



INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)

Dundigal - 500 043, Hyderabad, Telangana

COURSE CONTENT

COMPUTER AIDED ENGINEERING DRAWING								
I Semester: AE / ME / CE								
Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	T	P		C	CIA	SEE
AMED05	Foundation	0	1	2	2	40	60	100
Contact Classes: Nil	Tutorial Classes: 15	Practical Classes: 30			Total Classes: 45			
Prerequisite: There is no prerequisite required to this course								

I. COURSE OVERVIEW:

Engineering Drawing is the technique that develops the ability to visualize any object with all physical and dimensional configurations. The AutoCAD software assists in preparation of drawings to carry out sophisticated design and analysis of machine components and structures. This is the foundation course for civil engineering, mechanical engineering and aeronautical engineering that are improving their technologies in the era of digital manufacturing and construction.

II. COURSE OBJECTIVES:

The students will try to learn:

- The illustration of different objects using technical drawings using concepts of engineering drawing.
- The standard principles of orthographic projection of objects for making technical drawings.
- The representation of draw sectional views and pictorial views of solids.
- The computer aided drafting skills for producing the 2D and 3D drawings.

III. COURSE OUTCOMES:

At the end of the course students should be able to:

CO1	Demonstrate the use of draw, modify and dimension commands of AutoCAD for development of drawings used in design and analysis of structures.
CO2	Explain the constructional procedure of scales, conic sections and special curves used in engineering practices.
CO3	Utilize the principles of orthographic projection for projections of points, lines, planes and regular solids using first angle projections.
CO4	Interpret the sectional views and true shape of the section for revealing interior features of an object <i>veal interior features of an object</i>
CO5	Illustrate the development of surfaces for construction of storage vessels, chemical vessels, boilers, and chimneys in industrial applications
CO6	Make use of the concept of orthographic and isometric projections for converting isometric view to orthographic views and Vice-versa for engineering applications.

IV. COURE CONTENT:

MODULE – I: Introduction to engineering graphics

Principles of engineering graphics and their significance, scales, plain & diagonal, conic sections including the rectangular hyperbola, general method, cycloid, epicycloid and hypocycloid, introduction to computer aided drafting, views, commands.

MODULE – II: Orthographic projections

Principles of orthographic projections, conventions, projections of points and lines, projections of plane regular geometric figures. Computer aided orthographic projections, points, lines and planes.

MODULE – III: Projections of regular solids

Projections of regular solids, auxiliary views, sections or sectional views of right regular solids, prism. Cylinder, pyramid, cone, computer aided projections of solids, sectional views.

MODULE – IV: Development of surfaces

Development of surfaces of right regular solids, prism, cylinder, pyramid and cone, development of surfaces using computer aided drafting.

MODULE – V: Isometric projections

principles of isometric projection, isometric scale, isometric views, conventions, isometric views of lines, plane figures, simple and compound solids, isometric projection of objects having non-isometric lines. Isometric projection of spherical parts, conversion of isometric views to orthographic views and vice-versa, conventions, conversion of orthographic projection into isometric view using computer aided drafting.

V.TEXT BOOKS:

1. N.D. Bhatt; *Engineering Drawing* Charotar Publishing House PVT Ltd, 15th edition 2011.
2. K. Venugopal; *Engineering Drawing and graphics Using AutoCAD*, 3rd edition 2007.

VI.REFERENCE BOOKS:

1. Basant Agrawal and C M Agrawal; *Engineering Drawing*, McGraw Hill, 3rd Edition 2011.
2. K L Narayana, P Kanniah; *Engineering Drawing*, New age international (P) limited, 3rd edition, 2022.
3. M. B. Shah, B.C. Rane; *Engineering Drawing*, Pearson publications.

VII. ELECTRONIC RESOURCES:

1. <https://archive.nptel.ac.in/courses/112/103/112103019>.
2. <https://archive.nptel.ac.in/courses/112/105/112105294>.

VIII. MATERIALS ONLINE:

1. Course Template
 2. Laboratory manual
-

EXERCISES COMPUTER AIDED ENGINEERING DRAWING

Note: Students are encouraged to bring their own laptops for laboratory practice sessions.

