# INSTITUTE OF AERONAUTICAL ENGINEERING

**(Autonomous)**

Dundigal - 500 043, Hyderabad, Telangana

## COURSE CONTENT

### COMPUTER AIDED ENGINEERING GRAPHICS

**I Semester:** CSE / IT

**II Semester:** CSE (AI&ML) / CSE(DS) / ECE / EEE / AERO / MECH / CE

| Course Code | Category | Hours / Week | | | Credits | Maximum Marks | | |
|---|---|---|---|---|---|---|---|---|
| | | L | T | P | C | CIA | SEE | Total |
| AMEE03 | Foundation | 1 | 0 | 2 | 2 | 40 | 60 | 100 |
| Contact Classes: 15 | Tutorial Classes: Nil | 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:**

I.   The illustration of different objects using technical drawings using concepts of engineering drawing.
II.  The standard principles of orthographic projection of objects for making technical drawings.
III. The representation of draw sectional views and pictorial views of solids.
IV.  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 veal interior features of an object

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.

**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. Venugoplal; *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 Kannaiah; *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://archieve.nptel.ac.in/cources/112/103/112103019.
2. https://archieve.nptel.ac.in/cources/112/105/112105294.

**VIII. MATERIALS ONLINE:**
1. Course Template
2. Laboratory manual

<h1 style="text-align:center">EXCERCISES ON</h1>

<h1 style="text-align:center">COMPUTER AIDED ENGINEERING GRAPHICS</h1>

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

## 1. Getting Started Exercises

### 1.1 Introduction to AUTOCAD

AutoCAD is a widely-used computer-aided design (CAD) software application developed by Autodesk. It has been an industry standard for drafting and designing since its inception in the early 1980s. AutoCAD provides a versatile platform for creating and editing 2D and 3D drawings and models, making it an essential tool in various fields such as architecture, engineering, construction, manufacturing, and more.

i.    Install AUTO CAD
ii.   Purpose and Application
iii.  Interface and Tools
iv.   Precision and Accuracy
v.    2D and 3D Modeling
vi.   Collaboration and Sharing
vii.  Customization
viii. Industry Usage
ix.   Versions and Licensing

### 1.1 Commands

The main purpose of using commands and shortcuts in AutoCAD boils down to increased productivity. They allow you to execute functions more quickly, as you don't need to search through the entire AutoCAD interface for the right tool. You can just type the command, and the function window appears.

i.   Basic Drawing Commands
ii.  Editing Commands
iii. Dimensioning Commands
iv.  Advanced and Miscellaneous Commands

**Basic Drawing Commands:**
- Line (LINE): Draws straight line segments between two points.
- Circle (CIRCLE): Creates circles by specifying a center point and radius.
- Rectangle (RECTANGLE): Constructs rectangles by defining two opposing corners.
- Arc (ARC): Draws arcs based on different methods, such as specifying start, end, and radius or center, start, and angle.

**Editing Commands:**
- Erase (ERASE): Deletes selected objects from the drawing.
- Copy (COPY): Copies objects to a specified location.
- Move (MOVE): Relocates selected objects to a different position.

- o Trim (TRIM): Cuts selected objects at the cutting edges defined by other objects.
- o Extend (EXTEND): Extends objects to meet the boundaries of other objects.

**Dimensioning Commands:**
- o Line Dimension (DIMLINEAR): Adds linear dimensions to objects.
- o Aligned Dimension (DIMALIGNED): Creates dimensions aligned with an angle of the object.
- o Radial Dimension (DIMRADIUS):  Add radius dimensions to arcs and circles.
- o Diameter Dimension (DIMDIAMETER): Creates diameter dimensions for circles.

**Advanced and Miscellaneous Commands:**
- o Hatch (HATCH): Fills enclosed areas with a pattern or gradient.
- o Offset (OFFSET): Creates parallel copies of objects at a specified distance.
- o Block (BLOCK): Defines reusable blocks (collections of objects) in the drawing.
- o Insert (INSERT): Inserts predefined blocks into the drawing.
- o Viewport (VPORTS): Manages viewports for layout and plotting in paper space.
- o Layer (LAYER): Manages layers for organizing and controlling object visibility.

