments. You have given 15 Minute for the task and you are expected draw properly in a neat sketch and correct scale

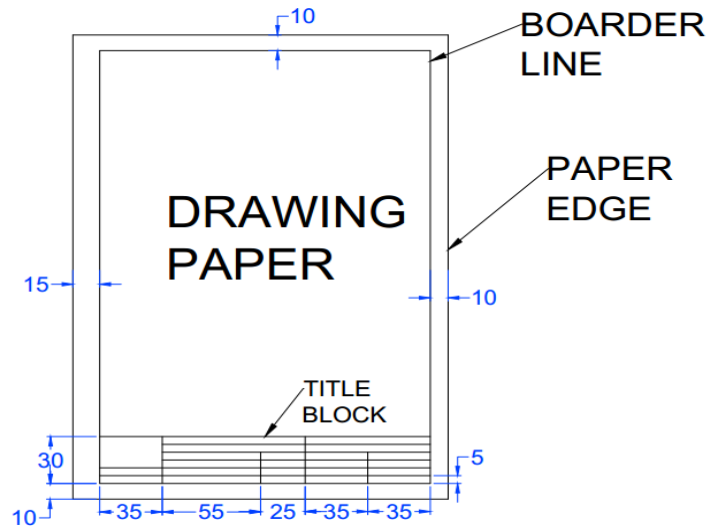


Figure 1.23: Figure given for operation sheet 1.3

- **Tools and requirement:**

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

- **Procedures in doing the task**

Operation Title: Drawing Template and Title Block

Step1. Set up your drawing paper on top of the drawing board.

Step2. Use the drawing template format given to you by your teacher.

Step3. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.

Step4. Using the basic drawing instruments and materials, perform the drawing task in the given following problems given in the Lap Test below.

Step5. Use appropriate pencil lead in your drafting works.

Step6. You may submit your finish work once you are true but should be within the time specified for submission

Lap Test-1

- Task-1: Perform set up drawing paper
- Task-2: draw title and title block.
- Task-3: divide and measure accurately
- Task-4: use all drawing instruments
- Task-5: Report what you doing

Lap Test-2

- Task-1: Perform set up drawing paper
- Task-2: convert scale
- Task-3: draw accurately by free hand sketch
- Task-4: Reproduce and redraw the weight drawing
- Task-5: Report what you doing

Lap Test 3

Practical Demonstration

Instructions:

Using the drawing instrument, you are required to do the following exercises:

Task1: Create the drawing template (Title Block), shown with the following dimensions in operation sheet -3.

Unit Two: Draw simple drawing

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

- Geometric shapes.
- Finished drawing.

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

- Perform a series of geometrical shapes
- Apply neat and clearing of smudges from the finished drawing.

2.1. A Series of Geometric Shapes

2.1.1. Geometrical construction problems

1. To bisect a given straight line.

- Let AB be the given line. With centre A and radius greater than half AB, draw arcs on both sides of AB.

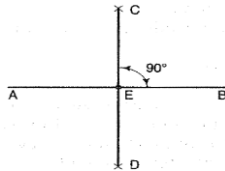


Fig.2.1. Bisect a straight line

- With centre B and the same radius, draw arcs intersecting the previous arcs at C and D.
- Draw a line joining C and D and cutting AB at E.

Then $AE = EB = \frac{1}{2} AB$.

Further, CD bisects AB at right angles.

1. To bisect a given arc.

Let AB be the arc drawn with centre O. Adopt the same method as shown in

Problem: 1 the bisector CD, if produced, will pass through the centre O.

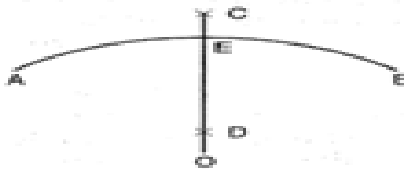


Fig.2.2. bisect arc

2. To draw a line through a given point, parallel to a given straight line

Let AB be the given line and P the point.

- With centre P and any convenient radius, draw an arc CO cutting AB at E.
- With centre E and the same radius, draw an arc cutting AB at F.
- With centre E and radius equal to FP, draw an arc to cut CO at Q.
- Draw a straight line through P and Q. Then this is the required line.

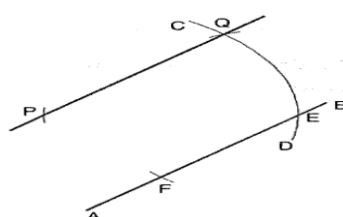


Fig.2.3 parallel line

3. To divide a given straight line into any number of equal parts

Let AB be the given line to be divided into say, seven equal parts.

- Draw the line AB of given length.
- Draw another line AC making an angle of less than 30° with AB .
- With the help of dividers mark 7 equal parts of any suitable length on line AC and mark them by points $1', 2', 3', 4', 5', 6'$ and $7'$ as shown.
- Join the last point $7'$ with point B of the line AB .
- Now, from each of the other marked points $6', 5', 4', 3', 2'$ and $1'$, draw lines parallel to $7'B$ cutting the line AB at 6, 5, 4, 3, 2 and 1 respectively.
- Now the line AB has been divided into 7 equal parts. You can verify this by measuring the lengths.

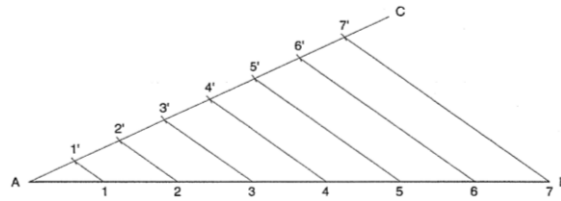


Fig.2.4. divide straight line

4. To divide a circle of a given radius into N equal parts

Given a circle of radius R , to divide it into 12 equal parts along its circumference, the geometric construction procedure is as follows.

- Draw two diagonals AB and CD at right angles to each other cutting the circle at A, B and C, D .
- With A as centre, and radius equal to the given radius of the circle, draw arcs cutting the circle at 2 and 7.
- Similarly, with B as centre, and with the given circle radius, draw arcs to cut the circle at 3 and 6.
- Similarly, from points C and D as centre, and with the given radius of circle, draw arcs to cut the circle at 1, 4 and 5, 8 respectively.
- Thus dividing it at the cuts are the required twelve equal parts of the circle.

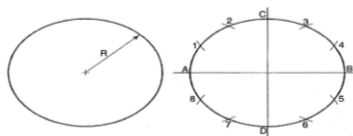


Fig.2.5. circle divide

5. To bisect a given angle

Let ABC be the given angle.

- With B as centre and any radius, draw an arc cutting AB at D and BC at E.
- With centers D and E and the same or any convenient radius, draw arcs intersecting each other at F.
- Draw a line joining B and F. BF bisects the angle ABC, i.e. $\angle ABF = \angle FBC$.

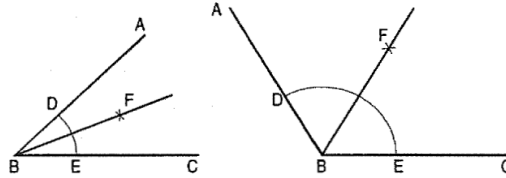


Fig.2.6. bisect angle

6. To draw a line inclined to a given line at an angle equal to a given angle.

Let PQ be the given line and AOB the given angle.

- With O as centre and any radius, draw an arc cutting OA at C and OB at D.
- With the same radius and centre P, draw an arc EF cutting PQ at F.
- With F as centre and radius equal to CD, draw an arc cutting the arc EF at G.
- From P, draw a line passing through G. This is the required line.

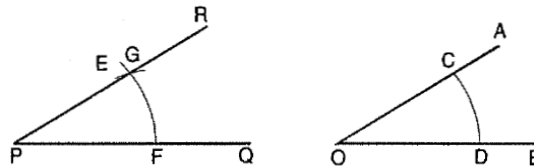


Fig.2.7. inclined line

7. To find the centre of a given arc.

Let AB be the given arc.

- In AB, draw two chords CD and EF of any lengths.
- Draw perpendicular bisectors of CD and EF intersecting each other at O. Then O is the required centre.

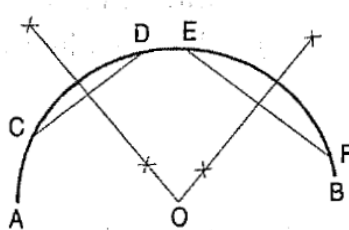


Fig.2.8. centre of arc.

8. To draw an arc of a given radius, touching a given straight line and passing through a given point.

Let AB be the given line, P the point and R the radius.

- i. Draw a line CD parallel to and at a distance equal to R from AB .
- ii. With P as centre and radius equal to R , draw an arc cutting CD at O .
- iii. With O as centre, draw the required arc.

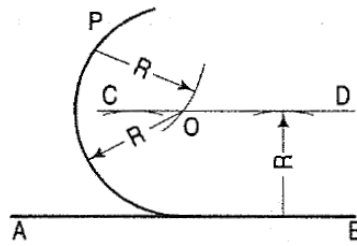


Fig.2.9. arc of radius

9. To draw an arc of a given radius touching two given straight lines at right angles to each other.

Let AB and AC be the given lines and R the given radius.

- i. With centre A and radius equal to R , draw arcs cutting AB at P and AC at Q .
- ii. With P and Q as centers and the same radius, draw arcs intersecting each other at O .
- iii. With O as centre and radius equal to R , draw the required arc.

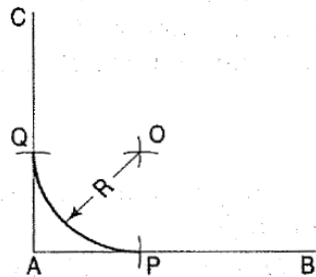


Fig.2.10. an arc at right angles

10. To construct an equilateral triangle, given the length of the side

a. With T-square and set-square only.

- i. With the T-square, draw a line AB of given length.
- ii. With 30° - 60° set-square and T-square, draw a line through A making 60° angle with AB .
- iii. Similarly, through B , draw a line making the same angle with AB and intersecting the first line at C .

Then ABC is the required triangle.

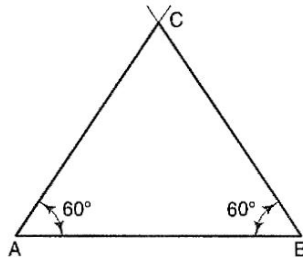


Fig.2.11. A. equilateral triangle

b. With the aid of a compass.

- i. With centers A and B and radius equal to AB, draw arcs intersecting each other at C.
- ii. Draw lines joining C with A and B.
Then ABC is the required triangle.

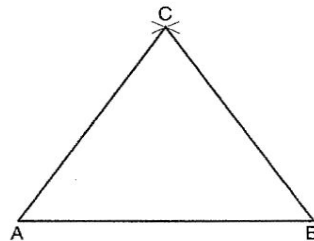


Fig.2.11. B. equilateral triangle

11. To construct a square, length of a side given

a. With T-square and set-square only

- i. With the T-square, draw a line AB equal to the given length.
- ii. At A and B, draw verticals AE and BF.
- iii. From point A draw a line inclined at 45° to AB, cutting BF at C.
- iv. From point B draw a line inclined at 45° to AB, cutting AE at O.
- v. Draw a line joining C with O.

Then ABCO is the required square.

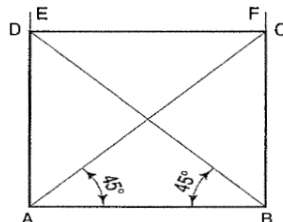


Fig.2.12.A. a square construction

b. With the aid of a compass

- i. Draw a line AB equal to the given length.

- ii. At A, draw a line AE perpendicular to AB.
- iii. With centre A and radius AB, draw an arc cutting AE at D.
- iv. With centers B and D and the same radius, draw arcs intersecting at C.
- v. Draw lines joining C with B and D.

Then ABCD is the required square.

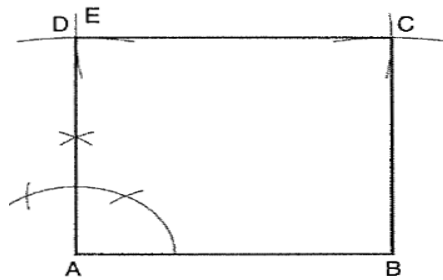


Fig.2.12.B. a square construction

12. To inscribe a circle in a regular polygon of any number of sides, say a pentagon

Let BCDE be the pentagon.

- i. Bisect any two angles by lines intersecting each other at O.
- ii. From O, draw a perpendicular to any one side of the pentagon cutting it at P.
- iii. With centre O and radius OP, draw the required circle.

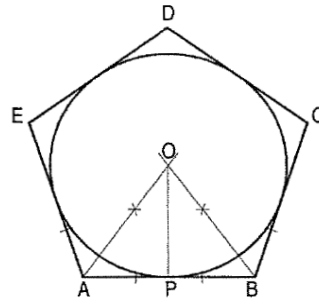


Fig.2.13. pentagon

13. To construct a regular octagon given the diagonal, i.e. within a given circle Steps

- i. Draw the circle and insert a diameter AE.
 - ii. Construct another diagonal CG, perpendicular to the first diagonal.
 - iii. Bisect the four quadrants thus produced to cut the circle in B, D, F, and H.
- ABCDEFGH is the required octagon.

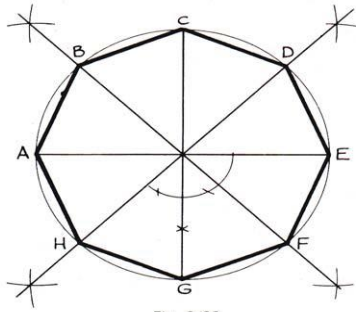


Fig.2.14. octagon

14. To construct a rectangular octagon; given the diameter, i.e., within a given square.

- Construct a square PQSR, length of side equal to the diameter.
- Draw the diagonals SQ and PR to intersect in T.
- With centers P, Q, R, and S draw four arcs, radius PT ($=QT = RT = ST$) to cut the square in A, B, C, D, E, F, G and H.

ABCDEFGH is the required octagon.

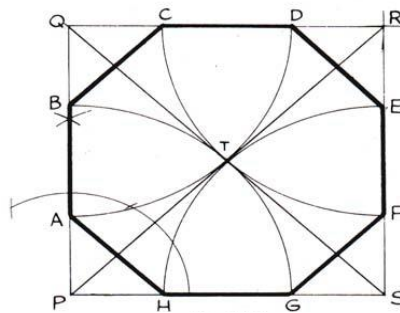


Fig.2.15. rectangular octagon

15. To construct any given polygon; given the length of a side.

There are three fairly simple way of constructing a regular polygon. Two methods require a simple calculation and the third requires very careful construction if it is to be exact. All three methods are shown. The constructions work for any polygon, and a heptagon (seven sides) has been chosen to illustrate them

Method 1

- Draw a line AB equal in length to one of the sides and produce AB to P.
- Calculate the exterior angle of the polygon by dividing $3600/7 = 51\ 30/7$.
- Draw the exterior angle PBC so that $BC = AB$.
- Bisect AB and BC to intersect in O.
- Draw a circle, centre O and Radius OA ($=OB = OC$).
- Step off the sides of the figure from C to D, D to E, etc. ABCDEFG is required heptagon.

- ii. Divide the circles into twelve equal parts i.e the angle in each division should be 30° .
- iii. A typical radius of the bigger circle is OBA, from B, draw a horizontal line which meets the vertical drawn from A at C. Repeat this simple method for the remaining seven radii as shown in the fig.7.1 iv All the meeting points of both the horizontals and verticals are joined to form the ellipse.
- iv. PQ is the MAJOR AXIS while.
- v. X Y is the MINOR AXIS of the ellipse.

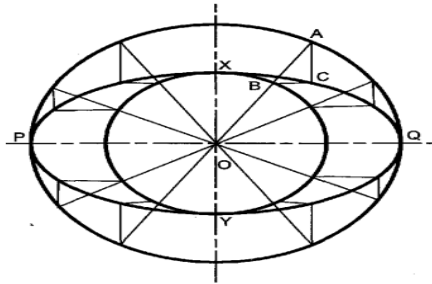


Fig.2.17.B. Ellipse concentric circle method

2.1. A few basic points for a drawing

- Should be complete and unambiguous
- Should be neat and easy to read
- Use only as many views as necessary to show all required detail
- Apply tolerances realistically - overly tight tolerances can add a great deal of additional cost with little or no added value to the part

Self check-1

Test-I Matching

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

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

<u>A</u>	<u>B</u>
_____ 1, bisecting	A) Polygon is outside the circle
_____ 2. Square	B) Bounded by straight line
_____ 3 Inscribed	C) divide it two equal parts
_____ 4.Circumscribed	D) Regular polygon
_____ 5.Polygon	E) Polygon is inside the circle

Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 1 Points.

1. Write basic points of drawing.
2. List at least five drawing instruments.

Test III: Choose the correct answer from the following Questions

1. How many pairs of parallel lines are there in regular hexagon?
A. 2 B. 3 C. 6
2. In general method of drawing an ellipse, a vertical line called as _____ is drawn first.
A. Tangent B. normal C. major axis D. miner axis
3. Given are the steps to construct an equilateral triangle, with help of compass; when the length of side is given. Arrange the steps.
 - i. Draw a line AB with given length
 - ii. Draw lines joining C with A and B
 - iii. ABC is required equilateral triangle
 - iv. With centers A and B and radius equal to AB, draw arcs cutting each other at C.
 - A. i, iv, ii, iii
 - B. iii, ii, iv, i
 - C. iv, iii, I, ii
 - D. ii, iii, iv, i

4. in the given figure which of the following construction line is drawn first

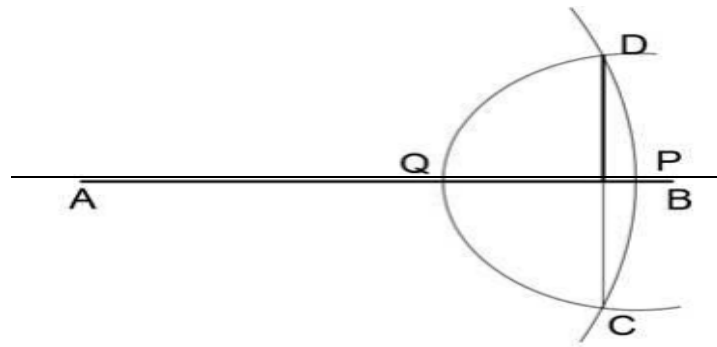


Figure 2.18: contract a line

- A. Line AP
- B. Arc DPC
- C. Arc DQC
- D. Line DC

2.1.2. Operation sheet 2.1: construct a N sides on a straight line

- **Operation title: draw geometrical Shape**
- **Purpose:** To draw construct geometrical shape
- **Instruction:** Using the figure below and given equipments measure the length of each line. You have given 20 Minute for the task and you are expected to draw neat and clean with the Wright geometrical futures.
- **Tools and requirement:**
 - Paper,
 - Ruler,
 - Pencil.
 - Sate square 30/60 and 45 degrees
- **Procedures in doing the task**
 1. To construct a regular figure of given side length and of N sides on a straight line. construction 1. Draw the given straight line AB.
 2. At B erect a perpendicular BC equal in length to AB.
 3. Join AC and where it cuts the perpendicular bisector of AB, number the point 4.
 4. Complete the square ABCD of which AC is the diagonal.
 5. With radius AB and centre B describe arc AC as shown.
 6. Where this arc cuts the vertical centre line numbers the point 6.
 7. This is the centre of a circle inside which a hexagon of side AB can now be drawn.
 8. Bisect the distance 4-6 on the vertical centre line.
 9. Mark this bisection 5. This is the centre in which a regular pentagon of side AB can now be drawn.
 10. On the vertical centre line step off from point 6 a distance equal in length to the distance 5-6. This is the centre of a circle in which a regular heptagon of side AB can now be drawn.
 11. If further distances 5-6 are now stepped off along the vertical centre line and are numbered consecutively, each will be the centre of a circle in which a regular polygon can be inscribed with side of length AB and with a number of sides denoted by the number against the centre.

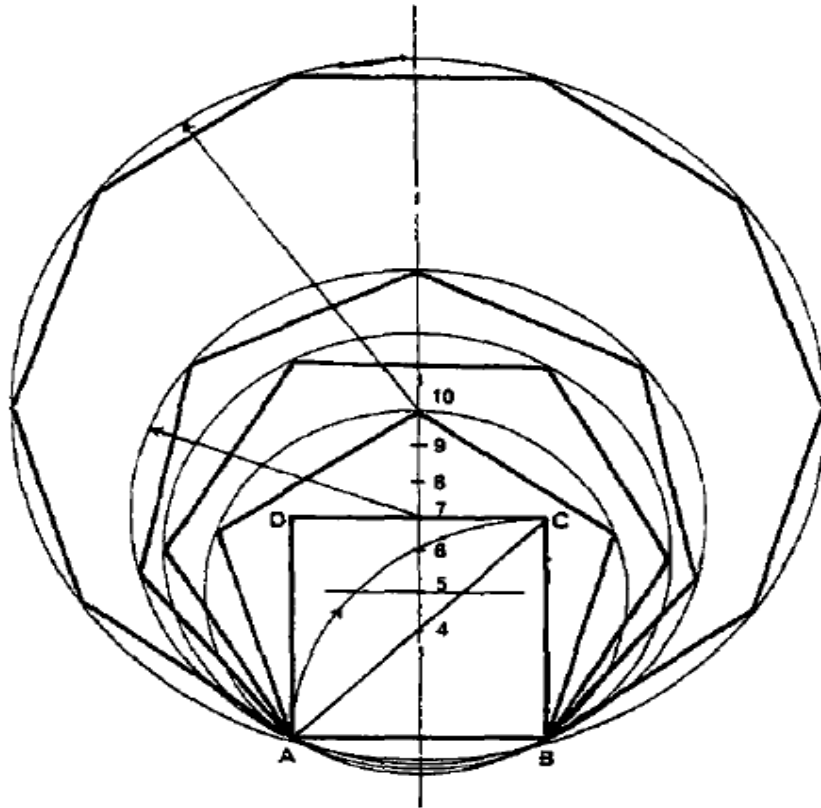


Figure 2.19: Figure given for operation sheet 2.1

- **Quality Criteria:** what you are use instruments and quality
- **Precautions:** use drawing instruments properly. .

Lap Test-2.1

- **Task-1:** Perform set up drawing paper
- **Task-2:** clearly understand the procedure
- **Task-3:** construct accurately
- **Task-4:** measure all dimensions are equal
- **Task-5:** Report what you doing and submit

Unit Three: Construct multi-view

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

- Views drawing.
- Multi-view.
- View orientation.
- pictorial (3D) drawings

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Illustrating three views drawing. Of specified object.
- Constructing multi-view drawing correctly.
- Constructing view orientation.
- Developing pictorial (3D) drawings

3.1. Projection view

Introduction:

All forms of engineering and technical work require that a two dimensional surface (paper) be used to communicate ideas and the physical description of a variety of shapes. To provide necessary information about an object to the manufacturer or to any other concerned party, it is usual practice to provide projection(s) of that object.

Projection: - Projection is the process in which the rays of sight are taken in a particular direction from an object to form an image on a plane. If straight lines (rays) are drawn from various points on the contour of the object to meet a transparent plane, thus the object is said to be projected on that plane. The figure or view formed by joining, in correct sequence, the points at which these lines meet the plane is called the projection of the object.

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

The projection theory is used to graphically represent 3-D objects on 2-D media (paper, computer screen).

The projection theory is based on two variables:

- Line of sight
- Plane of projection (image plane or picture plane)

Line of sight is an imaginary ray of light between an observer's eye and an object.

There are 2 types of LOS: parallel and converge.

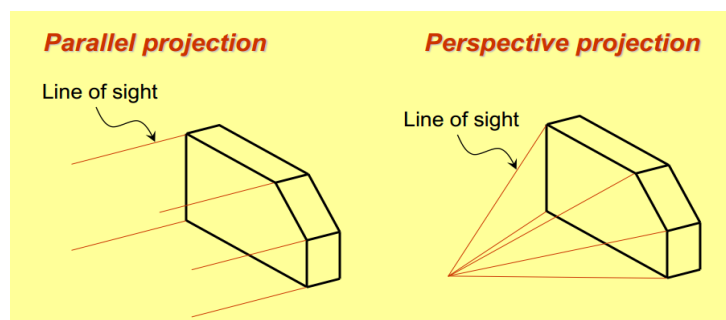


Fig .3.1. Line of sight

Plane of projection is an imaginary flat plane which the image is created. The image is produced by connecting the points where the LOS pierces the projection plane.

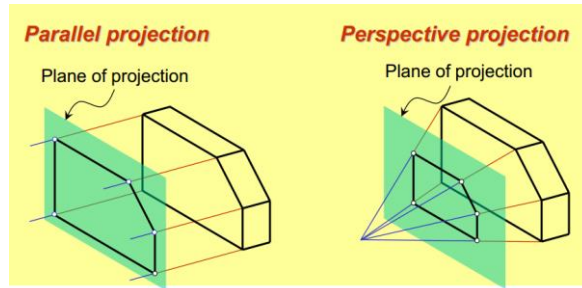


Fig .3.2. Plane of projection

3.1.1 Types of Projection

A. Perspective Projection

- ✓ Observer is at finite distance.
- ✓ Rays or Projectors are converging at observer's eye
- ✓ It does not provides exact size and shape of object

Disadvantage of Perspective Projection:

- ✓ It is difficult to create.
- ✓ It does not reveal exact shape and size.