1. Getting Started Exercises

1.1 Introduction to Computer Aided Drafting (CAD)

- i) Engineering Drawing and its Significance
 - ii) Lettering and dimensioning
 - iii) Installation of AutoCAD
 - iv) Manufacturing of a product is the main activity in engineering profession. The design of a product may start with trial designs in the form of sketches on paper.
 - v) Advantages of CAD,
 - vi) Auto Cad Main Window
 - vii) The Coordinate System
 - viii) The Formats to Enter Coordinates
 - ix) Choosing Commands in AutoCAD
 - x) Object Snaps
 - xi) The Drawing Tools of CADD
-

2. Construction of scales

A scale is defined as the ratio of the linear dimensions of element of the object as represented in a drawing to the actual dimensions of the same element of the object itself.

It may not be always possible to prepare full-size drawings. They are, therefore, drawn proportionately smaller or larger. When drawings are drawn smaller than the actual size of the objects (as in case of buildings, bridges, large machines etc.) the scale used is said to be a reducing scale (example 1 : 5). Drawings of small machine parts, mathematical instruments, watches etc. are made larger than their real size. These are said to be drawn on an enlarging scale (example: 5 : 1).

Scales on drawings

To construct a scale the following information is essential:

- 1) The R.F. of the scale.
- 2) The units which it must represent, for example, millimetres and centimetres, or feet and inches etc.
- 3) The maximum length which it must show.

Types of Scales

The scales used in practice are classified as:

- 1) Plain scales
 - 2) Diagonal scales
 - 3) Vernier scales
 - 4) Scale of chords.
 - 5) Comparative scales
-

2.1 Exercises

i) Construction of plain scale

1. Construct a scale of 1:50 to read meters and decimeters and long enough to measure 6 m. Mark on it a distance of 5.5 m.
2. Construct a scale of 1.5 inches = 1 foot to show inches and long enough to measure up to 4 feet. Represent a distance of 2 feet and 10 inches on it.
3. Construct a scale of R.F. 1/ 84480 to show miles and furlongs and long enough to measure up to 6 miles. Indicate on the scale a distance 3 miles and 4 furlongs.
4. The distance between Bombay and Poona is 180 km. A passenger train covers this distance in 6 hours. Construct a plain scale to measure time up to a single minute. The R.F. or the scale is 1/2000. Find the distance covered by the train in 36 minutes.

ii) Construction of diagonal scale

1. Construct a diagonal scale 1/50, showing meters, decimeters and centimeters, to measure up to 5 meters. Mark a length 4.75 m on it.
2. An area of 144 sq cm on a map represents an area of 36 sq.km on the field. Find the RF of the scale of the map and draw a diagonal scale to show Km, hectometers and decameters and to measure up to 10 kilometers. Indicate on the scale a distance 7 kilometers, 5 hectometers and 6 decameters.
3. On a map, the distance between two points is 14 cm. The real distance between them is 20 km. Draw a diagonal scale of this map to read kilometers and hectometers, and to measure up to 25 km. Show a distance of 17.6 km on this scale.
4. Construct a diagonal scale of R.F = 1/4000 and long enough to measure up to 500 meters. Also mark a distance of 374 m on it.

3. Construction of conic sections

The profile of number of objects consists of various types of curves. This chapter deals with various types of curves which are commonly used in engineering practice are: Conic sections, Evolutes, Cycloidal curves, Spirals, Involute and Helix.

3.1 Exercises

1. Construct a conic when the distance of its focus from the directrix is equal to 50 mm and its eccentricity is $3/4$. Draw a tangent at any point on the curve.
2. A fixed point is 75 mm from a fixed straight line. Draw the locus of a point P moving such a way that its distance from the fixed straight line is (i) twice its distance from the fixed point; (ii) equal to its distance from the fixed point. Name the curves.
3. Construct a hyperbola, when the distance of the focus from the directrix is 65 mm and eccentricity is $3/2$. Draw a tangent at any point on the curve.
4. Draw a parabola whose focus is at a distance of 75 mm from the directrix. Draw a tangent and normal at any point on it.
5. A point P is 30 mm and 50 mm respectively from two straight lines which are at right angles to each other. Draw a rectangular hyperbola from P within 10 mm distance from each line

