ME 174
Mechanical Engineering Drawing and CAD

INSTRUCTION SHEET

Course outline

Classes	Topics
1	Introduction: Basic drawing concepts and practice
2	Orthogonal views of simple blocks with holes
3	Orthogonal views with rounds and fillets
4	Sectional views
5	Isometric views of simple blocks
6	Isometric views with holes
7	Midterm Quiz
8 onwards	Mechanical engineering drawing using CAD

Note:

- If a student fails to attend any drawing class, he/she will get zero marks in that drawing.
- No student will be allowed in the class without the necessary INSTRUMENTS and INSTRUCTION SHEET.
- There will be a MIDTERM QUIZ, a FINAL QUIZ, and a VIVA during the term time. Marks obtained in these exams and those in drawings performed in the classes will be added together to calculate the final grade.

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INTRODUCTION

Drawing is the graphic language, expressed by mean of lines, symbols, sizes and shapes. It is the global language of engineers. It is the language every technical person wishes to communicate his ideas clearly to others. It is a process of thinking planning and setting thoughts drawn on paper in graphic form.

Almost every manufactured product and all major buildings are created on a drawing board at first and all technical persons such as engineers, technicians and workers manufacture the same according to the drawing. So a throughout knowledge of drawing and drafting is essential to all of these professional.

Because drawing is a graphic language it follows some rules and grammars.

There are two fundamental methods of writing the graphic language: freehand and with instruments. Freehand drawing is widely known as sketching. On the other hand, second type of drawing is known as drafting. All drawing made with the help of instruments are known as Mechanical Drawing.

Instruments and their uses

Since engineering drawing is entirely an instrument based graphic language, equipment is needed to record information on the drawing surface. In general, the following materials and equipment are widely used:

1. Drawing board/table
2. Drawing sheet/paper
3. Drafting tape
4. Pencils
5. Eraser
6. Sharpener
7. T-square
8. Set-squares/Triangles
9. Scales
10. Compass and divider

Drawing boards / tables: The drawing board may be a table top or a separate board. The working surface would be made of well seasoned wood. The working edge must be straight and should be tested with a steel straightedge. Some boards and tabletops are supplied with steel inserted on the working surface. In our drawing lab, tabletop drawing boards are used.

Drawing sheets / papers: Drawing papers are available on a number of colors and sizes. Common sizes of drawing papers are

216 x 280 mm
280 x 382 mm
382 x 560 mm
585 x 726 mm

Here, white plane surface drawing papers of size 585 x 726 mm are used.

Drafting tape: Drawing paper is usually attached to the drawing board by means of short pieces of scotch tape on each corner. Sometimes, for smaller drawing, entire edge of the paper is taped. After completion of the drawing, tapes should be cleanly removed from the paper of excess corner of the tapes should be cut by a sharp knife or scissors without damaging the drawing paper.

Pencils: The basic instrument of drawing is the graphite lead pencil, made in various hardness. Hardness gradation is: 6B, very soft and black; 5B, 4B, 3B; 2B, B and HB to F, the medium grade, and H, 2H, 3H, 4H, 5H, 6H, 7H and 8H to 9H the hardest. The soft (B) grades are used primarily for sketching and rendering drawings and the hard (H) grades for instrument drawing. Semiautomatic pencils (lead holder) are more convenient then ordinary wood pencils.

Eraser: Used to erase unnecessary lines and marks from drawing sheets.

Sharpener: For sharpening of the wood pencils. It may be a sharpening knife or other sharpening device.

T-square: The foxed head T-square is used for all ordinary work. It is generally made of hard wood or celluloid and the blade is perfectly straight. The celluloid T-square is more convenient for drawing. T-square is mainly used to draw horizontal lines.

Set-squares / Triangles: Set squares / triangles are made of transparent celluloid or other plastic materials. Set-squares are available in various sizes. For all drawing purposes a 45°–45° triangle and a 30°-90° triangle are good enough. Set-squares are used to draw vertical lines (by placing one of its straight edges on the T-square) or straight lines at angles 15°, 30°, 45°, 60°, 75°. Methods of straight lines at an angle are given at a later section.

Scales: For engineering drawing, different types of scale having different markings are used. For convenience, scales are classified according to their most common uses such as: Mechanical Engineers Scale, Civil Engineer's Scale and Architect's Scale.
In this course, general celluloid scales are prescribed.

Compass and divider: Pencil compass or ink compass is a device by which arcs or circles of different radius can be drawn. For engineering drawing some different types of standard compasses are used, which are different from ordinary compasses available in geometry box for school level. Suggested size of compass in six inches in size.

Drawing of Lines and Classification of Lines

Lines:

Different types of lines having different width are required in mechanical engineering drawing. The width (thickness) or boldness of these lines differ from each other according to their uses. Fig. 1 shows different types of lines with their thickness.