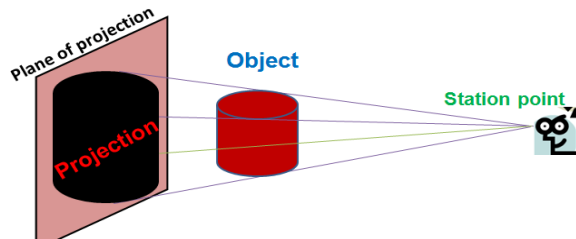


Fig .3.3 Perspective Projection

B. Orthographic Projection

- ✓ ORTHO means Perpendicular latin word.
- ✓ Assume that observer is at infinite distance and rays or Projection lines are parallel to each other and Perpendicular to the Plane of Projection.
- ✓ Since the projectors are perpendicular to the plane of projection, the view is called Orthographic View and the projection method is called Orthographic projection.
- ✓ Orthographic projection is a two dimensional projection method.
- ✓ FV : Length and height of Object

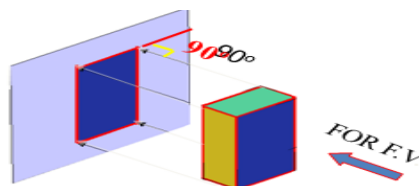


Fig .3.4. Orthographic Projection

As projectors are parallel to each other, the size of Orthographic View of an object is equal to the actual size of an object.

C. Oblique Projection

- ✓ Observer is at infinite distance
- ✓ Rays or Projectors are parallel to each other.
- ✓ Rays or Projectors are not Perpendicular to the Plane of projection. (i.e. projectors are inclined to the plane of projection i.e. oblique)

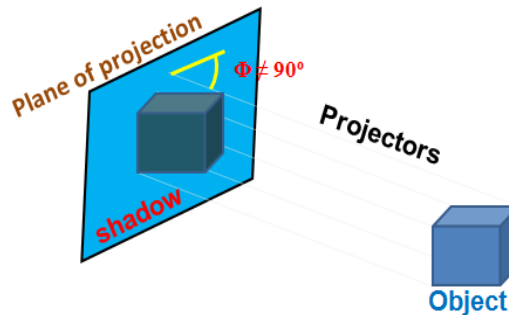


Fig .3.4. Oblique Projection

D. Isometric Projection

- ✓ Observer is at infinite distance.
- ✓ Rays or Projectors are parallel to each other & perpendicular to the plane of projection
- ✓ All faces of the object are equally inclined to the planes of projection.
- ✓ All faces of the object are visible in a single view.

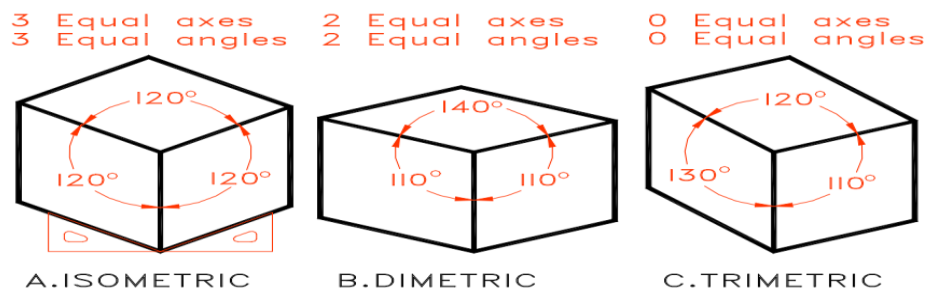


Fig .3.5. Types Isometric Projection

- ✓ **Advantage:** Easy to understand.
- ✓ **Disadvantage:** Shape and angle distortion.
- ✓ **Example:** Distortions of shape and size in isometric drawing.

3.1.2. Projection words

Picture Plane/Plane of Projection: - The plane or surface on which the rays of sight are projected and combined to form a view is called picture plane.

View: - The image formed on a picture plane by projecting rays of sight is called a view.

Projector: - The lines or rays drawn from the object to the plane are called projectors.

3.1.3. Quadrant system

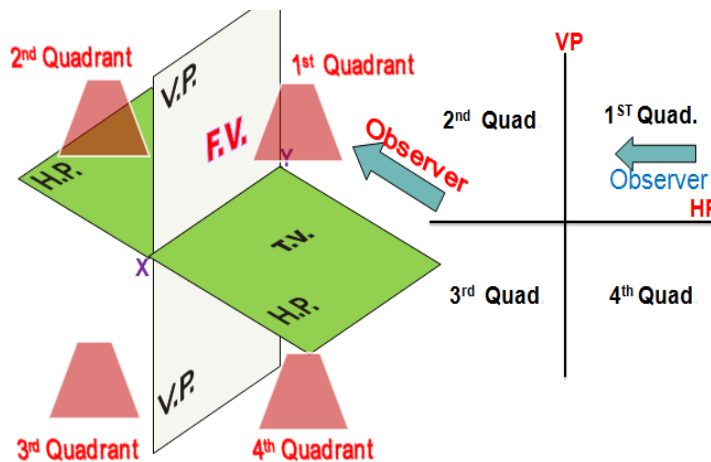


Fig .3.6 Quadrant system

3.2. Sketching Multi view Drawings

A **multi view drawing** is one that shows two or more two-dimensional views of a three-dimensional object.

Multi view drawings provide the shape description of an object. When combined with dimensions, multi view drawings serve as the main form of communication between designers and manufacturers.

The six principal of views

- The front view
- The top view
- The right side view
- The left side view
- The rear view
- The bottom view

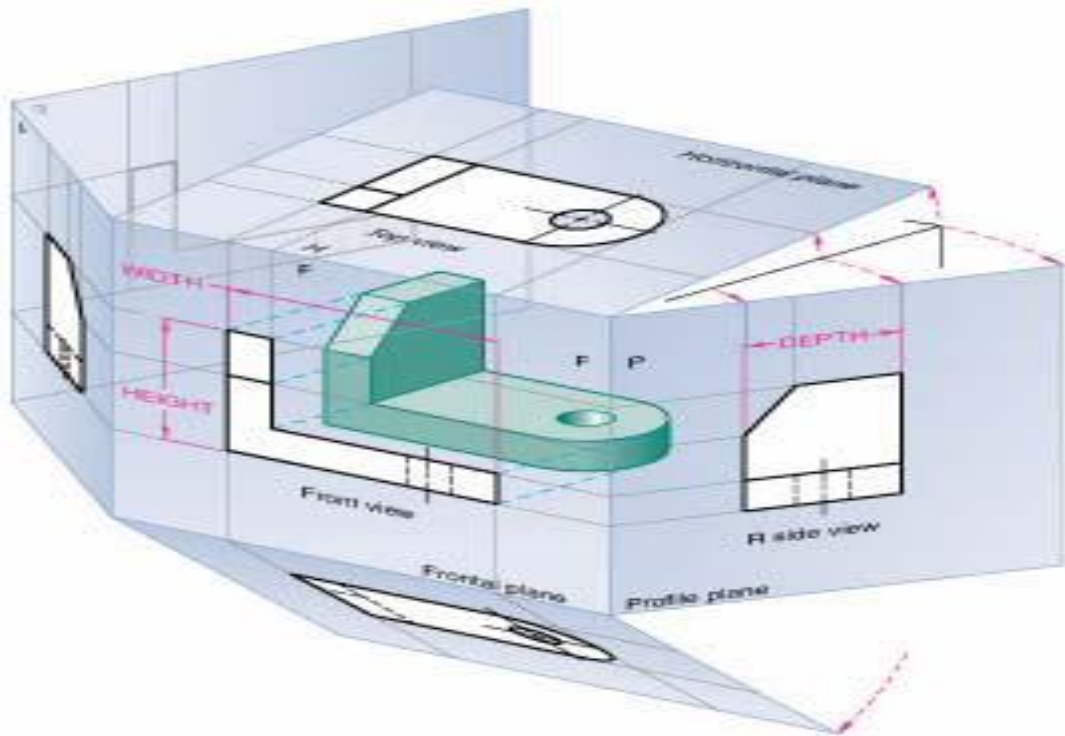


Fig .3.7: six principal views of projection

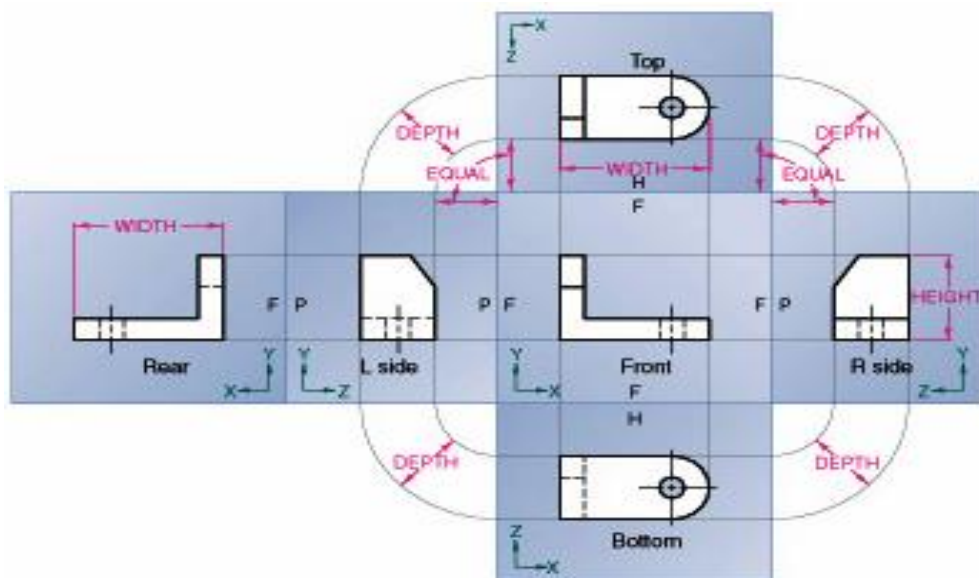


Fig .3.8: The six perpendicular planes of views

Conventional view placement

Conventionally, the standard views used in a three-view drawing are the top, front, and right side view. Because the other three principal views are mirror image and do not add to the knowledge about the object.

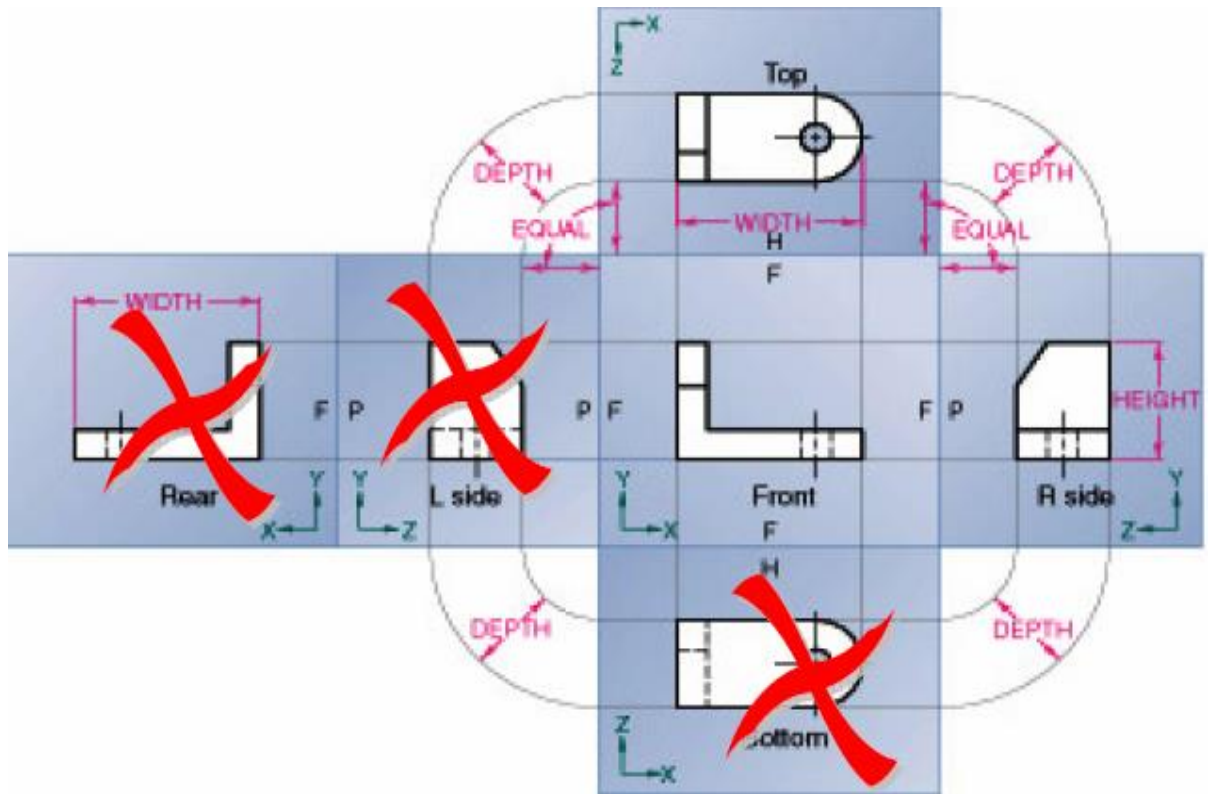


Fig .3.8: Conventional view placement

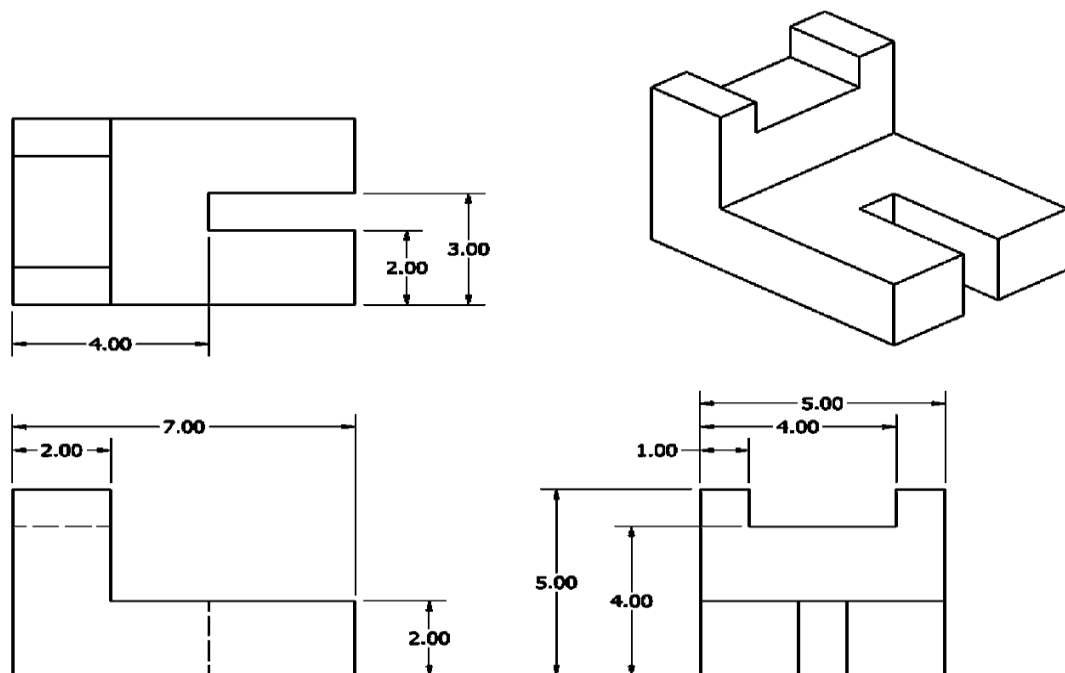


Fig .3.9: examples multi view object projection

3.2.1. Width, Depth, and Height

All three-dimensional objects have **width**, **height**, and **depth**.

Width is associated with an object's **side-to-side** dimension.

Height is the measure of an object from **top-to-bottom**.

Depth is associated with **front-to-back** distance.

Projection dimensions

The width dimension is common to the front and top views. The height dimension is common to the front and side views. The depth dimension is common to the top and side views.

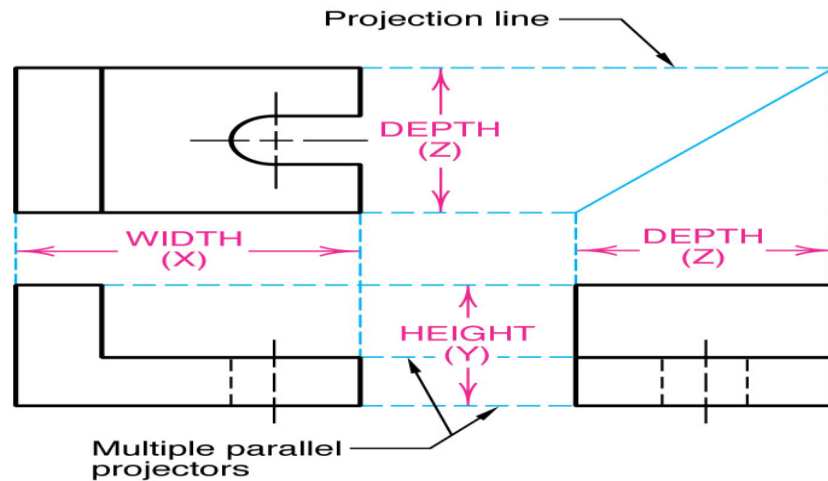


Fig .3.10: Projection dimension

3.2.2. First-Angle and Third-Angle Projection

A. First-Angle Projection

First angle projection is the standard in **Europe and Asia**.

First Angle Projection

When the object is situated in First Quadrant, that is, in front of V.P and above H.P, the projections obtained on these planes are called First angle projection.

- The object lies in between the observer and the plane of projection.
- The front view is drawn above the xy line and the top view below xy. (above xy line is v.p and below xy line is H.P).
- In the front view, H.P coincides with xy line and in top view v.p coincides with xy line.
- Front view shows the length (L) and height (H) of the object and Top view shows the length (L) and breadth (B) or width (W) or thickness (T) of it.

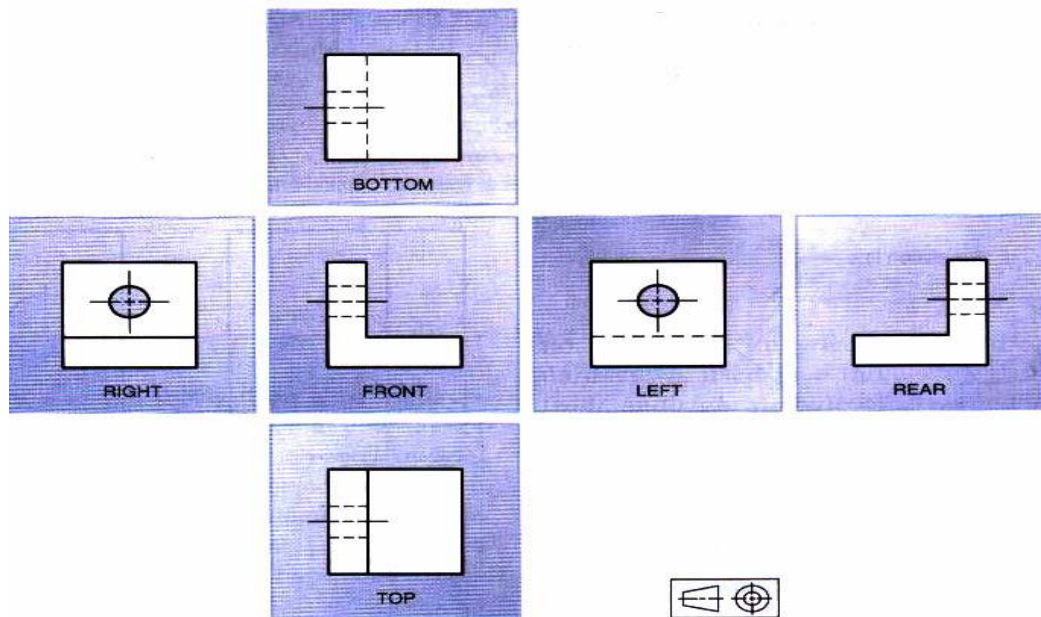


Fig .3.11: ISO standard first angle projection

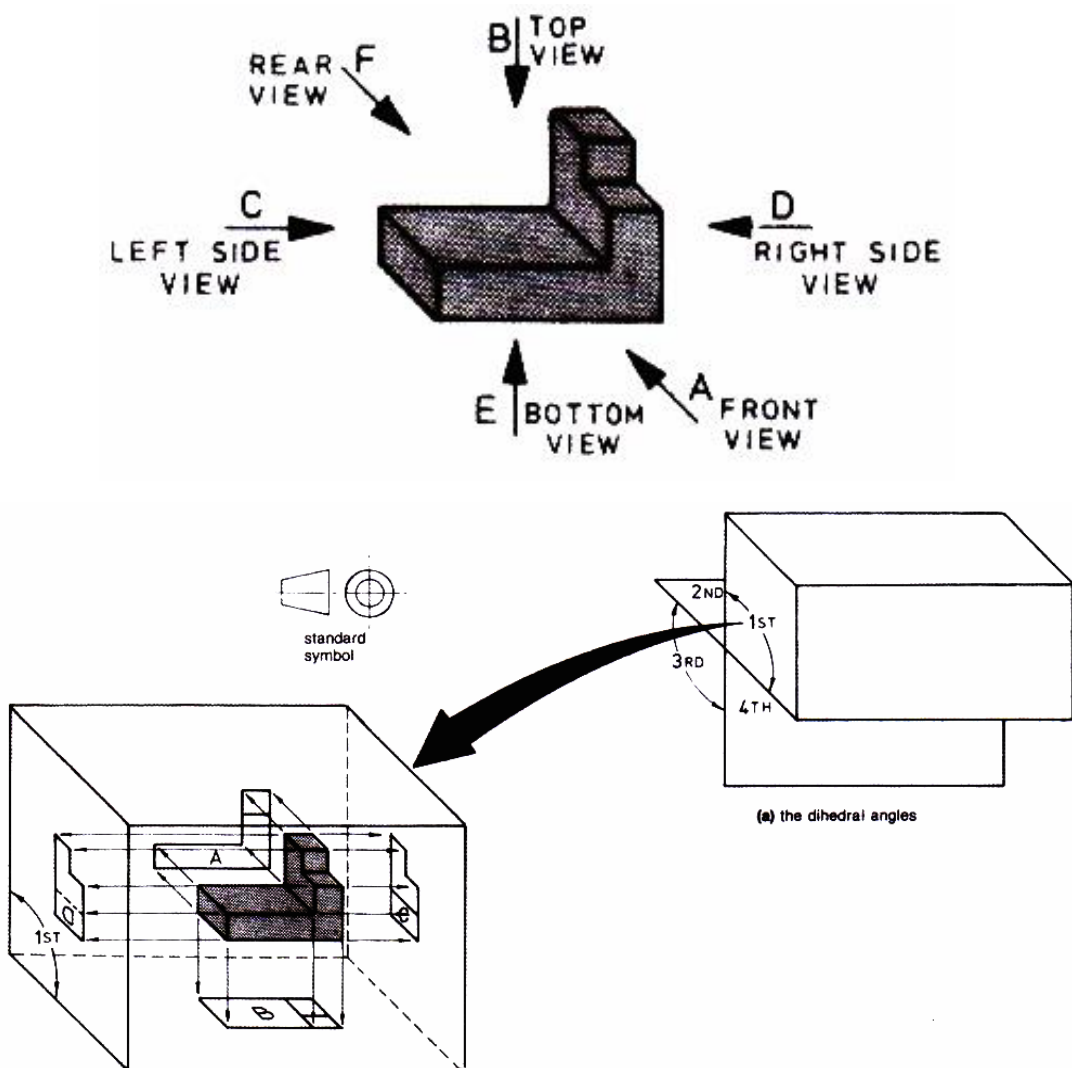


Fig .3.12: ISO standard first angle projection

3.2.3. Third-Angle Projection

Third angle projection is the standard projection for the United States and Canada.

In this, the object is situated in Third Quadrant. The Planes of projection lie between the object and the observer. The front view comes below the xy line and the top view about it.