4. Special curves used in engineering practices

4.1 Exercises

1. A circle of 50 mm diameter rolls along a straight line without slipping. Draw the curve traced out by a point P on the circumference, for one complete revolution of the circle. Name the curve. Draw a tangent to the curve at a point on it 40 mm from the line.
2. Circle of 50 mm diameter rolls on the circumference of another circle of 175 mm diameter and outside it. Trace the locus of a point on the circumference of the rolling circle for one complete revolution. Name the curve. Draw a tangent and a normal to the curve at a point 125 mm from the centre of the directing circle.
3. Construct a hypocycloid, rolling circle 50 mm diameter and directing circle 175 mm diameter. Draw a tangent to it at a point 50 mm from the centre of the directing circle.
4. A circle of 115 mm diameter rolls on another circle of 75 mm diameter with internal contact. Draw the locus of a point on the circumference of the rolling circle for its one complete revolution.
5. Draw an epicycloid having a generating circle of diameter 75 mm and a directing curve of radius 200 mm. Also draw a normal and a tangent at a point P on the curve.
6. Show by means of a drawing that when the diameter of the directing circle is twice that of the generating circle, the hypocycloid is a straight line. Take the diameter of the generating circle equal to 50 mm.

5. Orthographic projection


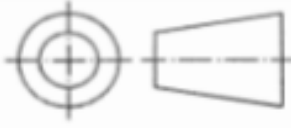
Practical solid geometry or descriptive geometry deals with the representation of points, lines, planes and solids on a flat surface (such as a sheet of paper), in such a manner that their relative positions and true forms can be accurately determined.

5.1 Types of projections

- I. Orthographic Projection
- II. Isometric Projection
- III. Oblique Projection
- IV. Perspective Projection

5.2 Symbol of Projections:

Table 5.1 Symbolic representation of first and third angle Projections

First Angle Projection		Third Angle Projection	
			
FV	LHSV	LHSV	FV

6 Projection of points

A point may be situated, in space, in any one of the four quadrants formed by the two principal planes of projection or may lie in any one or both of them. Its projections are obtained by extending projectors perpendicular to the planes.

One of the planes is then rotated so that the first and third quadrants are opened out as shown in figure 5.1. The projections are shown on a flat surface in their respective positions either above or below or in xy.

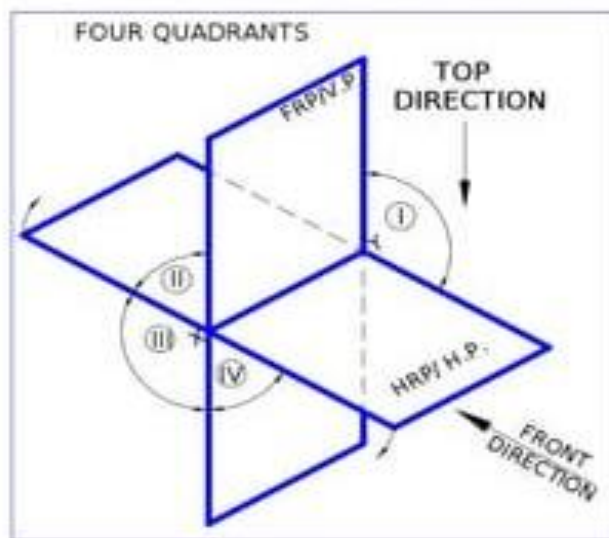


Figure 5.1: Four quadrants

6.1 Exercises

1. A point P is 15 mm above the H.P. and 20 mm in front of the V.P. Another point Q is 25 mm behind the V.P. and 40 mm below the H.P. Draw projections of P and Q keeping the distance between their projectors equal to 90 mm. Draw straight lines joining (i) their top views and (ii) their front views.
2. Two points A and B are in the H.P. The point A is 30 mm in front of the V.P., while B is behind the V.P. The distance between their projectors is 75 mm and the line joining their top views makes an angle of 45° with xy. Find the distance of the point B from the V.P.
3. A point A is situated in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and auxiliary plane is 60 mm and it is equidistant from the principal planes. Draw the projections of the point and determine its distance from the principal planes.
4. A point P is in the first quadrant. Its shortest distance from the intersection point of H.P., V.P. and Auxiliary vertical plane, perpendicular to the H.P. and V.P. is 70 mm and it is equidistant from principal planes (H.P. and V.P.). Draw the projections of the point and determine its distance from the H.P. and V.P.