**TRY:** Observe Exercise 1.1 in Solid works and in Creo software.

## 2. Introduction to Engineering Drawing

Engineering drawing, often referred to as technical drawing or drafting, is a graphical representation of an object, system, or structure used in various fields of engineering, manufacturing, and architecture. These drawings serve as a universal language that communicates design ideas, specifications, and instructions in a precise and standardized manner.

### 2.1 Basic Exercises

To be proficient in engineering drawing, basic exercises are required.
- i.   Identify the basic tools used for drafting
- ii.  Types of lines
- iii. Arcs
- iv.  Circles

### 2.2 Practicing the standard lettering and numbering

Practicing standard lettering and numbering in engineering drawing is crucial for creating clear, professional, and easily understandable technical drawings. Proper lettering and numbering enhance communication and ensure that your drawings convey information accurately.

The following exercises are to be practiced to become proficient in lettering and numbering.
- 1. Use the correct fonts
- 2. Maintain uniformity
- 3. Lettering style
- 4. Height and spacing

**Try:** The following questions are to be answered in Solid works
- 1.  How to use correct fonts in Solid Works
- 2.  What are the commands are used to maintain uniformity of lettering and numbering.

# 3. Dimensioning

Dimensioning in engineering drawing is a crucial aspect that involves adding measurements and annotations to convey the size, location, and tolerances of objects, features, and components accurately. Proper dimensioning is essential for manufacturing, construction, and other engineering processes.

## 3.1 Exercises on Dimensioning

1. Understanding and use of the conventional dimensioning techniques.
2. Placing the dimension lines
3. Extension lines
4. Dimensions on angles

**Hint: 1. The following Fig.3.1 shows the type of dimensioning on 2D drawing.**
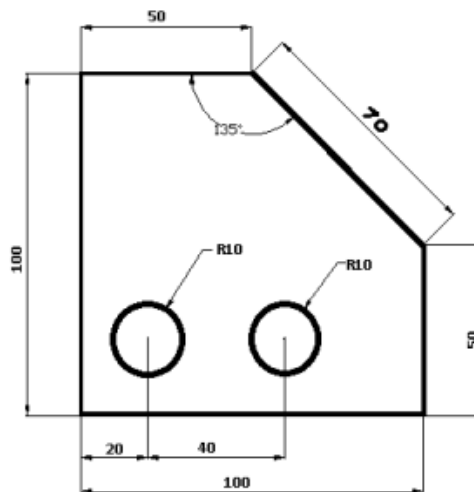


Fig.3.1 Dimensioning on 2D drawing

**Hint: 2. The following Fig.3.2 shows the type of dimensioning on concentric circles.**
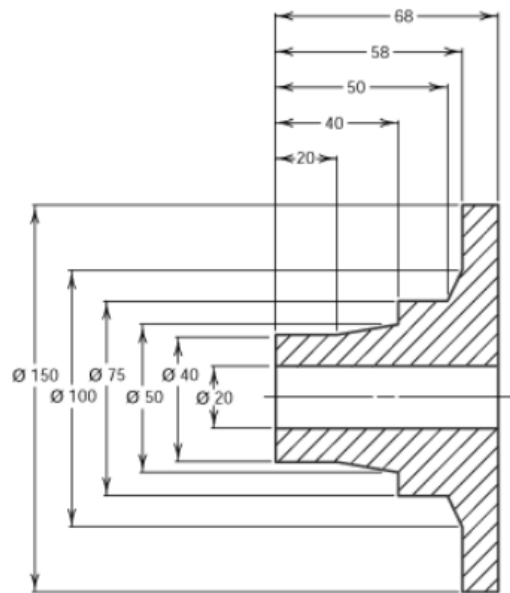
**Fig.3.2 Dimensioning on Concentric circle**

