CHAPTER 1

INRTRODUCTION TO COMPUTER AIDED DRAWING

1.1 INTRODUCTION

Drawing is the language through which an engineer communicates with his fellow engineers in the other departments. It gives It gives the detailed description about any component in a pictorial-form. Conventionally, object is prepared manually, using a drawing board, T-square/drafting machine and drawing instruments.

The advert of digital computer and software, has lead to the process of drawing on the screen and storing in form of soft/hard copy. This has been greatly reduced the manual labour on the hand and enabled the screen creation, transportation of drawing on the other. Consequently, it has resulted in a relatively better understanding, representation and quick production of parts and machinery, buildings, etc.

1.2 DRAWING INSTRUMENTS

The following drawing instruments are commonly used while preparing drawing in a conventional manner (Refer Fig. 1.1 to 1.13).

a) Drawing Board
b) Mini-drafter or T-Square
c) Drafting Instrument Box
d) Pencil or Eraser
e) Set Squares
f) protractor
g) templates
h) Set of Paper Scales
i) French Curves
j) Drawing Clips
k) Sandpaper
l) Drawing Sheet
m) Rotoscale (Roll-N-Draw scale)

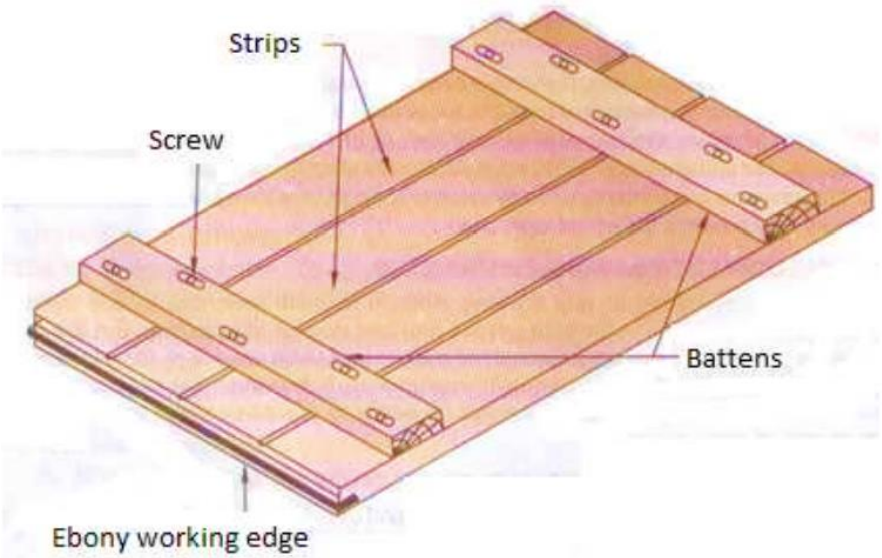


Fig. 1.1 Drawing Board

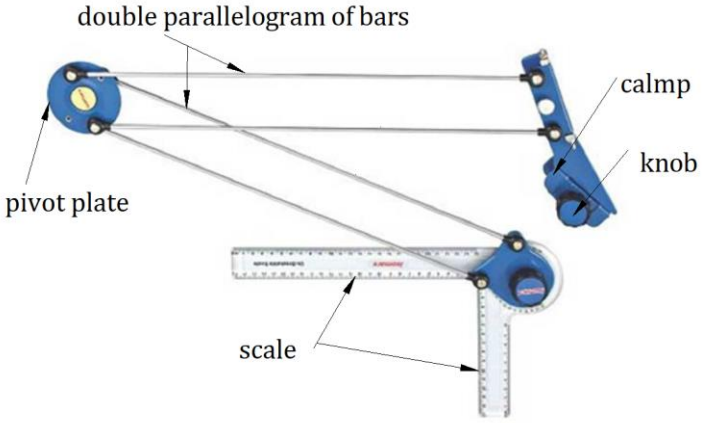


Fig. 1.2 Mini Drafter

Fig. 1.3 Drawing Instrument Box

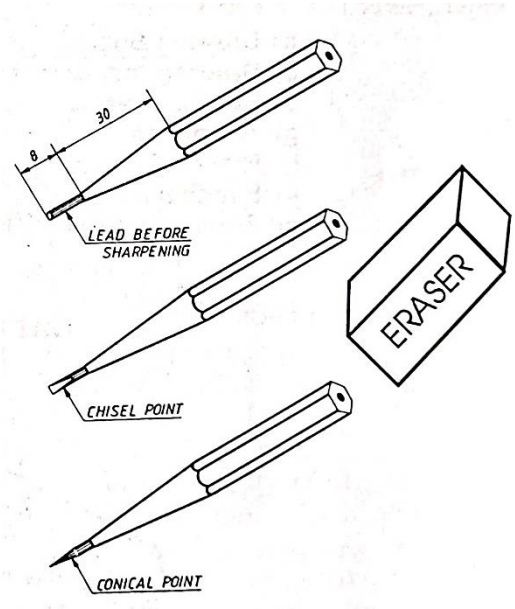
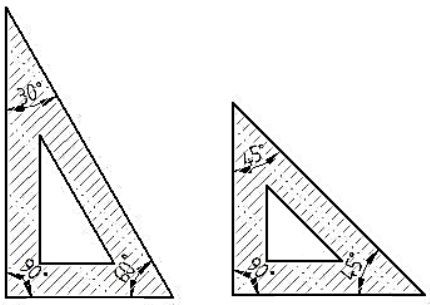