7. Projection of lines

A straight line is the shortest distance between two points. Hence, the projections of a straight line may be drawn by joining the respective projections of its ends which are points. The position of a straight line may also be described with respect to the two reference planes. It may be:

1. Parallel to one or both the planes.
2. Contained by one or both the planes.
3. Perpendicular to one of the planes.
4. Inclined to one plane and parallel to the other.
5. Inclined to both the planes.
6. Projections of lines inclined to both the planes.
7. Line contained by a plane perpendicular to both the reference planes.
8. True length of a straight line and its inclinations with the reference planes.

7.1 Exercises

1. A line AB, 75 mm long, is inclined at 45° to the H.P. and 30° to the V.P. Its end B is in the H.P. and 40 mm in front of the V.P. Draw its projections
2. A line AB, 90 mm long is inclined at 30° to the H.P. Its end A is 12 mm above the H.P. and 20 mm in front of the V.P. Its front view measures 65 mm. Draw the top view of AB and determine its inclination with the V.P.
3. The top view of a 75 mm long line AB measures 65 mm, while the length of its front view is 50 mm. Its one end A is in the H.P. and 12 mm in front of the V.P. Draw the projections of AB and determine its inclinations with the H.P. and the V.P.
4. A line AB, 90 mm long, is inclined at 45° to the H.P. and its top view makes an angle of 60° with the V.P. The end A is in the H.P. and 12 mm in front of the V.P. Draw its front view and find its true inclination with the V.P.
5. A line PQ, 75 mm long, has its end P in the V.P. and the end Q in the H.P. The line is inclined at 30° to the H.P. and at 60° to the V.P. Draw its projections.

8. Projections of planes

Plane figures or surfaces have only two dimensions, viz. length and breadth. They do not have thickness. A plane figure may be assumed to be contained by a plane, and its projections can be drawn, if the position of that plane with respect to the principal planes of projection is known.

Types of planes:

Planes may be divided into two main types:

- **Perpendicular planes.**
 - (i) Perpendicular to both the reference planes.
 - (ii) Perpendicular to one plane and parallel to the other.
 - (iii) Perpendicular to one plane and inclined to the other.
- **Oblique planes.**

Planes which are inclined to both the reference planes are called oblique planes.

8.1. Exercises

- 1) A square ABCD of 50 mm side has its corner A in the H.P., its diagonal AC inclined at 30° to the H.P. and the diagonal BD inclined at 45° to the V.P. and parallel to the H.P. Draw its projections.
- 2) Draw the projections of a rhombus having diagonals 125 mm and 50 mm long, the smaller diagonal of which is parallel to both the principal planes, while the other is inclined at 30° to the H.P.

- 3) Draw the projections of a regular pentagon of 40 mm side, having its surface inclined at 30° to the H.P. and a side parallel to the H.P. and inclined at an angle of 60° to the V.P.
- 4) Draw the projections of a regular hexagon of 40 mm side, having one of its sides in the H.P. and inclined at 60° to the V.P., and its surface making an angle of 45° with the H.P.
- 5) Draw the projections of a circle of 50 mm diameter resting in the H.P. on a point A on the circumference, its plane inclined at 45° to the H.P. and the top view of the diameter AB making 30° angle with the V.P.

9. Orthographic projections of solids

A solid has three dimensions, viz. length, breadth and thickness. For representing a solid on a flat surface having only length and breadth, at least two orthographic views are necessary. Sometimes, additional views projected on auxiliary planes become necessary to make the description of a solid complete.