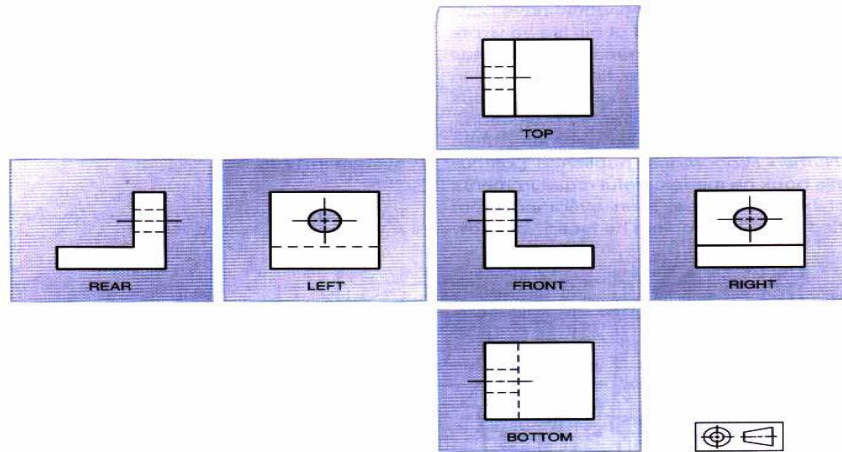


Fig .3.13: U.S.standared third angle projection

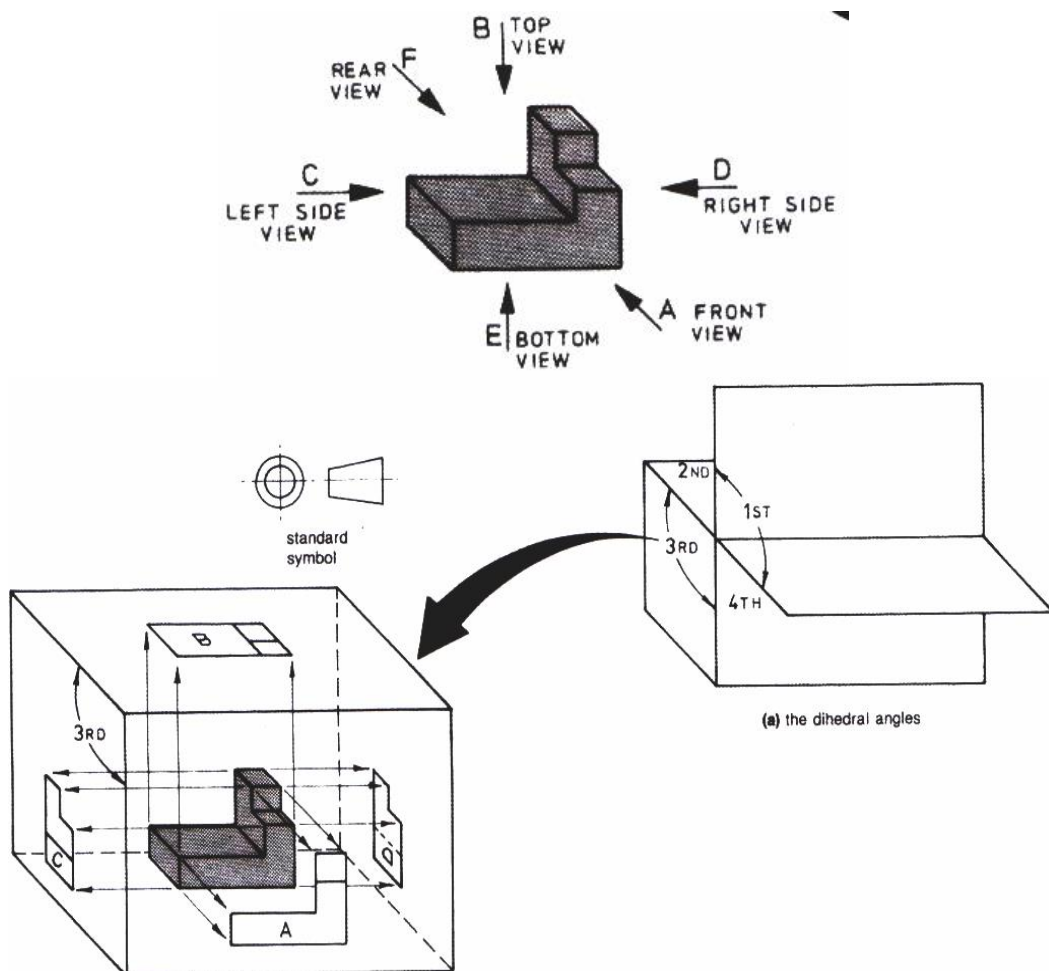


Fig .3.14: U.S.standared third angle projection

3.2.4. The rule of orthographic projection principles

1. Alignment of features
2. Distances in related views
3. True length and size
4. Foreshortening
5. Configuration of planes
6. Parallel features
7. Edge views

3.3. 3D Pictorial drawing

Definition:

It is a three dimensional representation of an object.

Comparison of Multi View Drawing and Pictorial Drawing

Pictorial drawings have the following features to multi view drawing:

- ✓ Is an effective means of communicating an idea
- ✓ Shows only the appearances of parts and designs
- ✓ Extensively used in catalogs of sales, manufacture, maintenance publications,
- ✓ Show several sides over a single view
- ✓ Not satisfactory for complete description of an object

3.3.1. Types of Pictorial Drawing:

The most common types are three. These are:

1. Oblique
2. Axonometric – Isometric
3. Perspective

1. Oblique Drawing:

It is easiest of the three to draw. But seldom used.

Front view is drawn exactly as it would appear in multi view drawing

- ✓ Circles appear as a true circle over the front view.
- ✓ Rectangles parallel to the frontal plane are in true size

You use 3-axes; two at right angles and one at an angle of convenient, but most of the time it is preferable to use 45°.

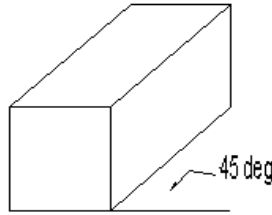


Fig .3.15 : oblique drawing set up

The line of sight should not make an angle less than 45° with the picture plane. This would result in a receding axis longer than true length, thereby distorting the pictorial.

Advantage:

- ✓ Circles or cylinders can easily drawn easily on the front face in their true shape
- ✓ Irregular shapes can be easily sketched on the front view in the same manner.

2. Axonometric Drawings

In axonometric drawing the three faces of rectangular object are all inclined to the plane of projection. Here the observer is considered to be at infinity, and the visual rays are parallel to each other and perpendicular to the plane of projection.

By chapter one, we have already considered the three types of axonometric projections.

These are:

- A. Isometric drawing
- B. Diametric drawing
- C. Trimetric drawing

I. Isometric drawing

Isometric drawing is way of presenting designs/drawings in three dimensions. The example below has been drawn with a 30 degree set square. Designs are always drawn at 30 degrees in isometric projection. It is vital that drawing equipment such as T-squares and 30/60 degree set squares are used carefully. The drawing paper should be clip securely to a drawing board.

- Isometric means equal measure.
- Makes equal angle with the principal plane (120°).
- Is the most commonly used axonometric drawing type.

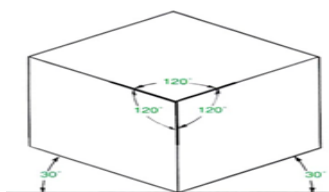


Fig .3.16: Isometric drawing set up

Notice:

- Isometric drawing is similar to an Isometric projection except that it is not a true axonometric projection, but an approximate method of drawing a pictorial.
- Isometric projection is foreshortened by 82% of full size. The Isometric drawing is drawn full size for convenience.

II. Diametric drawing

- Two principal planes have equal angle measurement.
- seldom used

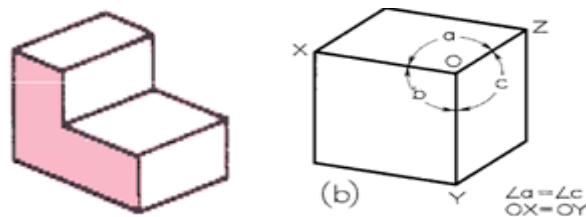


Fig .3.17: Diametric drawing presentation set up

III. Trimetric drawing

- All angles measured in principal planes are none equal.

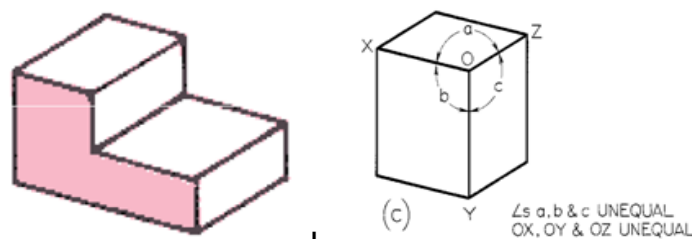


Fig .3.18: Trimetric drawing presentation set up

ii. Perspective Drawing

- Central projection is the other calling name.

It excels over all other types of projection in the pictorial representation of objects because it more closely approximates the view obtained by the human eye.

Terminology:

- ✓ The station of the observer's eye is called *Station point* (SP).
- ✓ The imaginary plane of projection is called *Picture plane* (PP).
- ✓ The point where all projection lines converge is called *vanishing point* (VP).
- ✓ A horizontal line in the front view representing an infinite horizontal is called *Horizon*.

The three basic types of perspectives are:

A. One point – single vanishing point

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- B. Two point – two vanishing point
- C. Three point – three vanishing point

One Point Perspective Drawing

Has one surface of the object parallel to the picture plane. However, other sides vanish to a single point. To draw one point perspective projection, we can develop from top and front views of an object.

- ✓ When drawing any perspective, the station point should be placed far enough away from the object to permit the cone of vision to be less than 30° to reduce distortion.

We can work one point perspective either by simply selecting a stationary point or by measuring points. The use of measuring point eliminates the need of placing top view above the front view.

3.3.2. Choice & layout of views

- ✓ Six principal views can be obtained for any object by using the principles of multi view drawing or orthographic projection which are the maximum views. Width dimension remains the same for top, front and bottom views. Whereas height is common for right side, front, left-side, and rear views.
- ✓ Only views that are necessary for a clear and complete description should be selected. Because the repetition of information may tends to confuse the reader. So that, it is important to have a set of views that describe an object clearly.
- ✓ Technical drawings usually include only the front, top and right side orthographic views because together they are considered sufficient to completely define an object's shape.

3.3.3. Ground Rules for Selection of Views

- ✓ Right hand side view should be used in preference to a left side view and a top view in preference to a bottom view.
- ✓ Place the object to obtain the smallest number of hidden lines. When both views of an equal numbers of hidden lines exist, the right side view will be traditionally selected.

- **Demonstration of the sketching technique of a circle drawn in isometric projection**

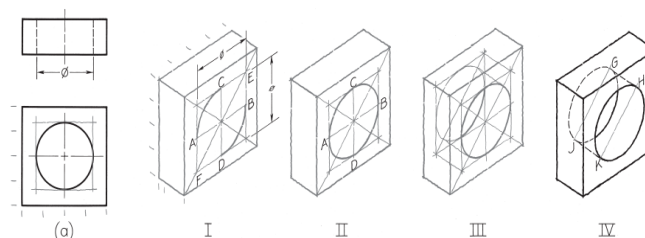


Fig .3.19: circle drawn in isometric

3.3.4. Precedence of Lines

The following listed lines are the various types conventionally used over the world now a day;

- ✓ Visible Lines – solid thick lines that represent visible edges or contours
- ✓ Hidden Lines – short evenly spaced dashes that depict hidden features
- ✓ Section Lines – solid thin lines that indicate cut surfaces
- ✓ Center Lines – alternating long and short dashes
- ✓ Dimensioning
 - Dimension Lines - solid thin lines showing dimension extent/direction
 - Extension Lines - solid thin lines showing point or line to which dimension applies
 - Leaders – direct notes, dimensions, symbols, part numbers, etc. to features on drawing
- ✓ Cutting-Plane and Viewing-Plane Lines – indicate location of cutting planes for sectional views and the viewing position for removed partial views
- ✓ Break Lines – indicate only portion of object is drawn. May be random “squiggled” line or thin dashes joined by zigzags.
- ✓ Phantom Lines – long thin dashes separated by pairs of short dashes indicate alternate positions of moving parts, adjacent position of related parts and repeated detail
- ✓ Chain Line – Lines or surfaces with special requirements

Hidden view technique

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

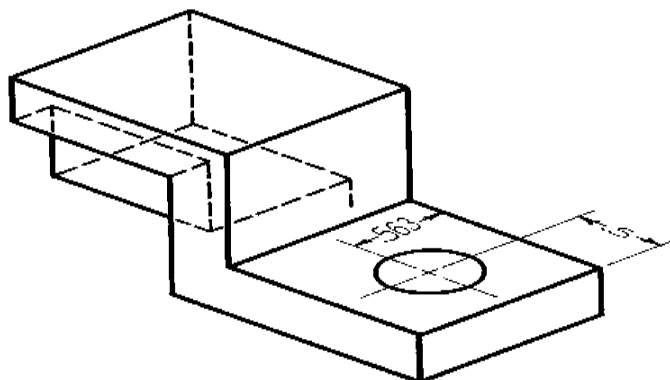


Fig .3.20: Hidden view technique

3.4. Sectional Views Overview

- Sections are used to show interior details clearly.
- A cutting-plane line shows where object was cut to obtain the section view.
- Cross hatching in the section view shows the solid surface of the object which were cut through to produce the section.
- Section views may replace standard views.
- Conventional practices, such as not showing hatching on ribs and webs, help make sections easier to interpret correctly.

ANSI standard section lines for various materials

The angle at which section lines are drawn is usually 45 degrees to the horizontal, but this can be changed for adjacent parts shown in the same section (135 degrees).

The sectional lines should be evenly equal space and should be thinner than visible lines

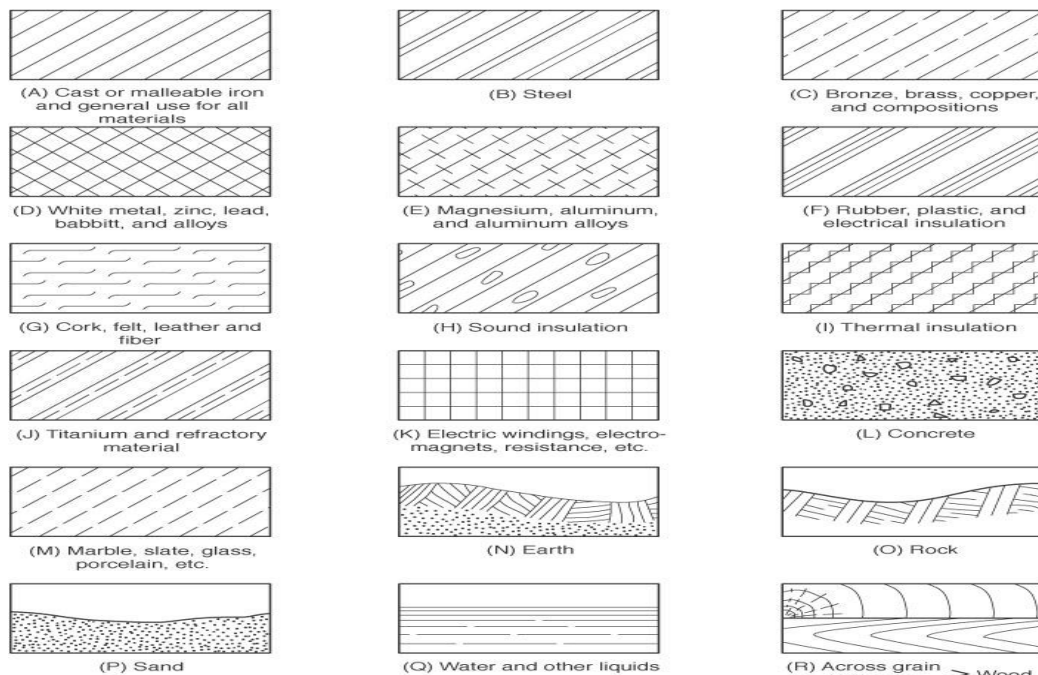
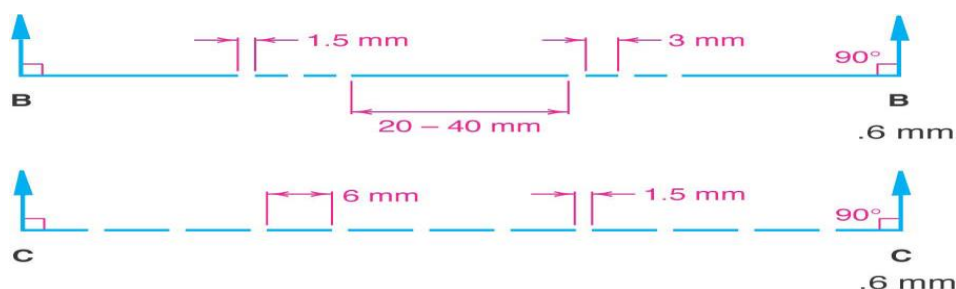


Fig .3.21: section lines for various materials

Standard cutting plane line styles



Section views are an important aspect of design and documentation and are used to improve clarity and reveal interior features of the parts and structures.

Cutting plane: Traditional section views are based on used of an imaginary cutting plane that cut through the object to reveal interior features

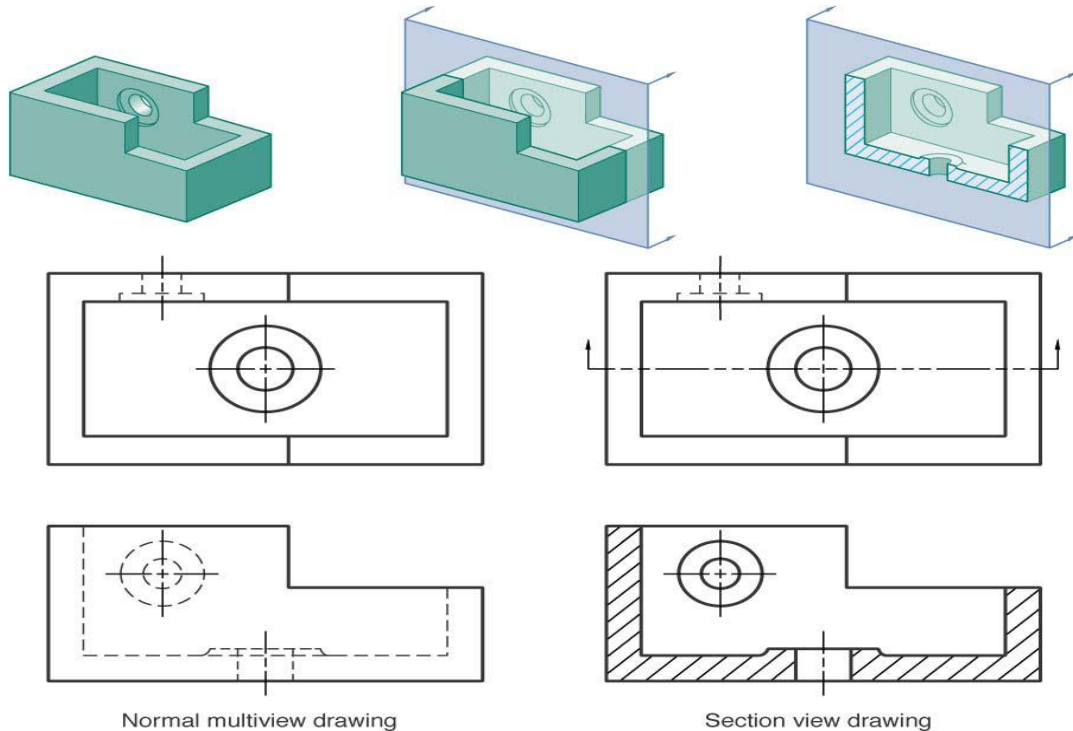


Fig .3.22: Figure shows a regular multi view drawing and a sectioned multiview drawing of the same part the front view; the hidden features can be seen after sectioning.

- ✓ An important reason for using section views is to reduce the number of hidden lines in a drawing.
- ✓ However, when a minimum number of hidden lines are needed to represent features other than primary one shown by the section
- ✓ Visible surfaces and edges that represent a change of plane behind the cutting plane are drawn in section view.

Kind of Sections

- A. Full Section
- B. Offset Section
- C. Half Section
- D. Broken-Out Section
- E. Revolved Section (Aligned Section)
- F. Removed Section (Detailed Section)

A. Full Section View

The view is made by passing the *straight* cutting plane *completely through* the part.