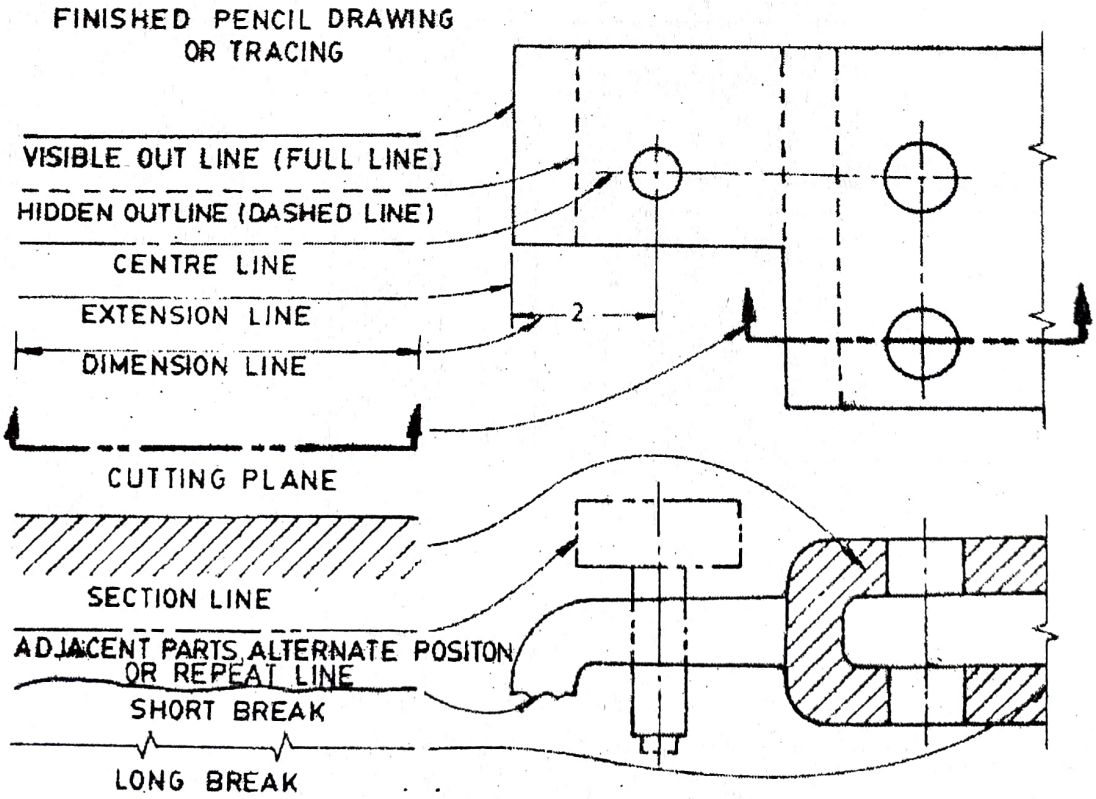
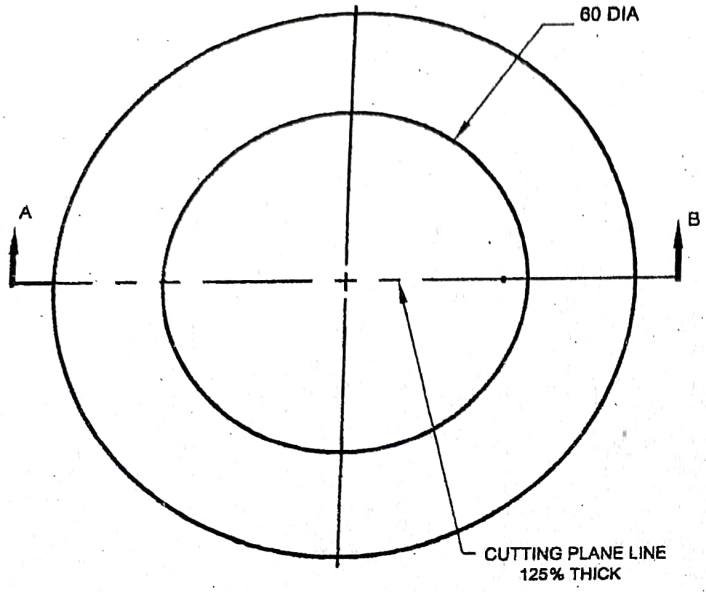
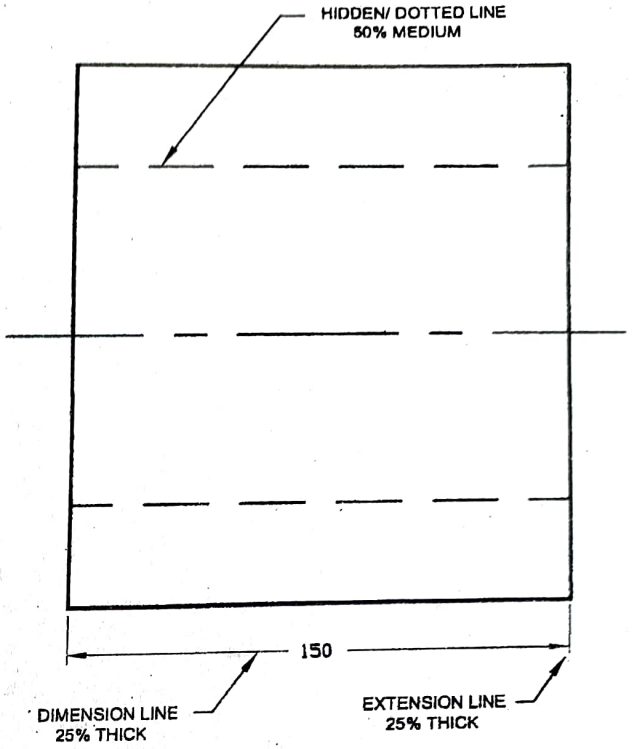
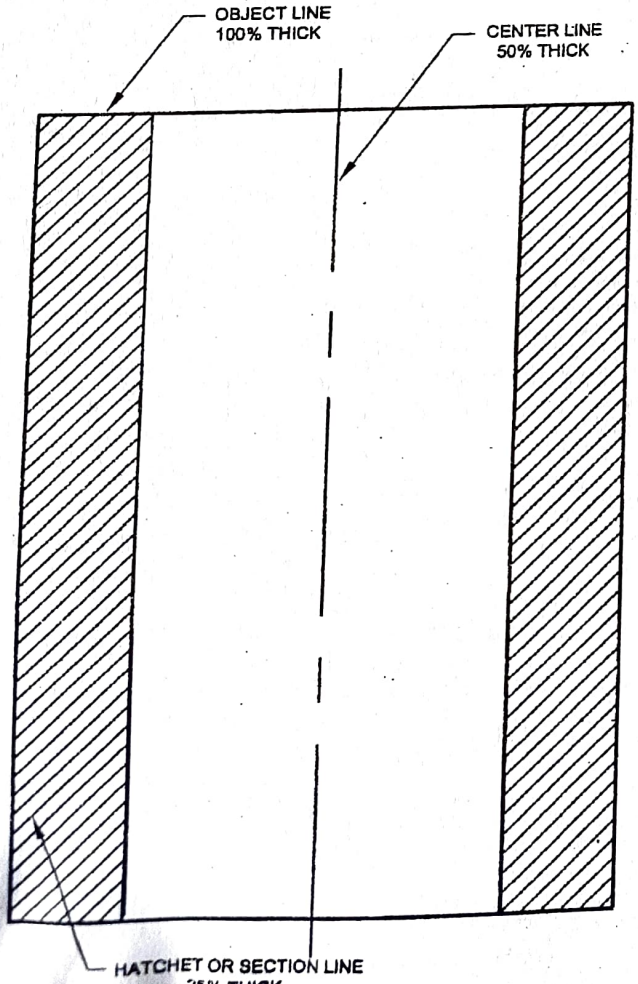


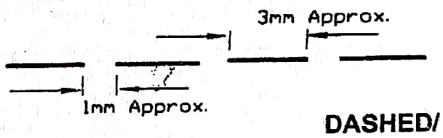
Fig. 1



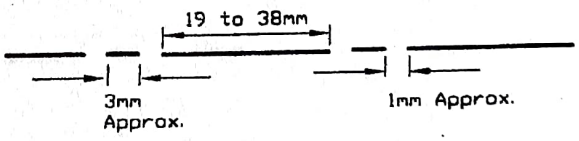




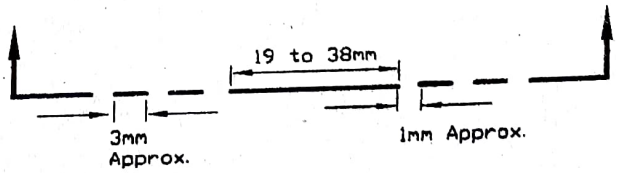
SECTION A-B



DASHED/ HIDDEN LINE



CENTER LINE



CUTTING PLANE LINE

FIGURE NOT DRAWN TO SCALE

PREPARING A DRAWING PAPER FOR DRAWING

Before starting a drawing, a drawing paper should be placed on the drawing board in such a way that the top and bottom edges of the paper make right angles with the left edge of drawing board. This can be ensured by means of a T-square. Then four corners of the sheet would have to be fixed on the board by means of drafting tape.

Drawing paper that would be used in our class is 585 x 724 mm should have a margin of 10 mm on all four sides. A title block on the right hand bottom corner of the drawing paper is drawn according to the Fig 2 & 3.