Fig. 1.4 Pencils and Eraser



30^0-60^0 45^0

Fig. 1.5 Set Squares

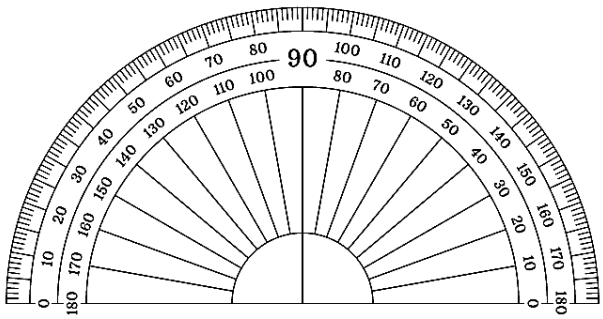


Fig. 1.6 Protractor

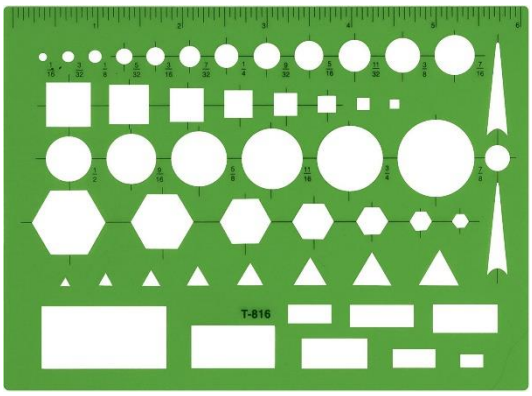


Fig. 1.7 Templates

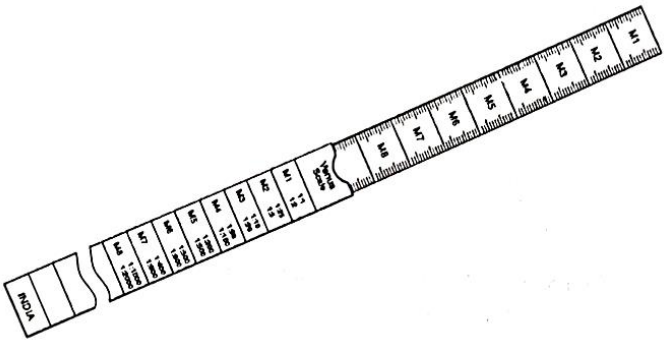


Fig. 1.8 Set of Paper Scales

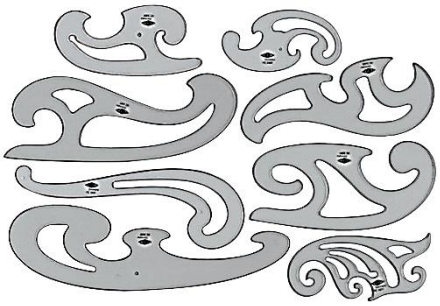


Fig 1.9 French Curves

Fig. 1.10 Drawing Clips

Fig. 1.11 Sandpaper

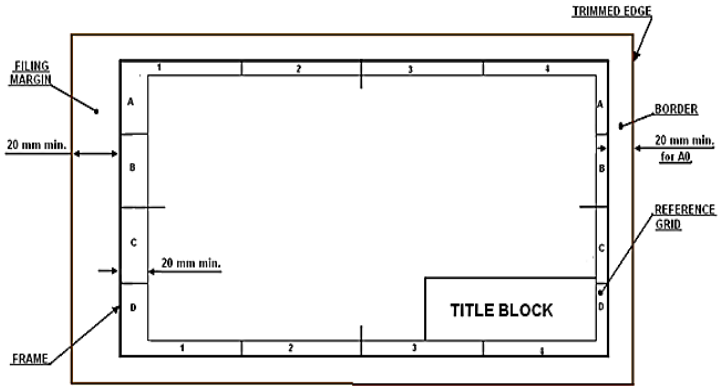


Fig. 1.12 Drawing Sheet

Fig. 1.13 Rotoscale

1.3 BIS CONVENTIANAL FOR LETERING AND DIMENSIONING

Standard like Bureau of Indian Standards(BIS), international standard organization, etc., are used in engineering drawing practice. SP46:2003 gives the consolidated list of BIS and ISO codes for engineering drawing practice.

Lettering is method of describing or specifying an object in the form of notes. Dimensioning refers to the way in which the size of object is expressed. SP46:2003 presents the detailed procedure for lettering and dimensioning the pencil drawing.

1.4 FREEHAND DRAWING PRACTICE

Frequently, free hand sketching is used to quickly represent the salient features of an object. This will help in preparing the detailed drawings and manufacture of components. In free hand sketching, the sketches are drawn using only pencil and eraser. To draw accurate drawings, scale, compass, set square or protractor and rotoscale may be used during free hand sketching.

1.5 CO-ORDINATE SYSTEM AND REFERENCE PLANES

Various co-ordinate systems can be used to represent the drawings. However, first-angle co-ordinate system is used as per the BIS Standard for drawing the objects as shown in Fig. 1.14a and 1.14b. Commonly used reference planes are Horizontal Plane (HP), Vertical Plane (VP), Profile Planes (PP) - Right Profile Plane (RPP) and Left Profile Plane (LPP). Fig. 1.14a shows the quadrants used for representing the reference planes, Fig. 1.14b shows the 3D view and 1.15 shows 2D view.

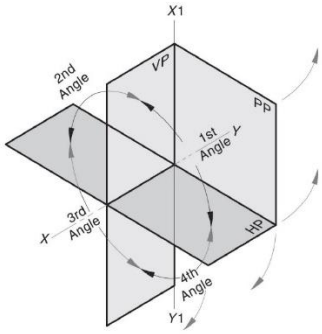


Fig. 1.14a Co-ordinate System

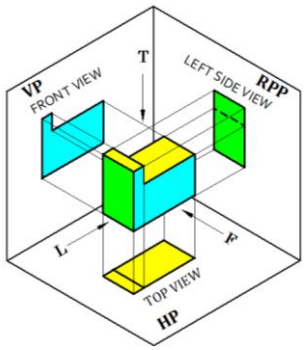


Fig. 14b 3D View

1.5.1 Definitions of HP, VP, RPP and LPP

HP: It is the horizontal reference plane on which the top view (view obtained by looking at the object from the top) is drawn. The views o the HP are represented by lower case letters such as a, b, p. q, etc.

