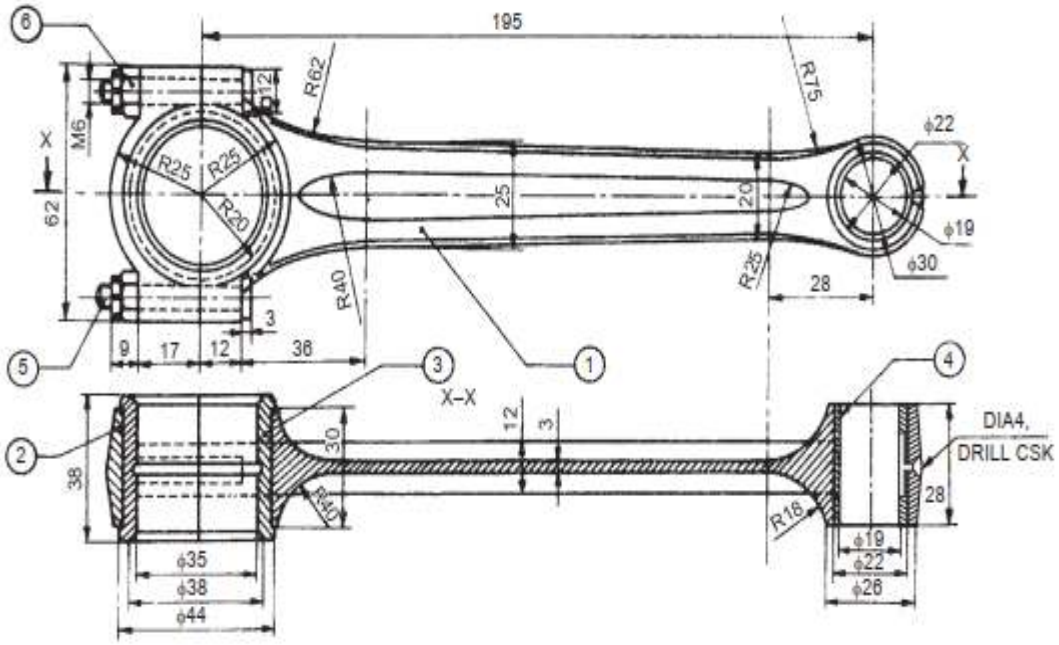
Automotive Mechanics

Level-II

Based on March 2022, Curriculum Version 1



Module Title: - Read and Interpret Machine Drawing

Module code: EIS AUM2 M02 0322

Nominal duration: 60 Hour

Prepared by: Ministry of Labor and Skill

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Addis Ababa, Ethiopia

Table of Contents

Acknowledgment

Ministry of Labor and Skills wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

Acronym

3D	Three dimensional
ANSI	American National Standard Institute
ISO	International Organization for Standardization
LAP Test	Learning Activity Performance Test

SI International Standard

TTLM Teaching, Training and Learning Materials

CAD. Computer Aided Drawing

Introduction to module

In Automotive field of study; Read and Interpret Machine Drawing is one of important task the mechanic it is pertaining to machine parts or components. It is presented through a number of orthographic views, so that the size and shape of the component is fully understood. Part drawings and assembly drawings.

This module contain how to identify Machine Drawing and Views Standard Symbols and Lines Interpreting in Machine Drawing.

This module is designed to meet the industry requirement under the automotive mechanics level II occupational standard, particularly for the unit of competency: **Read and Interpret Machine Drawing.**

This module covers the units:

- Fundamental Machine Drawing
- Views Standard Symbols and Lines
- Machine Drawing Interpret

Learning Objective of the Module

- Identifying Machine Drawing
- Identifying Views Standard Symbols and Lines
- Interpreting Machine Drawing

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" giver at the end of each unit and
5. Read the identified reference book for Examples and exercise

1. Unit one: Machine Drawing Fundamentals

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

- Overview of machine drawing
- Standards of Machine parts
- Alphabet of lines
- Identifying drawing conventions codes and symbols
- Types of section views

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:

- Overviewing of machine drawing
- Identifying Standards of Machine parts
- Knowing Alphabet of lines
- Identifying drawing conventions codes and symbols
- Classifying sectional views

1.1 Fundamentals of Machine Drawing

1.1.1 Standardization

Machine Drawing is an essential communicating medium employed in industries, to furnish all the information required for the Manufacture and Assembly of the components of a machine. Automotive Technology Students are required to practice the drawing standards in full, So that the students after their training, can adjust very well in industries and business.

In the general definition standardization refers to the act of using common information to produce uniformity and to facilitate interchangeability among objects.

Example - Size (length, thickness, & width) of objects such as drawing sheets, quality and grade of drawing pencils and Bearings.

1.1.2 Standardization Organizations

ISO (International Organization for Standardization), and ANSI (American National Standard Institute). The ISO standard specifies size and layout of sheets for any kind of technical drawing. The drawing is made on the smallest size of sheet that permits its clarity and resolution.

Designation	Trimmed sheet (a x b)	Drawing area ($a_1 \pm 5$ x $b_1 \pm 5$)	Untrimmed sheet ($a_2 \pm 2$ x $b_2 \pm 2$)
A0	841 x 1189	821 x 1159	880 x 1230
A1	594 x 841	574 x 811	625 x 880
A2	420 x 594	400 x 564	450 x 625
A3	297 x 420	277 x 390	330 x 450
A4	210 x 297	180 x 277	240 x 330

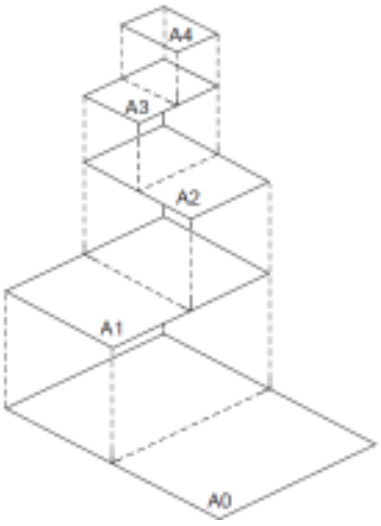


Figure 1-2 Paper size

1.1.3 Lines

The "Alphabet of Lines" refers to the different styles of symbolic lines used in drafting such as to show different features about an object that is drawn: hidden. Construction, cutting-plane, visible (object), dimension, extension, phantom, center, section, and border.

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

For example, a thick solid line is called an object line and represents the outline of a part on a drawing. A dash line represents an edge that is not visible in a particular view, hence it is called a hidden line.

Other common lines used in drafting include dimension lines, extension lines, construction lines, border lines, center lines among many others depending on the type of drawing.

Symbolic Lines are meant for symbolic purposes only. For example, you might sketch symbolic lines in an elevation view to represent a door swing. Symbolic lines are not part of the actual geometry of the family. Symbolic lines are visible parallel to the view in which you sketch them. Symbolic lines are mostly used in 2D drawing preparations.

1.1.4 Types of Line

There are standards for different types of lines along with line weight and quality called line type. Each has a definite meaning and is recognized as a typical symbol or object within the building trades industry. Listed below are the standard types of lines that will typically be used in design drawings.

Solid Lines or object lines – are used to indicate visible objects that can be seen in plan, elevation or 3D

Cutting Plane Lines – are heavy dash line followed by two shorter dashes. Each end has a short line at right angle to cutting plane line, with arrowheads pointing in direction from which cut surface is viewed. It is usually labelled with a letter at either end to identify cut surface drawing called a "section".

Dashed Lines – are used for hidden objects or edges . These are used to show hidden parts of an object or objects below or behind another object. Dashed are also used to indicate shelving or cabinets above a counter. These lines should be in contact at corners and when perpendicular to another line.

Movement, Ghost or Phantom Line – are thin lines and used to indicate alternate positions of parts or an object. It also shows repeated details or location of absent parts.

Leader Line – are used to connect notes or references to objects or lines in a drawing. Leader lines start as a solid line and end in an arrow. Leader lines may be drawn at an angle or curved.

Break lines – are used when extents of a drawing cannot fit on the size of paper being used for the drawing. It can also be used when you only need to illustrate a portion of a design or partial view.