9.1. Types of solids

Solid has three dimensions, the length, breadth and thickness or height. A solid may be represented by orthographic views, the number of which depends on the type of solid and its orientation with respect to the planes of projection. Solids are classified into two major groups. (i) Polyhedra, and (ii) Solids of revolution

Polyhedra

A polyhedra is defined as a solid bounded by plane surfaces called faces. They are:

- i. Regular polyhedral
- ii. Prisms
- iii. Pyramids.

Solids of Revolution

If a plane surface is revolved about one of its edges, the solid generated is called a solid of revolution. They are

- i. Cylinder
- ii. Cone
- iii. Sphere

9.2. Projections of solids in simple positions

- a. Axis perpendicular to the H.P.
- b. Axis perpendicular to the V.P.
- c. Axis parallel to both the H.P. and the V.P.

10. Projections of solids with axes inclined to one of the reference planes and parallel to the other

- a. Axis inclined to the V.P. and parallel to the H.P.
- b. Axis inclined to the H.P. and parallel to the V.P.

10.1 Exercises

- 1) A hexagonal prism, base 30 mm side and axis 75 mm long, has an edge of the base parallel to the H.P. and inclined at 45° to the V.P. Its axis makes an angle of 60° with the H.P. Draw its projections.
- 2) Draw the projections of a square pyramid having one of its triangular faces in the V.P. and the axis parallel to and 40 mm above the H.P. Base 30 mm side; axis 75 mm long.

- 3) Draw the projections of a cone, base 45 mm diameter and axis 50 mm long, when it is resting on the ground on a point on its base circle with the axis making an angle of 30° with the H.P. and its top view making 45° with the V.P.
- 4) A pentagonal pyramid, base 30 mm side and axis 65 mm long has one of its triangular faces in the V.P. and the edge of the base contained by that face makes an angle of 30° with the H.P. Draw its projections.
- 5) Draw the projections of a cone, base 50 mm diameter and axis 75 mm long, lying on a generator on the ground with the top view of the axis making an angle of 45° with the V.P.

11. Section of Solids

Invisible features of an object are shown by dotted lines in their projected views. But when such features are too many, these lines make the views more complicated and difficult to interpret. In such cases, it is customary to imagine the object as being cut through or sectioned by planes. The part of the object between the cutting plane and the observer is assumed to be removed and the view is then shown in section.

- The imaginary plane is called a section plane or a cutting plane.
- The surface produced by cutting the object by the section plane is called the section. It is indicated by thin section lines uniformly spaced and inclined at 45° .
- The projection of the section on a plane parallel to the section plane will show the true shape of the section is called True shape of the section.

11.1 Exercises

- 1) A pentagonal pyramid, base 30 mm side and axis 65 mm long has its base horizontal and an edge of the base parallel to the V.P. A horizontal section plane cuts it at a distance of 25 mm above the base. Draw its front view and sectional top view.
- 2) A cylinder of 40 mm diameter, 60 mm height and having its axis vertical, is cut by a section plane, perpendicular to the V.P., inclined at 45° to the H.P. and intersecting the axis 32 mm above the base. Draw its front view, sectional top view, sectional side view and true shape of the section
- 3) A cone, base 75 mm diameter and axis 80 mm long is resting on its base on the H.P. It is cut by a section plane perpendicular to the VP, inclined at 45° to the H.P. and cutting the axis at a point 35 mm from the apex. Draw its front view, sectional top view, sectional side view and true shape of the section.
- 4) A hexagonal prism, side of base 35 mm and height 75 mm is resting on one of its corners on the H.P. with a longer edge containing that corner inclined at 60° to the H.P. and a rectangular face parallel to the V.P. A horizontal section plane cuts the prism in two equal halves. Draw the front view and sectional top view of the cut prism.

12. Development of surfaces

Imagine that a solid is enclosed in a wrapper of thin material, such as paper. If this covering is opened out and laid on a flat plane, the flattened-out paper is the development of the solid. Thus, when surfaces of a solid are laid out on a plane, the figure obtained is called its development.