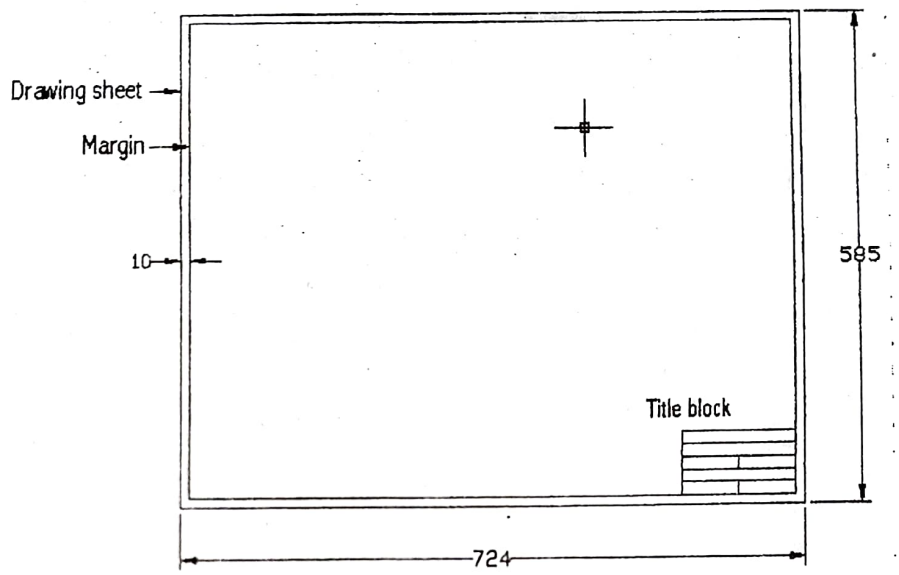


Fig. 2

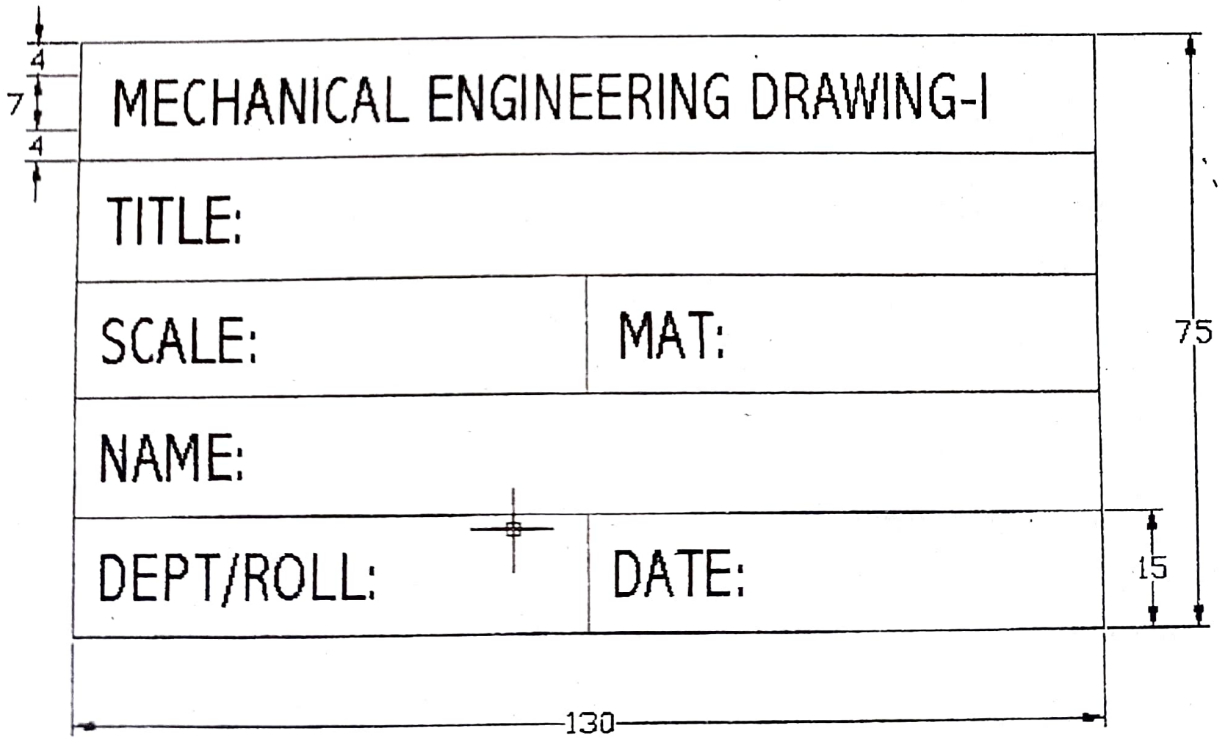
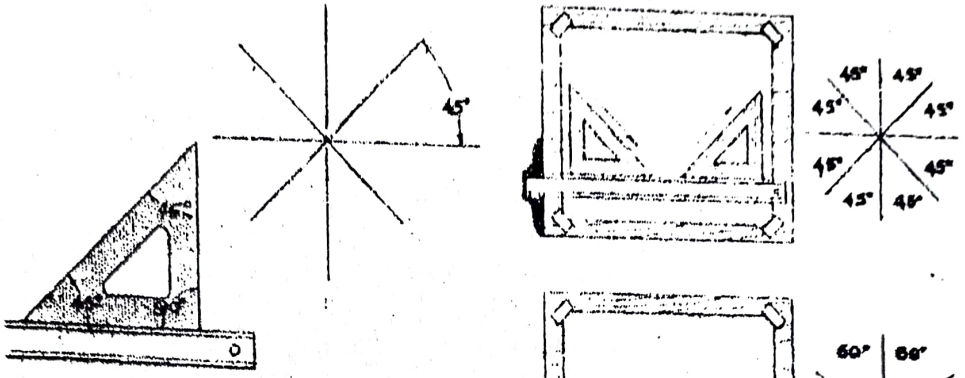


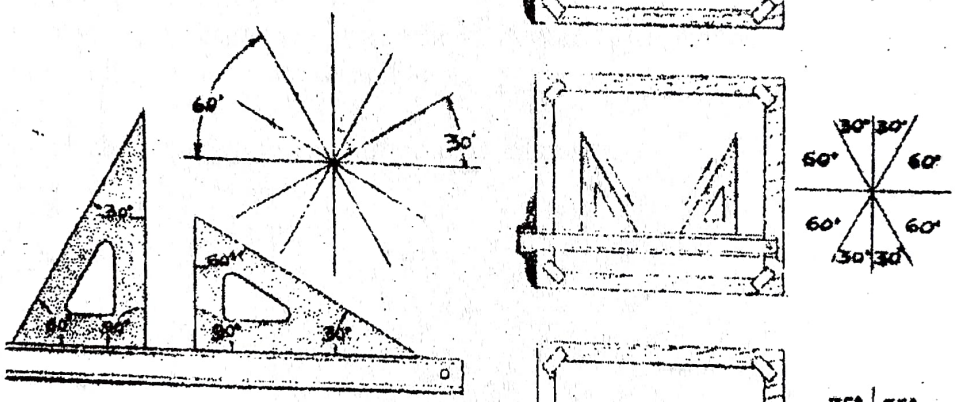
Fig. 3

Uses of T-square and Set-squares:

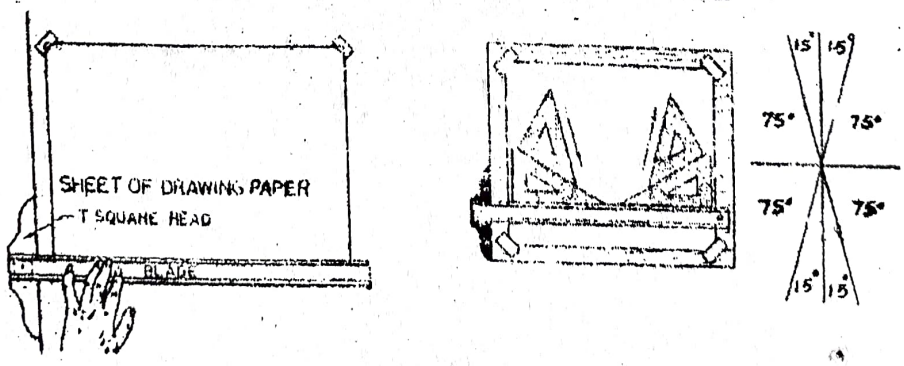
In instrument drawing, T-square and Set-squares are used widely. Different lines and angles can be drawn with the help of T-square and set-squares. For example, vertical lines, parallel lines, horizontal and inclined (in different standard angle such as 15°, 30°, 45°, 60°, 75°, 90°) lines and parallel lines can be drawn by placing Set-square in different positions as shown in Fig. 4 if it is necessary to draw any angle instead of those standard angles, a protractor can be used.



(a) The 45-degree triangle is used to divide space around a point into eight equal parts.



(b) The 30–60 degree triangle is used to divide space around a point into 12 equal parts.



(c) T-square is used to fix a drawing sheet properly.

Fig. 4

Dimensioning :

Dimensioning is a necessary part of all drawings. After the shape of an object has been described by orthographic (or pictorial) views. The value of the drawing for the construction of the object depends upon dimensions and notes that describe the *size*. In general, the description of shape and size together gives complete information for producing the object represented.

The basic factors in dimensioning practice are :

1. ***Lines and symbols:*** The first requisite is a thorough knowledge of the elements used for dimensions and notes and of the weight and spacing of the lines on the drawing.
2. ***Section of distance:*** The most important consideration for the ultimate operation of a machine and the proper working of the individual parts is the selection of distance to be given.
3. ***Placement of dimension:*** After the distances to be given have been selected, the next step is the actual placement of the dimensions showing these distances on the drawing. The dimensions should be placed in an orderly arrangement that is easy to read and in positions where they can be readily found.
4. ***Dimensioning standard features:*** these include angles, chamfers, standard notes, specifications of holes, spherical shapes, round-end, tapers and others for which, through long usage and study, dimensioning practice has been standardized.

Do's and Don'ts in dimensioning:

1. One can place dimensions with centerlines. In such cases, extension lines are not necessary.
2. Do not place dimension with dotted lines.

Dimensioning criteria as shown in Fig. 5 should be followed.