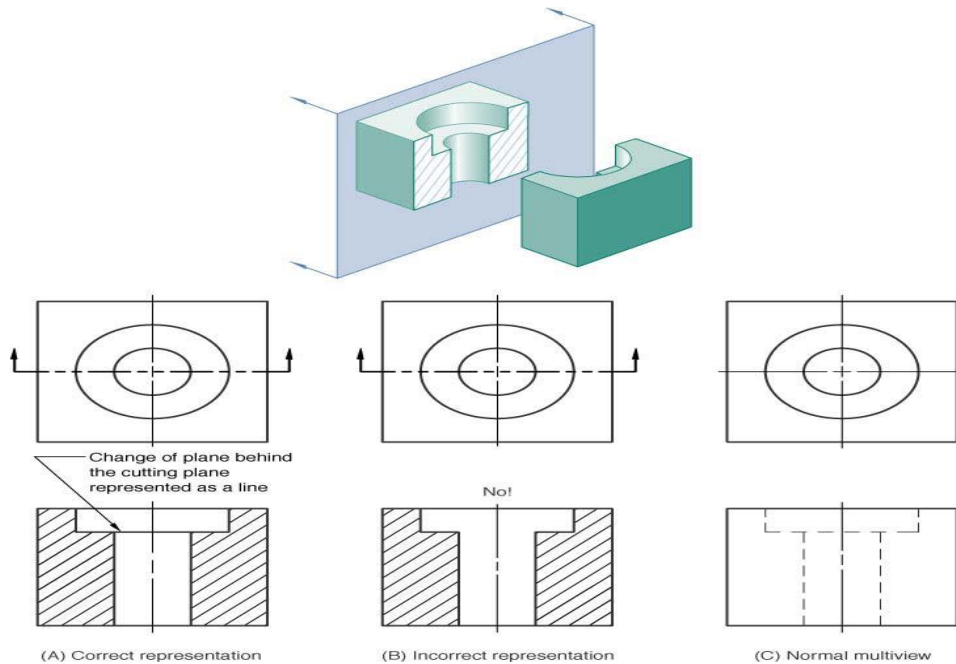


Fig .3.21: Full Section View

B. Offset Section

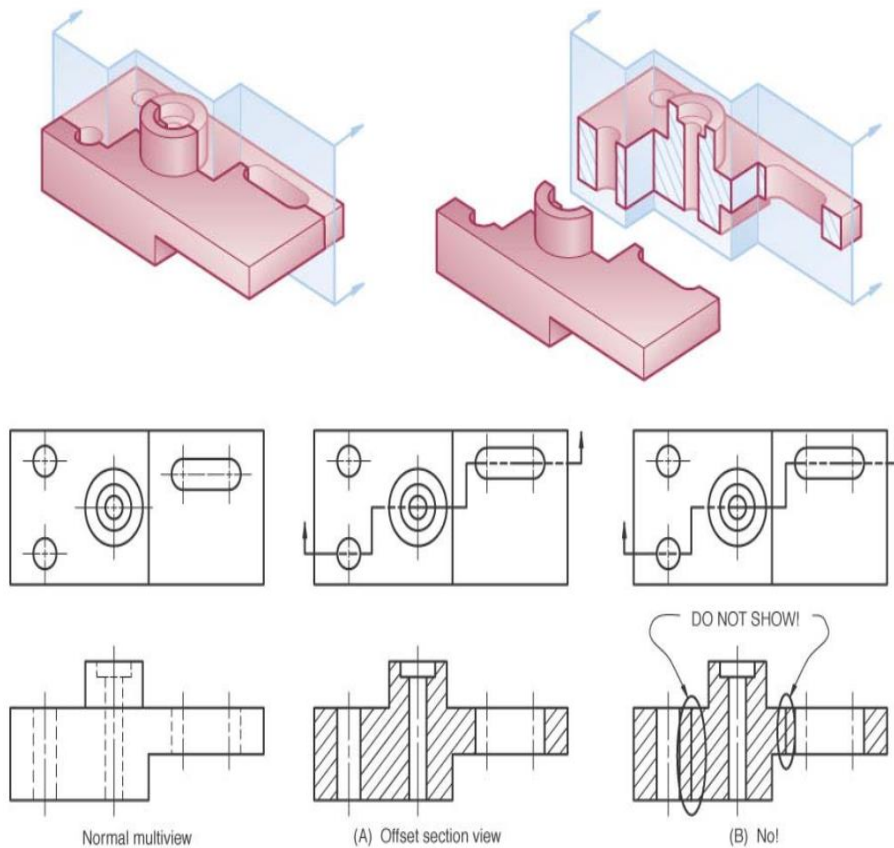


Fig .3.22: Offset Section

C. Half Section

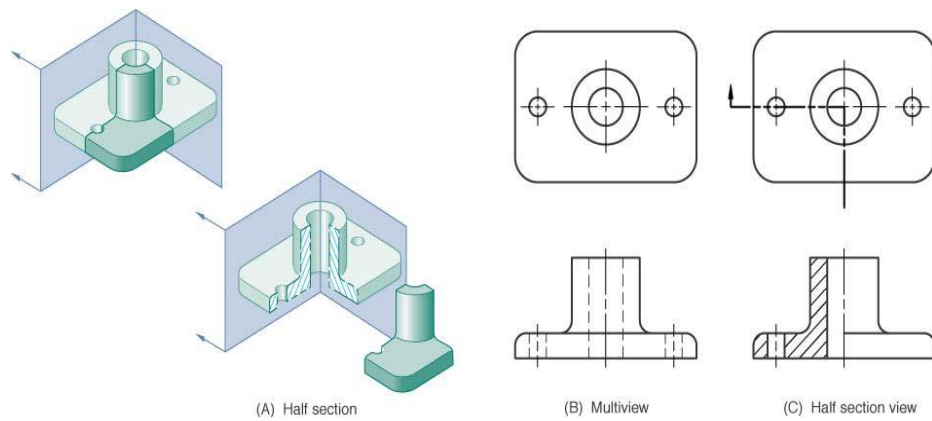


Fig .3.23: Half Section

D. Broken-out section

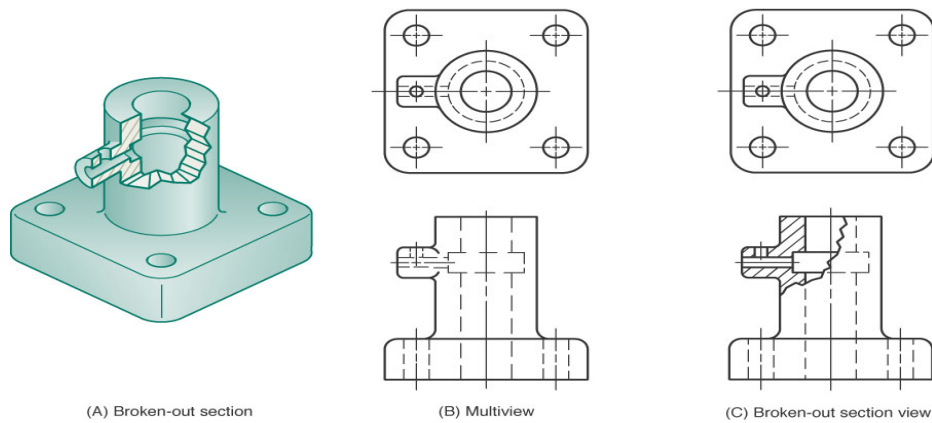


Fig .3.24: Broken-out section

E. Revolved section

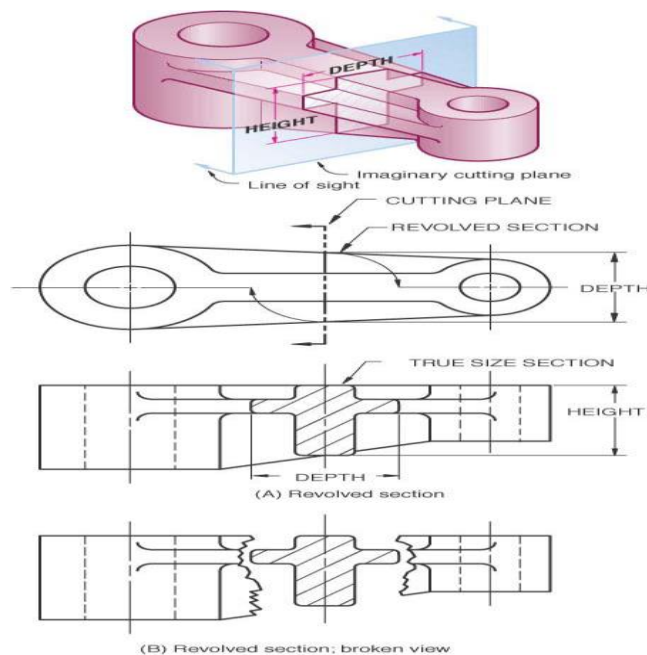


Fig .3.25: Revolved section

F. Removed section

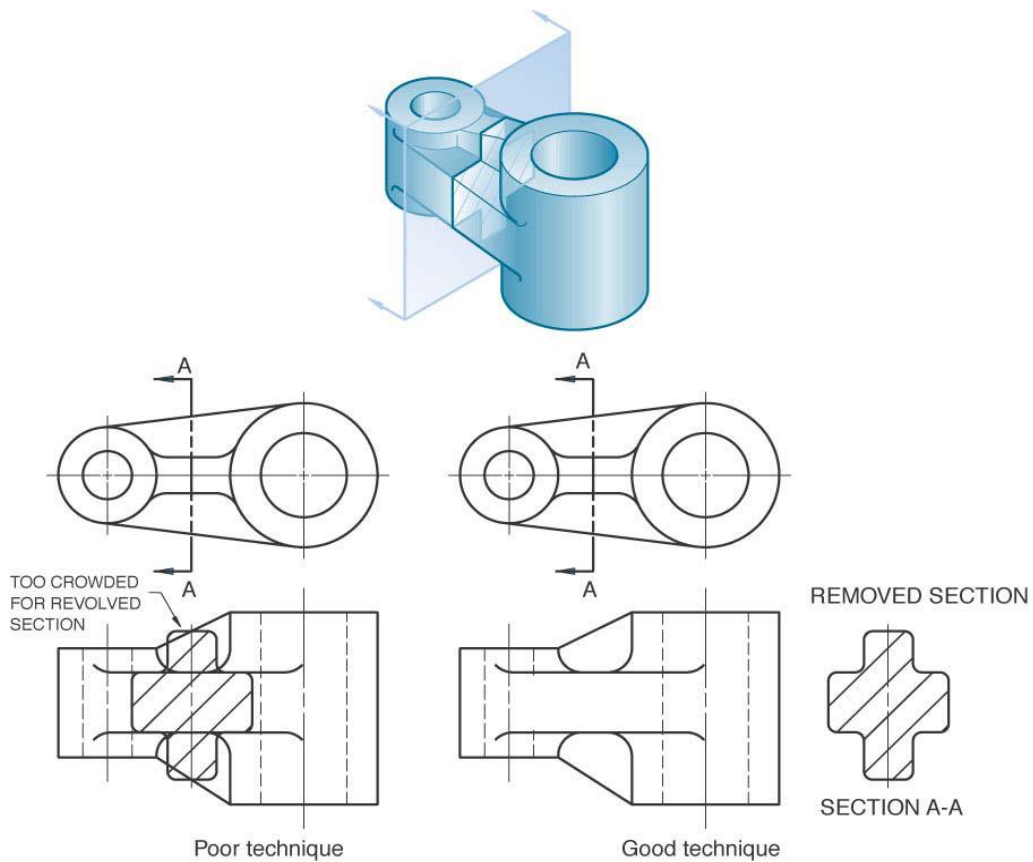
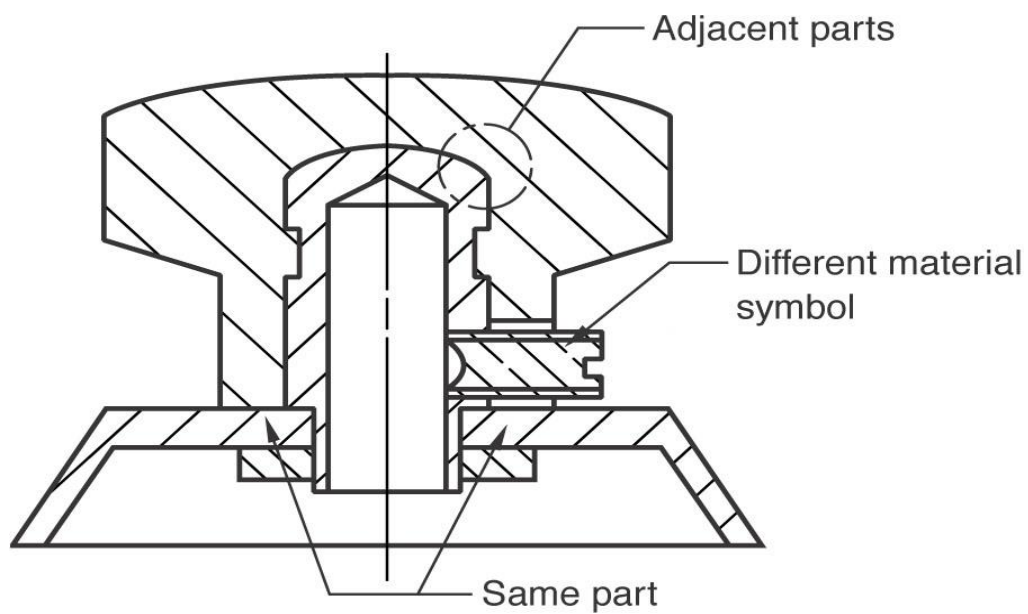


Fig .3.26: Removed section

G. Assembly section



A. Fig .3.27: Assembly section

Self check-3-1

Choose the correct answer for the following questions

1. Multi –view projection are collection of orthogonal two-dimensional projections of a three-dimensional body.
A. True B. False
2. In engineering drawing, the three-view multi-view drawing is standard. What is the collection of three-view drawings?
a. The top, front, and the left-side views
b. The front , bottom and the right-side views
c. The bottom, rare and the top views
d. The top, front, and the right side views
3. One of the following views gives length and width of dimensions?
a. side view B. Front view C. top view D. none
4. Which one of the common standard used in orthographic projection of drawing?
a. First angle projection c. European projection
b. Third angle projection d. A and C
5. Which orthographic views principles are in making drawing in first angle projection?
a. Front view on the above and the top view in the bottom
b. front view and the side view are always in line horizontally
c. Front view is drawn seeing the object in a direction is which its length is seen.
d. All above answer are correct
6. Which orthographic projection is not correct about third angle projection methods?
a. Object is placed in 3rd quadrant
b. Object is placed in 1st quadrant
c. Plane of projection is b/n observer and object
d. None of the above
7. _____ is a diagram, picture, schematic or technical drawing of an object, that shows the relationship or order of assembly of various parts.
a. Perspective drawing
b. Isometric drawing
c. Exploded drawing
d. Axonometric drawing

Part II: Give short answer for the following questions

1. _____ is the standard projection for the United States and Canada and the object is situated in Third Quadrant
2. When the object is situated in First Quadrant and the standard in Europe and Asia is called _____.
3. _____ are used to show interior details clearly.
4. What are the important reason for using section views

Operation Sheet 3.1.isometric and view

- **Operation title:** To draw Isometric view and Multi view drawing
- **Purpose:** To practice and demonstrate the knowledge and skill required in Isometric view and Multi view
- **Instruction:** Use the given figure below (Figure 3.21-3.24), use tools and equipment. For this operation you have given 6 Hour and you are expected to perform the exact drawing on your paper sheet.
- **Tools and requirement:**
A3 or A4 paper, Ruler, Scale, Pencil, T-square, set square 30/60 and 45 degrees
- **Precautions:** draw the Isometric view and Multi view drawings in the correct procedure:

Procedure:

Step1. Set up the drawing paper on top of the drawing board.

Step2. Check to see that the paper edges are parallel to the left and bottom edges of the board respectively.

Step3. Properly secure the paper on top of the table by using masking tape or tacks or the likes.

Step4. Using the set of triangles and T-square, draw the border line around the drawing paper, and title block at the bottom part.

Step5. Be sure to check the sharpness of your pencil lead. Use standard sharpening for good aesthetic result of your work.

Step6. For normal drafting or lettering use the soft lead pencil (**HB**) for final results. Use the harder lead pencil (**4H**) for guidelines drawing only.

Step7. For inking, drafting pens of 0.1, 0.3 and 0.5 pen points are needed.

Step8. Use the set of triangles, T-square and lead pencil this activity.

Step9. Always remember that construction lines and guidelines are necessary in sketching and drafting, so utilize this knowledge.

Step10. Apply the knowledge on line quality in your work.

Step11. Accuracy and aesthetics always go hand in hand with drafting, so do your work with quality.

Step12. You may submit your finish work once you are true but should be within the time specified for submission.

Lap Test-3.1

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8 hours.

You are required to do the following activities as required in the problem

Task 1: Draw the isometric view of the object whose orthographic projections are given in fig. All dimensions are in mm

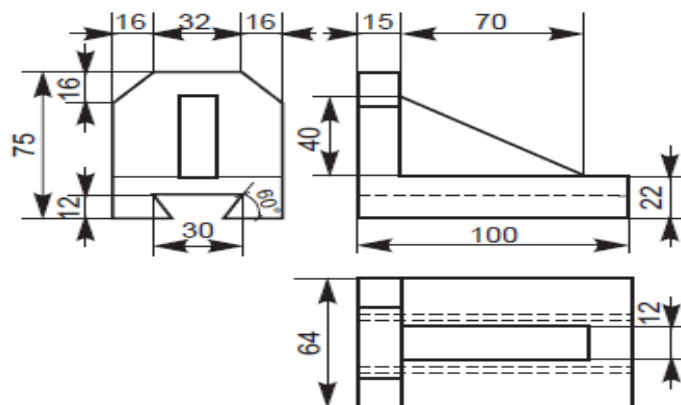


Fig .3.21: orthographic view

Task 2: - Draw the isometric view of the object whose orthographic projections are given in fig. All dimensions are in mm.

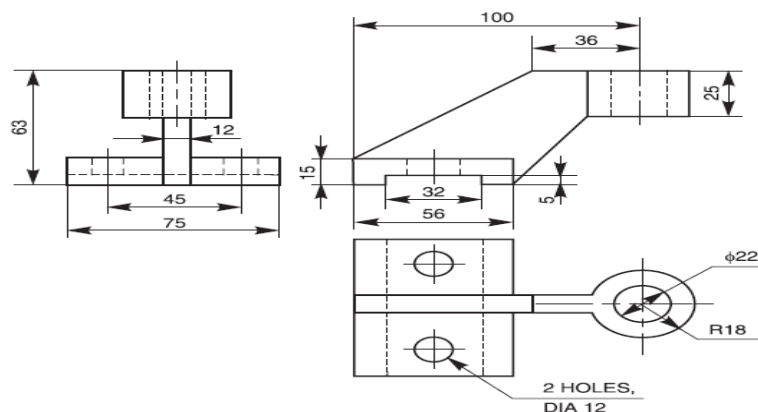


Fig .3.22: orthographic view

Task 3: Draw front view, top view and side view of the model shown below by **first** and **third angle** projection respectively.

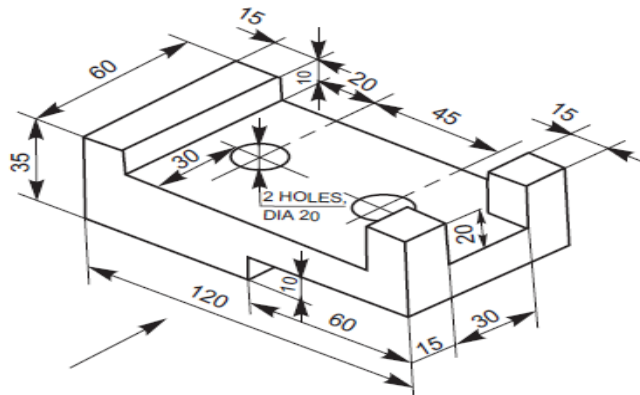


Fig .3.23: isometric view

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

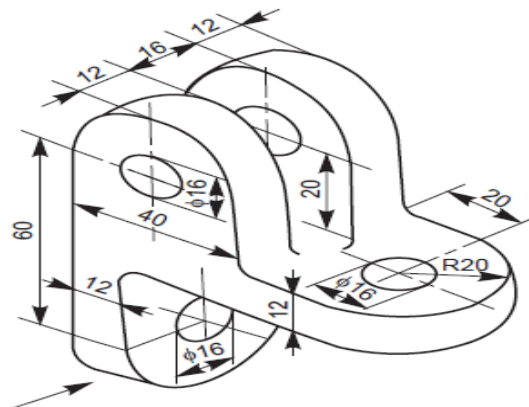


Fig .3.24: isometric view

Task 5: Draw sectional view front view, the view from above and the view from the right

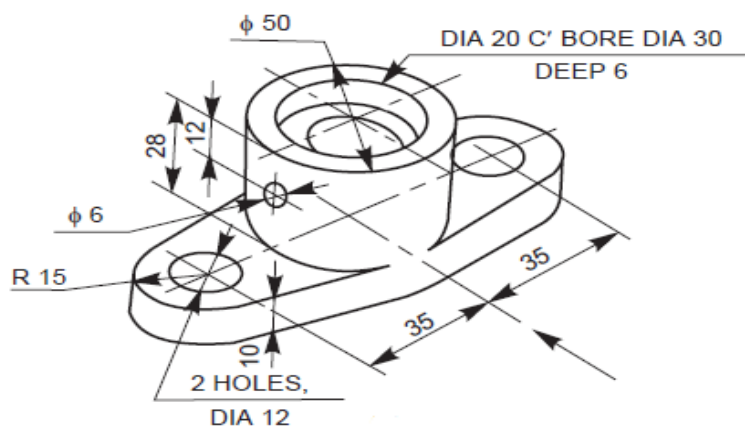


Fig .3.25:isometric view

Unit Four: Prepare freehand sketch

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

- Sketch views.
- necessary drawing dimensions

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Sketch correctly appropriate views.
- Showing the necessary dimensions using instruction on drawing

4.1. Free Hand Sketching

- Sketching is as much a thinking process as it is a communication technique and it is a rapid method of drawing.
- A free hand sketch is a hand drawn sketch that convey information about the detail of a particular part or section of a project or component
- It aids in eliminating errors on the drawings later on by having a clear understanding about the details that must be drawn
- It is a “step” between the actual part that must be drawn and the completed drawing

4.1.1. Requirements of a free hand sketch

- Free hand sketches should be made proportional. As in the example above, I used each block as a 5mm representation. This helped to keep the sketch of the different parts proportional
- Details should be indicated correctly, inaccurate information will translate to mistakes on the final drawing
- The free hand sketch should have as much detail as possible
- It should include all features that may have an impact on the design of the part/section
- It should be readable by someone else. Sometimes it may happen that someone else will be creating the drawings, so one should make sure that someone else can work from the sketch
- Neat and tidy sketches makes creating the drawings easier
- Complete with all the relevant dimensions. Missing dimensions will cause difficulties when the actual drawings are made.
- Correct and complete. Remember, the sketch is the main information where the drawing is created from, correctness and completeness is vital.

4.2. Dimensioning

The purpose of dimensioning is to provide a clear and complete description of an object. A complete set of dimensions will permit only one interpretation needed to construct the part. In some cases, engineering drawing becomes meaningless without dimensioning. Maintaining scale only does not make a drawing sufficient for manufacturer. By direct measurement from drawing according to the scale is very laborious, time-consuming and such a part cannot be manufactured accurately. In general dimensioning system provides following information

- ✓ Sizes and locations of features
- ✓ Material's type

- ✓ Number required
- ✓ Kind of surface finish
- ✓ Manufacturing process
- ✓ Size and geometric tolerance

Unit of Dimensioning:

As far as possible all dimensions should be given in millimeters, omitting the abbreviation mm. Even when it is not convenient to give dimensions in millimeters and another unit is used, only the dimension figures are written. But a foot note such as 'all dimensions are in centimeters' is inserted in a prominent place near the title block. The height of the dimension figures (as stated earlier) should be from 3 mm to 5 mm. The decimal point in a dimension should be quite distinct and written in line with the bottom line of the figure. A zero must always precede the decimal point when the dimension is less than unity.

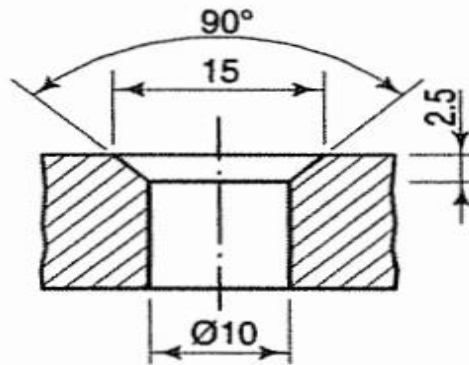


Figure: 4.1. General Rules for Dimensioning

- Dimensioning should be given within the extent of the view in general.
- Dimensioning should not be duplicated in other view.
- No subtraction or addition should be required to define or locate a feature.
- Dimensioning should be inserted on relatively larger available view to make it clear.
- One system of dimensions either unidirectional or aligned has to be used throughout the drawing.
- Dimensioning to the hidden lines should be avoided, in general.
- Dimensioning should be made on the view, which represents the shape of the part best.
- A zero must be placed before decimal point.

4.2.1. Elements of Dimensioning:

- Extension lines
- Dimension lines
- Arrowheads
- Leaders
- Texts, numbers and symbols.

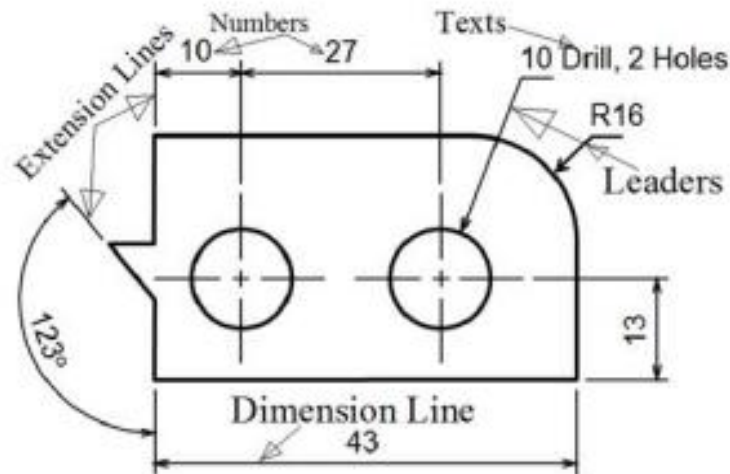


Figure: 4.2. Elements of Dimensioning

- ✓ **Dimension line** — it is a thin continuous line terminated by arrowheads touching the outlines, extension lines or centre lines.
- ✓ **Extension line** (Projection line) — It is a thin line drawn outside and along the outline. There should be a gap of about 1 mm between the extension line and the outline.
- ✓ **Leader line** —one end of the leader terminates either in an arrowhead or a dot. The arrowhead touches the outline, while the dot is placed within the outline of the object. The other end of the leader is terminated at a horizontal line
- ✓ **Arrowhead** — an arrowhead is placed at each end of a dimension line. Its pointed end touches an outline, an extension line or a centre line. The length of arrowhead should be about three times its maximum width. The triangle of the arrow should be completely filled in.

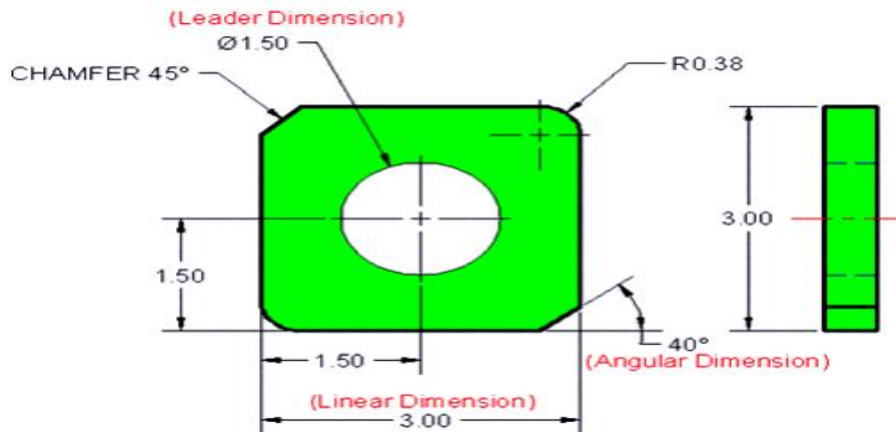


Figure: 4.3. Dimensioning

4.2.2. Size and Location Dimensions

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

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

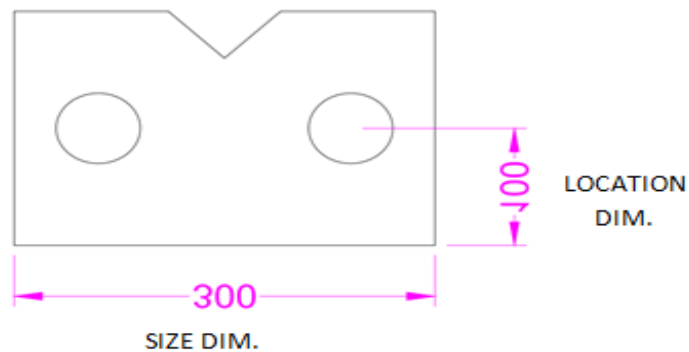


Figure: 4.4. Size and location Dimension

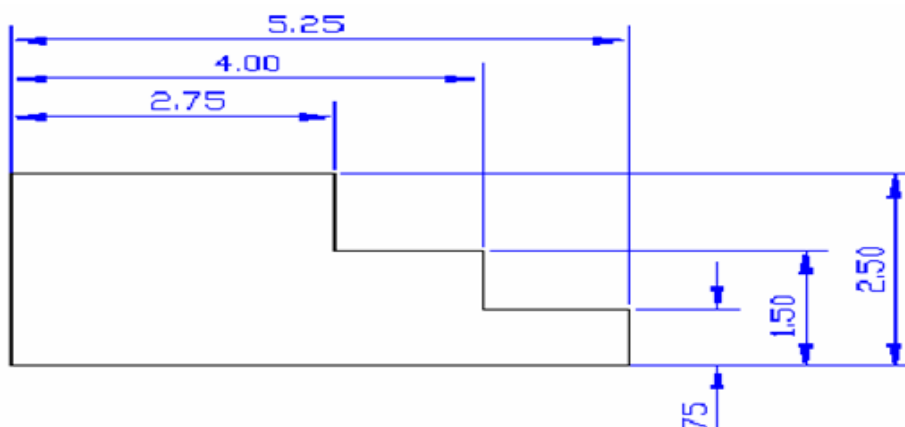


Figure: 4.5. Datum plane Dimensioning

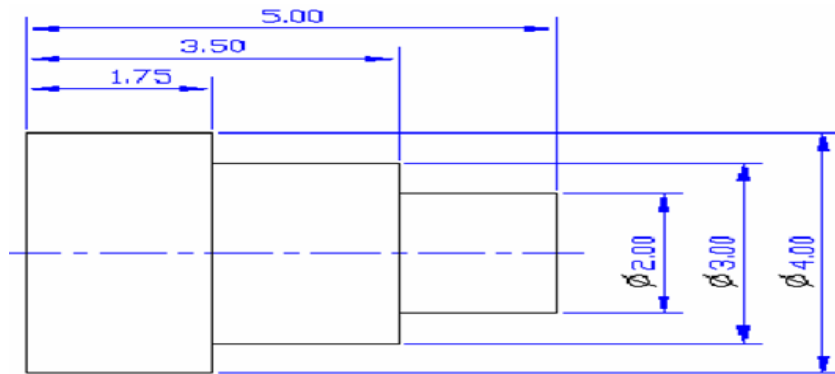


Figure: 4.6. Cylindrical Dimensioning

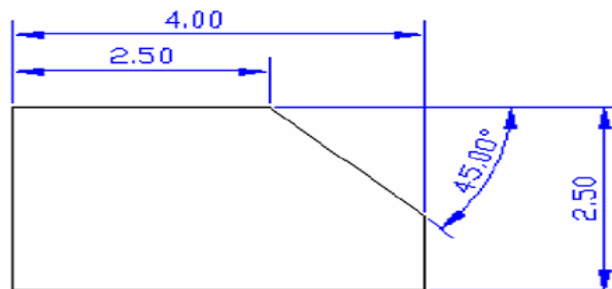


Figure: 4.7. Angular Dimensioning

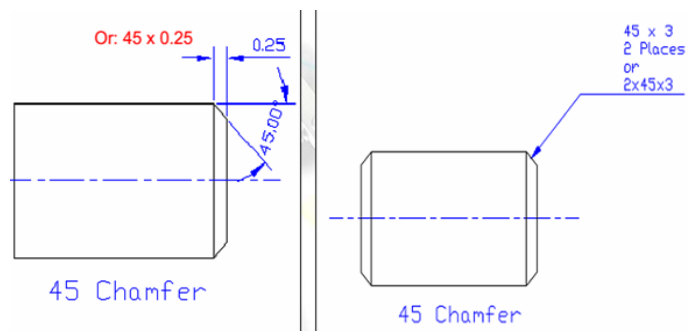


Figure: 4.8. Chamfer Dimensioning

Holes

The methods of dimensioning holes are shown in Fig.