VP: It is the vertical reference plane on which the front view (view obtained by looking at the object from the front) is drawn. The views on the VP are represented lower case letters with a prime such as a', b', p', q', etc.

RPP: It is the vertical reference plane adjoining with the VP towards right side of the observer. The views on the RPP are represented by lower case letters with double primes such as a", b", p", q", etc.

LPP:

It is the vertical reference plane adjoining with the VP towards left side of the observer, The views on the LPP are represented by lower case letters with double primes such as a", b", p", q", etc.

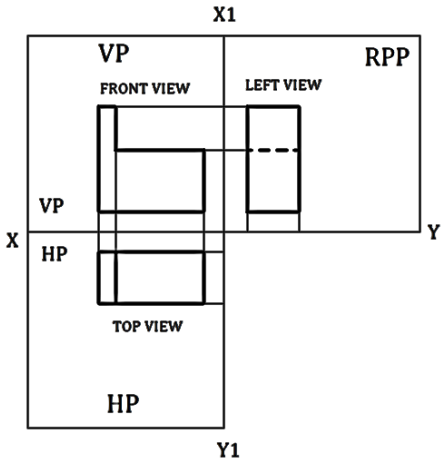


Fig. 1.15 2D views

15.2 Creation of 2D/3D Environment

2D environment is used to represent objects with only 2 dimensions indicated on it. The front view, the top view and the side views of an object in orthographic projection are in 2D format. 3D environment is the used to represent objects with all the 3 dimensions indicated on it. The isometric projection of an object is in 3D format.

6 SELECTION OF DRAWING SIZE AND SCALE

The drawing size and the scale for drawing an object can be suitably selected as per the requirement. The standard drawing sheet sizes used are A0 (841 X 1189mm), A1 (594 X 841mm), A2 (420 X 594mm), A3 (297 X 420mm), A4 (210 X 297mm) as shown in Fig. 1.16. The commonly used drawing scales are enlarged (2:1, 5:1, 10:1, 20:1, 50:1): full size (1:1); and reduced (1:2. 1:5, 1:10, 1:100).

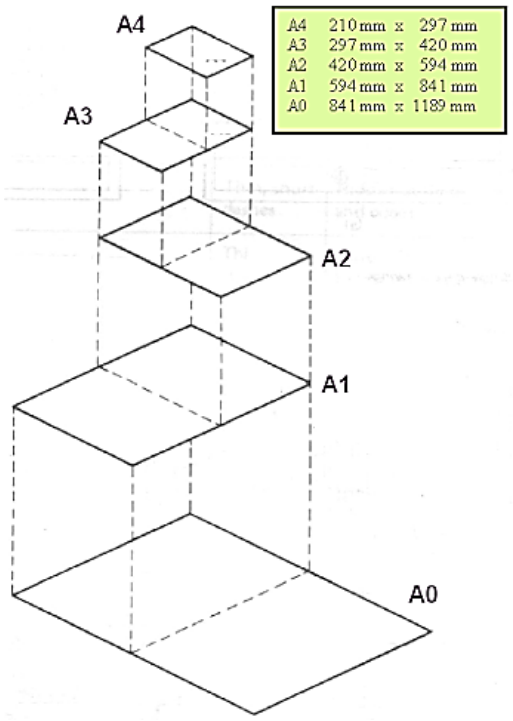


Figure 1.16 Standard Drawing Sheet

1.7 DIMENSIONING

The standard method of dimensioning is given in Fig.1.17. The angular dimensions are actual and represented in degrees. The angular dimension should not be scaled.

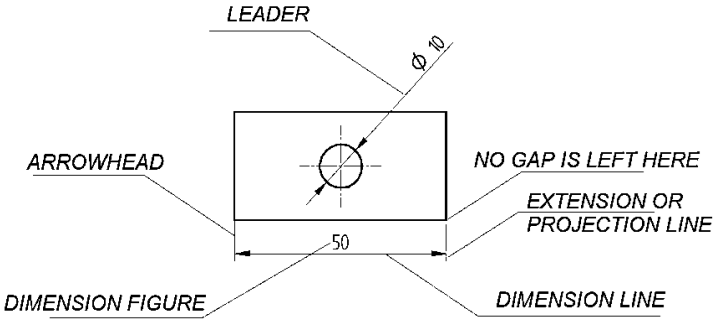


Figure 1.17 Standard Method of Dimensioning

1.8 LINE CONVENTIONS

Line conventions used to represent line such as chain line, dark line, thin line, thick line, long break line, double dashed line, hatching line, etc., are given in Table 1.1

Table 1.1 Types of Lines

TYPE	LINE	USES
A	Continues Thick Line	Outlines, visible edges, surface boundaries of objects, margin lines, these lines should be outstanding in appearance.
B	Dashed Line	Dotted or dashed or hidden lines. Invisible or interior surfaces.
C	Chain Line	Center lines, locus line, alternate long and short edges in proportion ranging from 6:1 to 4:1, closely and evenly spaced in one drawing, ratio adopted must be maintained.
D	Continues Thin Line	Dimension lines, extension lines, section lines leader or pointer lines, construction lines, border lines.
E	Chian Line thin and thick ends	Cutting-plane lines or section-plane line.
F	Wavy Line	Short break line or irregular boundaries lines.
G	Zigzag Line	Long break lines.

1.9 MATERAIL CONVENTIONS

Conventions used for representing material such as construction and production material (brick, stone, sand, cement concrete, different metals, non-metals, liquids, etc.). Typical representation shown in Table 1.2.