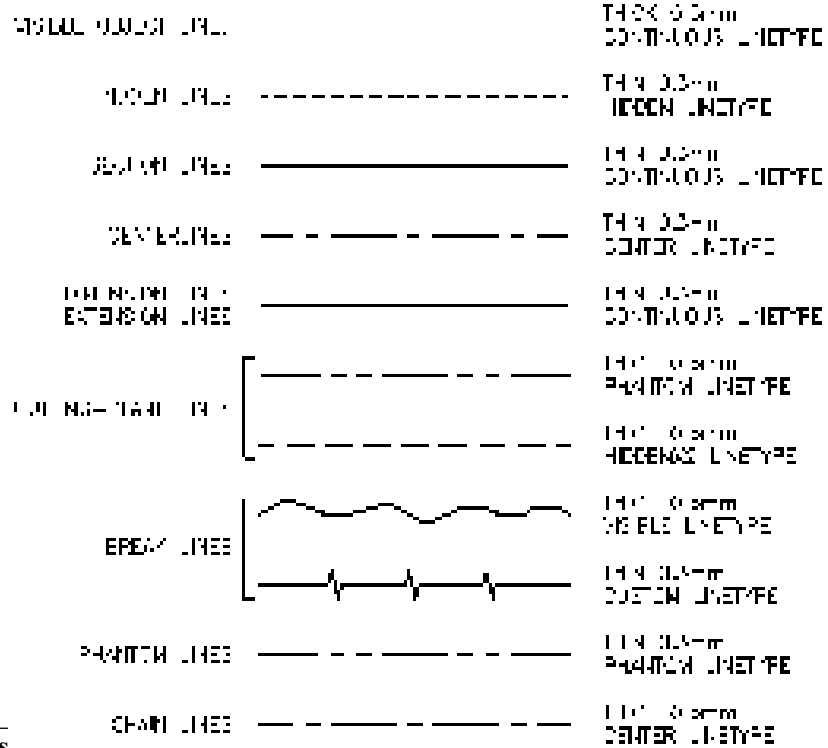
Center Lines – are used to indicate the center of a plan, object, circle, arc, or any symmetrical object. Use a series of very long and short dashes to create a center line. If two center lines intersect use short dashes at the intersection.

Section Line – is used to show a cutaway view of a floor plan. A section cutting all the way through a floor plan is referred to as a full section. The direction of the arrows shows the direction of the section view. The symbols on the end of the section line indicate the drawing number on top and the page number the section will be located on the bottom.

Dimension Line – is used to show measurement of an object. It can be used to indicate length, width, diameter, etc. The dimensions are listed in feet and inches (imperial) or meter and mm (SI) on floor plans and elevations. Detailed drawings of cabinetry or other custom pieces are dimen-sioned either in Imperial or SI.

The Following Figures shows the standard line conventions and samples on drawing applications:

A. Standard line types and line weights A



B. Standard line types and line weights B

Figure 1-4 Standard line types and line weights

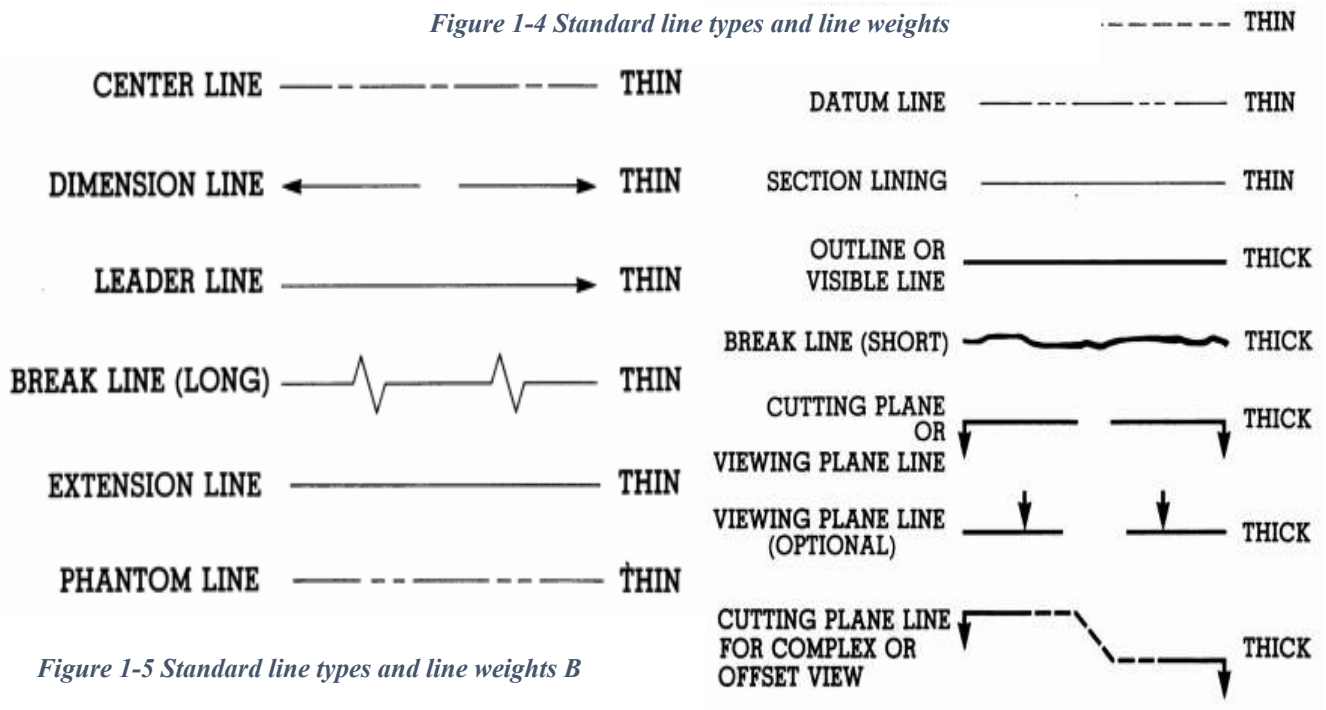


Figure 1-5 Standard line types and line weights B

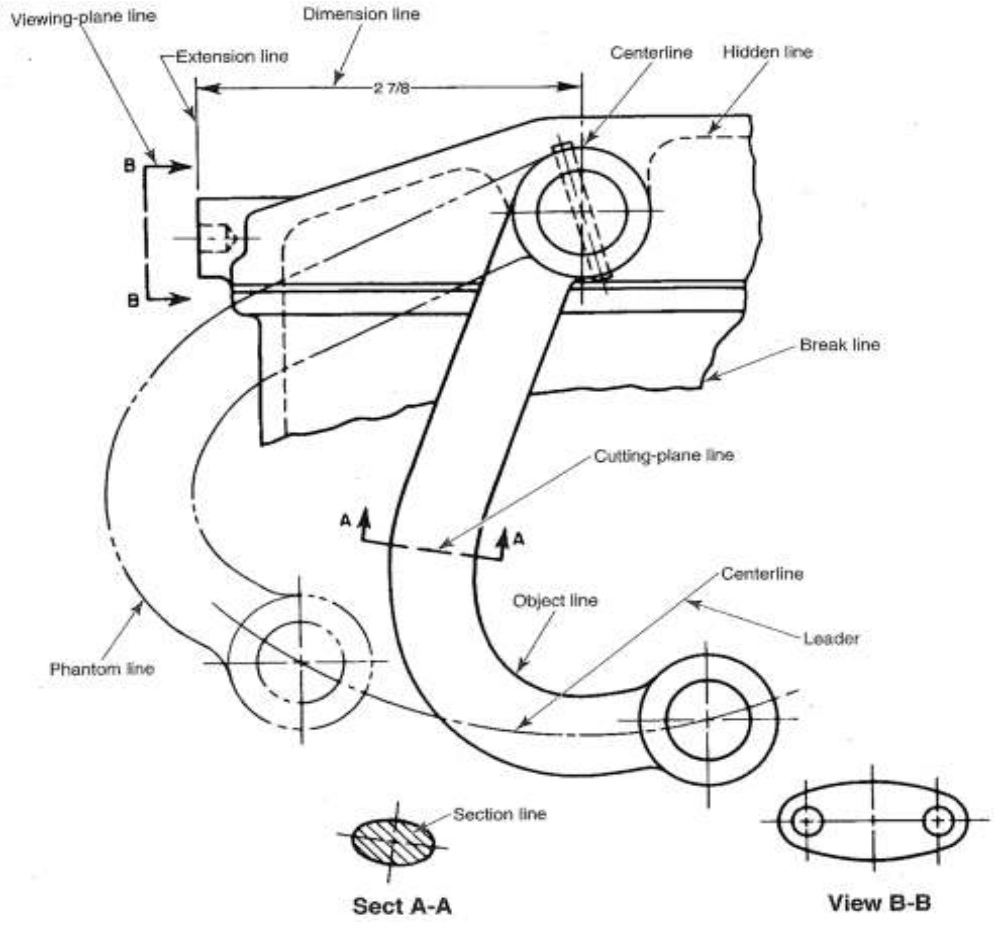


Figure 1-6 Example on how to apply line convention to a drawing

1.1.5 Scale

Scale is defined as the ratio of the linear dimension of an object as it is represented in the drawing to the real dimension of the same object.