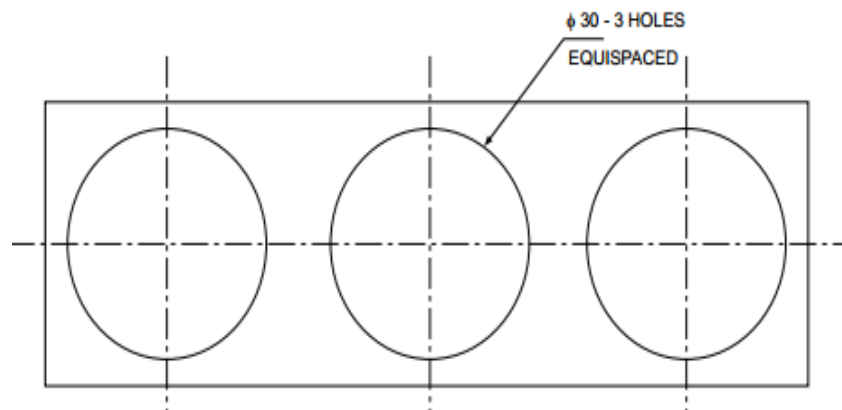


Figure: 4.9. Dimension of holes and circular shapes

Tapers:

Dimensioning of tapered objects is shown in Fig.

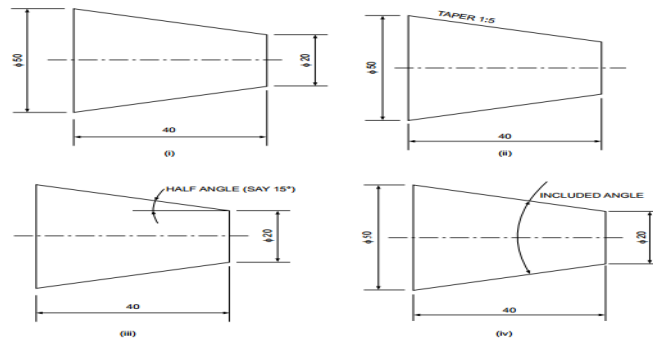


Figure: 4.10. Tapers Dimensioning

4.2.3. Dimensioning Tolerance and Notation

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

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

Type of tolerances

I. General Tolerance

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

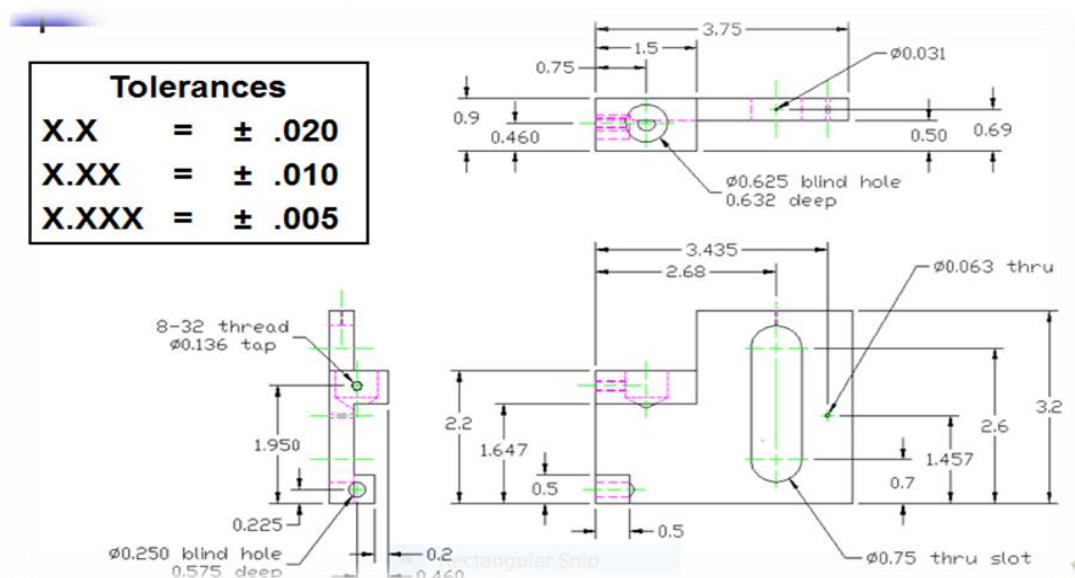


Figure: 4.11. General Tolerances

II. Geometric tolerance

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

The use of linear tolerances when dimensioning the part can control the size of a product. It is however possible for limits of size to be maintained while the shape of a part or feature deviates significantly from the intended form. To control this deviation, a method of specifying the acceptable tolerance of form is required and this is done using geometric dimensioning and tolerance symbols. These enable the designer to specify on the drawing, the geometry or shape of a component and they provide a precise definition of what constitutes a functionally good part.

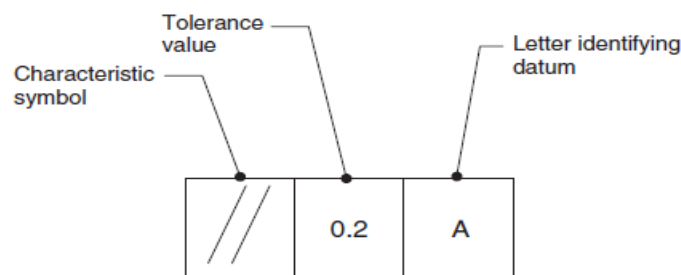


Figure: 4.12. Representing Geometric Tolerances

III. Angular tolerance

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

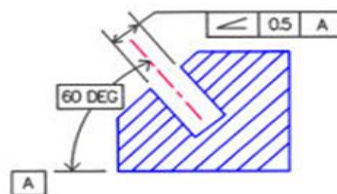


Figure: 4.13. Angular Tolerances

Rules of Dimension Lines:

Dimension lines are the lines that show the dimensions of a specific portion indicated by extension lines.

Following conditions should be maintained while inserting a dimension line:

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- Dimension line should be approximately 10mm away from visible line.
- Spacing between consecutive parallel dimension lines may also be kept as 10mm.
- Dimension lines are broken near the middle to allow space for dimensions.
- As far as possible dimension lines should be placed outside the view.
- Dimension lines should not cross each other.
- Center lines should never be used as dimension lines.
- If space between extension lines is very short for inserting arrows, the arrows may be provided outside the extension lines

Self Check-4.1

Part: I. Say true or false.

1. Dimension is a numerical value expressed in appropriate units of measurement.
2. Dimensions should be placed parallel to their dimension lines.
3. Notes should always be written horizontally in capital letters

Part: II. Choose the correct answer from the following Questions

1. One is true about Rules of Dimension Lines
 - A. Dimension lines should not cross each other.
 - B. Center lines should never be used as dimension lines.
 - C. As far as possible dimension lines should be placed outside the view.
 - D. All
2. Dimensioning should follow these guidelines.
 - A. Accuracy
 - B. Readability
 - C. Completeness
 - C. Clearness
3. In general dimensioning system provides following information
 - A. Sizes and locations of features
 - B. Kind of surface finish
 - C. Size and geometric tolerance
 - D. All

Part: III. Give short answer

1. List Elements of Dimensioning?
2. Write at list three Requirements of a free hand sketch?

Operation sheet-4-1

- **Operation title:** Techniques for Indicating dimensions, notes and specifications
- **Purpose:** To practice and demonstrate the knowledge and skill required dimensions notes and specifications of the given drawing part.
- **Instruction:** Use the given figure below (Figure 4.13), all necessary For this operation you have given 20minuts and you are expected to perform the exact dimensions.
- **Tools and requirement:**

A4 paper, Ruler, Scale, Pencil, set square 30/60 and 45 degrees

- **Precautions:** set the correct dimensions neat and clean
- **Procedures in doing the task**

Step 1- Identify method of dimensioning

Step 2- Dimensions should be placed outside the view.

Step 3 - Dimensions should be taken from visible outlines rather than from hidden lines.

Step 4-Dimensioning to a center line should be avoided except when the centre line passes through the center of a hole.

Step-5- Each feature should be dimensioned once only on a drawing.

Step 6 - Dimensions should be placed on the view or section that relates most clearly to the corresponding features.

Step 7 – Each drawing should use the same unit for all dimensions, but without showing the unit symbol.

Step 8 - No more dimensions than are necessary to define a part should be shown on a drawing.

Step 9 – Complete dimensioning

Lap Test-4

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 4 hours.

1. Redraw the isometric drawing, the orthographic views and the complete dimensioning of the following object.

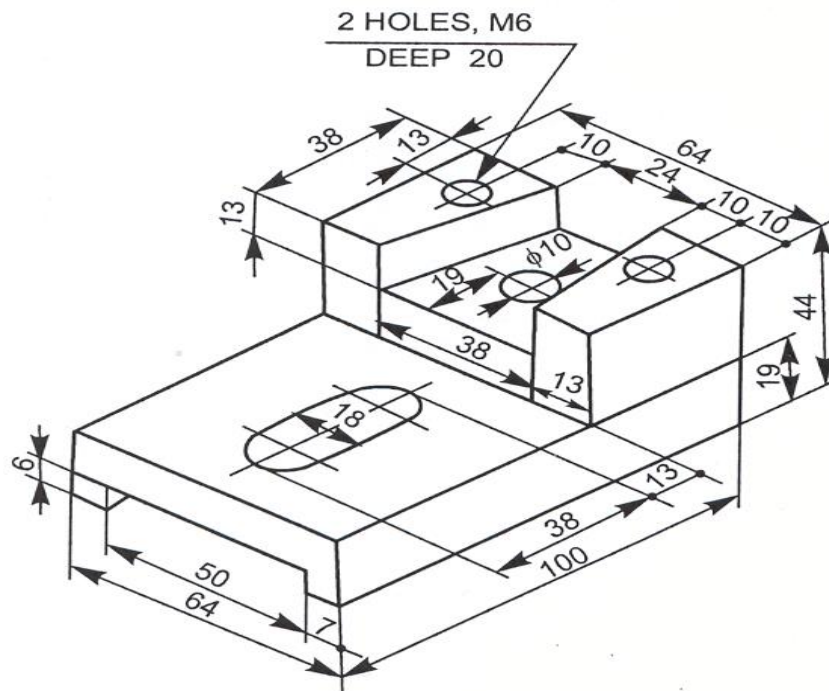


Figure: 4.13. Isometric part drawing

Unit Five: Interpret details from sketches and drawings

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

- Components and assemblies
- symbols and abbreviations
- dimensions and instructions
- material requirements

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Identifying Components, assemblies or objects.
- Recognizing Commonly used symbols and abbreviations
- Identifying and following dimensions and instructions
- Identifying material requirements

5.1. Components and Assemblies

5.1.1. Component

A. Threaded Fastener: - Fastening devices are very important in the manufactured products such as, in the machines, fabrication and in the construction of buildings. Threaded fasteners are widely used for fastening or joining of two elements temporarily by means of screw threads. These are used in pairs for their action. The important types of screw threads are bolts and nuts, studs, screws etc. A threaded fastener is a cylindrical bar having a screw thread on one end and having a head at the other. The bolt passes through holes in two parts and is rotated into a nut at the other end. The bolt head, usually hexagonal form, is used to rotate the bolt by a wrench.

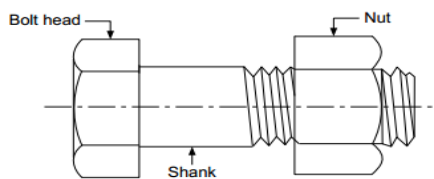


Figure 5.1. Bolt with head

Nuts: A device used with a bolt and cap screw to join two parts together temporarily is known as nut. A nut has internal threads. It is expressed in terms of diameter of the threaded hole in the nut into which a bolt, or cap screw is fitted. These are available in two styles: square and hexagonal. In addition to the plain form usually associated with bolts, several special purpose styles are available. The top corner of a nut is chamfered at an angle of 30° to 45° .

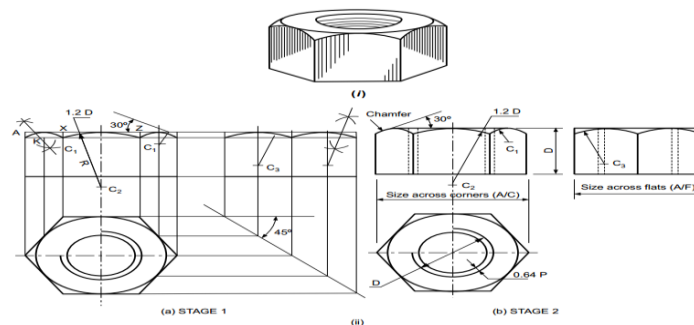


Figure 5.2. Nut

Bolts: A bolt is a cylindrical piece of metal, having a head on one end. Thread on the other end, passed through clearance holes in two parts and draws them together by means of a nut screwed on the threaded end. The shape of the head depends upon the purpose for which the bolt is required. Bolts are available in a variety of shapes and sizes. The square and hexagonal heads are the two most important designs.

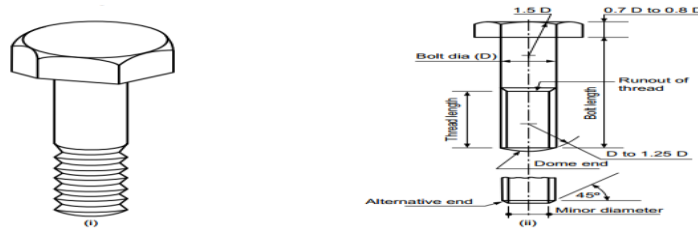


Figure 5.3. Bolt

Hexagonal Head Bolt: A hexagonal head bolt is the most common form of bolt. The length and diameter of bolt depends upon the thickness of parts to be joined. The bolts are usually chamfered at the upper end surface at an angle of 30° . A hexagonal head bolt has wide applications in engineering works.

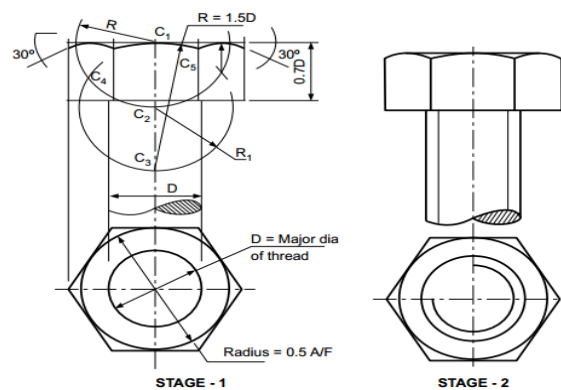


Figure 5.4 A hexagonal head bolt geometrical construction

Screw Threads: - Different parts of steel structure, various types of machines and other engineering products are joined together by fastening. Then screw threads are used for connecting two or more different parts together. A threaded piece consists of a cylindrical rod along with a projection, or thread in form of a helix. The threads are formed by cutting helical grooves on a cylindrical surface. The threaded rod is called screw. It is an operating element of temporary fastening. It is used on bolts, nuts, screws etc. Threads are generally cut on lathe machine, whereas small size screw threads are cut by means of a die.

Applications: The main uses of threads are in steel structure, various types of machines and other engineering products such as in the construction of all types of buildings.

Terminology of Screw Threads: - A screw thread is formed by cutting a continuous helical groove on a cylindrical surface. It may be single threaded or double threaded. The helical grooves may be cut either right hand or left hand.

- ✓ External Threads
- ✓ Internal Threads

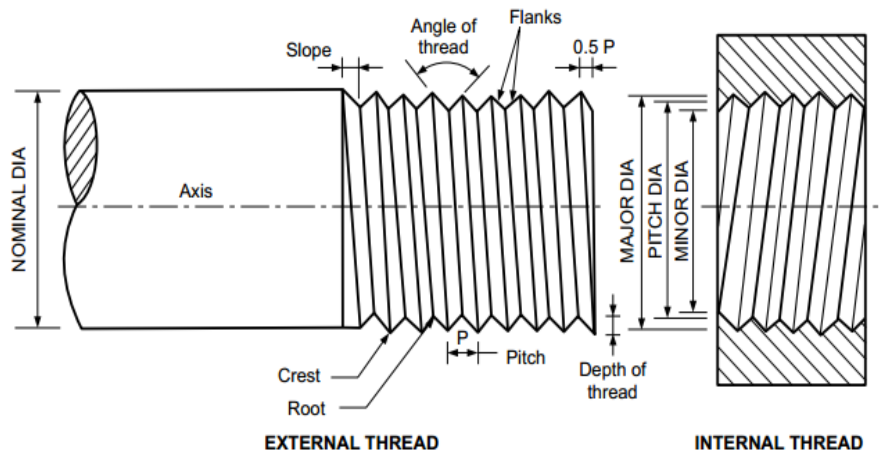


Figure 5.5 Terminologies of Screw Threads

Major Diameter: It is the largest diameter of an external or internal screw thread. It is also known as outside diameter or nominal diameter.

Minor Diameter: It is the smallest diameter of an external or internal screw thread. It is also known as core or root diameter.

Pitch Diameter: It is the diameter of that imaginary cylinder whose surface will intersect the threads at such point where the width of the threads will equal the adjacent width of the space between them.

Pitch: It is the distance measured parallel to the axis between corresponding points of adjacent thread forms.

Crest: It is the top surface which connects adjacent flanks of the threads.

Root: It is the innermost part of a thread.

Lead: It is the distance between two corresponding points on the same thread. Lead is equal to the pitch in case of single start threads; it is twice the pitch in double start and so on.

Flank: The surface between the crest and the roots of a thread is known as flank.

Threaded Angle: It is the angle of the threads.

Depth of thread: It is the distance between crest and root of a thread, measured normal to the axis of the screwed part.

Apex: The sharp corner the triangle opposite to its base.

Axis: The axis of the pitch cylinder of a screw thread.

Right and Left Hand Threads:

Right Hand Thread: When a threaded system winds, in a clockwise direction when seen axially is known as right hand thread. Threads are always assumed as right hand unless otherwise specified

Left Hand Thread: When a threaded system winds, an anticlockwise direction when seen axially, is known as left hand thread

Forms of Screw Threads: There are various forms of screw threads, which are used in engineering field. They are as follows:

- ✓ **British Standard Whitworth (B.S.W) Threads:** This type of thread is used in Great Britain. It is similar to a V-thread with only a minor difference. This thread forms an angle of 55° . These threads are found on bolts, nuts and studs etc. Now it is replaced by metric threads.

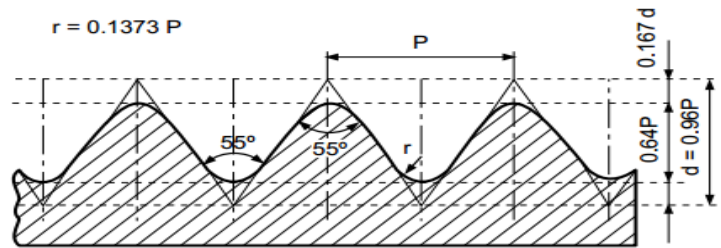


Figure 5.6. British Standard Whitworth (B.S.W) Threads

- ✓ **British Association (B.A.) Thread:** This type of thread is recommended by British Standard Association. The angle of the thread is 47.5° with both crests and roots rounded.
- **American National Standard Thread:** These types of threads are commonly used in United State of America with a thread angle of 60° . They are of 'V' shape and both crests and roots are flat. These threads are used for general purpose. The examples are: bolts, nuts, screw and tapped holes.

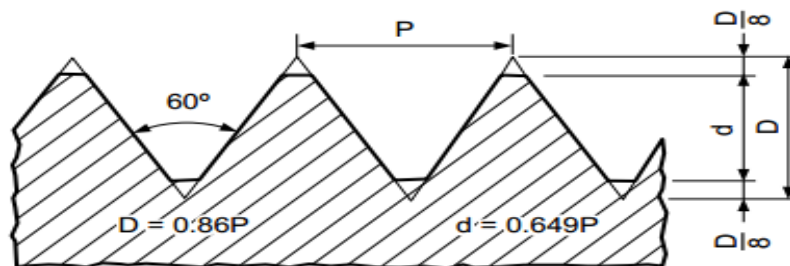


Figure 5.7. American National Standard Thread

- ✓ **Single Thread:** When only one helix forms the thread, which runs on a cylinder throughout its length is called a single thread or single start thread. On a single thread the pitch is equal to its lead.
- ✓ **Multiple Threads:** When more than one helix parallel to each other, form the thread, which runs on a cylinder throughout its length is called a multiple thread or multiple start thread. Its lead is equal to number of start times its pitch

- **Unified Standard Thread:** These threads, mostly adopted by America, Britain and Canada, carry an included angle of 60° . The thread has rounded crests and roots as shown in Fig. 2.24.

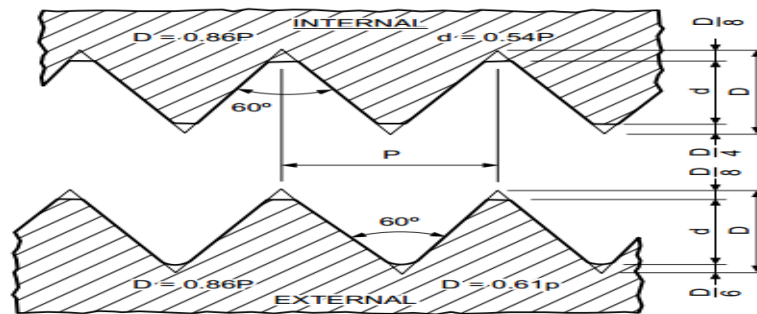


Figure 5.8. Unified Standard Thread

- **Square Thread:** In square thread the depth is kept half of the pitch. These square threads are widely used for transmission of power in either direction. These types of threads are usually found on lead screw of lathe machine, jack screw, valve spindles and vices etc. The various proportions of square threads are shown in Fig. 2.25.

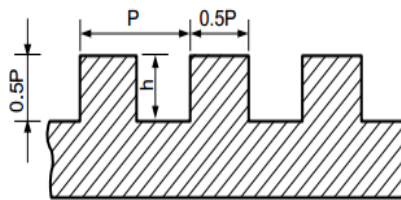


Figure 5.9. Square Thread

ACME Thread (IS: 7008: 1998): It is a modified form of a square thread and V-thread. It is easier to cut and is stronger at the root than the square thread. These types of threads are extensively used for transmission of power and motion. The thread angle is 29° . These threads are commonly used on screw cutting lathes, brass valves cock and bench vices. Acme thread can be cut on milling machine also. It is shown in Fig. 2.26.

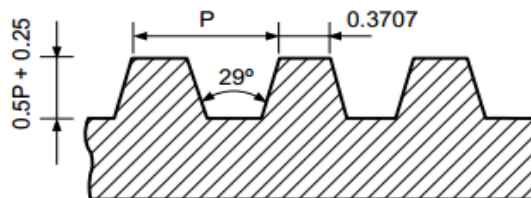


Figure 5.10. ACME Thread

Knuckle Thread: This thread is also a modified form of square thread with both crests and roots made semi-circular. It has rounded top and bottom as shown in Fig. 2.28. It can be cast easily and cannot economically be made on a machine. This type of thread is used for rough work. It is used in railway carriage, couplings, electrical bulbs and necks of glass bottle etc.

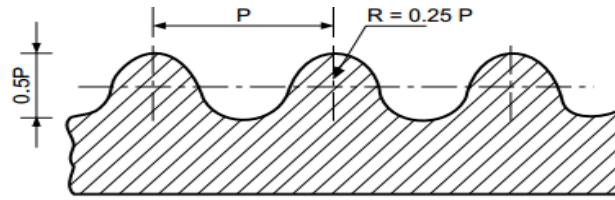


Figure 5.11. Knuckle Thread

Buttress Thread: Buttress thread is a combined form of ‘V’ and square threads with one flank of the thread perpendicular to the axis of the screw. The angle between its two flanks is 45° . It is used for transmission of power in one direction only and shown in Fig. 2.29. The application of buttress threads can be seen in carpenters vice, jacks’ plane and screw presses etc.

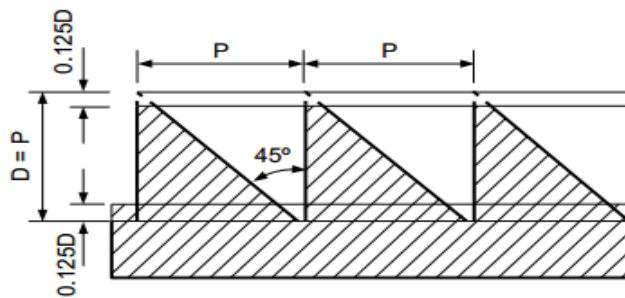


Figure 5.12. Buttress thread

Metric Thread: The Bureau of Indian Standards has recommended the adoption of the unified screw threads profile based on metric system. It is an Indian Standard thread and is similar to B.S.W. threads. It has an included angle of 60° instead of 55° . The basic profile of the thread is shown in Fig.