Table 1.2 Conventions to Represent Materials

Material	Convention	Material	Convention
Brick		Cast iron, Coper, Aluminum	
Stone- Random Rubble Masonry/ Course Rubble Masonry		Lead, Zinc, Tin, White-Metal	
Sand		Steel	
Plain cement concrete (P.C.C) Lime Concrete		Porcelain, Marble	
Reinforced cement concrete (R.C.C)		Asbestos, Paper, Rubber, Leather, Insulating Materials	
Wood/Timer		Water, Oil, Petrol, Kerosene	
Glass		Plywood	
Plaster		Brass, Bronze, Gun Metal	
Earth (Ground level)			

1.10 LETTERING

Two types of lettering formats in both upper and lower case are used in describing or specifying the dimensions and notes (Type A and Type B). In type A (Fig. 1.18), the height of the letter is divided into 14 parts. In type B (Fig. 1. 19), the height is divided into 10 parts. Also, different letter sizes are used for dimensioning and marking, writing notes, subtitles and main titles. Both vertical and inclined letters, with inclination of 15 ° to the vertical, are used.

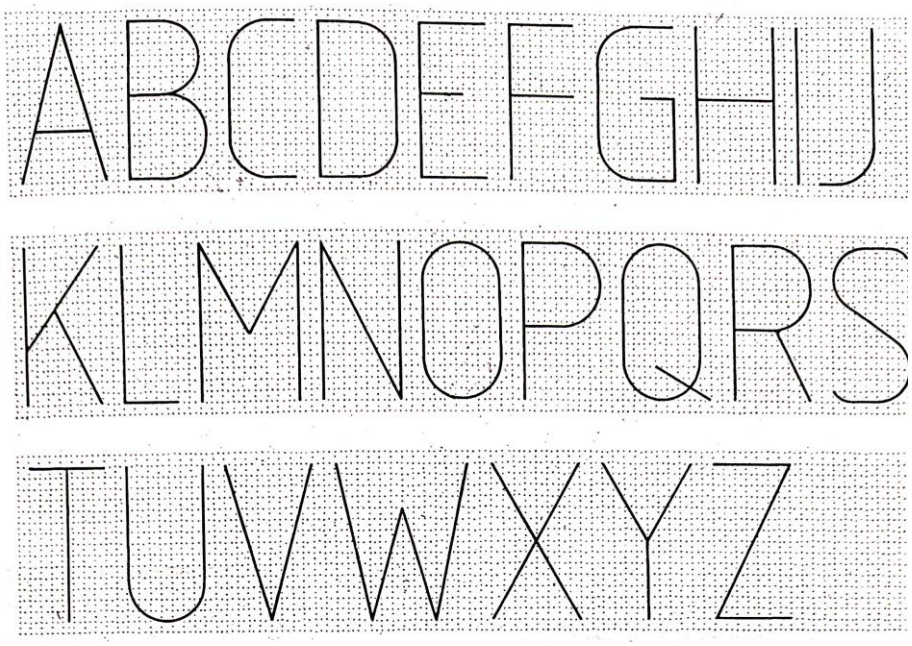


Fig. 1.18 Type A Letters

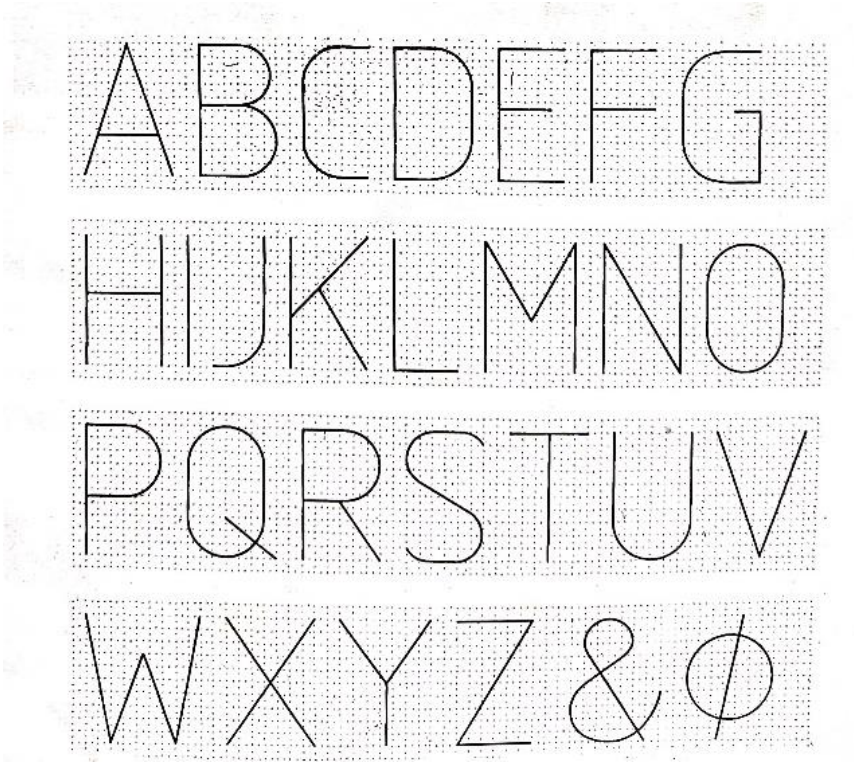


Fig. 1.19 Type B Letters

1.11 COMPUTER AIDED ENGINEERING DRAWING

Computer Aided Engineering Drawing (CAED) required the following hardware and software.