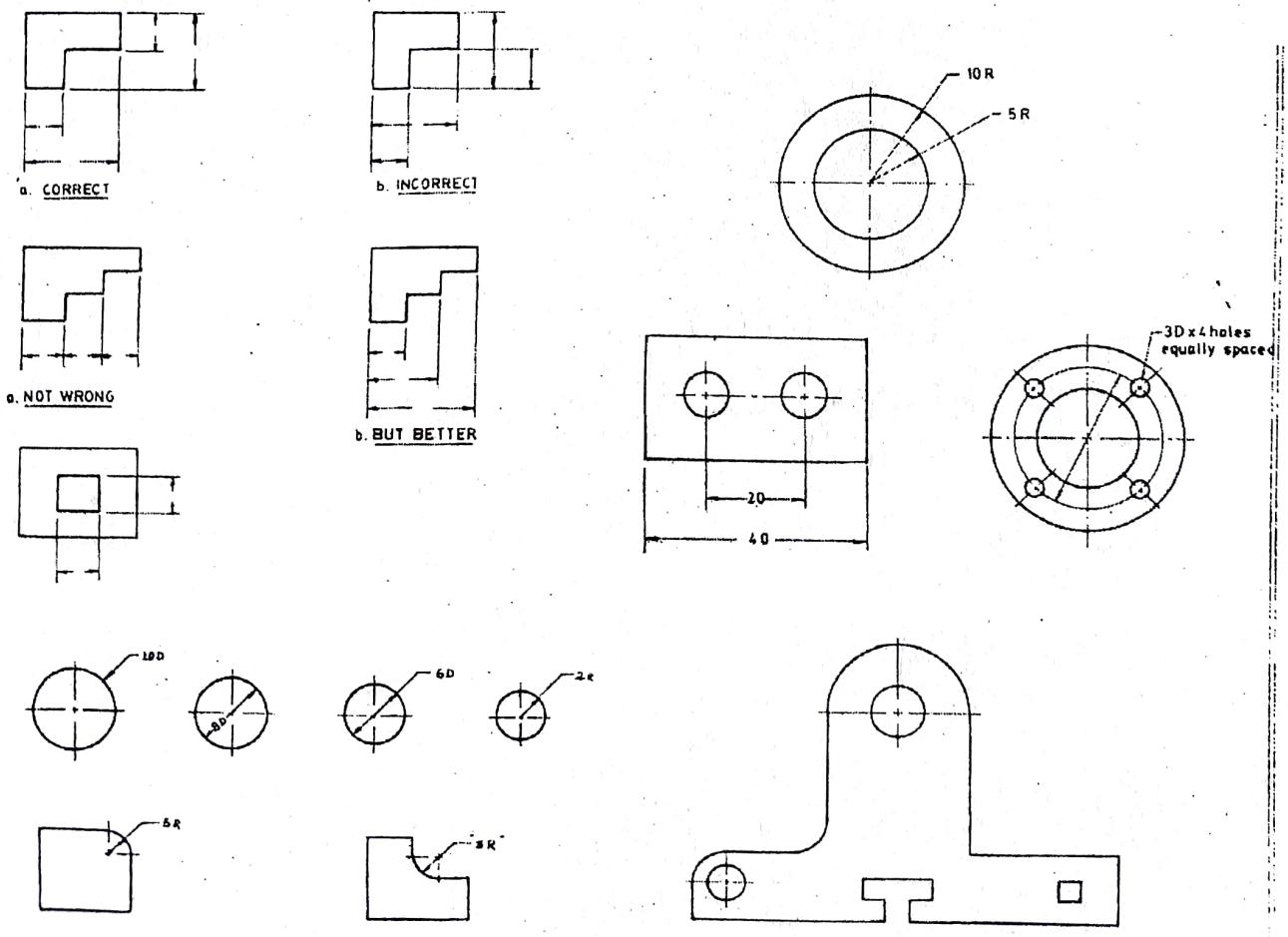


Fig. 5

LETTERING

Lettering is also a branch of design. Students of lettering fall into two general classes. Those who will use letters and words to convey information on drawing and those who will use letters and words to convey information on drawings and those who will use lettering in applies design. The engineering student takes up lettering as an early part of his work in drawing and continues its practice throughout his course becoming more and more skillful and proficient. The greatest amount of lettering on drawing is done in a rapid single stroke letter either vertical or inclined. The term "single stroke' or 'one stroke', does not mean that the entire letter is made without lifting the pencil or pen but that the width of the stroke of the pencil or pen is the width of the stem of the letter.

The equality of lettering is important. The penciling must be clean, firm and opaque. The lettering pencil should be selected carefully by trial on a paper. The same grade must be chosen as that used for the drawing. Sharpen the pencil to a long, conic point, and then round the lead slightly on the send so that it is not as sharp as a point used for drawing.

For better performance lettering style of stroke CAPITAL and numbers printed below (Fig. 6) be studied and practiced.

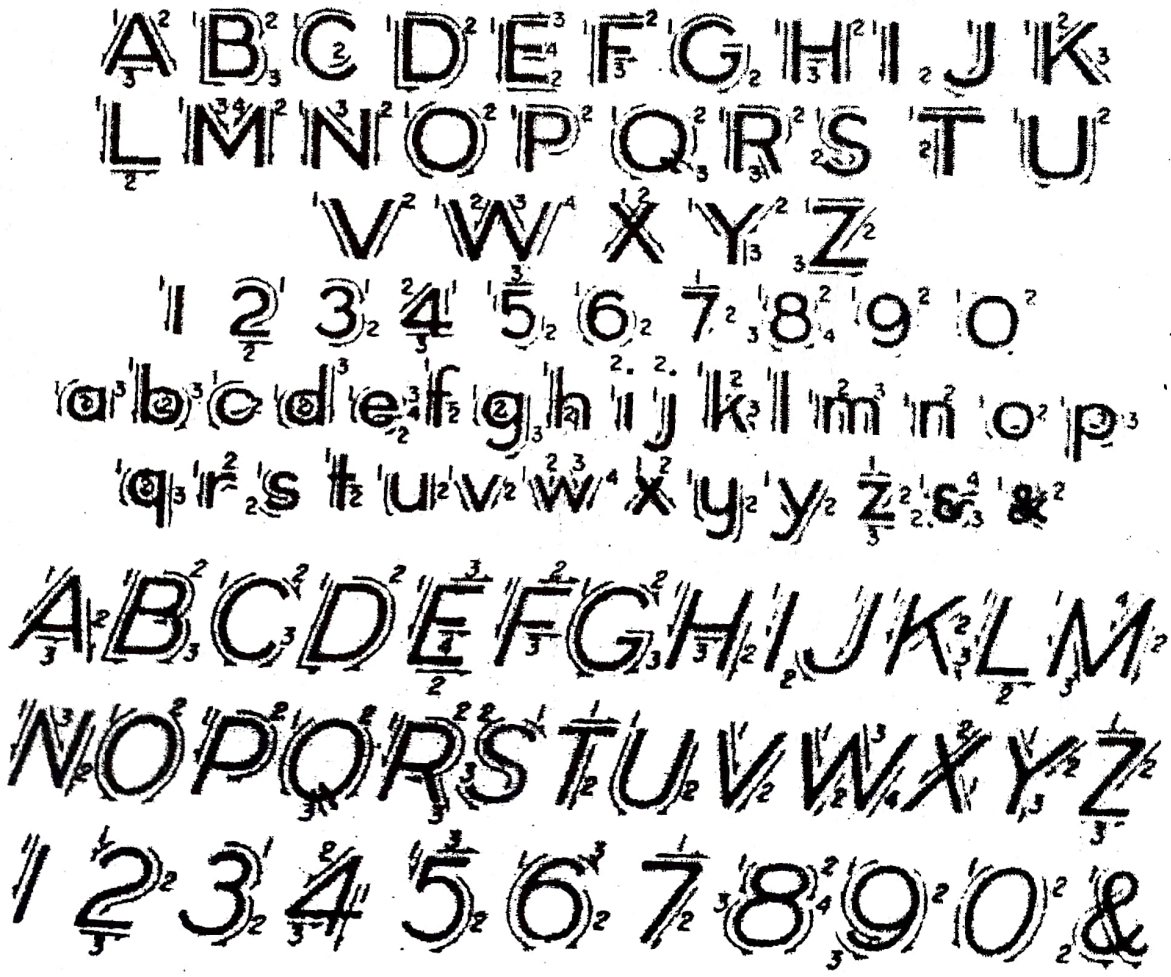


Fig. 6

TYPE OF DRAWING

Orthographic Drawing:

Orthographic views of an object focuses only one face in a single view. Here, the station point from where the viewer focuses his / her eye is imagined to be a infinity. For example, if an object is placed in a box according to the fig. 7 & 8 the orthogonal projection of the six faces will be appeared on the six surfaces of the box. According to the position of these faces with respect to the viewer orthogonal views are named as: top view, front view, right-hand side view, left-hand side view, rear view and bottom view (Fig. 9).

To describe an object fully two to three views out of the six views are needed. In this case, top view and front view are drawn when only two views are required. When three views are required then right-hand side or left hand side view is added to top and front views.