Designation

SCALE 1: 1 - Full size;

A: 1 - Enlargement scale;

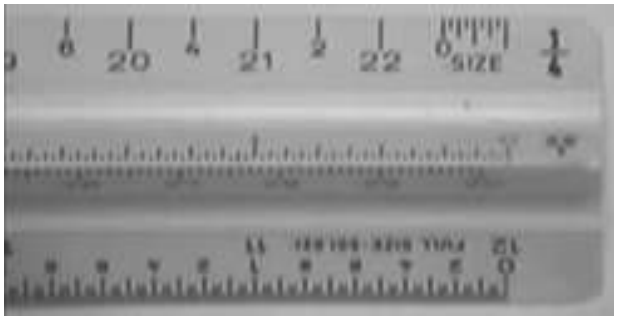
1: A - Reduction scale;

Recommended scales in technical drawings:

Enlargement scales 50 : 1, 20 : 1, 10 : 1, 4 : 1, 2 : 1;

Reduction scales 1: 2, 1: 4, 1: 10, 1: 20, 1: 50;

The ***mechanical engineers (Automotive division categorized under mechanical) scale*** is useful in drawing machine parts where the dimensions are in inches or fractional parts of an inch. Common graduations for mechanical engineer's scales represent one inch. Typical mechanical engineer's scales is shown below.



Mechanical Engineer's Scales	
Scale	Size
1" = 1"	Full size
1/2" = 1"	Half size
1/4" = 1"	1/4 size
1/8" = 1"	1/8 size

Mechanical engineer's scales are open divided scales. They are often called size scales.

For instance, a 1/8” scale is used for drawings that are one-eighth the size of the object. The “1” scale is used for full-size scale drawings.

Figure 1-7 Mechanical Engineer’s Scale

1.1.6 Technical Lettering

Lettering can be defined as the method of transferring non graphical information on to the drawing which is relevant for the intended application. Such information includes dimensions, heat treatment notes, surface preparation notes, testing and inspection notes, plating and coating notes, scales, and revision notes. Lettering it should be legible. The Lettering dimensions including Nominal size, lettering angle, Spacing between characters and Spacing between words.

1.1.7 Title block

The title block should lie within the drawing space such that, the location of it, containing the identification of the drawing, is at the bottom right hand corner. This must be followed, both for sheets positioned horizontally or vertically. The direction of viewing of the title block should correspond in general with that of the drawing. The title block can have a maximum length of 170 mm. Figure 1-8 shows a typical title block, providing the following information:

(i) Title of the drawing
(ii) Sheet number
(iii) Scale
(iv) Symbol, denoting the method of projection
(v) Name of the firm
(vi) Initials of staff drawn, checked and approved.

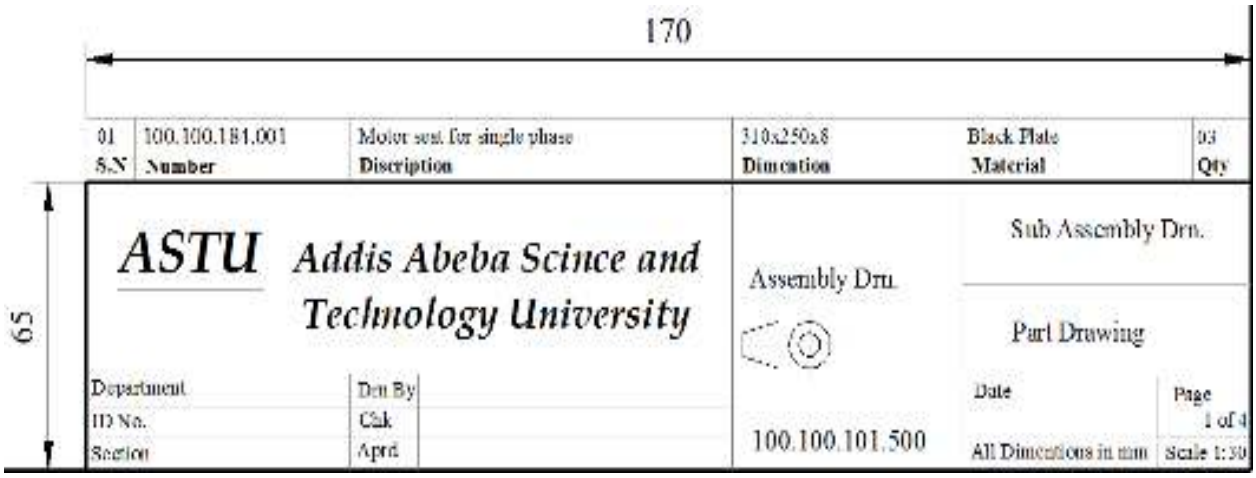


Figure 1-8 Title block

1.1.8 Convention Representation

Certain draughting conventions are used to represent materials in section and machine elements in engineering drawings.

A. Material

As a variety of materials are used for machine components in engineering applications, it is preferable to have different conventions of section lining to differentiate between various materials. The recommended conventions in use are shown in Fig.8.

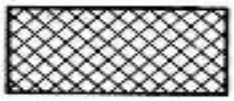
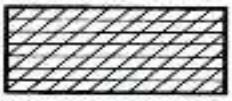
TYPE	CONVENTION	MATERIALS
METALS		STEEL, CAST IRON, COPPER AND ITS ALLOYS, ALUMINIUM AND ITS ALLOYS, ETC
		LEAD, ZINC, TIN, WHITE METAL, ETC
GLASS		GLASS
PACKING AND INSULATING MATERIALS		PORCELAIN, STONEWARE, MARBLE, SLATE, ETC
		ASBESTOS, FIBRE, FELT, SYNTHETIC RESIN PRODUCTS, PAPER, CORK, LINOLEUM, RUBBER, LEATHER, WAX, INSULATING & FILLING MATERIALS
LIQUIDS		WATER, OIL, PETROL, KEROSENE, ETC
WOOD		WOOD, PLYWOOD, ETC
CONCRETE		

Figure 1-9 Types of material

B. Machine component

When the drawing of a component in its true projection involves a lot of time, its convention may be used to represent the actual component. Figure 9 shows typical examples of conventional representation of various machine components used in engineering drawing.