12.1 Methods of development.

1. Parallel-line: It is employed in case of prisms and cylinders in which stretch-out-line principle is used.
2. Radial line: It is used for pyramids and cones in which the true length of the slant edge or the generator is used as radius.
3. Triangulation: This is used to develop transition pieces. This is simply a method of dividing a surface into a number of triangles and transferring them into the development.
4. Approximate: It is used to develop objects of double curved or warped surfaces as sphere, paraboloid, ellipsoid, hyperboloid and helicoids.

12.2 Exercise

1. A hexagonal prism of side of base 30 mm and axis 70 mm long is resting on its base on HP. such that a rectangular face is parallel to V.P. It is cut by a section plane perpendicular to VP and inclined at 30° to HP. The section plane is passing through the top end of an extreme lateral edge of the prism. Draw the development of the lateral surface of the cut prism.
2. A pentagonal prism with edge of base 30 mm and height 80 mm rests on its base with one of its base edges perpendicular to VP. An inclined plane at 45° to H.P. cuts its axis at its middle. Draw the development of the truncated prism
3. A cylinder of diameter of base 40 mm and height 50 mm is standing on its base on HP. A cutting plane inclined at 45° to the axis of the cylinder passes through the left extreme point of the top base. Develop the lateral surface of the truncated cylinder.
4. A hexagonal pyramid with side of base 30 mm and height 75 mm stands with its base on HP and an edge of the base parallel to VP. It is cut by a plane perpendicular to VP, inclined at 45° to H.P and passing through the mid-point of the axis. Draw the (sectioned) top view and develop the lateral surface of the truncated pyramid
5. A pentagonal pyramid, side of base 50 mm and height 80 mm rests on its base on the ground with one of its base sides parallel to V.P. A section plane perpendicular to VP and inclined at 30° to H.P cuts the pyramid, bisecting its axis. Draw the development of the truncated pyramid
6. A cone of diameter of base 75 mm and height 60 mm is cut by horizontal cutting plane at 20 mm from the apex. Draw the development of the truncated cone.
7. A cone of base 50mm diameter and height 60 mm rests with its base on H.P. and bisects the axis of the cone. Draw the development of the lateral surface of the truncated cone.