1.11.1 Hardware

Processor	:	Intel P-III and above
RAM	:	128MB or more
Display	:	17” color Monitor or above with high resolution AGP adapter
Input devices	:	Standard Keyboard, Mouse, Pen
Output devices	:	Printer, Digitizer, Plotter, Tablet, Joystick, Scanner (optional)

While preparing drawing using a Computer, the following computer hardware shown, in Fig 1.20-1.28

Fig. 1.20 Processor

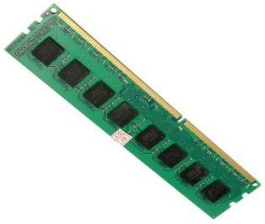


Fig. 1.21 RAM

Fig. 1.22 Monitor

Fig. 1.23 Tablet

Fig. 1.24 Keyboard

Fig. 1.25 Mouse

Fig. 1.26 Pen

Fig. 1.27 Scanner

Fig. 1.28 Plotter

1.11.2 Software

The following are a few computer software packages, which can be used for preparing engineering drawing. AUTOCAD, CATIA, IDEAS, IRONCAD, MECHANICAL DESK TOP, PRO - E, SOLID EDGE, SOLIDWORKS. The discussion of the generic layout of the software follows along with the description on some of the commonly used 'menus' and 'tool bars'. Appendix A1 gives the typical format of CAED sheet and Appendix A2 provides the types and thickness of the lines to be used uniformly and for drafting clarity.

1.11.3 Menus

The standard menu used by different software packages basically consist of various commands for drawing, modifying, dimensioning, etc. These commands may vary from one package to another. The supporting user manual of the packages gives the details of the various menus. The typical menus such as File, Edit, View, Insert, Format, Tools, Inspect, Manage, Window, Help are shown in figure 1.29 - 1.38.