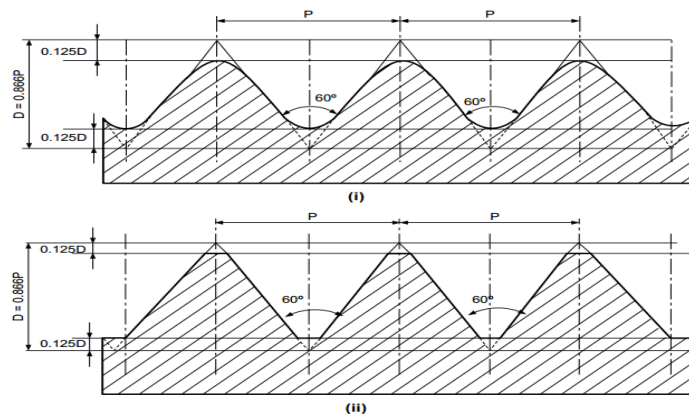


Figure 5.13. Metric Thread

Method of Drawing Hexagonal Nut: Draw a top view containing circle of diameter A/F equal to $1.5D + 3 \text{ mm}$ and circumscribe a regular hexagon about the circle with two sides horizontal. Next draw front view taking thickness equal to D . A 30° conical chamfer is recommended. Describe the arc with the radius R and centre $C2$. Draw the perpendicular

bisector of AX. The perpendicular bisector of AK intersects the perpendicular through K at C1. Describe the arc AX with centre C1; similarly, draw the side view which is a two face view.

Hexagonal Nut: - The following proportions are used to draw hexagonal nut:

- (I) Thickness of nuts = $TN = 0.8D$ to D
- (II) Size across flats = $A/F = 1.2D + 3$ mm (For bolts less than 12 mm in dia)
 $= 1.5 D + 3$ mm (For bolts more than 12 mm in dia)
- (III) Size across corners = $1.15 D \times$ size across the flats
- (IV) R = radius of front chamfer = $1.2D$
- (V) Angle of chamfer = 30° where, D = outer diameter of bolt

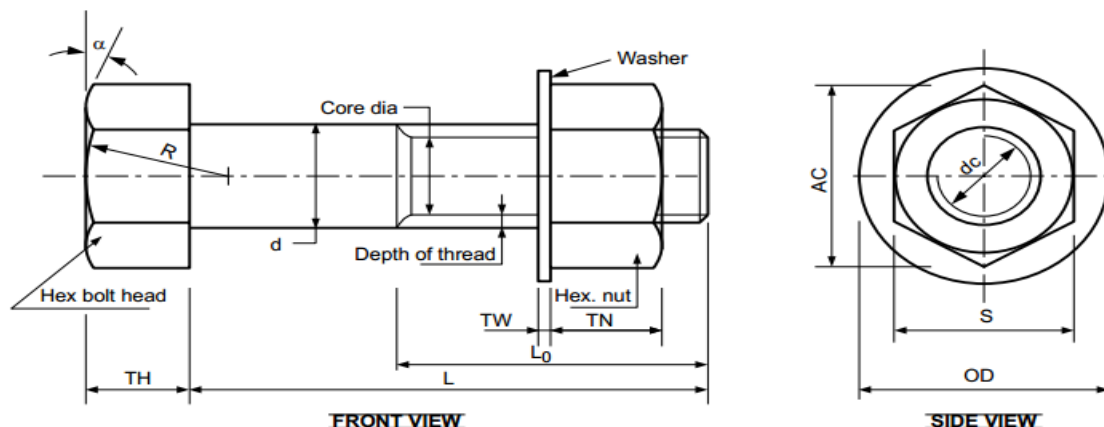
Fig. 2.32 (I) and (II) show the hexagonal nut.

Proportion of the hexagonal bolt:

- Width across flats = $S = 1.5D + 3$ mm
- Thickness of head = $TH = 0.7D$ to $0.8D$
- Angle of chamfer = 30°
- Radius of chamfer arc = $R = 1.5D$
- Length of the bolt = $L = 4D$ to $6D$
- Length of threaded portion = $L_0 = 2D + 6$ mm
- For length up to 150 mm = $2D + 6$ mm
- For length over 150 mm = $2D + 12$ mm
- Core diameter = $d_c = 0.85 D$
- Radius of arc = $R_1 = 0.5 \times S$
- Where, D = nominal diameter of bolt.

Assembly of Bolt, Nut and Washer: Assembly of all the three parts is shown in Fig. 2.35.

All the dimensions of bolt, nut and washer are based on the nominal diameter of thread.



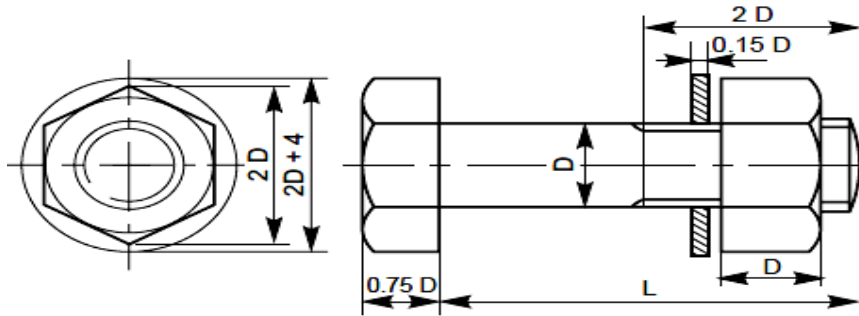


Figure 5.14. Assembly of Bolt, Nut and Washer

Where, Hex -Hexagonal

M — Metric threads

N — Nut of some shape

L_0 = Threaded portion of shank = $2.5 d + 5 \text{ mm}$

L = Length of shank $4 d$ to $6 d$ [If not given then assume]

TH = Thickness of head = $0.7 d$ to $0.8 d$

R = Radius of chamfer = $1.2d$

O.D = Outer dia of washer = $2 d + 3 \text{ mm}$

S = Distance across the flats to flat = $1.5 d + 1 \text{ mm}$ or 3 mm .

AC = Distance across the corner = $2 d$

d_c = Core dia = $0.85 d$

TN = Thickness of nut = $0.8 d$ to d

TW = Thickness of washer = $0.15 d$

α = Angle of chamfer = 30°

$R1 = 0.5 A/F$ or S

Where, A/F or S = $1.5 d + 3 \text{ mm}$

B. Washers

A washer is a cylindrical piece of metal with a hole to receive the bolt. It is used to give a perfect seating for the nut and to distribute the tightening force uniformly to the parts under the joint. It also prevents the nut from damaging the metal surface under the joint.

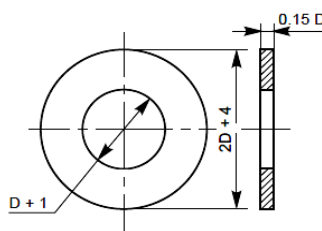


Figure 5.15. Washer

C. Rivets and Riveted Joints: -

Rivets are used for fastening and joining two or more plates of metal permanently or semi-permanently. The joints which are made by rivets are called riveted joints. Basically, a rivet is a short cylindrical bar of ductile material with a head, formed during manufacturing, at one end and tail at the other. The cylindrical portion of the rivet is called shank as shown in Fig. head is formed on the tail side by forging when it is assembled to fasten the parts. Rivets are widely used in structural work like roof, trusses, bridges, tank, ship building, and air craft industry and also for pressure vessels like boilers and receivers.

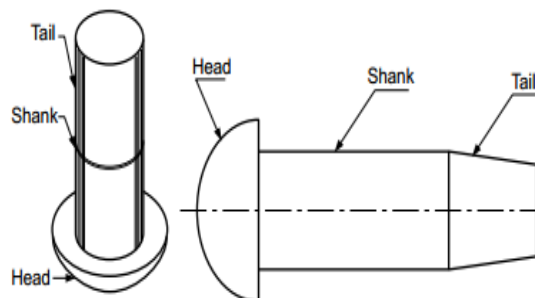


Figure 5.16. Parts of Rivet

Types of Riveted Heads: The various forms of riveted heads specifically by BIS are shown in Fig.

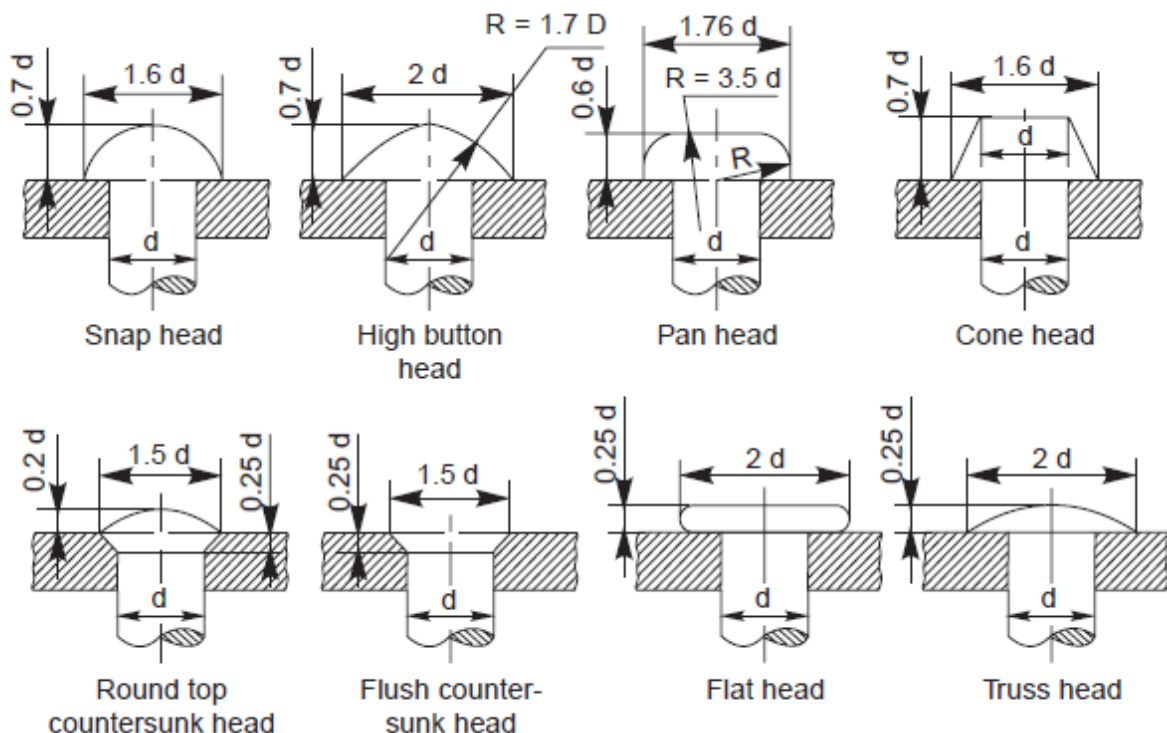
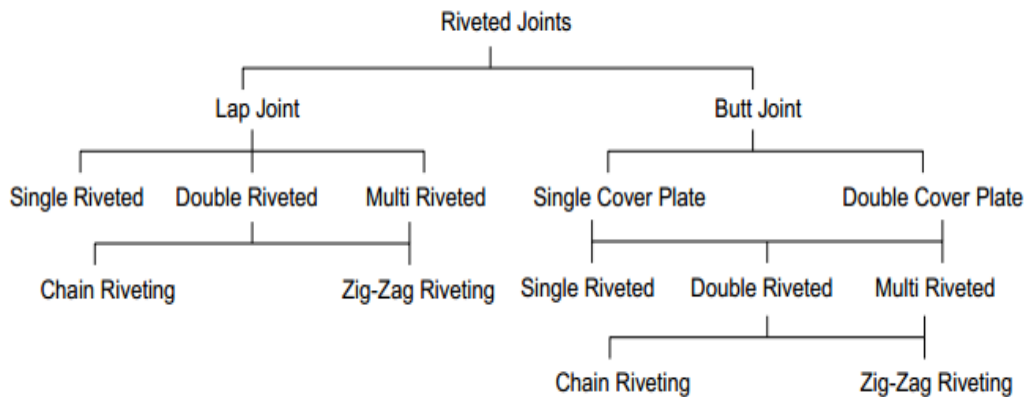


Figure 5.17. Types of Riveted Heads

Types of Riveted Joints: Riveted joints may be divided into two types depending upon the manner in which the plates are held in relation to each other. The following flow chart shows a classification of riveted joints:



Lap Joint: A lap joint is that in which one plate overlaps the other and the two plates are then riveted together. These joints may be single riveted, double riveted and multi riveted according to one, two and three rows of rivets. Further arrangements of rivets differ in chain and zig-zag riveting.

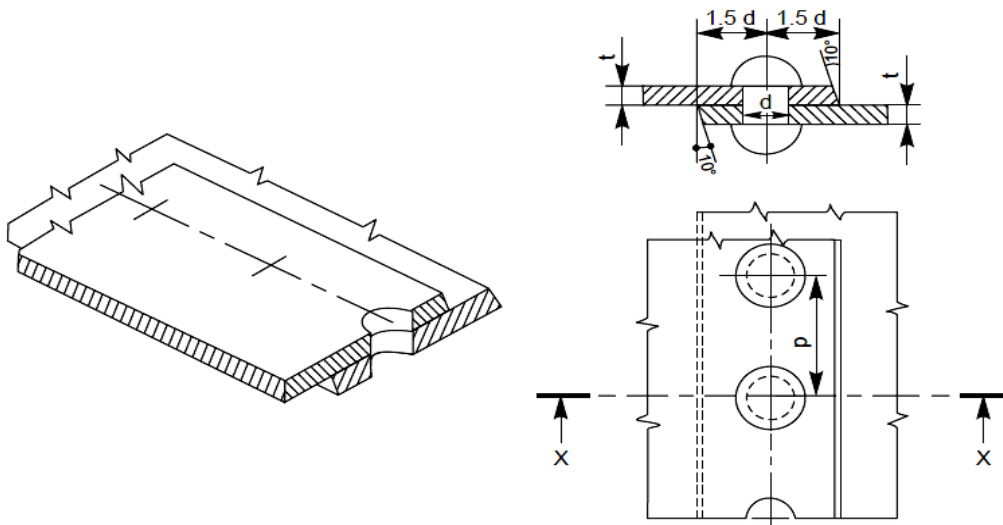


Figure 5.18. Single –riveted lap joint

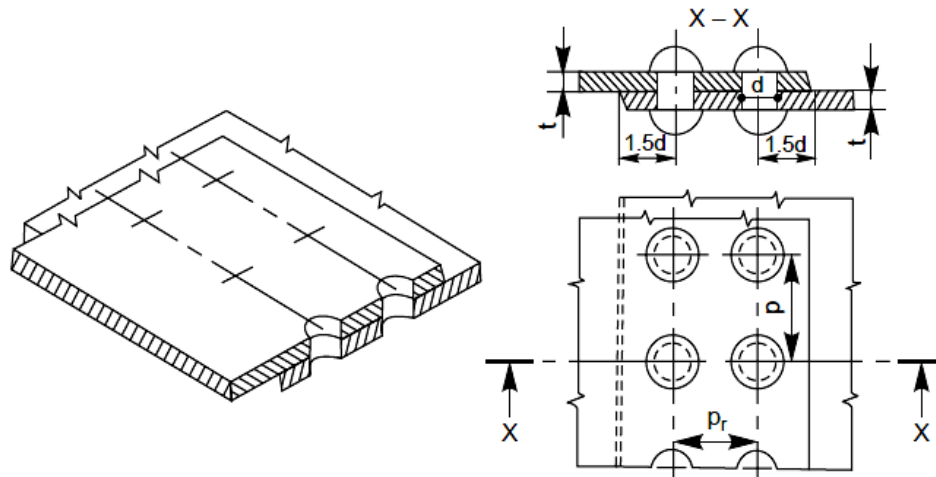


Figure 5.19. Double-riveted lap joint, chain riveting

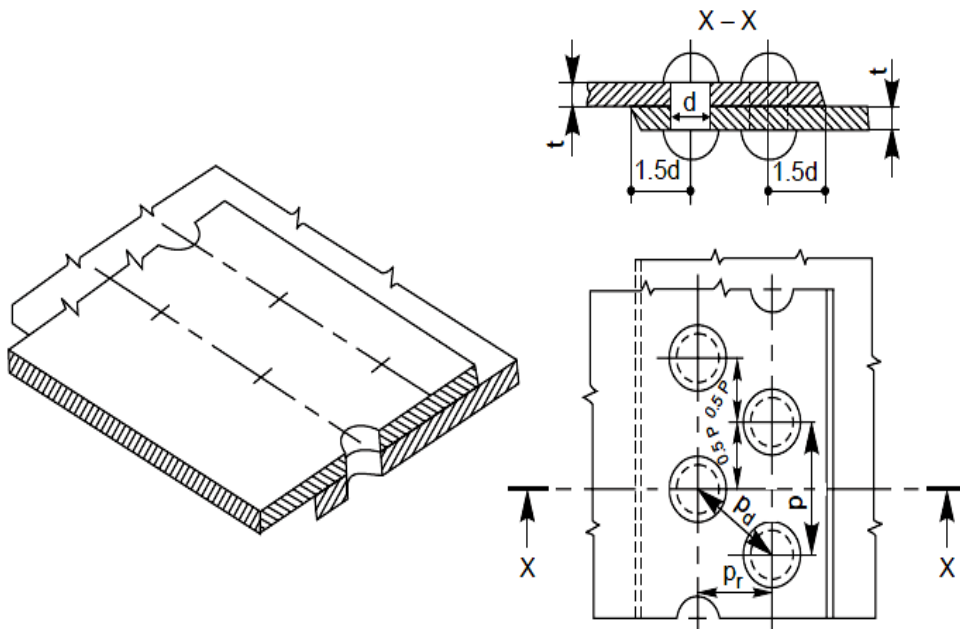


Figure 5.20. Double riveted lap joint, zig-zag riveting

Butt Joint: When plates are placed end to end and joined through cover plate, they form a butt joint. One or more cover plates may be covered on the main plates and accordingly the joint may be called single cover plate and double cover plate joint. These joints are single riveted, double riveted and multiple riveted according to one, two and three rows of rivets respectively.

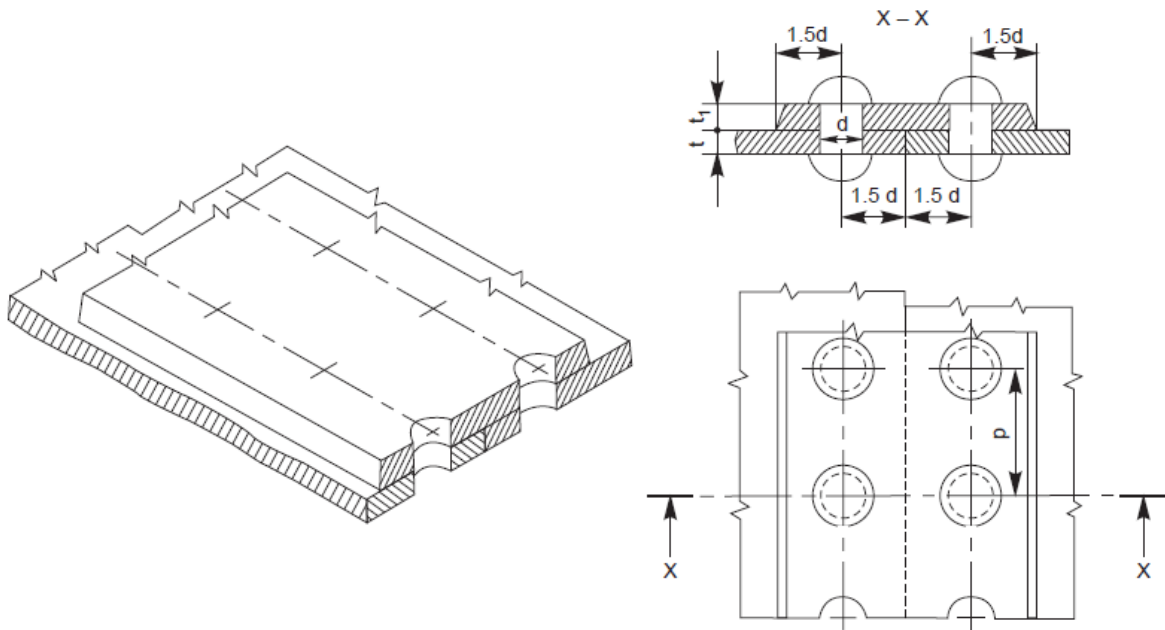


Figure 5.21. Single riveted single strap butt joint

Thickness of Cover Plate t_1 : When one cover plate is used, the thickness is made more than the thickness of main plates, usually

$$t_1 = 1.125t \text{ of single cover plate}$$

$$t_1 = 0.625t \text{ for double cover plate.}$$

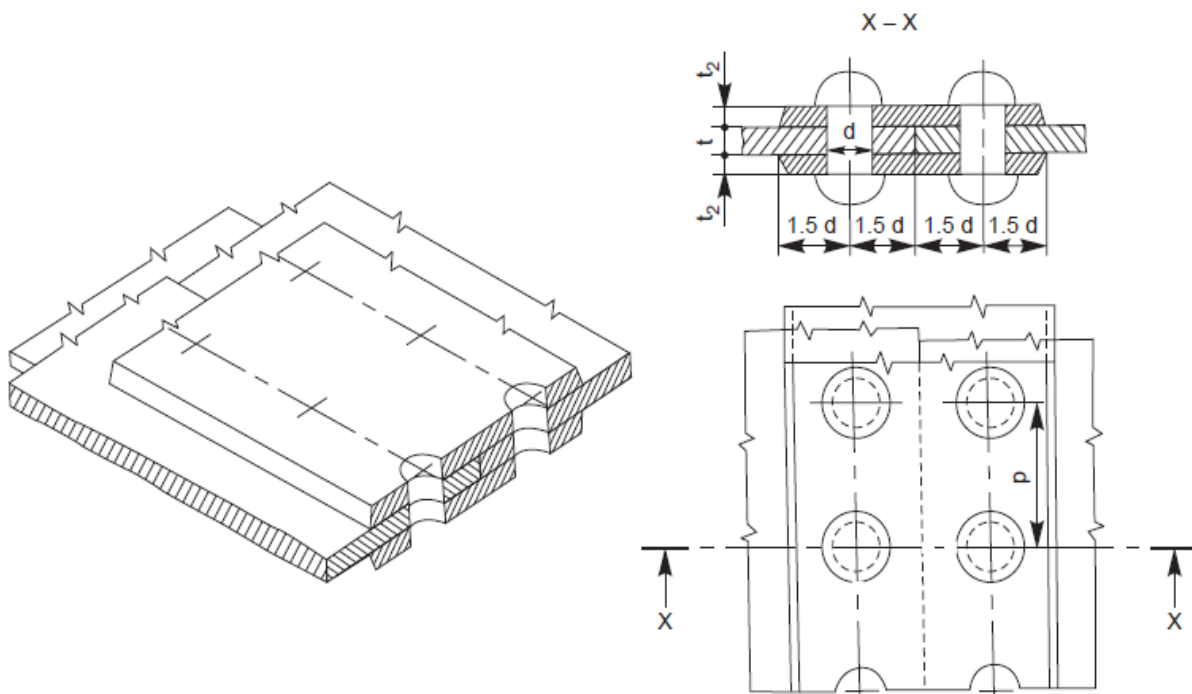


Figure 5.22. Single Riveted Double covers Butt Join

D. Sleeve and Cotter Joint:

Sleeve and cotter joint is used to connect two round rods or sometimes to connect two pipes/tubes. The rods are forged and increased in diameter to some length just to compensate for the loss of material, for making rectangular hole, accommodate the rectangular tapered cotter in each rod. The ends of both the rods are chamfered to avoid burring and easy insertion in the **hollow** steel sleeve (socket/cylinder/muff). Both the rods are of the same dimensions. A hollow **sleeve** is passed over both the rods and has two rectangular holes for the insertion of cotter at right angle to the axes of the rods. The cotters are automatically adjusted due to the extra margin given for the clearance in the rod and the sleeve. The relative position of slots is such that the driving in of the cotters tends to force the rods towards each other in socket or hollow sleeve. When sleeve and rods are subjected to axial tensile force then the cotter is subjected to shearing force, these joints are useful for light transmission of axial loads.

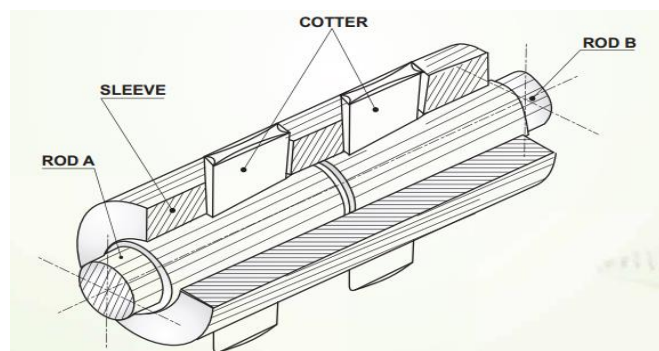


Figure 5.23. Sleeve and cotter joint

Gib and Cotter Joint: This joint is used to join two rods of square or rectangular in cross section. The end of one rod is forged in the form of a fork or strap. The height of the other rod is increased for compensating the loss of material in making the slot for cotter. The Gib is made up of mild steel and has the same thickness as that of the cotter. The Gib has projections at the top and bottom ends which act like hooks. While connecting two rods the Gib is inserted first and pushed towards the end of the fork and then the cotter is hammered over. The tapering sides of the Gib and the cotter mate with each other, while their outer sides are parallel to each and perpendicular to the common axis of the rods. Hence, when a Gib is used with a cotter, the opposite faces of the slots in the rods are parallel to each other. The Gib acts like a counter part of the socket/strap. The Gib increases the tearing area of the cotter and prevents slackening of the joint besides holding the jaws of the strap or fork from opening wide when the cotter is inserted. The use of Gib and Cotter enables the parallel holes

to be used. When Gib is used the taper is provided in the Gib. This joint is useful to fasten connecting rod of a steam engine or marine engine.