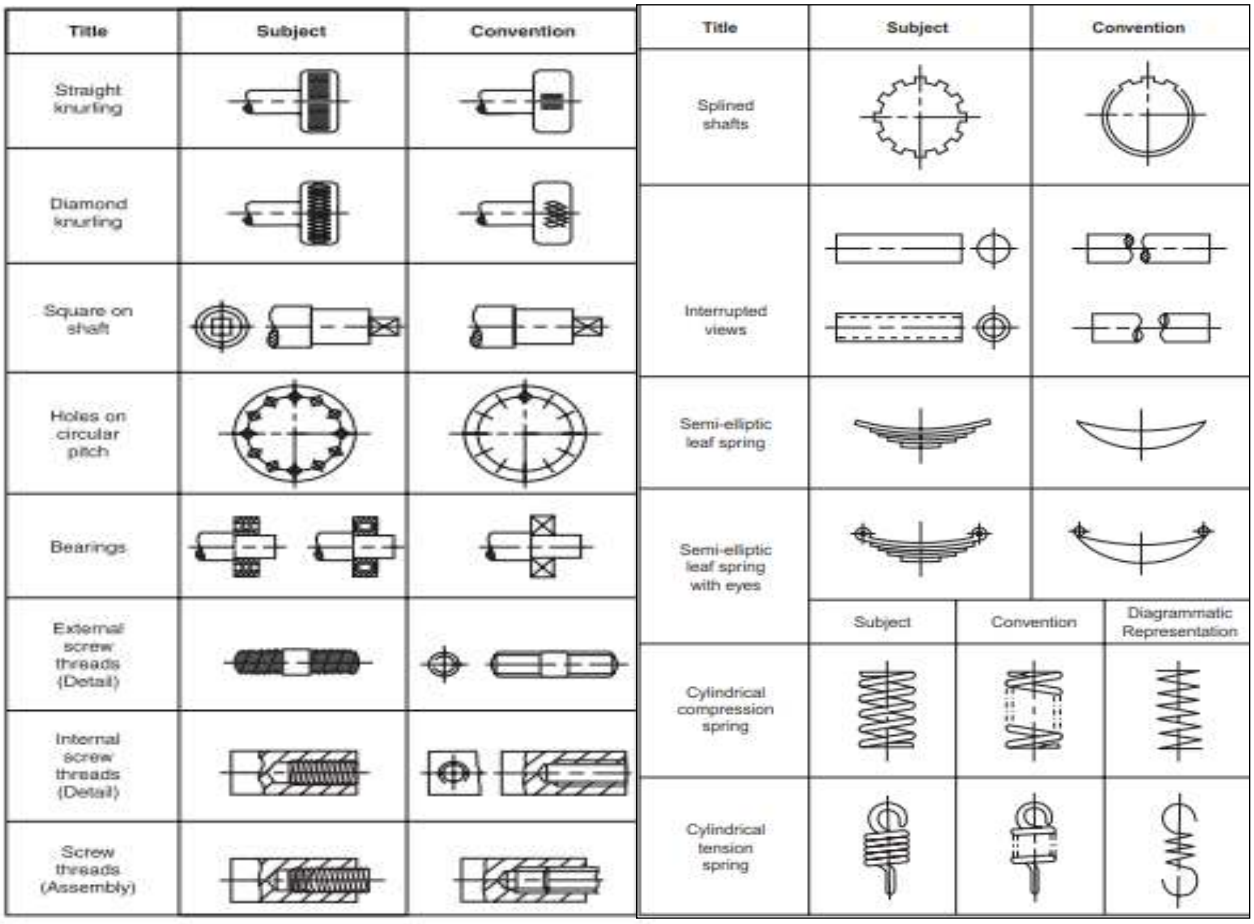


Figure 1-10 Conventional Representations and Standard Abbreviations

1.1.9 Sectioning

In order to show the inner details of a machine component, the object is imagined to be cut by a cutting plane and the section is viewed after the removal of cut portion. Sections are made by at cutting planes and are designated by capital letters and the direction of viewing is indicated by arrow marks.

The cutting plane(s) should be indicated by means of type H line. The cutting plane should be identified by capital letters

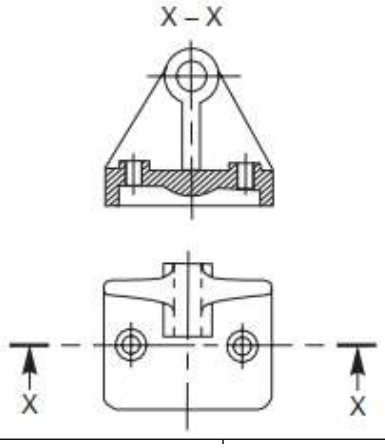


Figure 1-11 Sectioning

and the direction of viewing should be indicated by arrows. The section should be indicated by the relevant designation.

In principle, ribs, fasteners, shafts, spokes of wheels and the like are not cut in longitudinal sections and therefore should not be hatched. Sectioning in two parallel planes and that of sectioning in three continuous planes.

1.1.9.1 Types of Sections

A. Full Sections

When a cutting plane line passes entirely through an object, the resulting section is called a full section Fig. 11 illustrates a full section.

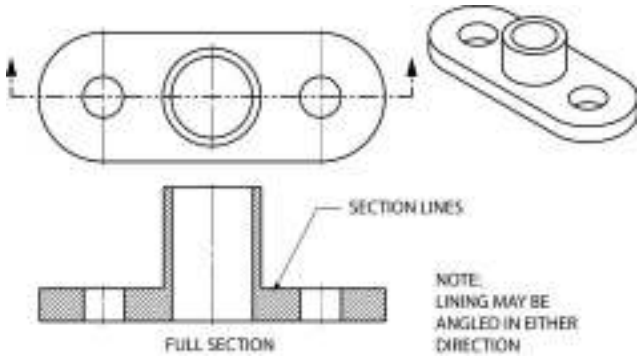


Figure 1-12 Full Sections

B. Half Sections

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

It is frequently used for symmetrical objects. Hidden lines are usually not shown on the un-sectioned half unless they are needed for clearness or for dimensioning purposes. As in all sectional drawings, the cutting plane take precedence over the center line.

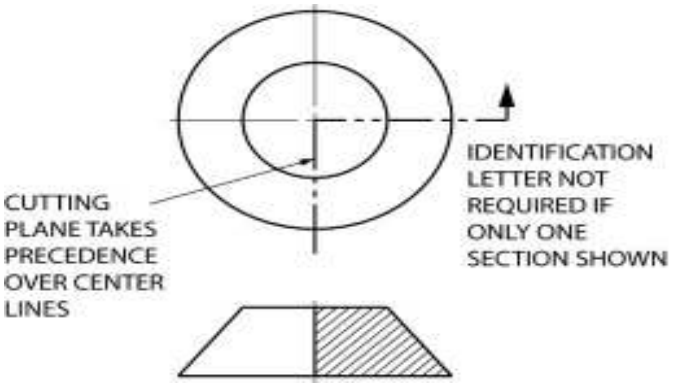
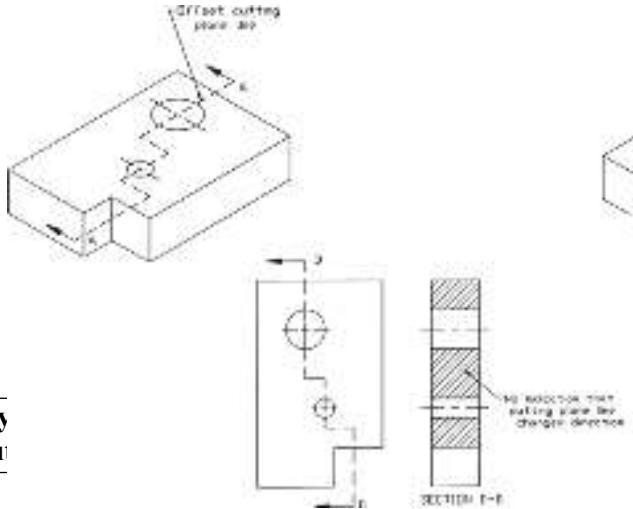


Figure 1-13 Half Sections

C. Offset Sections

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



D. Part Section

Part section is a technique that is used to expose a small part of the interior of an object by removing a small part of the object. The view is basically an outside view with a small portion removed. The break line is illustrated with irregular thin continuous lines.

Figure 1-14 Offset

Figure 1-15 Part Section

E. Revolved Section

Revolved section shows only the features on the cut plane. It is used to depict the section of an elongated object without the need to show the entire sectional view. Instead of projecting the section onto an adjacent view, the resulting section obtained from the cutting is revolved 90° and is placed on the same view.

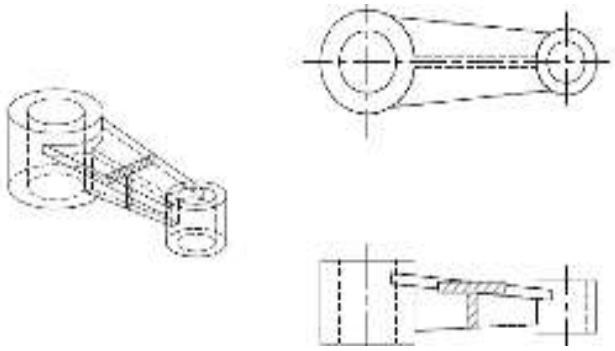


Figure 1-16 Revolved Section

1.1.9.2 Removed Section

Removed section is similar to revolved section in that only the cut plane is shown. However, the section is placed elsewhere on the drawing.

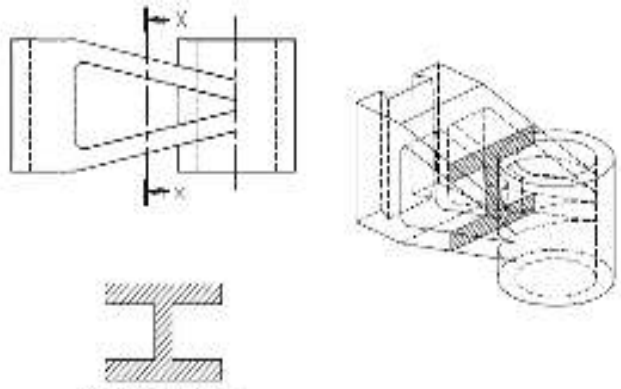


Figure 1-17 Removed Section

1.1.9.3 Parts not sectioned

To improve clarity, standard parts will not be section-lined even though the cutting plane passes them.

These standard parts are solid shafts, bolts and nuts, ribs and spokes of wheels, and webs.

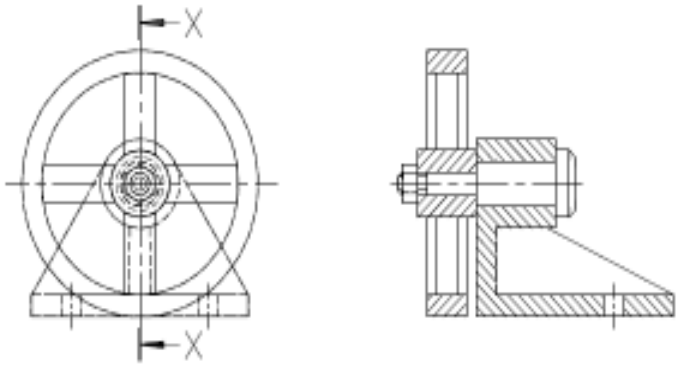


Figure 1-18 Parts not sectioned

1.1.9.4 Conventional Revolutions

The strict rules of projection may sometimes be relaxed for the sake of better clarity. This happens with odd numbers of holes on a plate or odd number of spokes on a wheel. Revolving and aligning the features on an outside view or sectional view will improve clarity.