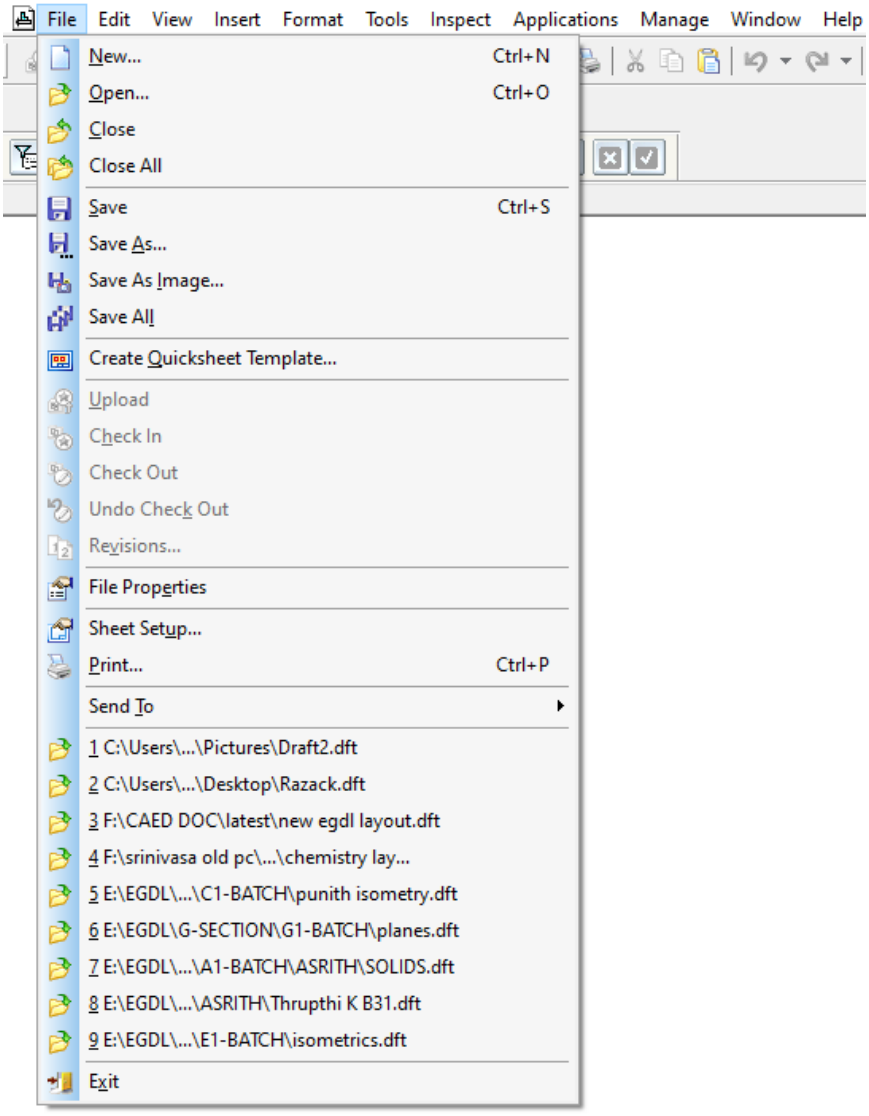


Fig. 1.29 File

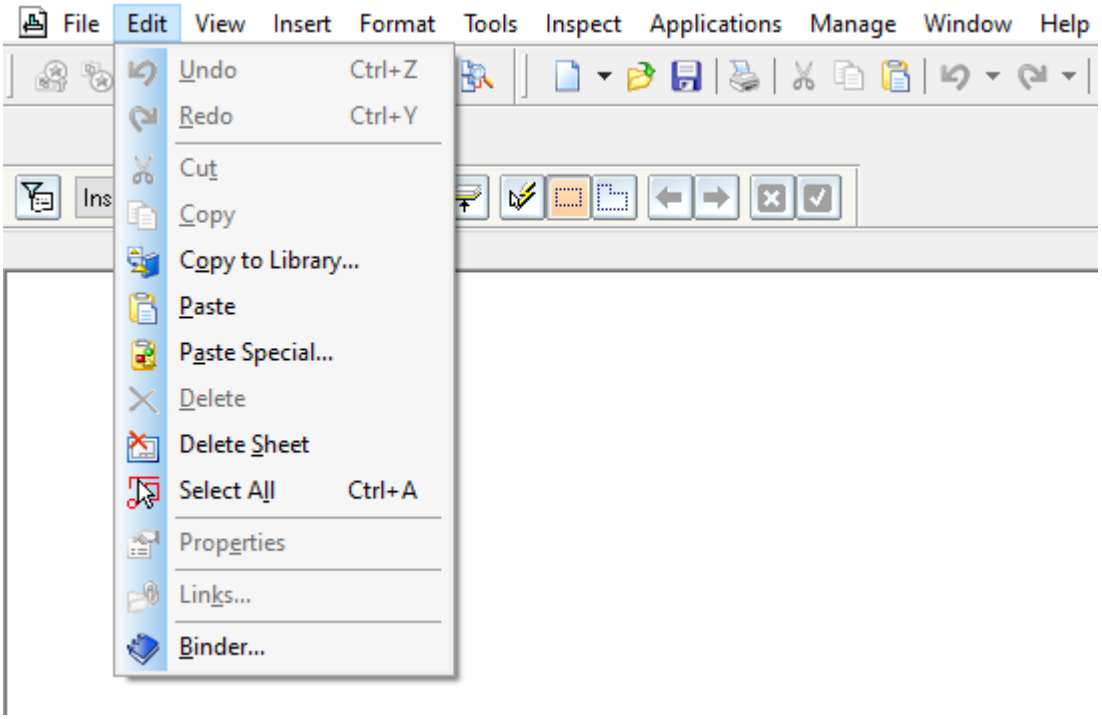


Fig. 1.30 Edit

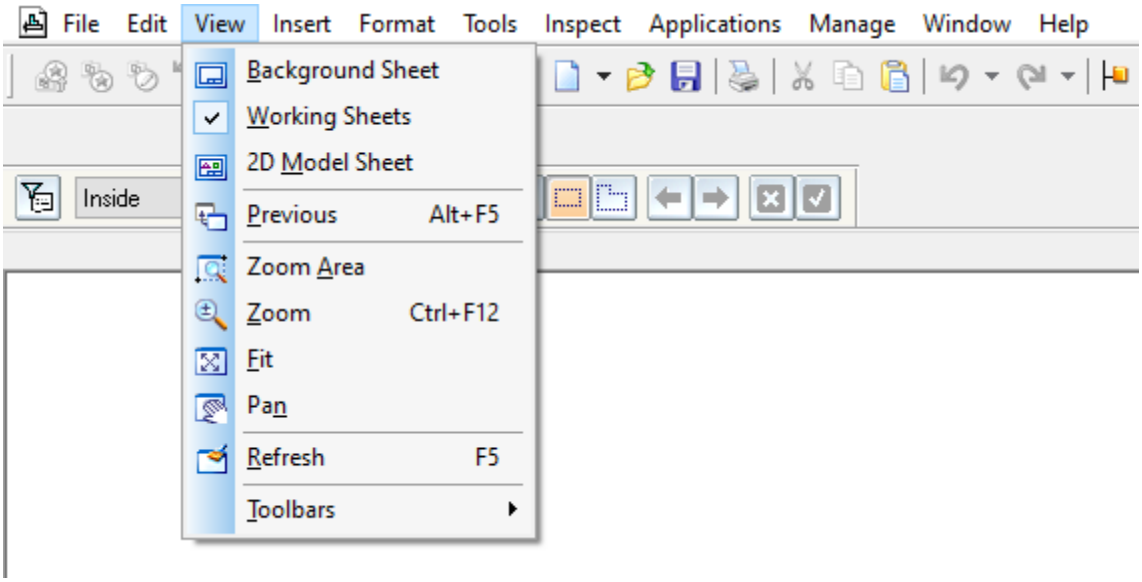


Fig. 1.31 View

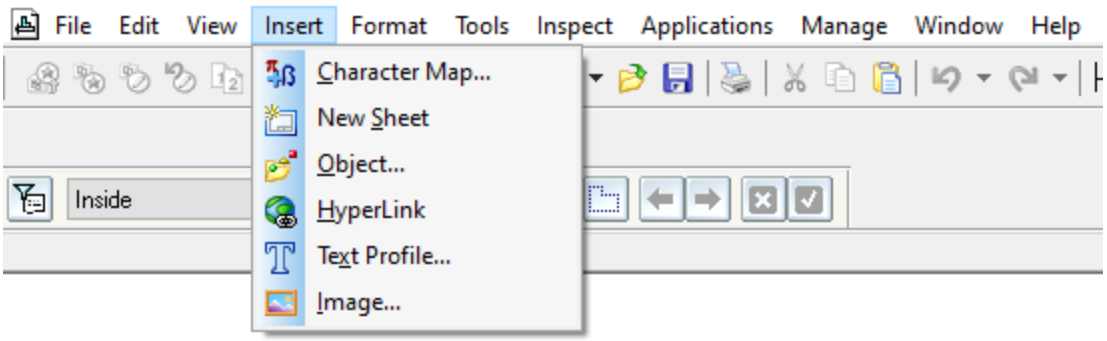


Fig. 1.32 Insert

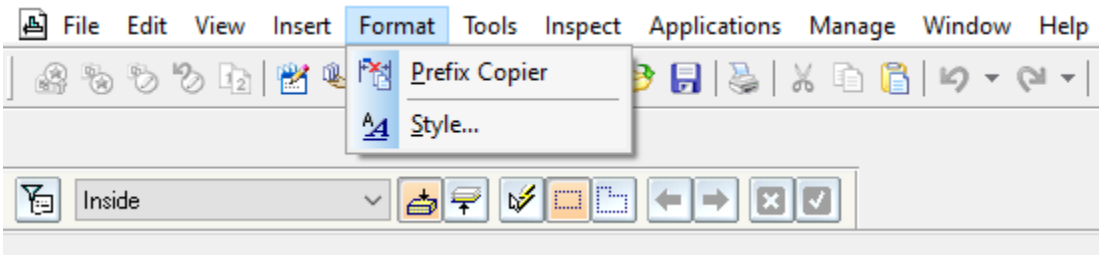