13 Isometric Views

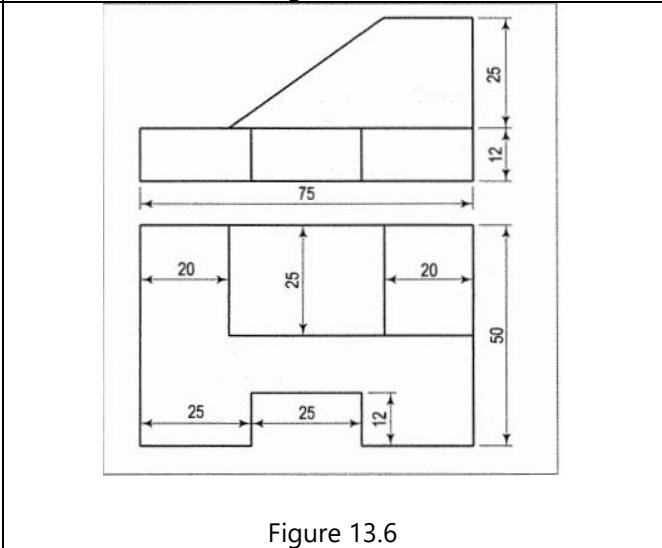
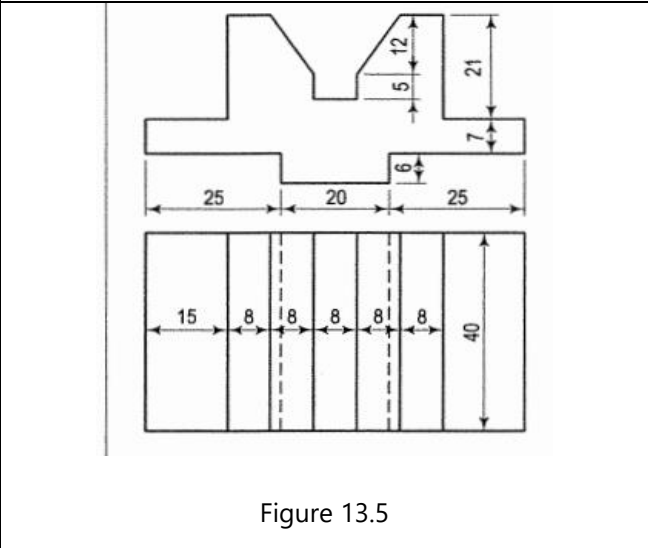
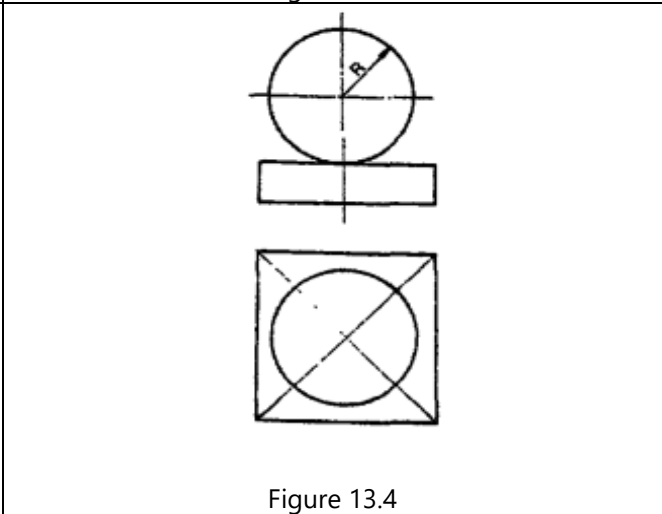
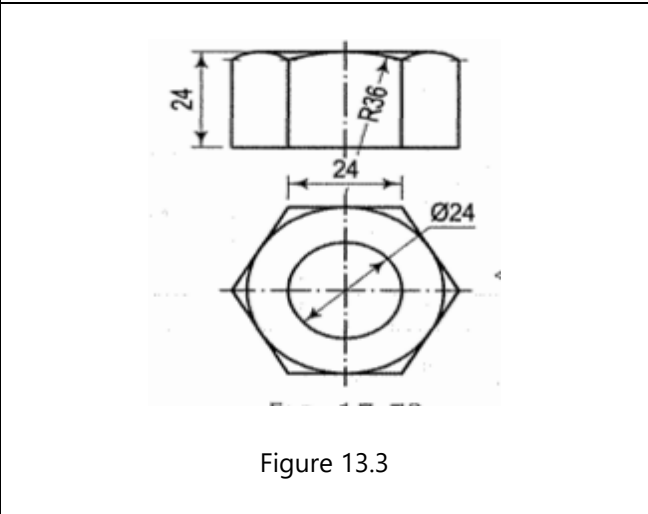
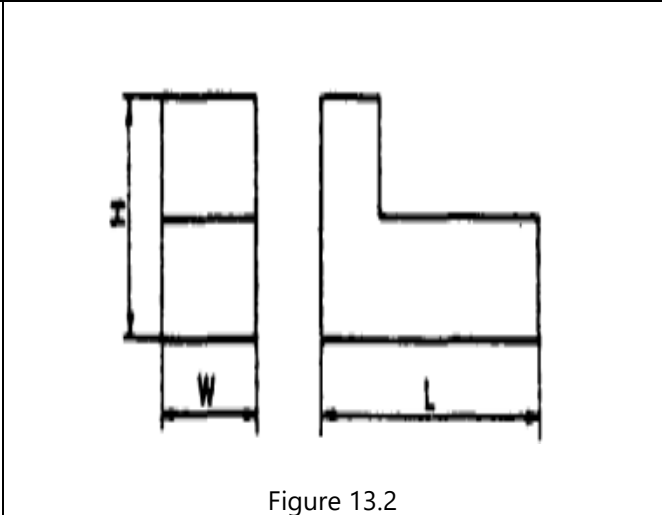
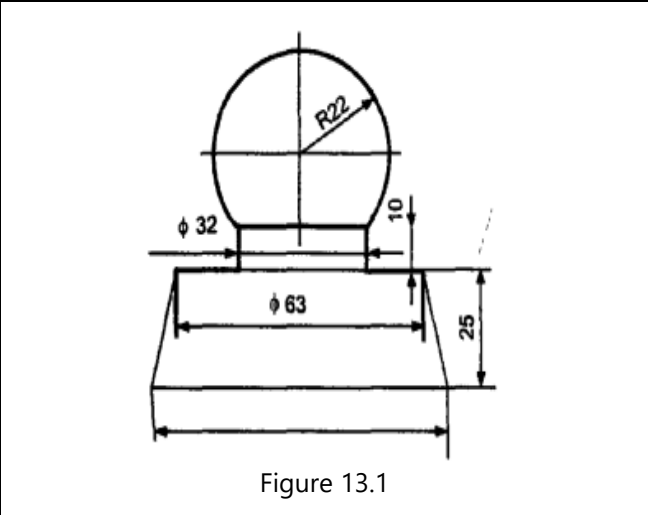
Isometric projection is a type of pictorial projection in which the three dimensions of a solid are not only shown in one view, but their actual sizes can be measured directly from it.