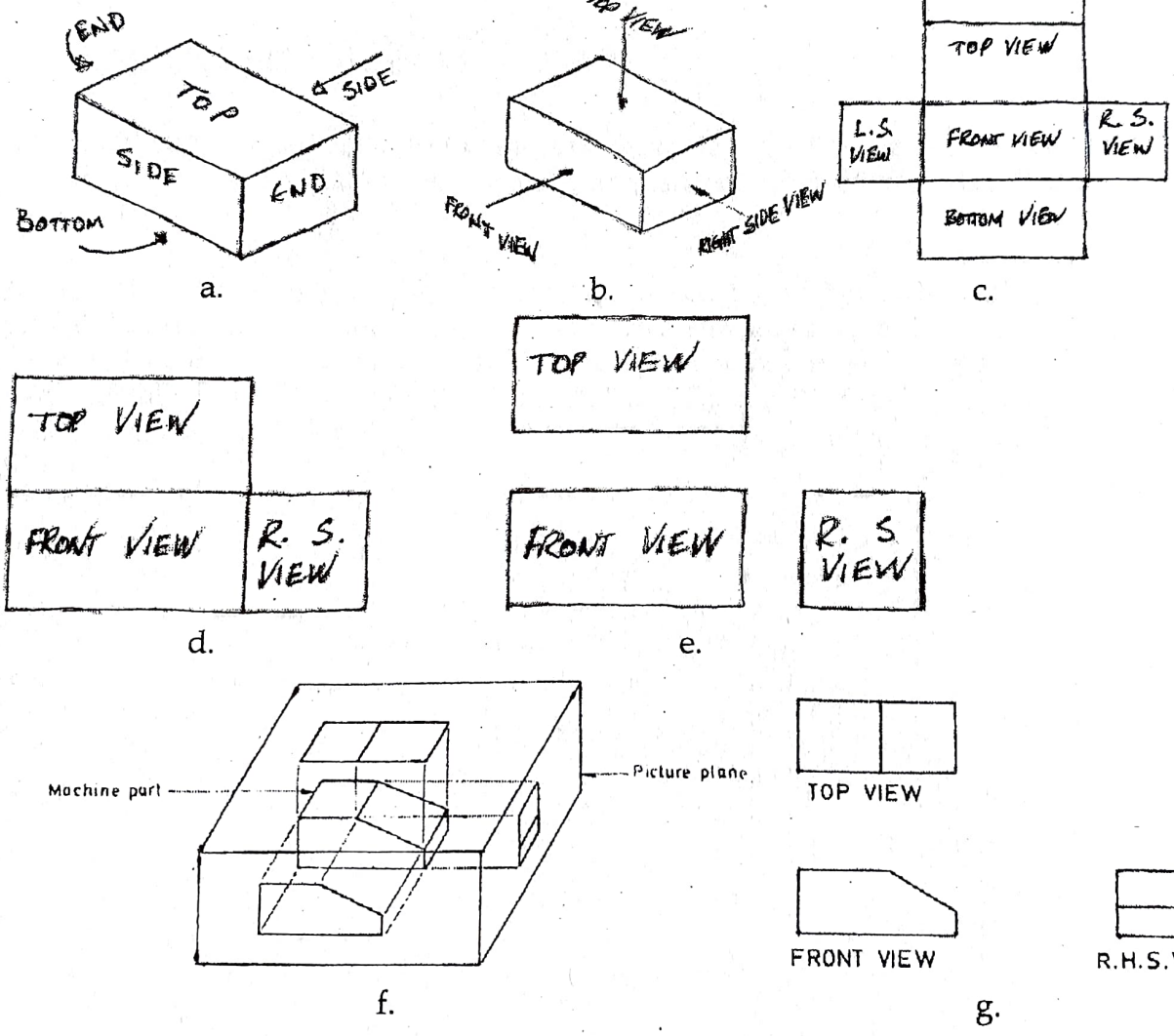


Fig. 9

Orthographic projection:

Orthographic projection is the method of representing the exact shape of an object by dropping perpendiculars from two or more sides of the objects to planes, generally at right angles to each other, collectively, the views on these planes describe the object completely (See Fig. 10)

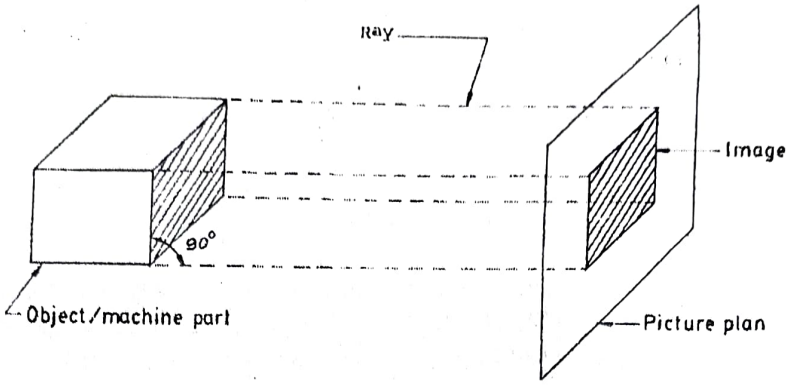


Fig. 10

THIRD ANGLE PROJECTION

Generally, three planes are used to draw orthographic projection e.g. (a) horizontal (b) frontal and (c) profile. With these planes one may get four quadrants, each of which is called angle and is shown in Fig. 11.

In mechanical drawing generally two types of projections are considered: (a) First angle projection and (b) Third angle projection. We consider third angle projection only. In third angle projection, the picture plane is placed in between the machine part and observed. In Fig. 11 three planes are placed perpendicular to each other (on three axes X, Y and Z). For third angle projection, object is placed on third quadrant.

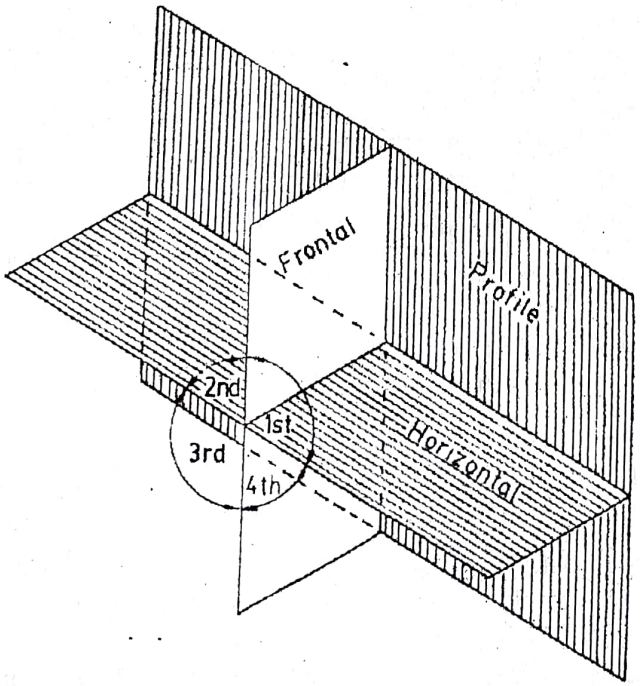


Fig. 11

Sectional views:

When the interior of an object is complicated or when the component parts of a machine are drawn assembled, an attempt to show hidden portions by the customary dashed (dotted) lines in regular orthographic views often results in a confusing network, as shown in Fig. 12 which is difficult to draw and almost impossible to read clearly. In that case, to describe the object, one or mote views are drawn to show the object, one or more views are drawn to show the object as if a portion had to be cut awat to reveal the interior as in Fig. 12b. also if some detail of the shape of an object is not clear, an imaginary cut taken through the portion and then turned u as in Fig. 13c to describe the actual shape.

These imaginary cuts are known as Sections and views of these kinds are called Sectional view.

The place from which the section is taken must be identifiable on the drawing and the solid portions and voids must be distinguished on the sectional view. In general, the section is quite evidently taken through the center of the Top view. A section line with directional arrows is drawn to identify the section clearly.