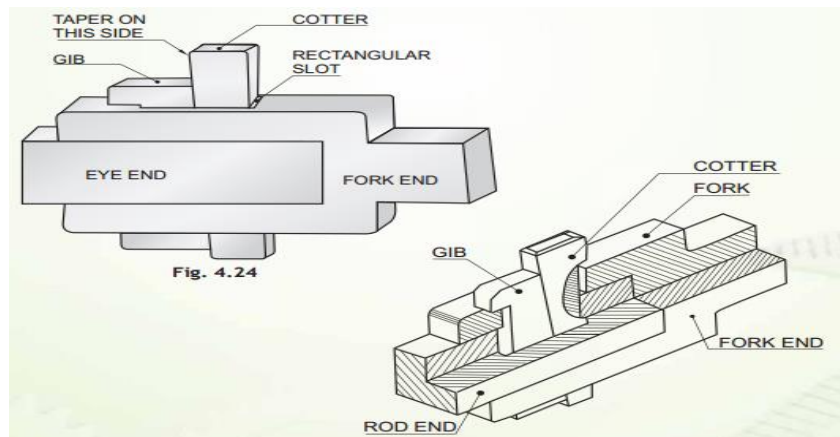


Figure 5.24. Assemble and sectional view of gib and cotter joint

E. Knuckle Joint: Knuckle joint is also one of the most important joint and has advantages over the cotter joint. It is also known as pin joint. A knuckle joint is used to connect two rods which are under the action of tensile or compressive loads. The joint is not rigid. It permits angular movement between the rods. Hence, it is commonly used when a reciprocating motion is to be converted into a rotator motion or vice versa. One end of one of the rods is made into an eye and the end of the other rod is formed into a fork with an eye in each of the fork leg. The pin is kept in position by means of a collar and a taper pin. The rods are quite free to rotate on the cylinder pin. The material used for the joint may be steel or wrought steel.

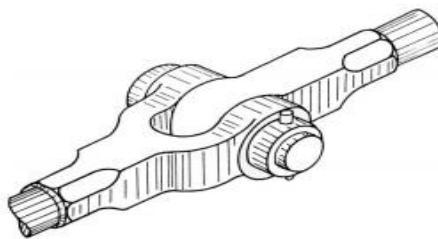


Figure 5.25. Pictorial view of a knuckle joint

F. Keys

Keys are machine elements used to prevent relative rotational movement between a shaft and the parts mounted on it, such as pulleys, gears, wheels, couplings, etc. Keys are classified into three types, viz., saddle keys, sunk keys and round keys.

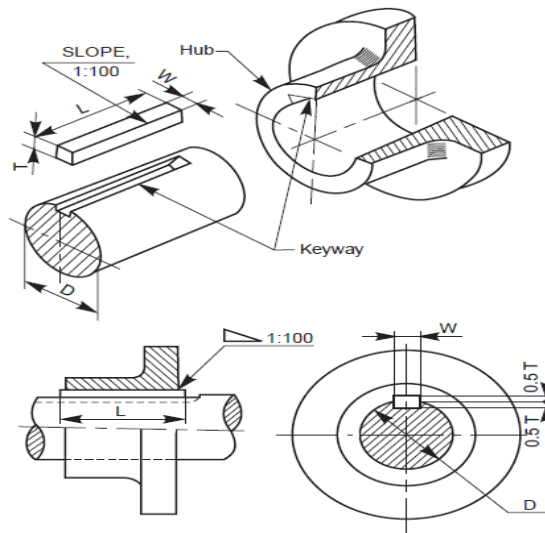


Figure 5.26.Keyed Joint Shaft and Coupling

G. Splines

Splines are keys made integral with the shaft, by cutting equal-spaced grooves of uniform cross section. The shaft with splines is called a splined shaft. The splines on the shaft, fit into the corresponding recesses in the hub of the mounting, with a sliding fit, providing a positive drive and at the same time permitting the latter to move axially along the shaft

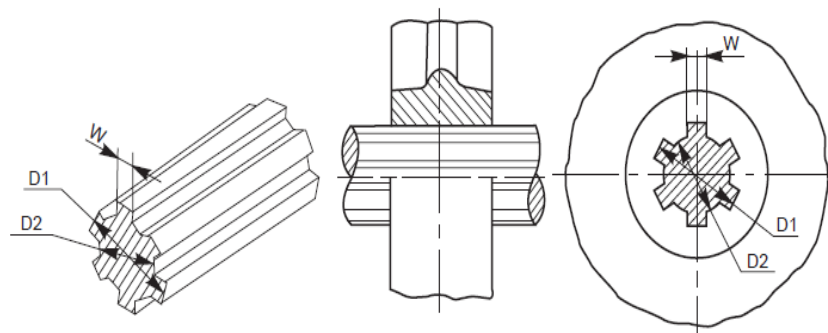


Figure 5.27 splined shaft and hub

H. Pin

In a pin joint, a pin is used to fasten two rods that are under the action of a tensile force; although the rods may support a compressive force if the joint is guided. Some pin joints such as universal joints use two pins and are used to transmit power from one rotating shaft to another.

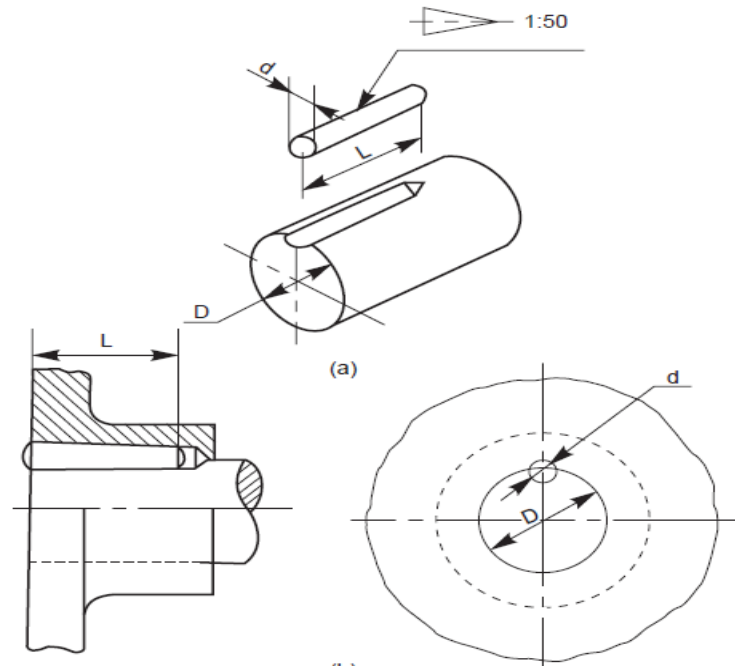


Figure 5.28 Round key

I. Shaft coupling

Shaft couplings are used to join or connect two shafts in such a way that when both the shafts rotate, they act as one unit and transmit power from one shaft to the other. Shafts to be connected or coupled may have collinear axes, intersecting axes or parallel axes at a small distance. Based on the requirements, the shaft couplings are classified as:

- rigid couplings,
- flexible couplings,
- loose or dis-engaging couplings and
- Non-aligned couplings.

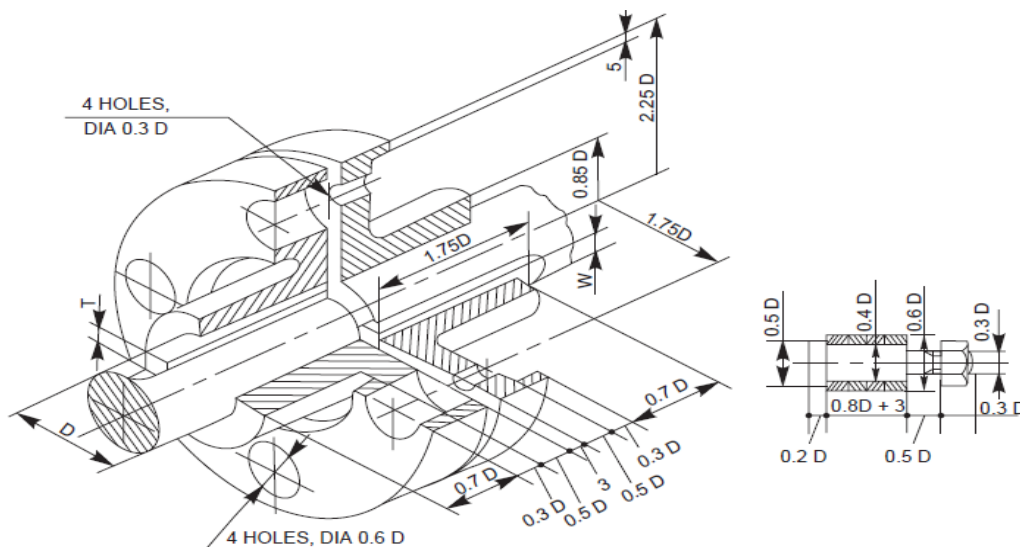


Figure 5.29: Bushed pin type flanged coupling

5.1.2. Assembly Drawing:

The drawing of a machine showing all the parts assembled in their functional position is called assembly drawing. It is a design document containing a representation of all the parts. It also gives the clear picture of location and relationship of different machine parts along with necessary data. The part list should be provided just above the title block as shown in Fig. 5.30.

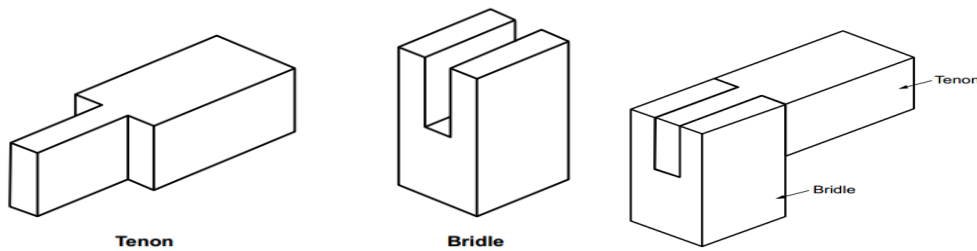


Figure 5.30: Assembly of tenon and birdie components

Assembly Drawing Principles:

The assembly drawing furnishes the following information such as:

- Representation of all the parts, giving an idea of location and relative position of the components which are assembled in their functional position.
- Information enabling all the parts to be assembled.
- Dimensions, limits, fits and tolerance etc. which are checked in accordance with the assemble drawing.
- Specification or characteristics of the product.
- Details of permanent joints and the methods of their manufacture such as welding, soldering etc.
- Sectional view to explain internal details, relative position and shape.
- Part list or material list indicating the component part, material, number of units and other in formations.

Complete drawings and/or parts lists records

A drawing that shows the various parts of a machine in their correct working locations is an assembly drawing. See Fig. below:

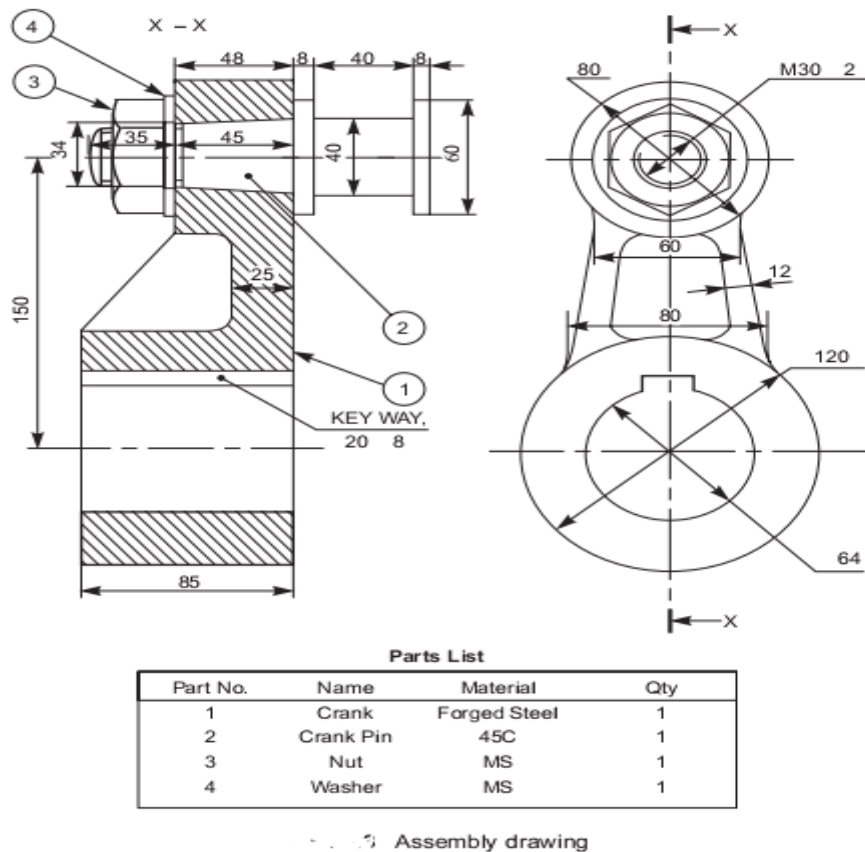


Figure 5.31: Assembly parts of a machine and part list

5.2. Symbols and abbreviations

Geometrical Tolerance Characteristic Symbol:

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

Representing Geometric tolerance

Just as dimensional tolerances restrict size to certain limits, geometrical tolerances limit the shape of a component to certain limits.

The tolerance frame is usually divided into two or more sections. These will contain a geometrical tolerance symbol in the first section followed by a tolerance value in the second

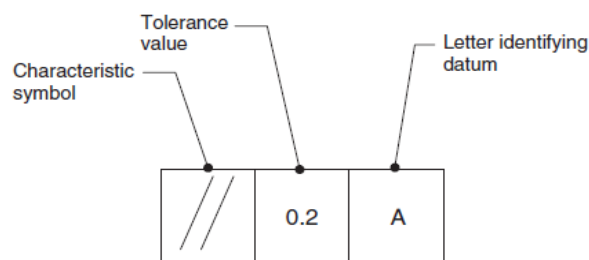


Figure: 5.33. Representing Geometric tolerance

Table: 5.1 basic geometrical symbols

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

Figure: 5.32. Geometric Tolerance Characteristic Symbols

Datum's:- Datum's are used to establish the relationship of geometrically tolerance features and a datum is a theoretically exact geometrical reference, such as an axis, plane, straight line, etc. The datum is indicated by an equilateral triangle symbol as shown in Fig below and is usually identified by a capitol letter enclosed in a frame, with different letters used to identify each datum.



Figure: 5.34. Datum surface

Surface Finish: - Surface Finish is a measure of the overall texture of a surface that is characterized by the lay, surface roughness, and waviness of the surface. Surface Finish when

it is intended to include all three characteristics is often called Surface Texture. Another term, analogous to Surface Texture, is Surface Topology.

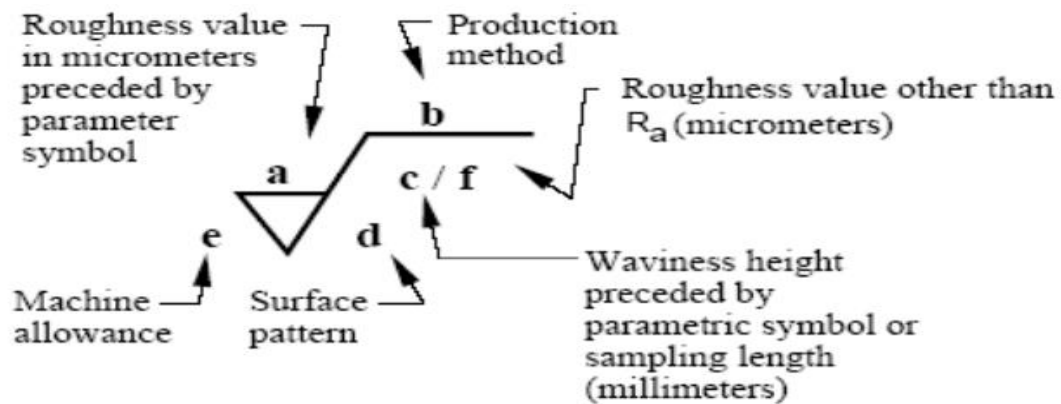


Figure: 5.35. Surface Finish symbols and explanation

5.2.1. Basic welding symbols

Table: 5.2: basic welding symbols

No.	Designation	Illustration	Symbol
1.	Butt weld between plates with raised edges (the raised edges being melted)		
2.	Square butt weld		
3.	Single-V butt weld		
4.	Single-bevel butt weld		
5.	Single-V butt weld with broad root face		
6.	Single-bevel butt weld with broad root face		
7.	Single-U butt weld (parallel or sloping sides)		
8.	Single-U butt weld		

Fig 5.36 basic welding symbol

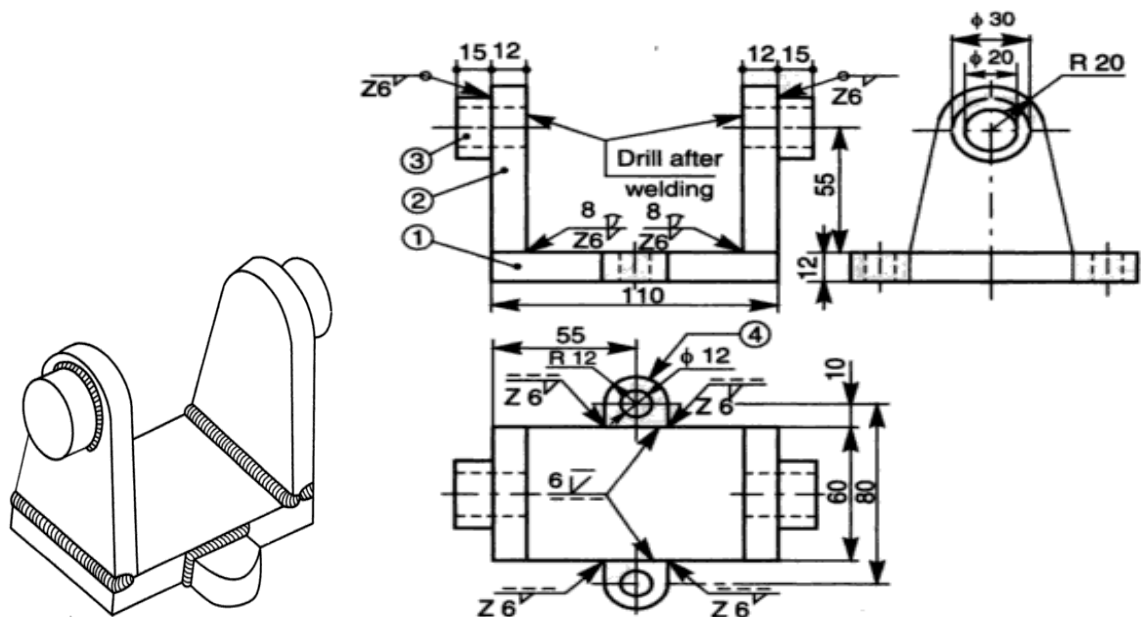


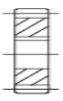
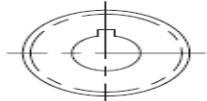
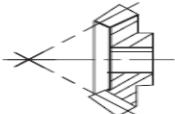
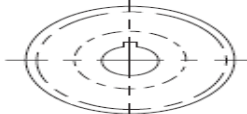
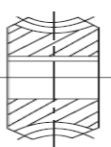
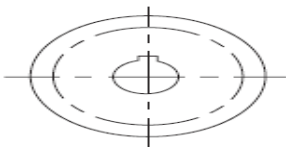


Fig 5.37. Examples To Basic Welding Symbol To Shaft Support




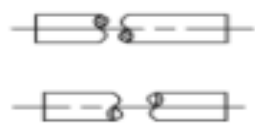




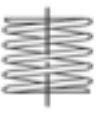

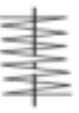



Table 5.3. Drawing to the conventional representation of materials

TYPE	CONVENTION	MATERIALS
Metals		Steel, Cast Iron, Copper and its Alloys, Aluminium and its alloy, etc
		Lead, Zinc Tin White-metal, etc.
Glass		Glass
Packing and Insulating materials		Porcelain, Stoneware, Marble, Slate etc
		Asbestos, Fibre, Felt, Synthetic resin, Products, Paper, Cork, Linoleum, Rubber, Leather, Wax, insulating & Filling Materials etc
Liquid		Water, Oil, Petrol, Kerosene etc
Wood		Wood, Plywood etc
Concrete		Concrete

5.2.2. Conventional representation of machine components

Table 5.4. Conventional representation of machine components

Title	Convention	
Spur gear		
Bevel gear		
Worm wheel		
Worm		

Title	Subject	Convention	
Splined shafts			
Interrupted views			
Semi-elliptic leaf spring			
Semi-elliptic leaf spring with eyes			
		Subject	Convention
Cylindrical compression spring			
Cylindrical tension spring			



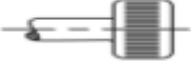

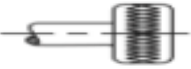
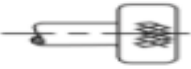




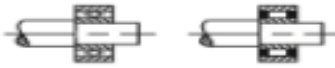
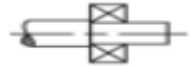


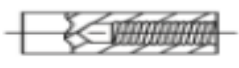



Title	Subject	Convention
Straight knurling		
Diamond knurling		
Square on shaft		
Holes on circular pitch		
Bearings		
External screw threads (Detail)		
Internal screw threads (Detail)		
Screw threads (Assembly)		

Table: 5.5. basic averbation in drawing

S.No.	Note	Meaning/Instruction
1.	DIA 25 DEEP 25	Drill a hole of diameter 25 mm, to a depth of 25 mm.
2.	DIA 10 CSK DIA 15	Drill a through hole of diameter 10 mm and countersink to get 15 mm on top.
3.	4 HOLES, DIA 12 C BORE DIA 15 DEEP 8	Drill through hole of ϕ 12 mm, counterbore to a depth of 8 mm, with a ϕ 15 mm, the number of such holes being four.
4.	6 HOLES, EQUI-SP DIA 17 C BORE FOR M 16 SOCKET HD CAP SCR	Drill a through hole of ϕ 17 and counterbore to insert a socket headed cap screw of M 16. Six holes are to be made equi-spaced on the circle.
5.	KEYWAY, WIDE 6 DEEP 3	Cut a key way of 6 mm wide and 3 mm depth.
6.	KEY SEAT, WIDE 10 DEEP 10	Cut a key seat of 10 mm wide and 10 mm deep to the length shown.

7. U/C, WIDE 6 DEEP 3	Machine an undercut of width 6 mm and depth 3 mm.
8. (a) DIAMOND KNURL 1 RAISED 30° (b) M 18 × 1	Make a diamond knurl with 1 mm pitch and end chamfer of 30°. Cut a metric thread of nominal diameter 18 mm and pitch 1 mm.
9. (a) THD RELIEF, DIA 20 WIDE 3.5 (b) NECK, WIDE 3 DEEP 1.5 (c) CARB AND HDN	Cut a relief for thread with a diameter of 20.8 mm and width 3.5 mm. Turn an undercut of 3 mm width and 1.5 mm depth. Carburise and harden.
10. (a) CARB, HDN AND GND (b) MORSE TAPER 2	Carburise, harden and grind. Morse taper No. 1 to be obtained.
11. DIA 6 REAM FOR TAPER PIN	Drill and ream with taper reamer for a diameter of 6 mm to suit the pin specified.
12. 6 ACME THD	Cut an ACME thread of pitch 6 mm.