Fig. 1.33 Format

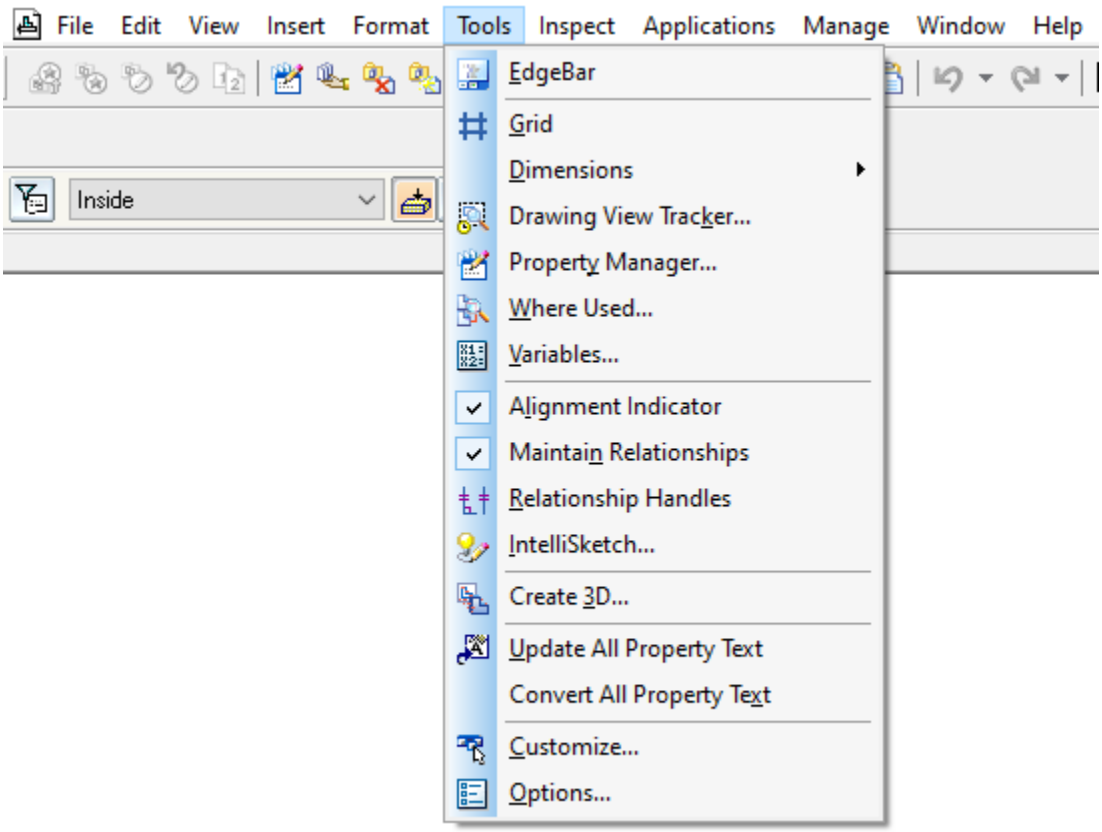


Fig. 1.33 Tools

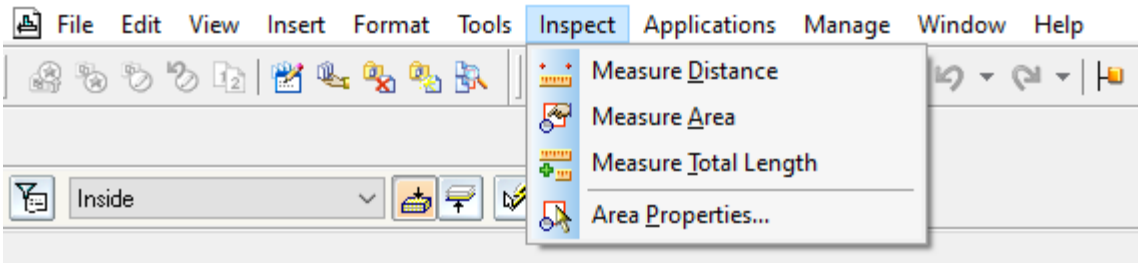


Fig. 1.35 Inspect

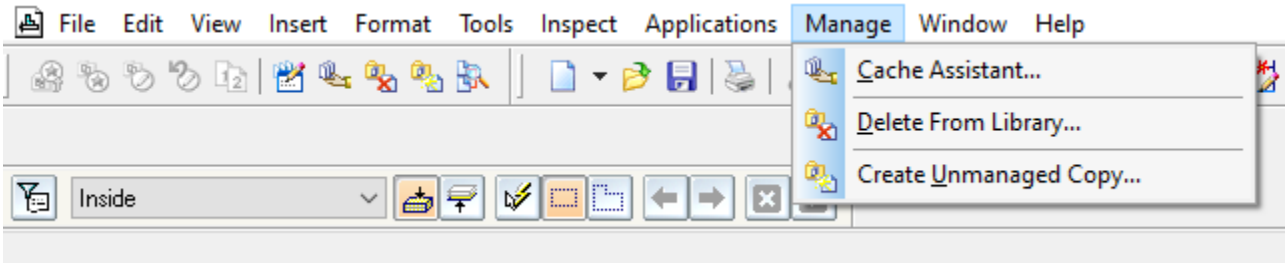


Fig. 1.36 Manage

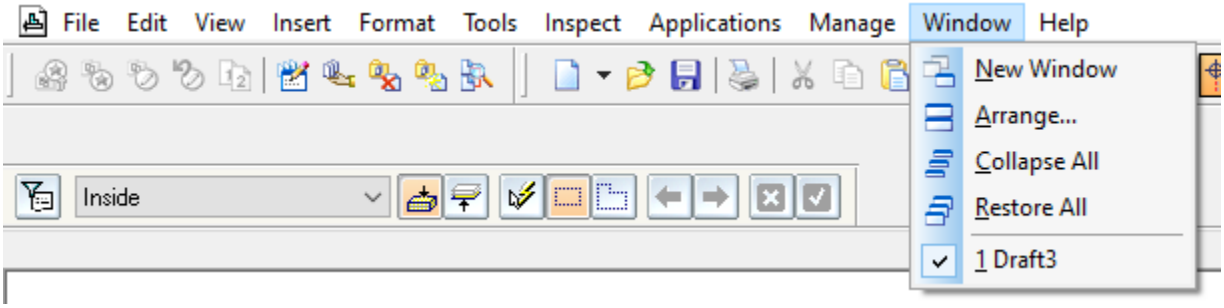


Fig. 1.37 Windows