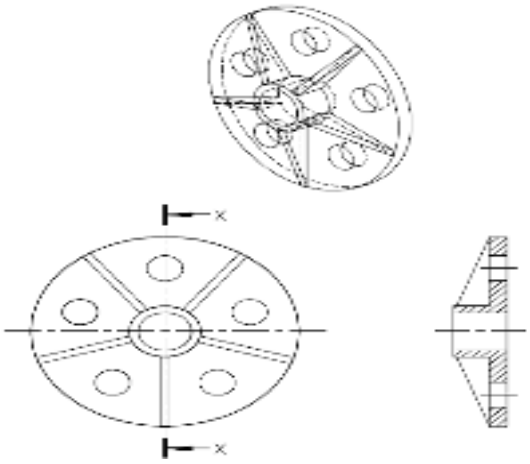


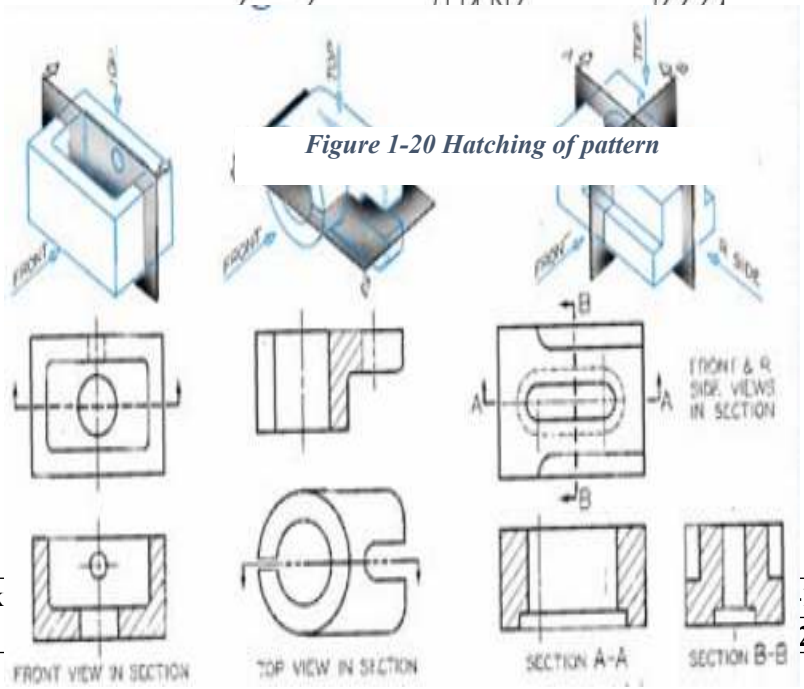
Figure 1-19 Conventional Revolutions

1.1.9.5 Hatching of section

Hatching is generally used to show areas of sections. The simplest form of hatching is generally adequate for the purpose, and may be continuous thin lines (type B) at a convenient angle, preferably 45°, to the principal outlines or lines of symmetry of the sections.

Figure 1-20 Hatching of pattern

Separate areas of a section of the same component shall be hatched in an identical manner. The hatching of adjacent components



shall be carried out with different directions or spacing's. In case of large areas, the hatching may be limited to a zone, following the contour of the hatched area.

Where sections of the same part in parallel planes are shown side by side, the hatching shall be identical, but may be off-set along the dividing line between the sections. Hatching should be interrupted when it is not possible to place inscriptions outside the hatched area.

Figure 1-21 Example of hatching

1.1.10 Dimensioning

A drawing of a component, in addition to providing complete shape description, must also furnish information regarding the size description. These are provided through the distances between the surfaces, location of holes, nature of surface finish, type of material, etc. The expression of these features on a drawing, using lines, symbols, figures and notes is called dimensioning.

The general principle of dimension is a numerical value expressed in appropriate units of measurement and indicated on drawings, using lines, symbols, notes, etc., so that all features are completely defined.

1. As far as possible, dimensions should be placed outside the view.
2. Dimensions should be taken from visible outlines rather than from hidden lines.
3. Dimensioning to a center line should be avoided except when the center line passes through the center of a hole.
4. Each feature should be dimensioned once only on a drawing.
5. Dimensions should be placed on the view or section that relates most clearly to the corresponding features.
6. Each drawing should use the same unit for all dimensions, but without showing the unit symbol.
7. No more dimensions than are necessary to define a part should be shown on a drawing.
8. No features of a part should be defined by more than one dimension in any one direction.

Self- check 1

Short Answer

1. Explain the terms, (a) half section, (b) full section and (c) offset sections
2. List out the various principles to be followed while dimensioning a drawing.
3. Distinguish between the drawings for catalogues and instruction manuals.
4. What is meant by a schematic assembly drawing and when is it preferred?
5. What is a machine shop drawing and how is it different from machine drawing?

True or false

1. The center line should end at the outline of the drawing (True/False).
2. Dimensions may be marked from hidden lines (True/False).
3. Extension lines should end at the dimension line (True/False).
4. Dimension lines should not cross each other (True/False).
5. Centre lines are drawn in thick lines (True/False).
6. Leader lines are drawn in thick lines (True/False).

2. Unit Two: Machine Drawing Practices

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

- Identify Machine Drawing
    - Fundamental of machine drawing
    - Assembling and Exploding drawing
    - Following and confirming instructions

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

- Overviewing of machine drawing
- Identifying types of section views
- Interpreting assembling and exploding drawing

1.2 Assembly drawing

It is usually made for simple machines, comprising of a relatively smaller number of simple parts. All the dimensions and information necessary for the construction of such parts and for the assembly of the parts are given directly on the assembly drawing. Separate views of specific parts in enlargements, showing the fitting of parts together, may also be drawn in addition to the regular assembly drawing.

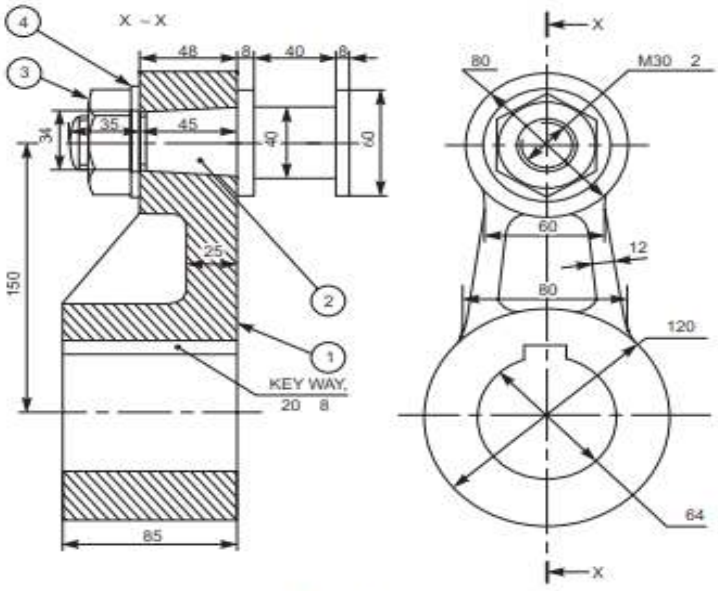
1.2.1 Design assembly drawing

When a machine is designed, an assembly drawing or a design layout is first drawn to clearly visualize the performance, shape and clearances of various parts comprising the machine.

It is usually made for simple machines, comprising of a relatively smaller number of simple parts. All the dimensions and information necessary for the construction of such parts and for the assembly of the parts are given directly on the assembly drawing. Separate views of specific parts in enlargements, showing the fitting of parts together, may also be drawn in addition to the regular assembly drawing.

Many assemblies such as an automobile, lathe, etc., are assembled with many pre-assembled components as well as individual parts. These pre-assembled units are known as sub-assemblies.

A sub-assembly drawing is an assembly drawing of a group of related parts that form a part in a



Parts List

Part No.	Name	Material	Qty
1	Crank	Forged Steel	1
2	Crank Pin	45C	1
3	Nut	MS	1

Figure 2-1 Assembly Drawing

more complicated machine. Examples of such drawings are: lathe tail-stock, diesel engine fuel pump, carburetor, etc.