**Try:** Demonstrate the exercise 3 in Solid Works and CREO software.

# 4. Geometrical Constructions

Geometric construction is useful for learning how to use geometric tools like a ruler, compass, and straightedge to draw various angles, line segments, bisectors, and other forms of polygons, arcs, circles, and other geometric figures. Fig.4.1 shows the various geometric shapes to draw orthographic projections of lines, planes and solids.
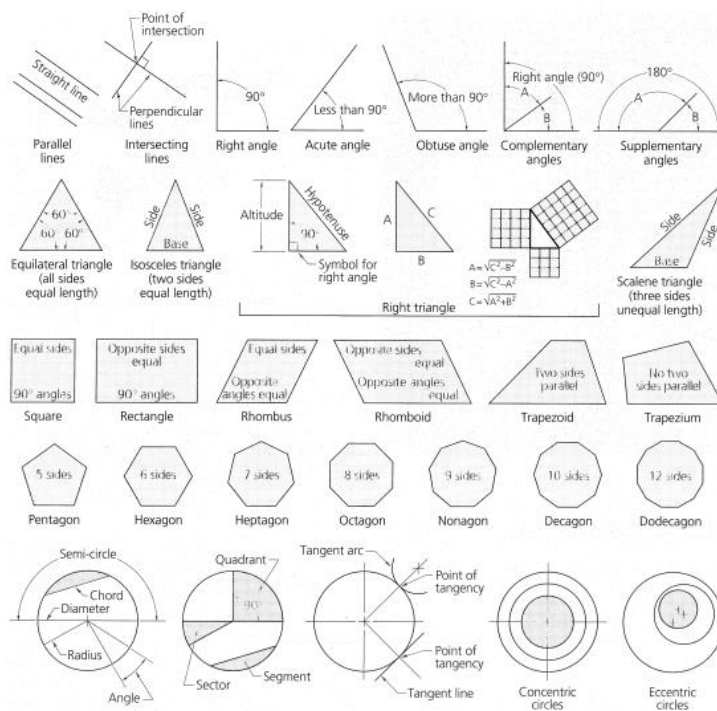


**Fig.4.1** **Geometric shapes**

## 4.1. Exercises on Geometrical Constructions

To become proficient in engineering graphics geometrical constructions are required: Drawing lines, angles, triangle, square, pentagon, hexagon, octagon. Dividing line into equal or proportional parts. Drawing lines and arcs tangent to each other.

1. Divide a 16 cm straight line into a given number of equal parts say 5.
2. Divide a 8 cm line into 9 number of parts.
3. Bisect a given 45 degree sector.
4. Bisect a given straight line.
5. To draw a perpendicular to a given line from a point within it.
6. Construct a regular polygon, given the length of its side.

**Hint: Dividing a line into equal number of parts**



| Given | Step 1 | Step 2 | Step 3 | Step 4 |
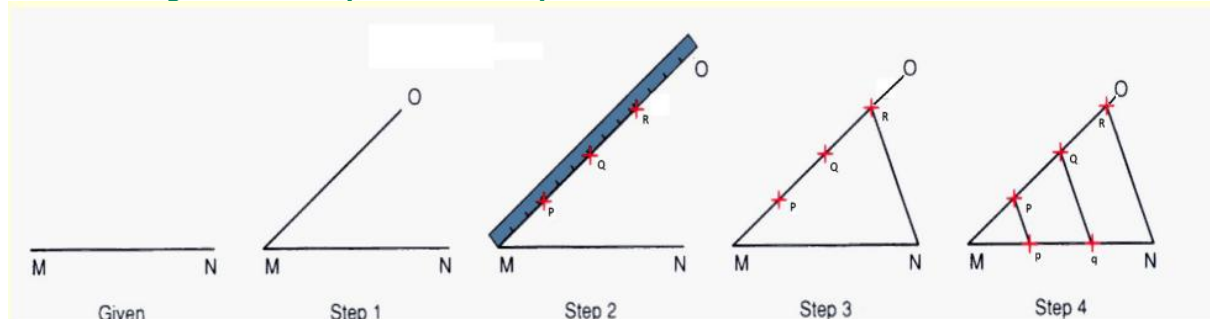
**Try:** The exercise 4 in Solid Works and CREO software.

## 5. Conic Sections

A conic section, conic or a quadratic curve is a curve obtained from a cone's surface intersecting a plane. The three types of conic section are the hyperbola, the parabola, and the ellipse.