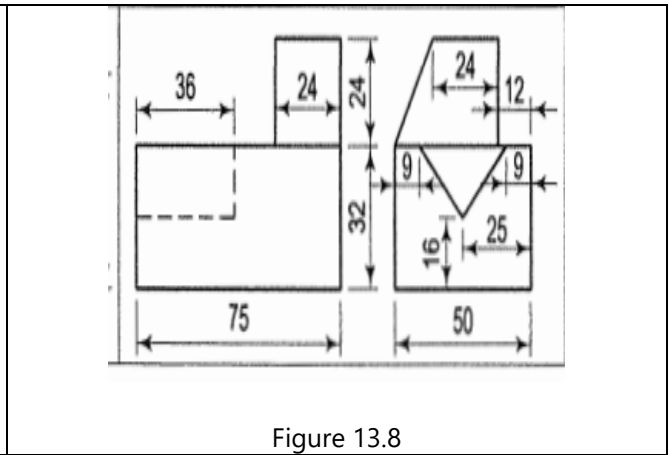
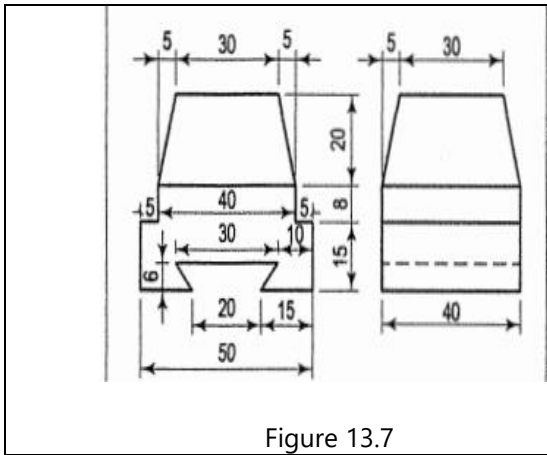
13.1 Exercises

1. Draw the isometric view, Principle of isometric Projections and isometric scale
 2. Draw the isometric view of square, pentagon and hexagon of side length 40 mm, kept (i) parallel to VP and (ii) parallel to HP.
 3. Draw the isometric view of circle of 60 mm diameter kept (i) parallel to VP and (ii) parallel to HP
 4. Draw the isometric drawing of a cone of base diameter 30mm and axis 50 mm long resting on its base on HP.
-

5. A pentagonal pyramid of side of base 30 mm and height 70 mm is resting with its base on HP and one of its edges is parallel to VP. Draw the isometric drawing of the pyramid.

13.2 Draw the isometric views of given objects





14 Pictorial views into Orthographic Projections

Orthographic reading is the ability to visualize the shape of an object from its drawing in orthographic views. Every engineer or technician connected with the work of construction should possess this ability. Without it, it would be difficult to execute, independently, any work according to a given drawing.

14.1 Exercise

Using first-angle projection method, draw the front view, top view Insert and side of a given pictorial view. Insert all dimensions in the views.