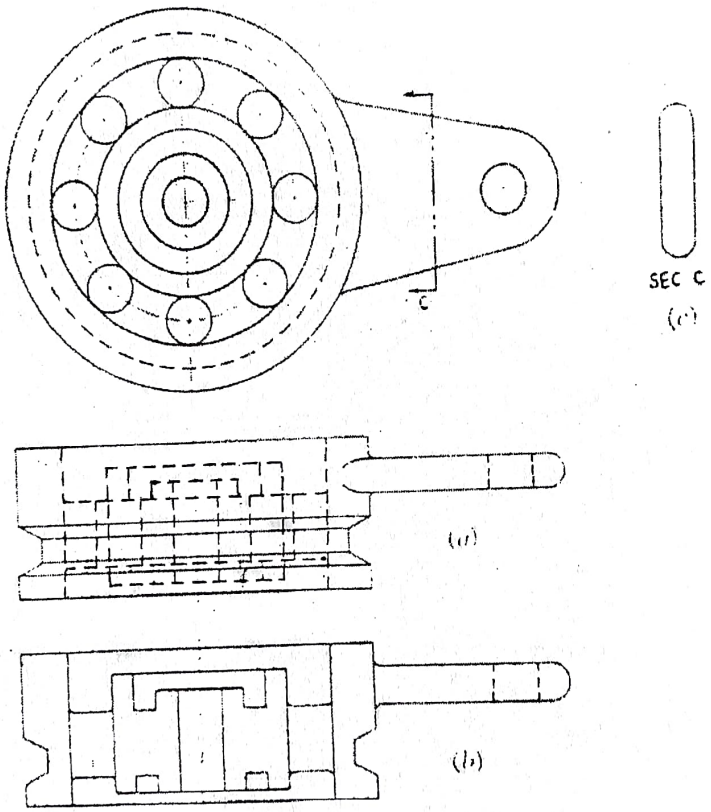


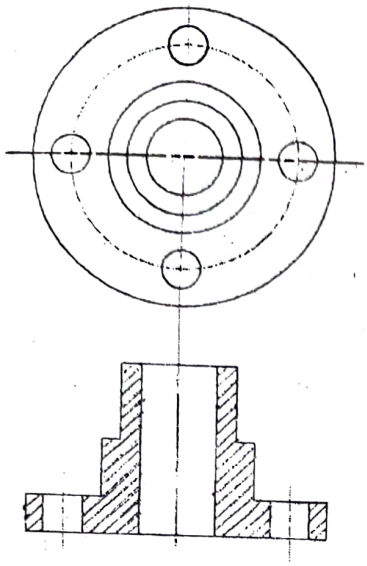
Fig. 12 Advantage of sectional views. (a) Orthographic view with hidden edges indicated by dashed lines; (b) the same view but made as a section to clarify the shape; (c) cross-sectional shape of lug shown by removing section.

Types of sections: Different types of sectional views have to be drawn in accordance with different views.

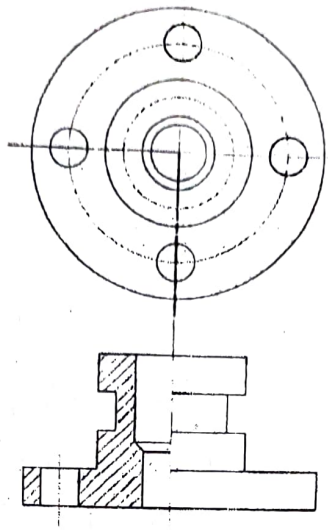
(a) **Full sections:** A full section is one which the cutting plane passes entirely across the object, as in Fig. 13, so that the resulting view is completely "in section".

Other type of sectional views are, (b) Half Section (c) Broken out Section (d) Rotated Section (e) Removed Section (f) Assembly Section etc.

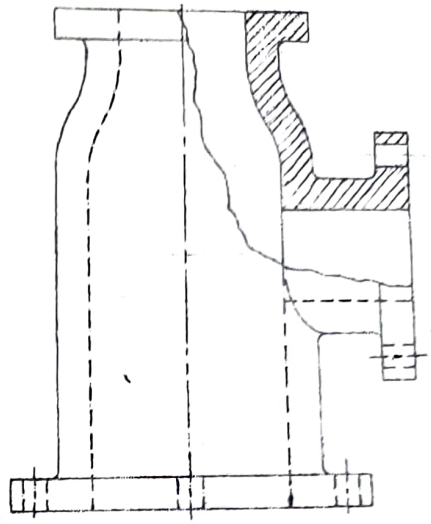
A sectional view must show which portions of the object are solid material and which are spaces. This is done by section lining, called Crosse *Hatching*, the solid parts with lines as shown is Fig. 13. Different materials are hatched with different patterns. Some common hatches are shown in Fig. 14.



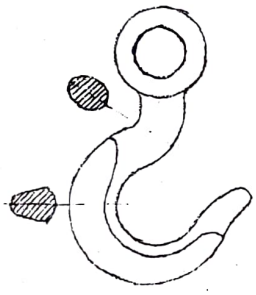
Full Section.



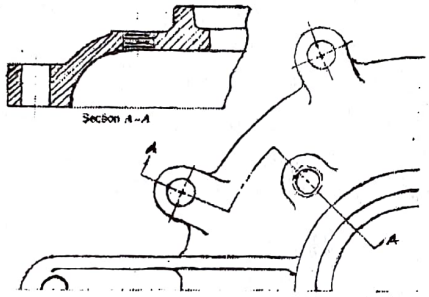
Half Section.



Broken-out Section.



Removed Sections.



Removed Section—Noncontinuous Cutting Plane.

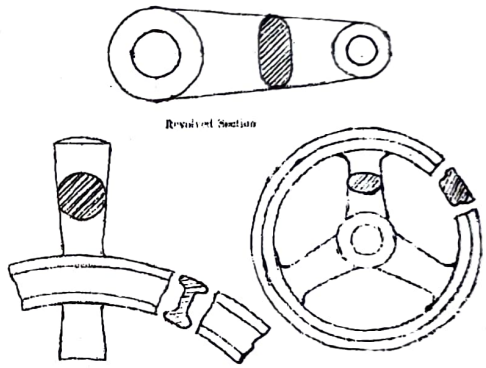
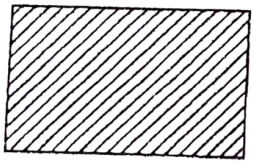
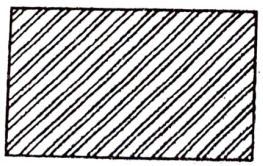


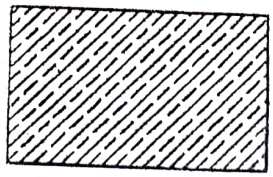
Fig. 13



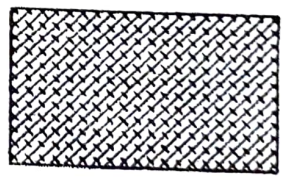
CAST IRON. USED IN GENERAL FOR ALL SECTIONING



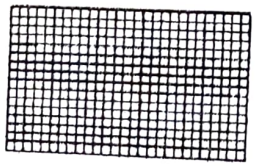
STEEL



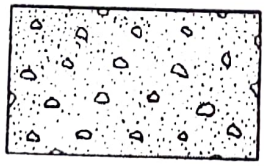
BRONZE, BRASS, COPPER AND COMPOSITIONS



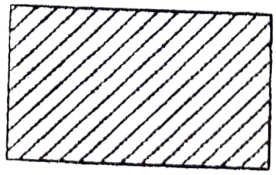
MAGNESIUM, ALUMINUM, AND ALLOYS



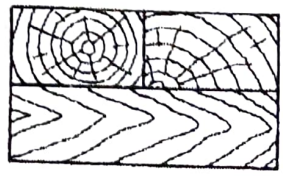
ELECTRIC WINDINGS, ELECTRO-MAGNETS, RESISTANCES, ETC.



CONCRETE



BRICK AND STONE MASONRY



WOOD

Fig. 14

Sometimes the cutting plane is to be chosen in such a way that no vital feature is missed from it. Cutting plane line to be offset which is shone in Fig. 15