5.3. Dimensions and instructions

5.3.1. Technical Dimensioning

- Dimensions allow a part to be manufactured
- Dimensions are ALWAYS in real world units
- Dimensions should be applied in a concise, coherent manner

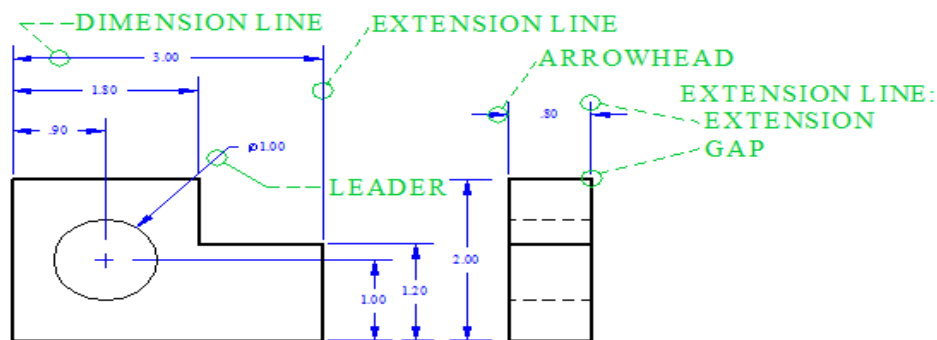


Fig 5.37. Technical Dimensioning

A. Avoid placing dimensions on the part (inside the view).

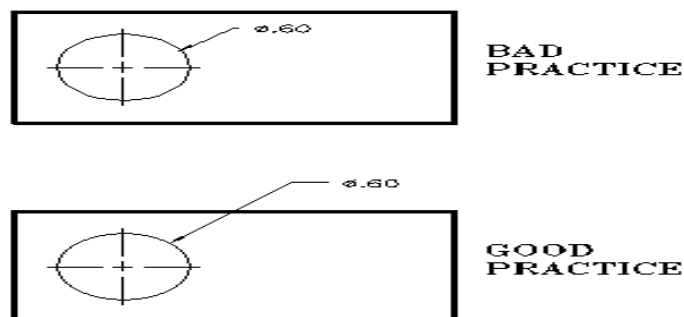


Fig 5.38. Inside diameter

6. Avoid dimensioning to hidden features

This is one exception:when the hidden line is a finished ($\sqrt{}$) surface

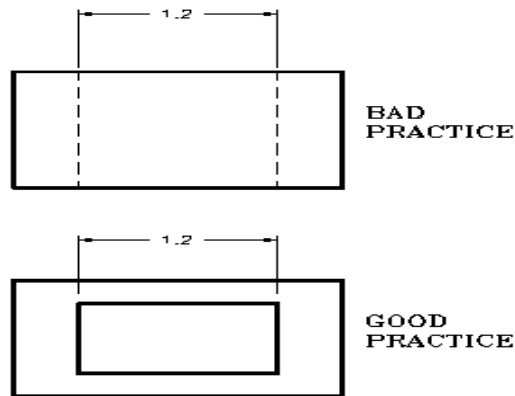


Fig 5.39. Hidden features

7. Always place dimensions where the characteristic shape is shown in the most descriptive view



Fig 5.40. Descriptive views

8. Always dimension holes in their circular view with the \varnothing . Specify special features (hole types) with a note. Also: Remember to locate hole position with ordinate dimensions to hole centers

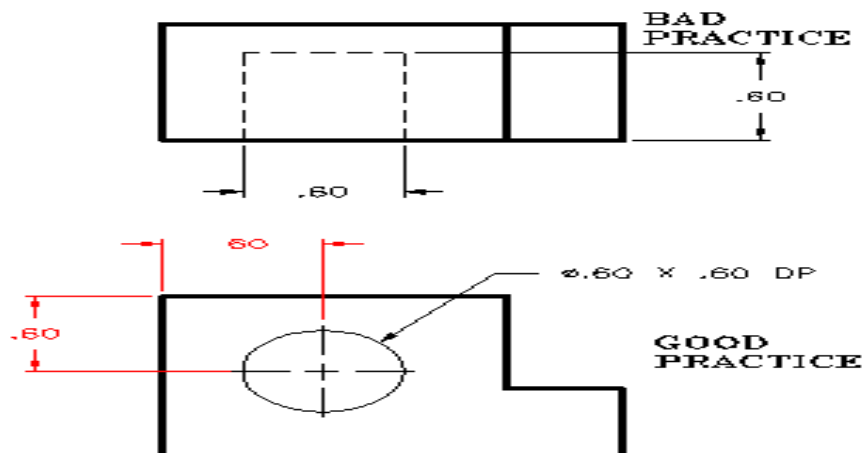


Fig 5.41. Holes

9. Dimension rounded corners and arc features as radii where they appear in their rounded view.

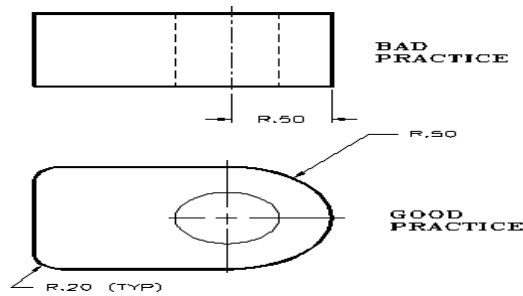


Fig 5.42. Rounded corners

10. If the same value is repeated many times, then use a general note for the feature.
(All Fillets And Rounds Are .125r)

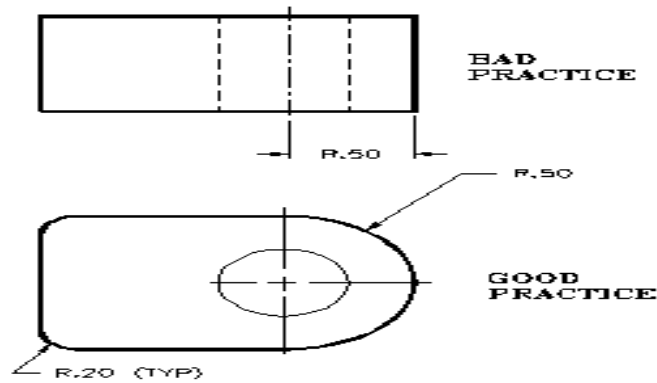


Fig 5.43. Fillets and rounds

11. Dimension cylinders in their rectangular view with a diameter symbol...Ø.

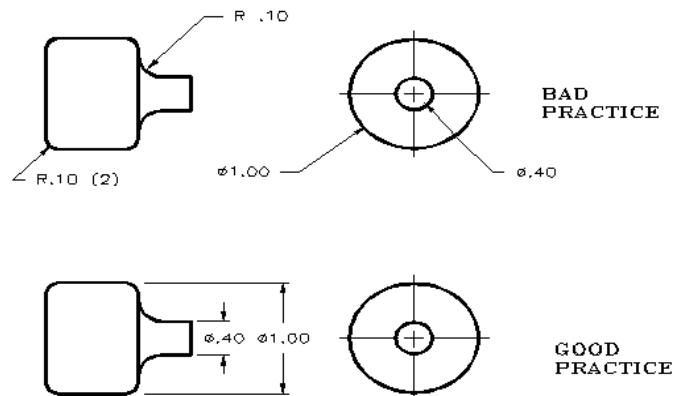


Fig 5.44. Cylinders in rectangular view

12. Place the first row of dimensions 3 text heights (3/8 "or 10 mm) away from the edge of the part. Additional stacks of dimensions can be a minimum of two text heights (1/4 "or 6 mm) away from each other

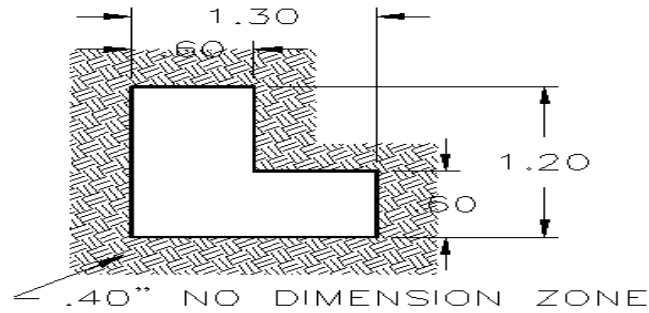


Fig 5.45. Additional stacks

13. The overall dimension should always be given. It should be placed outside of smaller dimensions and be the farthest from the part.

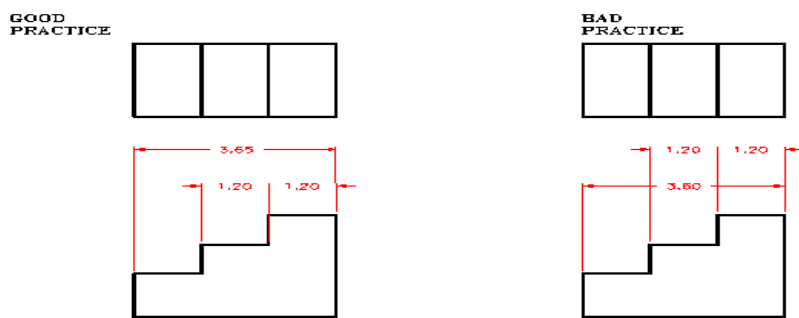


Fig 5.46. overall dimension

14. Do not duplicate dimensions and avoid using unnecessary or superfluous dimensions

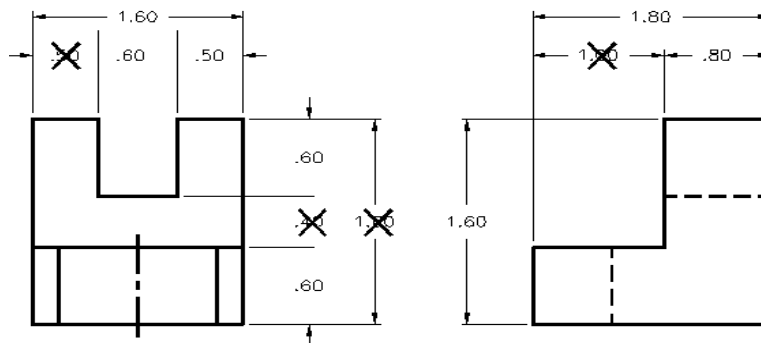


Fig 5.47. duplicated dimensions

5.4. Identifying material requirements

5.4.1. The required points for complete working drawing.

- The graphical representation of the shape of each part, namely shape description.
- The dimensions of each part; size description.
- Explanatory notes on the individual drawings, giving the specifications of material, heat treatment, and surface finish.
- A descriptive title on each drawing.

- Relationships of each part to the others (in assembly drawings)
- Part list.

5.4.2. Identify work equipment to be cleaned and maintained: -

In all areas of all properties there are many items and surfaces to be cleaned and maintained. It is important as a cleaner that you know exactly what items are to be cleaned and how. The equipment that can be clean; T-squares, drawing board, mini drafter, ruler etc and it can be clean mechanically by duster.

5.4.3. Maintain a safe and clean environment: -

If the property is clean and well-maintained it is more likely to be safe. If spills are not cleaned promptly people can slip and in our case form blurred leads to misunderstanding of drawing.

Self Check-5.1

Test: I: Write true if the Statement is Correct Write False if not Correct

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





Test II: short Answer writing

Instruction: write short answer for the given question. You are provided 3 minute for each question and each point has 2 Points.

1. What is a key and what for is it used?
2. What is the function of a cover plate in riveted joints?
3. What is a knuckle joint and where is it used?
4. What is a shaft coupling?

Test-III Matching

Instruction: select the correct answer for the give choice. You have given 1 Minute for each question. Each question carries 2 Point.

	A		B
			B. Glass
			5. Square on shaft
			6. Splined shaft
			7. Spur gear

Operation Sheet-5.1 Hexagon Bolt Nut

- **Operation title:** hexagon bolt nut
- **Purpose:** To measure the dimension of geometrical shape
- **Instruction:** Using the figure below and given equipments measure the length of each line. You have given 3 hours for the task and you are expected to draw the hexagonal bolt nut.

PROCEDURS

1. Draw the view from above by drawing a circle of diameter, W and describe a regular hexagon on it, by keeping any two parallel sides of the hexagon, horizontal.
2. Project the view from the front, and the view from side, and mark the height equal to D.
3. With radius R, draw the chamfer arc 2-1-3 passing through the point 1 in the front face.
4. Mark points 4 and 5, lying in-line with 2 and 3.
5. Locate points 8,9 on the top surface, by projecting from the view from above.
6. Draw the chamfers 4-8 and 5-9.
7. Locate points 6 and 7, lying at the middle of the outer two faces.
8. Draw circular arcs passing through the points 4, 6, 2 and 3, 7, 5, after determining the radius R1 geometrically.
9. Project the view from the side and locate points 10, 11 and 12.
10. Mark points 13 and 14, lying at the middle of the two faces (view from the side).
11. Draw circular arcs passing through the points 10, 13, 11 and 11, 14, 12, after determining the Radius R2 Geometrically.

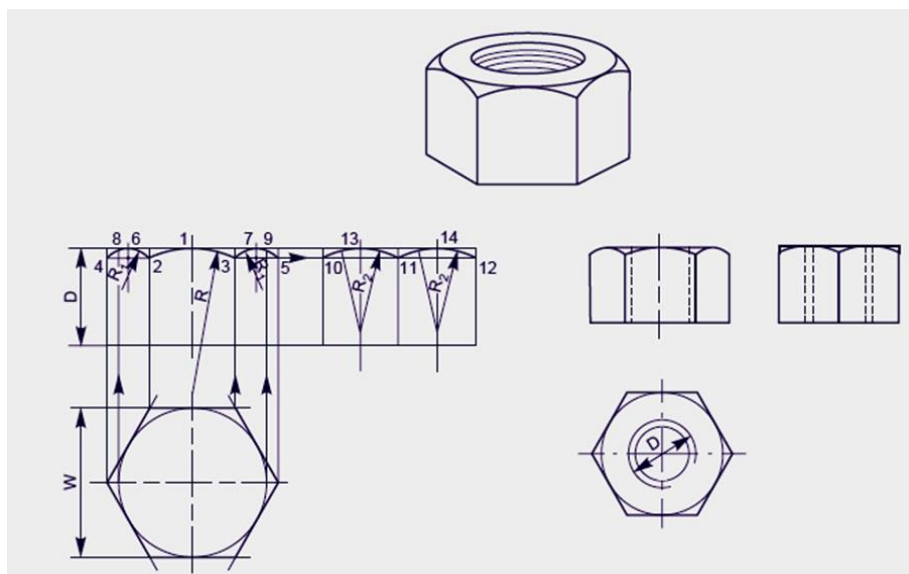


Fig 5.48. drawing operation sheet 5.1: bolt nut

Method 1

Empirical relations:

Major or nominal diameter of bolt = D

Thickness of nut, T = D

Width of nut across flat surfaces, W = 1.5D + 3 mm

Radius of chamfer, R = 1.5D

Operation Sheet-5.2 Assembly Drawing

- **Operation title:** assembly drawing
- **Purpose:** To identify assembled parts and use to red manuals
- **Instruction:** Using the figure below and given equipments measure the length of each line. You have given 3 hours for the task and you are expected to draw the hexagonal bolt nut.
- **Tools and requirement:**
A4 paper, Ruler, Scale, Pencil, set square 30/60 and 45 degrees
- **Precautions:** set the correct dimensions neat and clean
- **Procedures in doing the task**

The steps to be followed to prepare part drawings from the assembly drawing are:

1. **Step-1:** Understand the assembly drawing thoroughly, by referring to the parts list and the different orthographic views of the unit.
2. **Step-2:** Study the functional aspect of the unit as a whole. This will enable to understand the arrangement of the parts.
3. **Step-3:** Visualize the size and shape of the individual components.
4. **Step-4:** As far as possible, choose full scale for the drawing. Small parts and complicated shapes may require the use of enlarged scales so that their presentation will have a balanced appearance.
5. **Step-5:** Select the minimum number of views required for describing each part completely. The view from the front selected must provide maximum information of the part.
6. **Step-6:** The under mentioned sequence may be followed for preparing different views of each part :
 - a. Draw the main centre lines and make outline blocks, using the overall dimensions of the views.

- b. Draw the main circles and arcs of the circles.
 - c. Draw the main outlines and add all the internal features.
 - d. Cross-hatch the sectional views.
 - e. Draw the dimension lines and add dimensions and notes.
7. **Step-7:** Check the dimensions of the mating parts.
 8. **Step-8:** Prepare the parts list and add the title block.

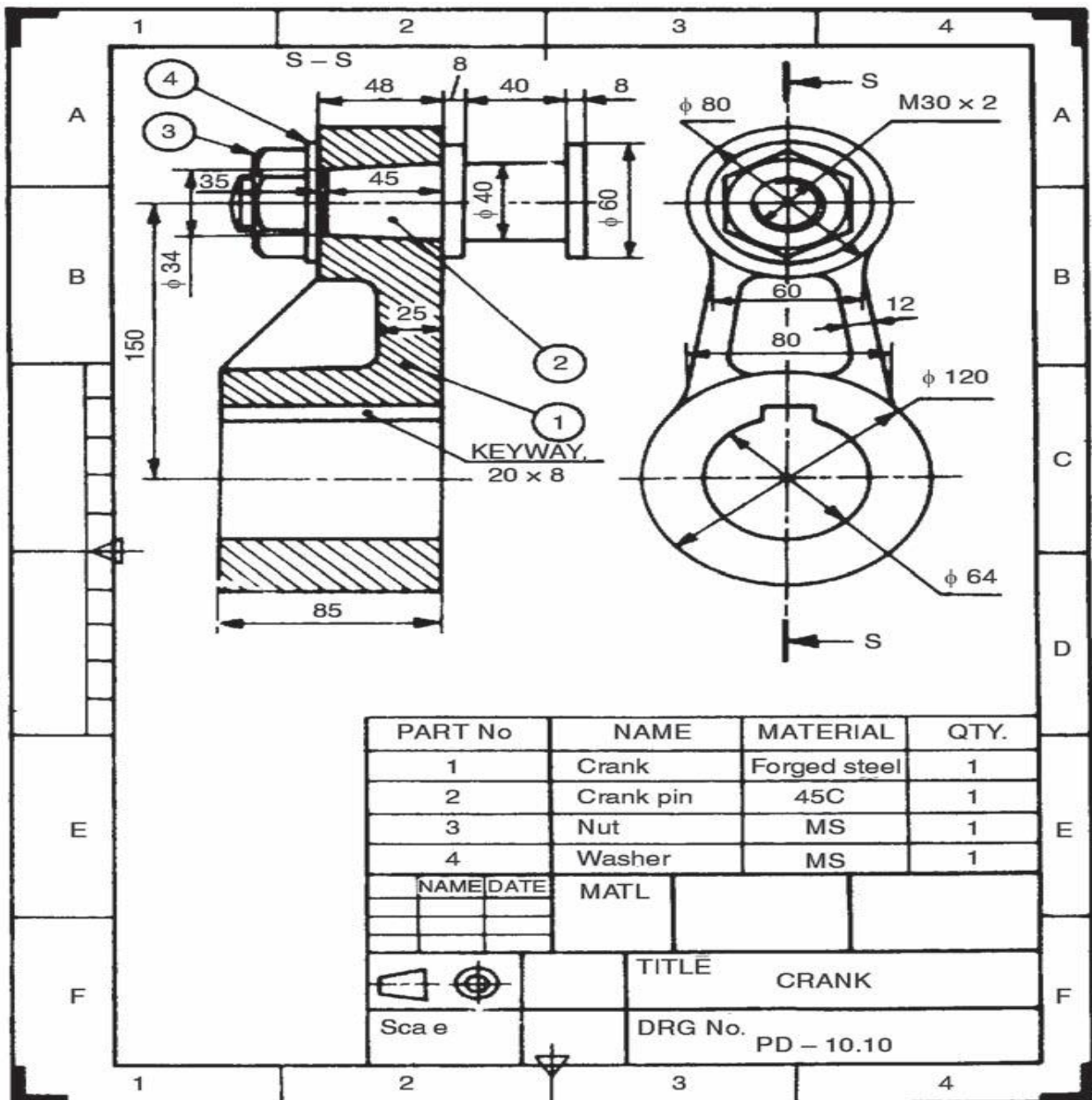


Fig 5.49. drawing operation sheet 5.2:assembly drawing

Lap Test-5.1

Instructions: Given necessary templates, tools and materials you are required to perform the following tasks within 8 hours.

You are required to do the following activities as required in the problem

Task-1: Perform set up drawing paper

Task-2: clearly understand the procedure

Task-3: construct accurately

Task-4: redraw the part drawing with neat sketch

Task-5: Report what you doing and submit

Lap Test-5.2

You are required to do the following activities as required in the problem

Task-1: Perform set up drawing paper

Task-2: clearly understand the procedure

Task-3: Identify each parts with dimensions

Task-4: redraw the assembly drawing with neat sketch

Task-5: Report what you doing and submit

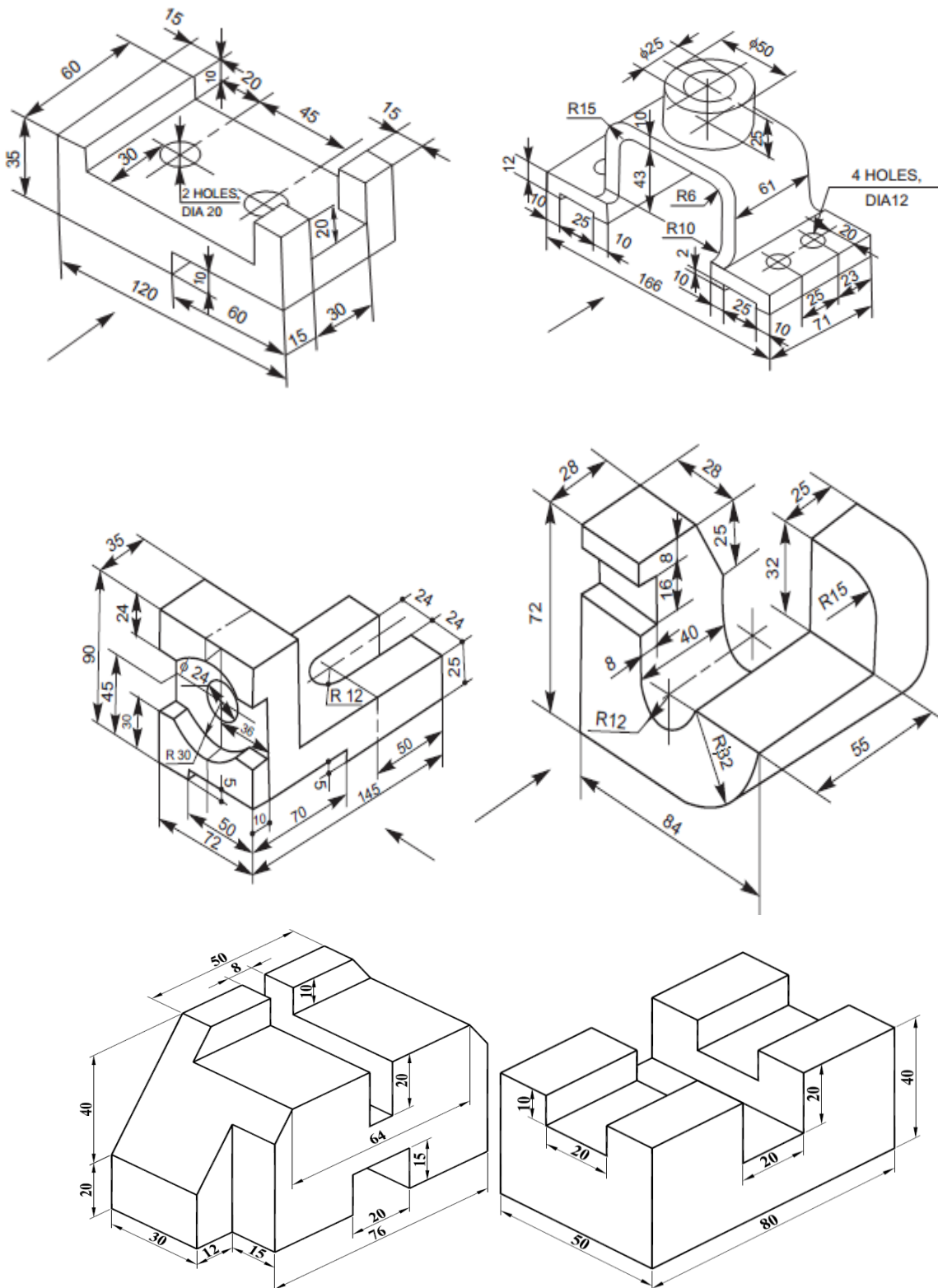
Reference

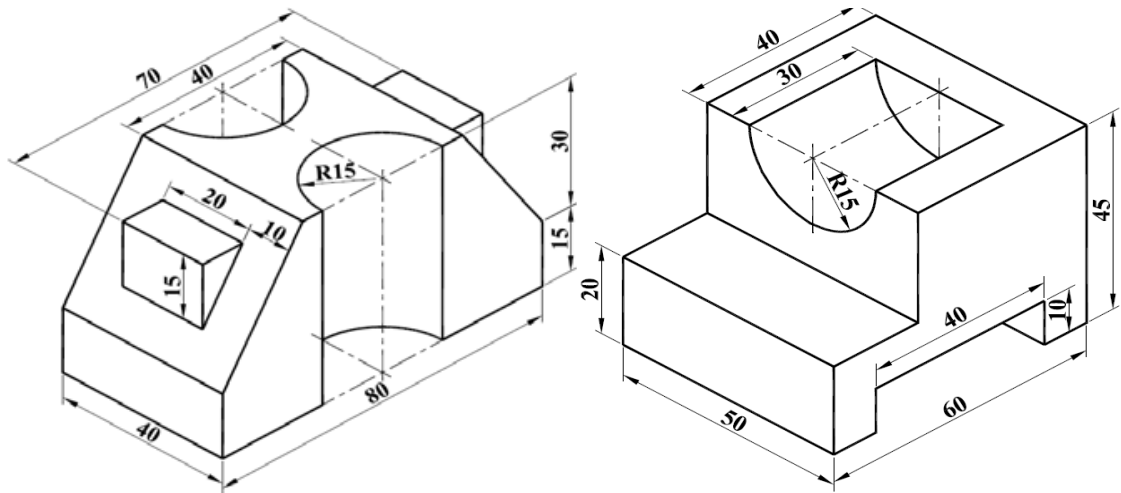
1. **Dr. M.A. Veluswami NEW AGE MACHINE DRAWING**
Visit us at www.newagepublishers.com first edition
2. **K. Venkata Reddy A Text Book Of Engineering Drawing**, Phone: 040-23445688 (2nd ed)
3. David L. Goetsch et al, **Technical drawing**, 1994,3rd ed., Delmar Publishers Inc.

Assignments and exercise

1. Sketch the following types of keys in two views, as fitted in position between a shaft and the mounting. Choose the shaft diameter as 30 mm and the hub diameter of the mounting as 60 mm:
 - (a) Hollow saddle key,
 - (b) flat saddle key,
 - (c) Taper sunk key,
 - (d) single headed feather key,
 - (e) Splines and
 - (f) woodruff key.
2. Name different types of shaft couplings. What is the basis, on which shaft couplings are classified?
3. What is a shaft coupling?
4. What is the purpose of providing a head at the end of a taper sunk key?
5. Give the proportions of a gib head, in terms of shaft diameter?
6. Where and why the woodruff key is used?
7. What is a feather key and what are its uses?
8. Name the commonly used materials for rivets.
9. Define the following :
 - (a) pitch, (b) row pitch, (c) diagonal pitch and (d) margin.
10. Draw (a) sectional view from the front and (b) view from above, of the following riveted joints, to join plates of thickness 10 mm:
 - (i) single riveted lap joint,
 - (ii) double riveted chain lap joint,
 - (iii) double riveted zig-zag lap joint,
 - (iv) single riveted, single strap butt joint,
 - (v) single riveted, double strap butt joint
 - (vi) double riveted, double strap, chain butt joint and
 - (vii) double riveted, double strap, zig-zag butt joint.

11. Isometric drawing exercise





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6						
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