## 5.1. Exercises on Conic Sections

1. Draw an ellipse with the distance of the focus from the directrix at 50mm and eccentricity = 2/3 (Eccentricity method)
2. Draw an ellipse with the distance of the focus from the directrix at 60mm and eccentricity = 2/3 (Eccentricity method)
3. Draw an ellipse with the distance of the focus from the directrix at 80mm and eccentricity = 2/3 (Eccentricity method)
4. Draw a parabola with the distance of the focus from the directrix at 50 mm (Eccentricity   method).
5. Draw a parabola with the distance of the focus from the directrix at 40mm (Eccentricity method).
6. A vertex of a hyperbola is 60 mm from its focus. Draw two parts of the hyperbola; if the eccentricity is 3/2.
7. A vertex of a hyperbola is 50 mm from its focus. Draw two parts of the hyperbola; if the eccentricity is 1.5.

**Try:** The exercise 5 in Solid Works and CREO software.

# 6. Technical Sketching and Shape Description

## 6.1. Projections of planes and regular solids

1. Draw the projections of a regular pentagon of 30 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.
2. 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.
3. Draw the projections of a regular hexagon of 35 mm side, having one of its sides in the H.P. and inclined at 50° to the V.P., and its surface making an angle of 45° with the H.P.
4. Draw the projections of a regular pentagon of 40 mm side, having one of its sides in the H.P. and inclined at 30° to the V.P., and its surface making an angle of 45° with the H.P.

Try: The exercise 6.3 in Solid Works and CREO software.

# 7. Sectional views

A sectional view represents the part of an object remaining after a portion is assumed to have been cut and removed. The exposed cut surface is then indicated by section lines. Hidden features behind the cutting plane are omitted, unless required for dimensioning or for definition of the part.

## 7.1. Exercise on Sectional views of right regular solids, prism, cylinder, pyramid, cone.

1. A pentagonal pyramid, base 40 mm side and axis 60 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 20 mm above the base. Draw its front view and sectional top view.
2. A hexagonal prism, side of base 40 mm and height 70 mm is resting on one of its corners on the H.P. with a longer edge containing that corner inclined at 40° to the H.P. and a rectangular face parallel to the V.P. Draw the front view and sectional top view of the cut prism when a horizontal section plane cuts the prism in two equal halves. Draw the front view and sectional top view of the cut prism.
3. A pentagonal pyramid, base 40 mm side and axis 70 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 40° with the H.P. Draw its projections.
4. 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.

Try: The exercise 7.1 and 7.2 in Solid Works and CREO software.

# 8. Development of surfaces

Knowledge of development is very useful in sheet metal work, construction of storage vessels, chemical vessels, boilers, and chimneys. Such vessels are manufactured from plates that are cut according to these developments and then properly bend into desired shaped.

## 8.1. Exercise on Basics of development of surfaces

1. Draw the development of the lateral surfaces of a right square prism of edge of base 30 mm and axis 50 mm long.
2. Draw the development of the complete surface of a cylindrical drum. Diameter is 40 mm and height 60 mm.

## 8.2. Exercise on Development of surfaces of Prisms

1. A hexagonal prism of base side 20 mm and height 45 mm is resting on one of its ends on the HP with two of its lateral faces parallel to the VP. It is cut by a plane perpendicular to the VP and inclined at 30° to the HP. The plane meets the axis at a distance of 20 mm above the base. Draw the development of the lateral surfaces of the lower portion of the prism.
2. A hexagonal prism, edge of base 20 mm and axis 50 mm long, rests with its base on HP such that one of its rectangular faces is parallel to VP. It is cut by a plane perpendicular to VP, inclined at 45° to HP and passing through the right corner of the top face of the prism. (i) Draw the sectional top view. (ii)Develop the lateral surfaces of the truncated prism.
3. A pentagonal prism, side of base 25 mm and altitude 50 mm, rests on its base on the HP such that an edge of the base is parallel to VP and nearer to the observer. It is cut by a plane inclined at 45° to HP, perpendicular to VP and passing through the center of the axis. (i) Draw the development of the complete surfaces of the truncated prism.
4. A pentagonal prism of side of base 30 mm and altitude 60 mm stands on its base on HP such that a vertical face is parallel to VP and away from observer. It is cut by a plane perpendicular to VP, inclined at an angle of 50° to HP and passing through the axis 35 mm above the base. Draw the development of the lower portion of the prism.