On this drawing, the location and dimensions of few important parts and overall dimensions of the assembled unit are indicated. This drawing provides useful information for assembling the machine, as this drawing reveals all parts of a machine in their correct working position.

1.2.2 Assembly drawing for catalogues

Special assembly drawings are prepared for company catalogues. These drawings show only the pertinent details and dimensions that would interest the potential buyer.

Figure 2.2 shows a typical catalogue drawing, showing the overall and principal dimensions.

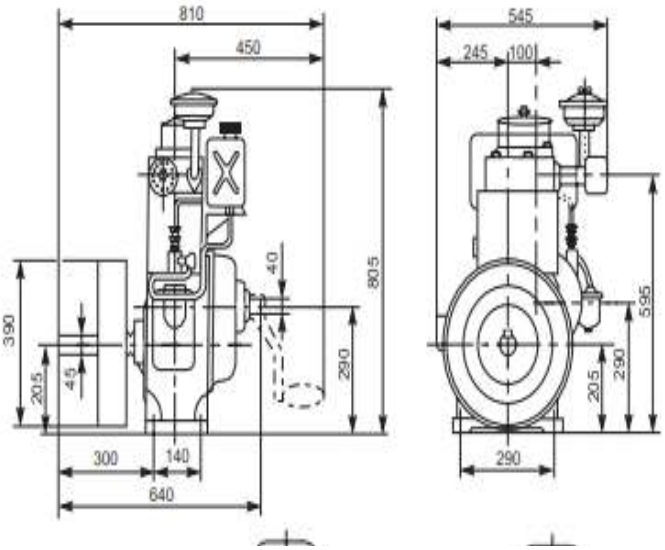
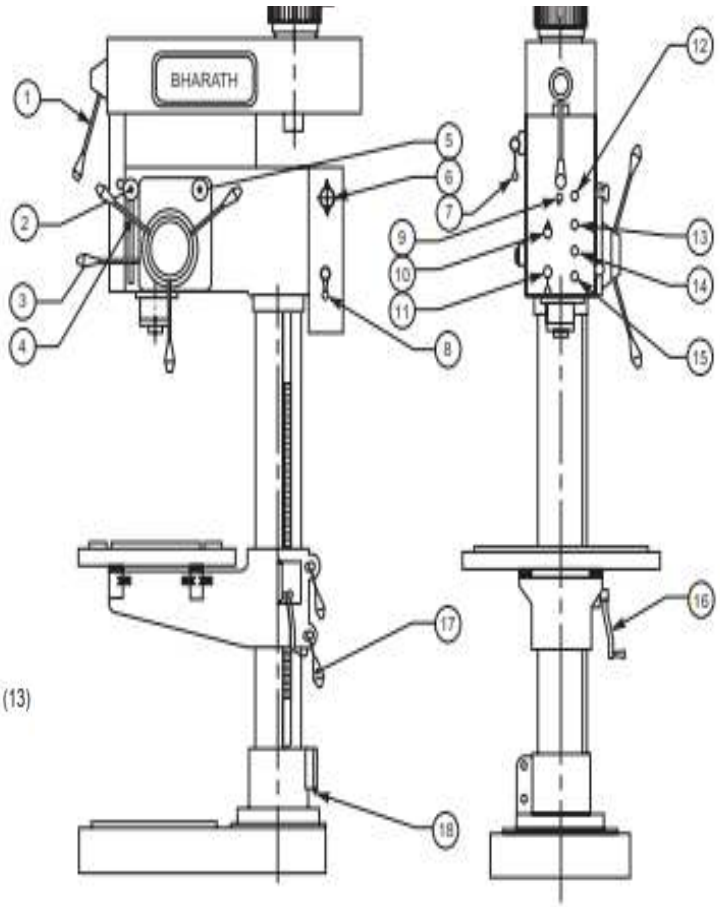


Figure 2-2 Assembly drawing for catalogues

1.2.3 Assembly drawing for instruction manual

These drawings in the form of assembly drawings, are to be used when a machine, shipped away in assembled condition, is knocked down in order to check all the parts before reassembly and installation elsewhere.



Speed change lever (1)	Selector switch (10)
Depth adjusting knob (2)	Forward/reverse switch (11)
Mech. feed engagement lever (3)	Pilot lamp (12)
Hand feed lever (4)	Feed disengagement push button (13)
Feed change knob (5)	Start push button (14)
Switch for tapping (6)	Emergency stop (15)
Gear shifting lever (7)	Elevating handle (16)
Main switch (8)	Clamping handle (17)
Lamp switch (9)	Supply inlet (18)

These drawings have each component numbered on the job. Figure 2.3 shows a typical example of such a drawing.

1.3 Exploded drawing

In some cases, exploded pictorial views are supplied to meet instruction manual requirements. These drawings generally find a place in the parts list section of a company instruction manual.

Figure 1.6 shows drawings of this type which may be easily understood even by those with less experience in the reading of drawings; because in these exploded views, the parts are positioned in the sequence of assembly, but separated from each other.

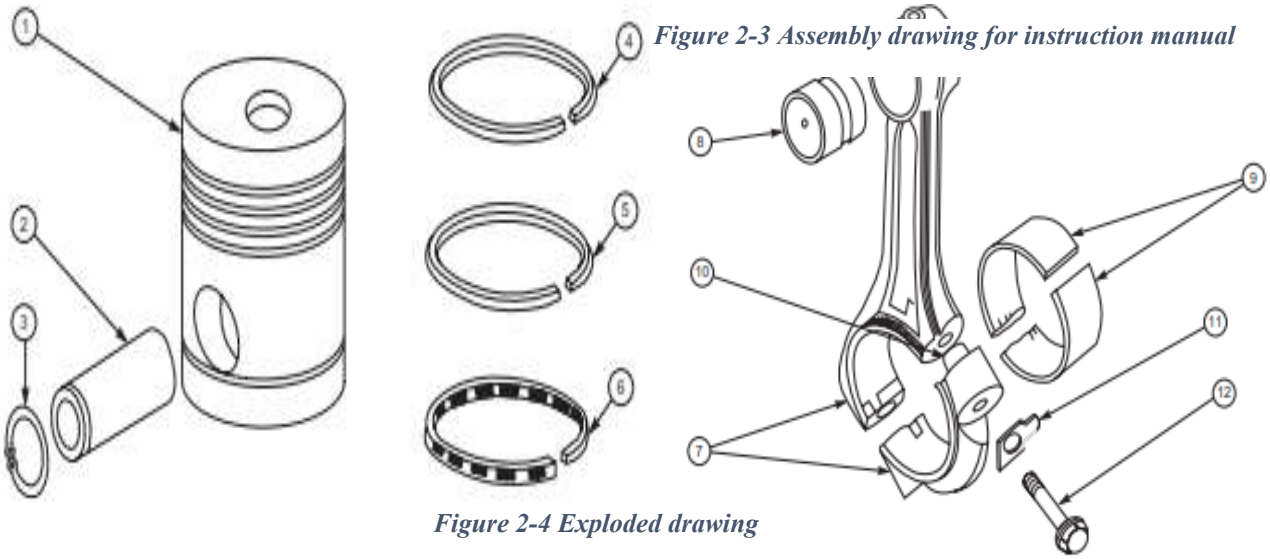


Figure 2-3 Assembly drawing for instruction manual

Figure 2-4 Exploded drawing

1.3.1 Schematic assembly drawing

It is very difficult to understand the operating principles of complicated machinery, merely from the assembly drawings. Schematic representation of the unit facilitates easy understanding of its operating principle.

It is a simplified illustration of the machine or of a system, replacing all the elements, by their respective conventional representations. Figure 2.5 shows the

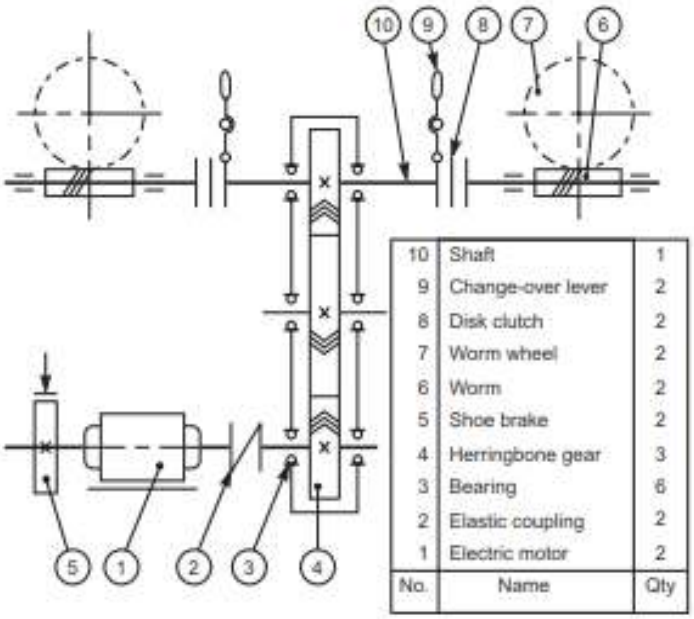


Figure 2-5 Schematic assembly drawing

schematic representation of a gearing diagram.