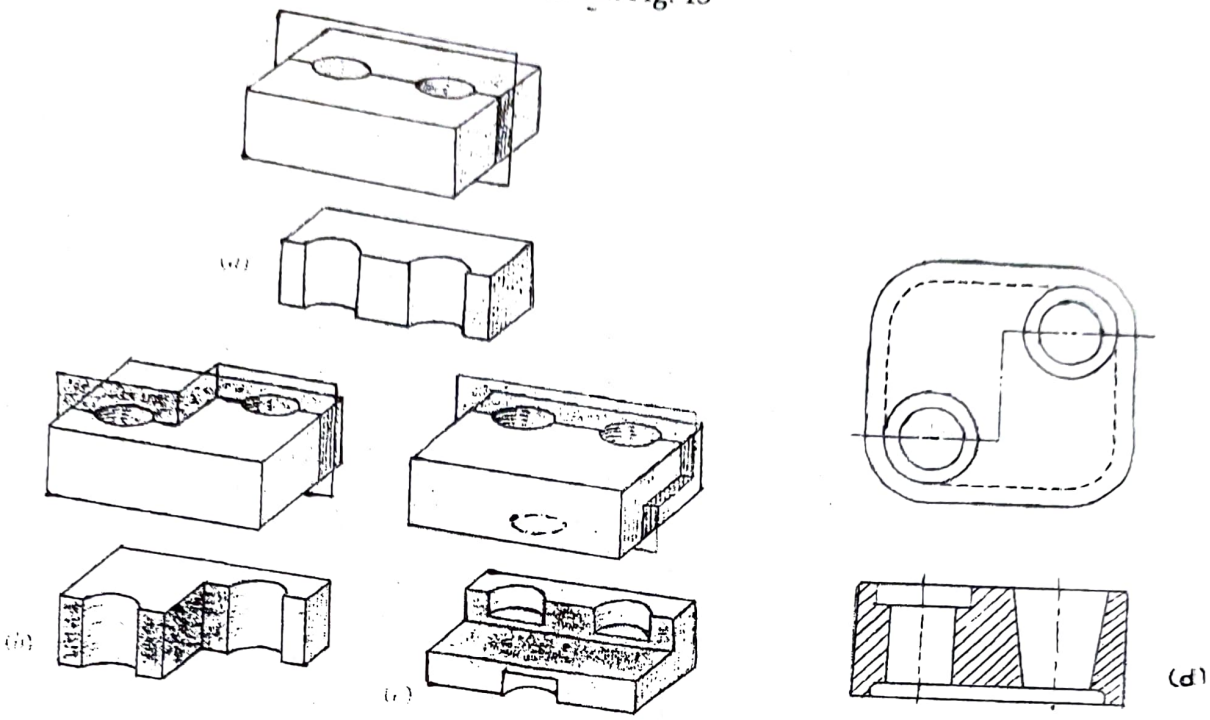


FIG. Cutting planes for a full section. The plane may cut straight across (*a*) or change direction (*b* and *c*) to pass through features to be shown.

FIG. A full section. The cutting plane is offset to pass through both principal features of the object.

Fig. 15

Ribs in section: Ribs and webs are not machine parts, they are used to strengthen the parts. So when a cutting plane passes longitudinally through the center of a rib or web the cross hatching is eliminated from the ribs as shown in Fig. 16.

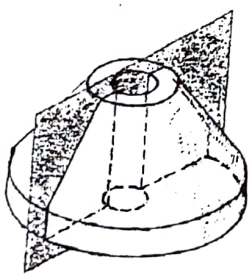


FIG. 16a Ribs in section. Ribs at (*a*) are treated as though the cutting plane were in front of them, to avoid misreading the section as a solid (*b*).

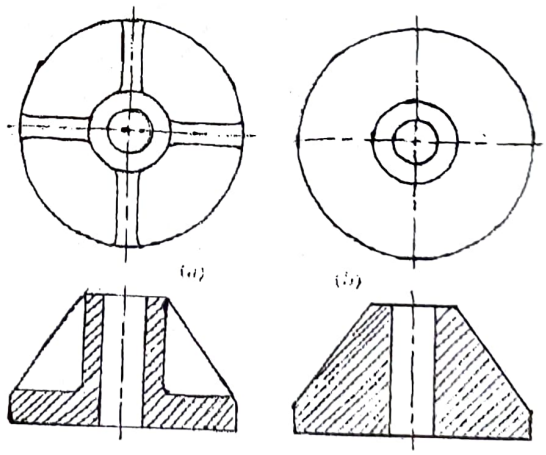


Fig. 16

PICTORIAL DRAWING

Pictorial drawing shows an object in three dimensions. Pictorial drawing may be of different types: Isometric drawing, oblique drawing, perspective drawing etc. Only isometric drawing will be studied in this course.

Isometric drawing:

Isometric drawing of the object is projected such a way that three adjacent surfaces of the object are equally exposed so that all the dimensions except angles are drawn equally to the object. Here the center of the three axes i.e. at the corner of the three surfaces all three right angles are drawn 120° each as well as opposite 3 angles are also drawn equal to 120°, other six right angles are converted into 60° each Fig. 17.

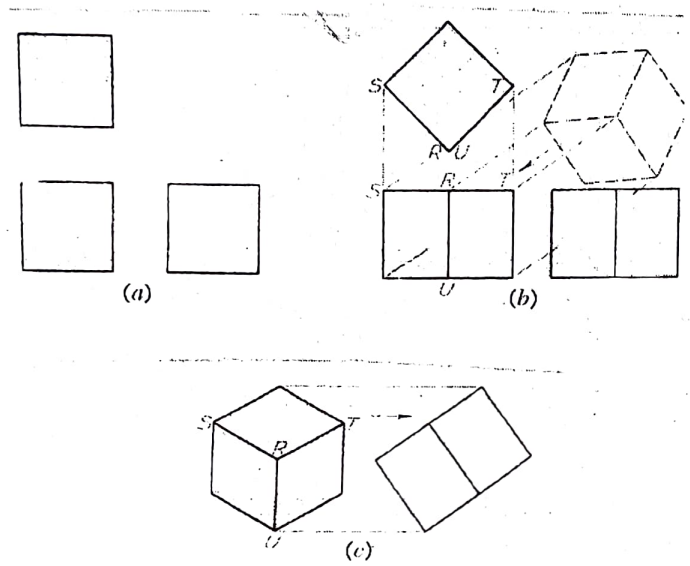


FIG. 17 The isometric cube. Rotated position (*a*) to (*b*) then to (*c*), the three pendicular edges are now equally shortened

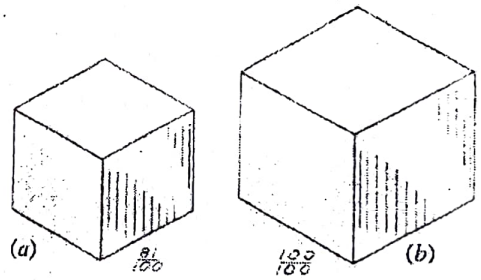


FIG.18. (*a*) isometric projection; (*b*) isometric drawing.

Drawing of isometric projection and view:

If the object in the Fig. 17a is a rotated about a vertical axis through 45°, as shown in Fig. 17b and then tilted forward, as in Fig. 17c. until the RU is foreshortened equally with RS and RT. The front view of the cube in this position is said to be an Isometric Projection.

In practical use of the isometric system this foreshortening of the edge is disregarded and *their fill lengths are laid off on the axis* as explained Fig. 18.

HOW ISOMETRIC VIEWS ARE DRAWN

If the object is rectangular (Fig. 19), start with a point representing a front corner. Shown at Fig. 19a with heavy lines, and from it the three isometric axes 120° apart are drawn on vertical (Fig. 19b), the other with the 30° triangle. On these three lines the light, width and depth of the object are measured as indicated at Fig. 19c. Through the points so determined lines parallel to the axes are drawn and following this way the drawing is completed hidden lines are omitted except when they are needed to describe the piece.

It is often convenient to build up an isometric drawing lower front corner as illustrated in Fig. 20. Starting from axes in what may be called the *sectional position.*

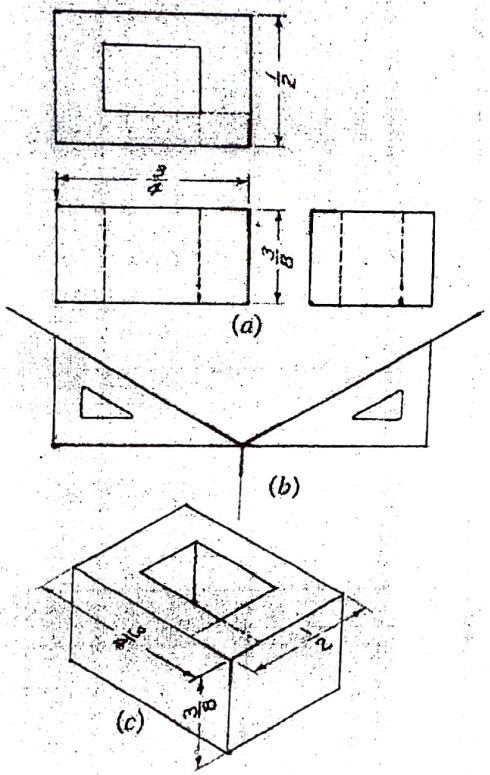


FIG. 19 Isometric axes, first position. The starting point is the upper front corner.