**Try** : The exercise 8.1 and 8.2  in Solid Works and  CREO software.

# 9. Exercise on Development of surfaces-2

## 9.1. Exercise on Development of surfaces of cylinder and cone

1. Draw the development of the lateral surface of the lower portion of a cylinder of diameter 50 mm and axis 70 mm when sectioned by a plane inclined at 40° to HP and perpendicular to VP and bisecting axis.
2. A Cone of base diameter 60 mm and height 70 mm is resting on its base on HP. It is cut by a plane perpendicular to VP and inclined at 30° to HP. The plane bisects the axis of the cone. Draw the development of its lateral surface.

## 9.2. Exercise on Development of surfaces of pyramid

1. Draw the development of the lateral surfaces of a square pyramid, side of base 25 mm and height 50 mm, resting with its base on HP and an edge of the base parallel to VP.
2. A square pyramid of base side 25 mm and altitude 50 mm rests on it base on the HP with two sides of the base parallel to the VP. It is cut by a plane bisecting the axis and inclined a 30° to the base. Draw the development of the lateral surfaces of the lower part of the cut pyramid.
3. A pentagonal pyramid side of base 30 mm and height 52 mm stands with its base on HP and an edge of the base is parallel to VP and nearer to it. It is cut by a plane

perpendicular to VP, inclined at 40° to HP and passing through a point on the axis 32 mm above the base. Draw the sectional top view. Develop the lateral surface of the truncated pyramid.

**Try:** The exercise 9.1 and 9.2 in Solid Works and CREO software.

# 10. Orthographic views

Orthographic views are two-dimensional views of three-dimensional objects. Orthographic views are created by projecting a view of an object onto a plane which is usually positioned so that it is parallel to one of the planes of the object.