1.3.2 Machine shop drawing

Rough castings and forgings are sent to the machine shop for finishing operation. Since the machinist is not interested in the dimensions and information of the previous stages, a machine shop drawing frequently gives only the information necessary for machining.

Based on the same principle, one may have forge shop drawing, pattern shop drawing, sheet metal drawing, etc.

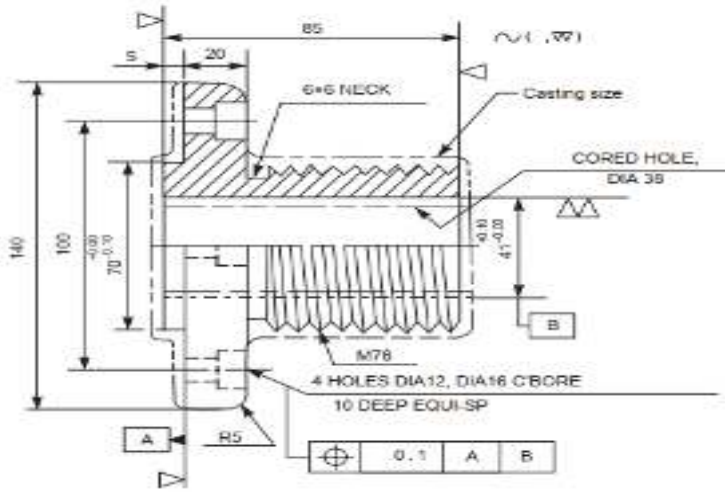


Figure 2-6 Machine shop drawing

1.4 Part Drawing

The drawing is analyzed thoroughly, final assembly drawings are made from these drawings. To facilitate the manufacture of the unit, individual parts of the unit are to be produced first, which requires the preparation of part drawings. These are prepared from the final assembly drawings.

The part drawing must contain all the information required such as size and shape description, dimensions, notes, suitable material, etc., to enable the student to understand the functional aspects of the unit.

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

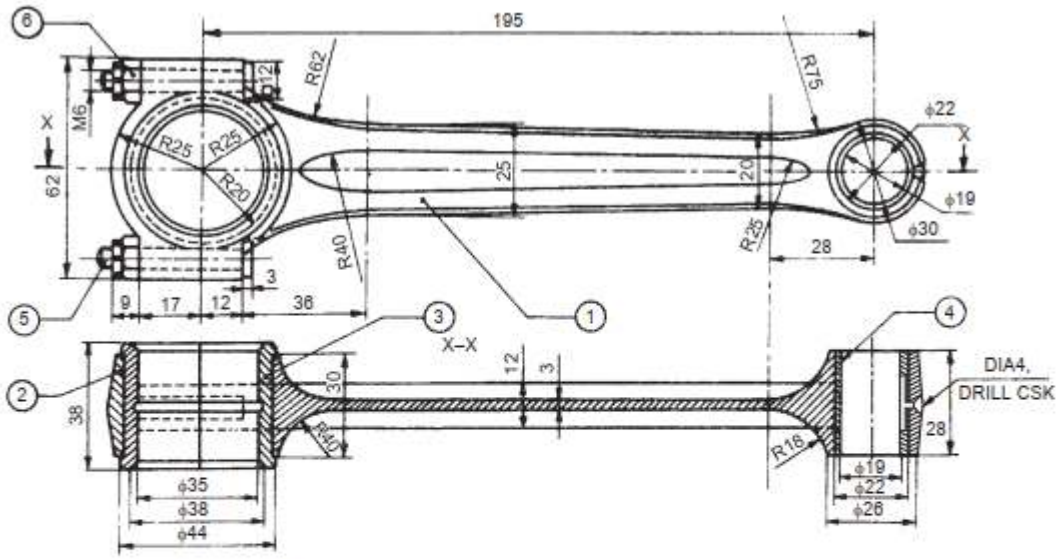
9. Understand the assembly drawing thoroughly, by referring to the parts list and the different orthographic views of the unit.
10. Study the functional aspect of the unit as a whole. This will enable to understand the arrangement of the parts.
11. Visualize the size and shape of the individual components.
12. 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.

13. 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.
14. The undermentioned sequence may be followed for preparing different views of each part:
    (i) Draw the main center lines and make outline blocks, using the overall dimensions of the views.
    (ii) Draw the main circles and arcs of the circles.
    (iii) Draw the main outlines and add all the internal features.
    (iv) Cross-hatch the sectional views.
    (v) Draw the dimension lines and add dimensions and notes.

7. Check the dimensions of the mating parts.

8. Prepare the parts list and add the title block.

2.1



Parts list

Part No.	Name	Matl.	Qty.
1	Rod	FS	1
2	Cap	FS	1
3	Bearing brass	GM	2
4	Bearing bush	P Bronze	1
5	Bolt	MCS	2
6	Nut	MCS	2

Figure 2-7 Part Drawing

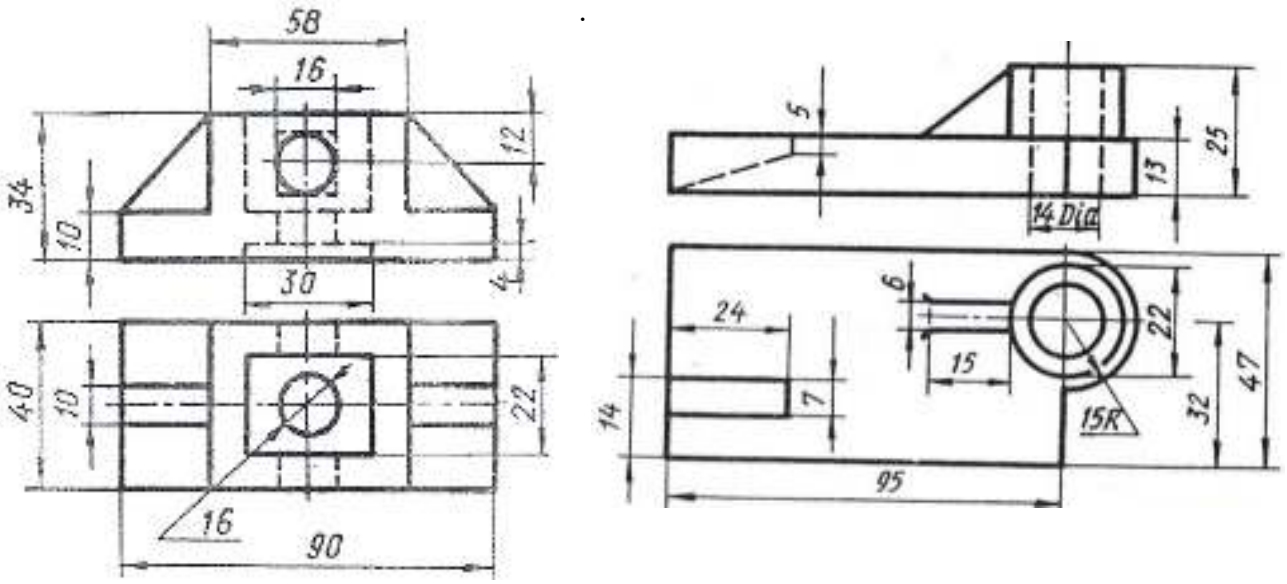
Operation sheet

Operation sheet-1

Operation title: Draw Sectional view

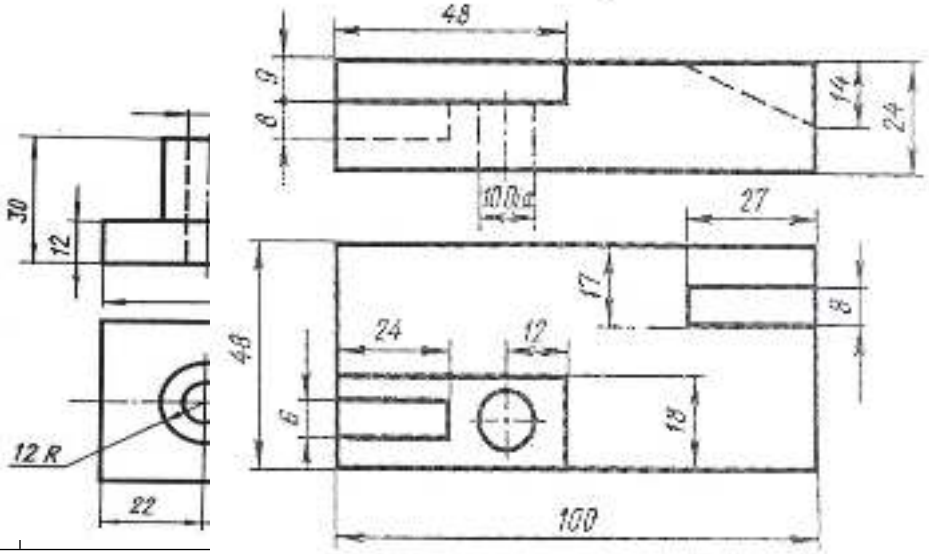
Purpose: To draw the sectional view of a given models

Instruction: Two views of a model are given in each of the following cases. Replace one of the views using either Full, Half or Off-set sectional view and show your cutting plan line.