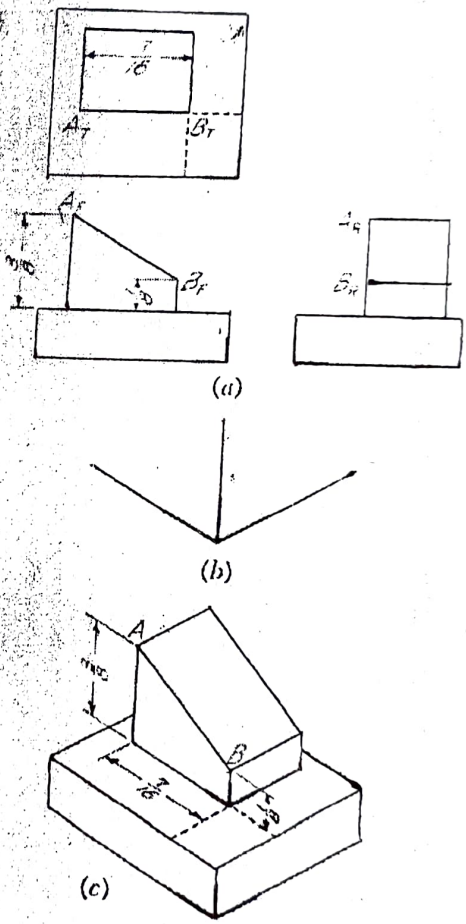
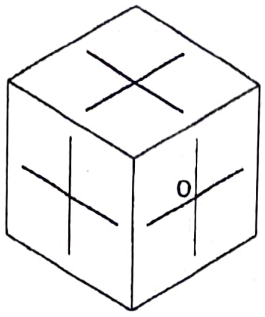
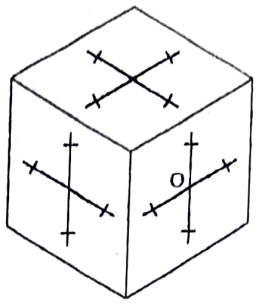


FIG. 20. Isometric axes, second position. The starting point is the lower front corner

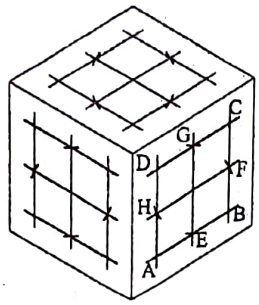
DRAWING OF AN ISOMETRIC CIRCLE



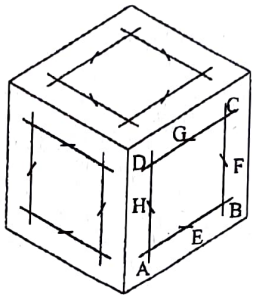
Locate the centers 'O' and draw two lines which are parallel to the sides of the object and passing through the centre.



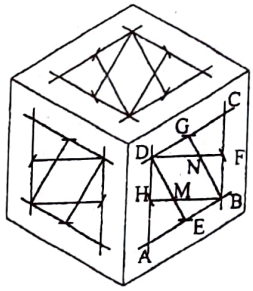
Draw arcs which cuts the lines and whose radii are equal to the given radius of the desired circle.



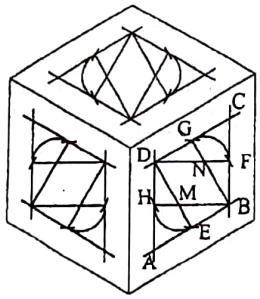
Draw lines through the intersections E, F, G and H and parallel to the sides of the object to form a rhombus ABCD.



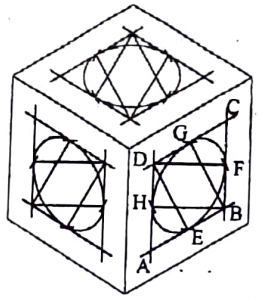
Erase the crossed lines inside the rhombus. The four arcs imply the midpoints of the arms of the rhombus.



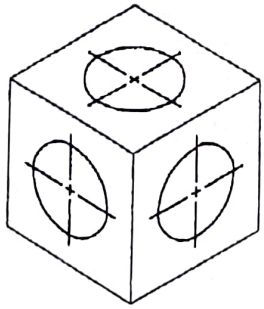
Connect the tip of the **obtuse angles** to the midpoints of the arms opposite to them.



B, D, M and N are the centers required to draw the isometric circle. Draw an arc of radius ME or MH taking M as center. Similarly draw another arc of radius NG or NF taking N as center.

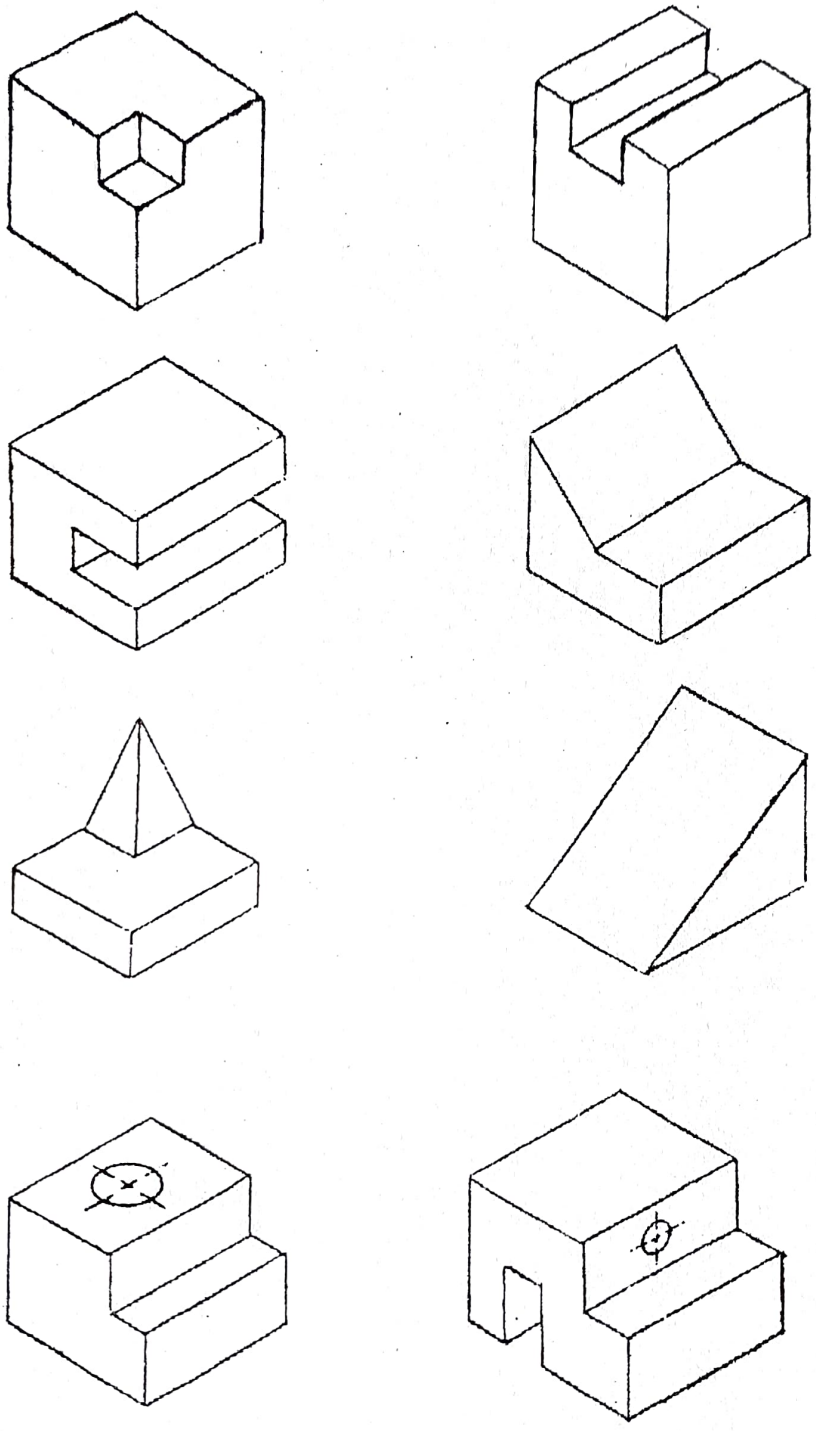


Now draw an arc of radius BH or BG taking B as center. Similarly draw another arc of radius DF or DE taking D as center. The isometric circle is formed.



Erase all unnecessary lines and draw centerlines for the isometric circles. Centerlines will be parallel to the axes of the isometric plane upon which the isometric circle is drawn.

Some practices:



Tips for a better drawing presentation:

Keep your hands clean
Remove eraser dust from the drawing sheet with brush of soft cloth.
Check your drawing carefully before handing it over.
Always keep your pencils sharp as you cannot do good work with a dull pencil.