## 10.1. Exercise on Conversion of isometric view to orthographic projections using CAD

1. Draw the front view, side view and top view for the below Fig.10.1
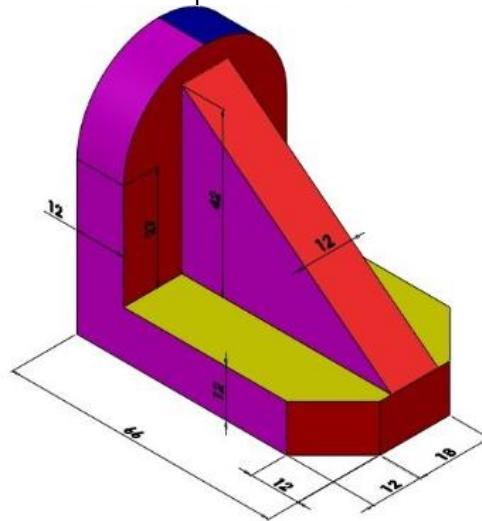


Fig.10.1

2. Draw the front view, side view and top view for the below Fig.10.2.
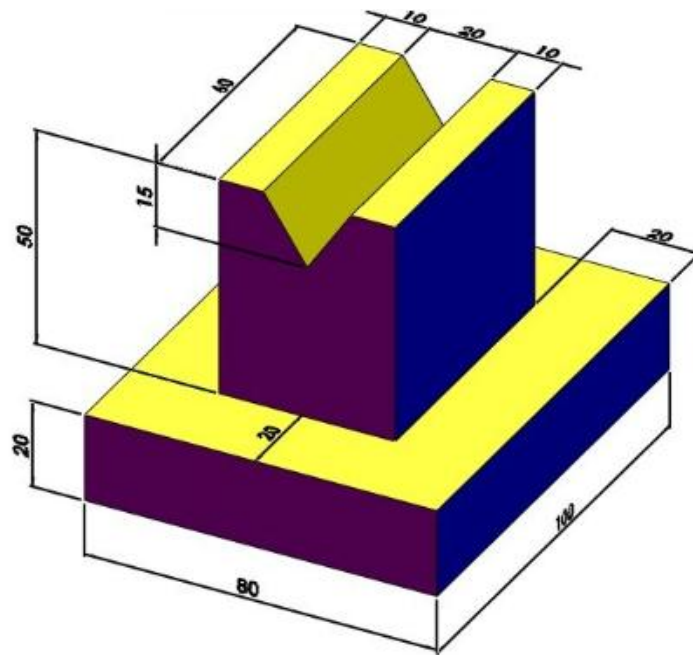
Fig.10.2

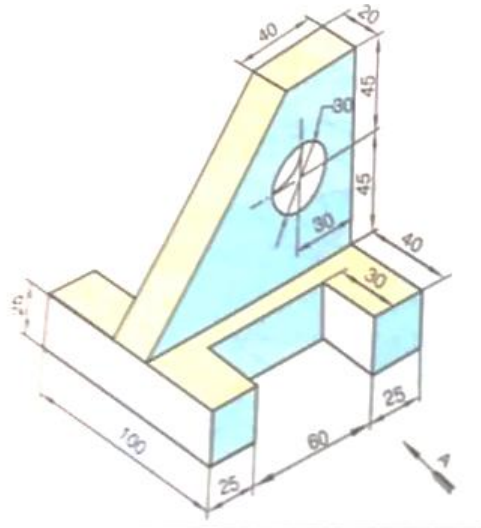3. Draw the front view, side view and top view for the below Fig.10.3.


Fig.10.3

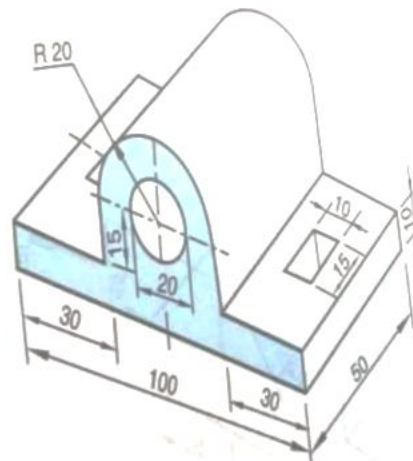4. Draw the front view, side view and top view for the below Fig.10.4.

Fig.10.4

**Try:** Practice Exercise 10 in Solid Works

## 11. Isometric projection of planes

Isometric projection is a method for visually representing three-dimensional objects in two dimensions in technical and engineering drawings. It is an axonometric projection in which the three coordinate axes appear equally foreshortened and the angle between any two of them is 120 degrees.

### 11.1. Isometric scale

In engineering and technical drawing, an isometric scale is a method used to create an isometric projection of a three-dimensional object onto a two-dimensional surface, such as a drawing sheet or a computer screen. Isometric projection is a type of pictorial representation that shows an object in a three-dimensional view with all three principal axes (x, y, and z) at equal angles to the picture plane. An isometric scale is used to ensure that the dimensions and proportions of objects in the isometric drawing are accurate and maintain the proper relationships.

### 11.2. Exercise on Isometric projections of circle, square and rectangle and solids

1.  Draw the isometric view of a circle of 60 mm diameter whose surface is parallel to the V.P.
2.  Draw the isometric view of a square of side 60 mm whose surface is parallel to the H.P.
3.  Draw the isometric view of a circle of 40 mm radius whose surface is parallel to the H.P.
4.  Draw the isometric view of a square prism, side of the base 20 mm long and the axis 40 mm long, when its axis is i) Veritcal and ii) Horizontal.
5.  Draw the isometric view of the semi-circle whose front view of its surface is parallel to the V.P.. The diameter of semi-circle is 60 mm.

**Try :** The exercise 11.2 in Solid Works and  CREO software.

## 1.    Isometric  projections of solids

### 12.1. Exercise on conversion of orthographic view to isometric view using CAD

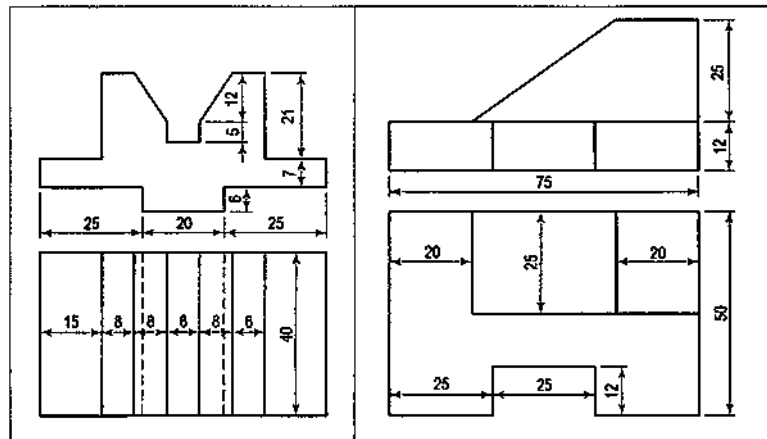1. Draw the isometric view for the given orthographic views Fig.12.1