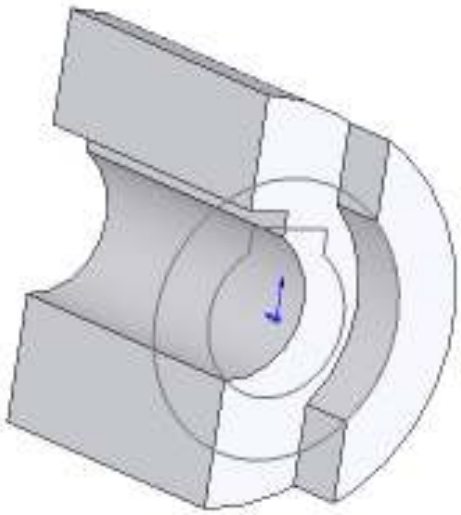
Operation sheet-2

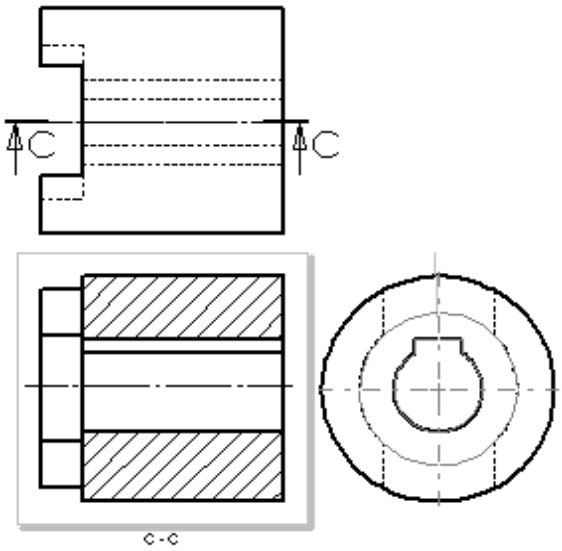
Operation title: Sectional view

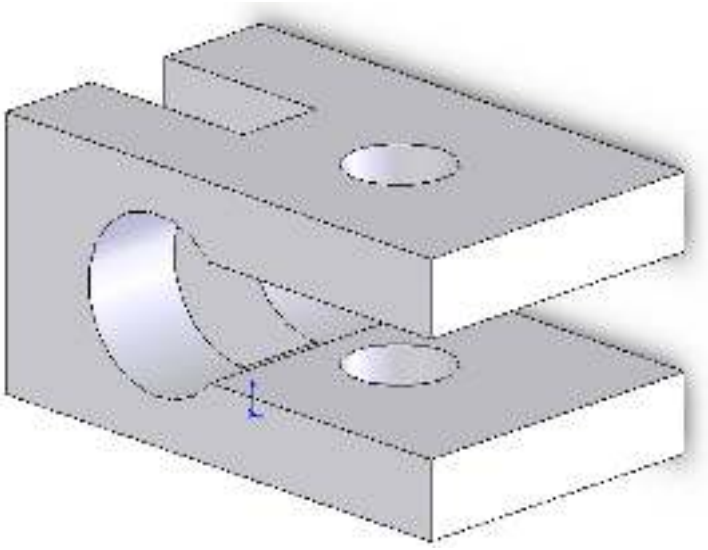


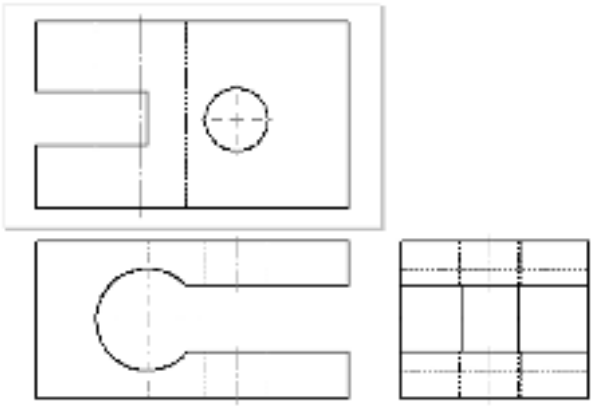
Purpose: To draw the sectional view of a given models

Instruction: Exercise the sectional pictorial and Sectional view drawing for the following views









Operation sheet-3

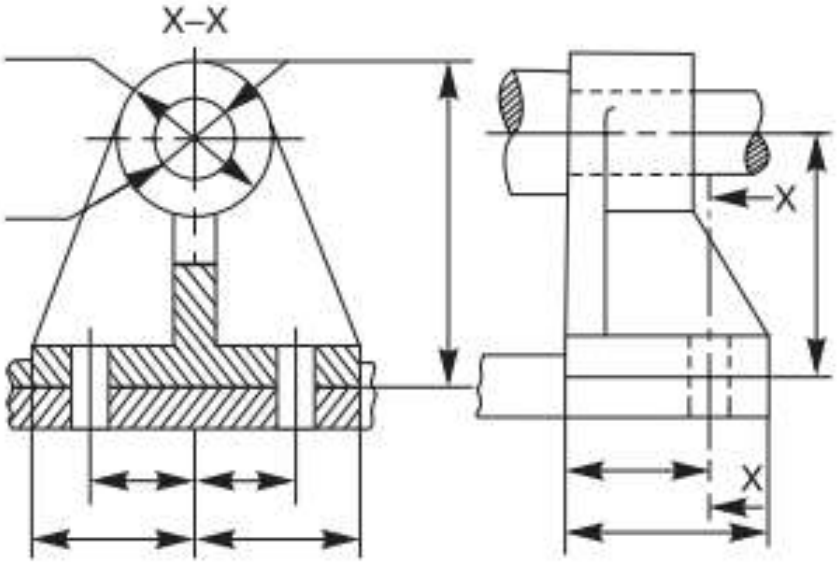
Operation title: Lines identification

Purpose: To exercise different types of lines

Instruction:

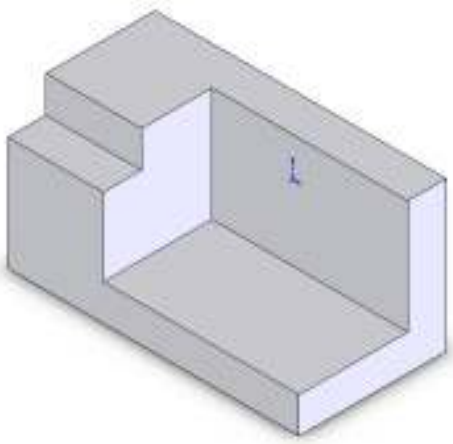
1. Sketch the following types of lines: (a) center line, (b) cutting plane line and (c) long break

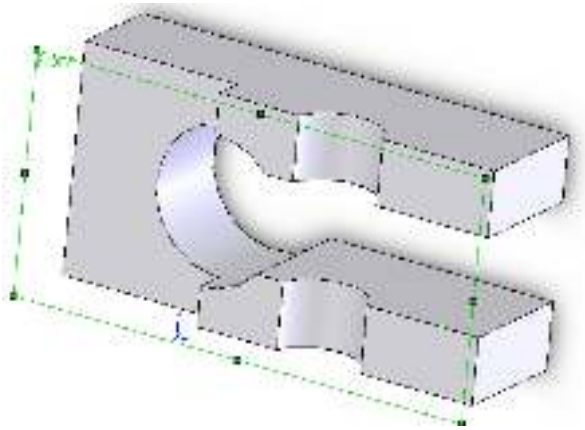
2. Sketch the conventional representation of the following materials: (a) bronze, (b) cast iron,(c) concrete, (d) wood and (e) white metal.
3. Sketch the various dimension line terminations and origin indication.



LAP Test

1. Draw the sectional pictorial and Sectional view drawing for the following views





2. The drawings in below are not dimensioned properly. Correct them according to standards**.**