Fig.12.1

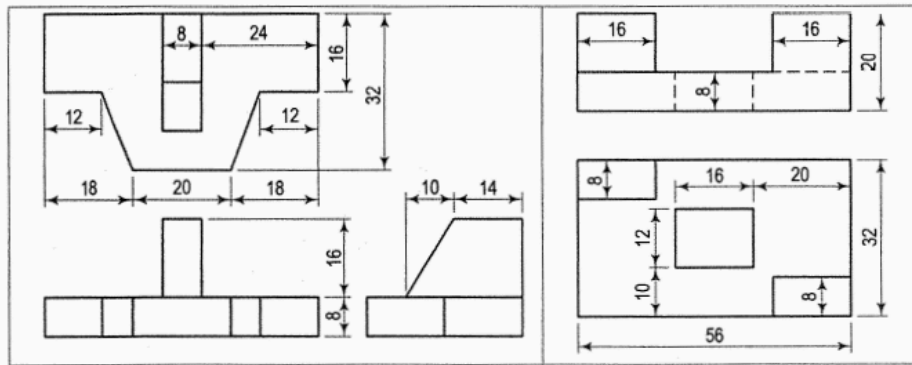2. Draw the isometric view for the given orthographic views for Fig.12.2



Fig.12.2

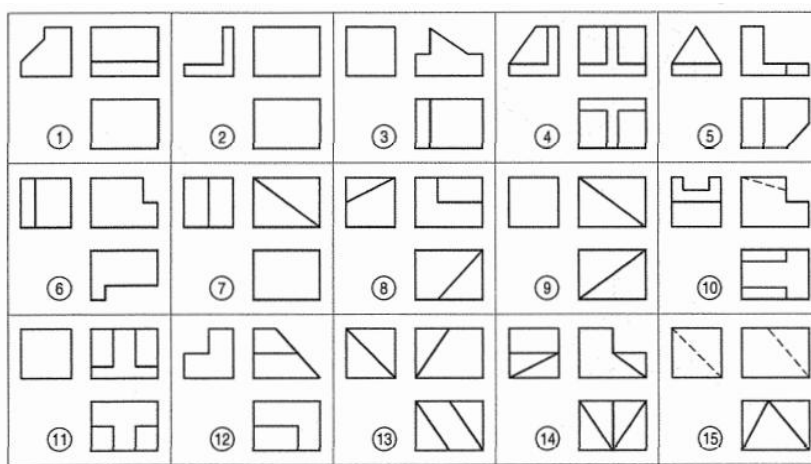3. Draw the isometric view for the given orthographic views by assuming the dimensions for Fig.12.3



Fig.12.3

**Try** : The exercise 12  in Solid Works and  CREO software.

## 13.Demonstration of SOLID WORKS Software

1. Introduction to SOLID WORKS
2. Demonstration of commands
3. 2D drawings
3. 3D drawings

### V. TEXT BOOKS:

1.  Frederick E Giesecke, Alva Mitchell, Henry C Spencer, Ivan L Hill, John T Dygdon, James E. Novak, R. O. Loving, Shawna Lockhart, Cindy Johnson, *Technical Drawing with Engineering Graphics*, Pearson Education, 15th Edition, 2016.
2.  Kulkarni D.M, Rastogi A.P. and Sarkar A.K., *Engineering Graphics with Auto CAD*. (Revised Edition), Prentice Hall India, New Delhi, 2011.
3.  Donald Hearn, "*Computer Graphics*", 12th Edition, Pearson, 2021.

### VI. REFERENCE BOOKS:

1.  Basant Agrawal and C M Agrawal, *Engineering Drawing*, McGraw Hill, 3rd Edition, 2018.
2.  James M. Leake, Molly Hathaway Goldstein, Jacob L. Borgerson, *Engineering Design Graphics, Modelling and Visualization*, Wiley, 3rd Edition, 2020.

### VII. ELECTRONICS RESOURCES:

4.  https://archive.nptel.ac.in/courses/112/103/112103019.
5.  https://archive.nptel.ac.in/courses/112/105/112105294.

### VIII. MATERIALS ONLINE:

1.  Course Template
2.  Laboratory manual