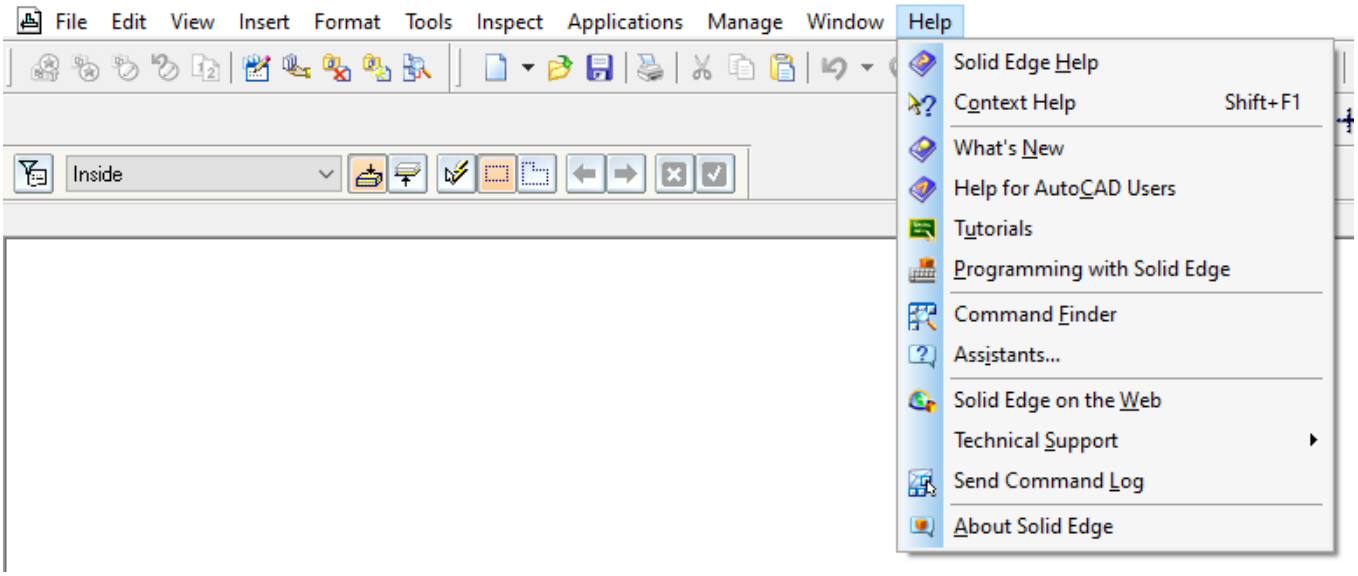
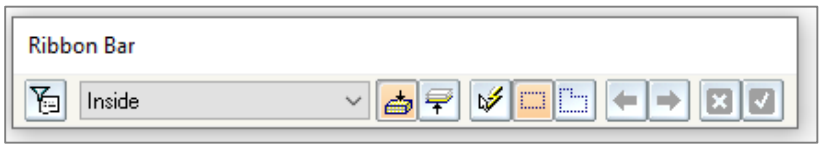


Fig. 1.38 Help

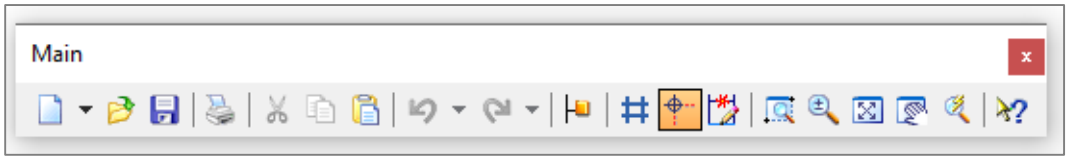
1.11.4 Tools Bars

Commonly used Tool Bars are represented in Figure 1.39.

Ribbon Bar

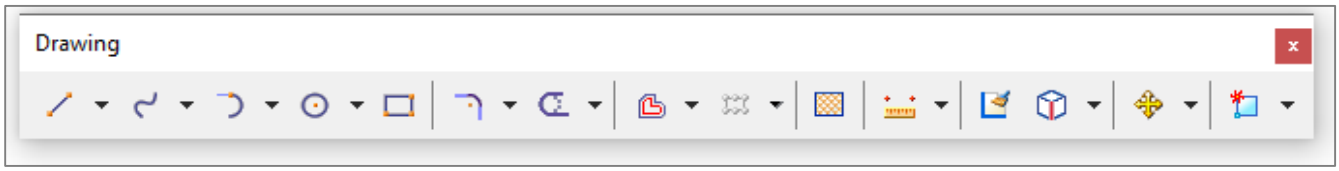


Main



Drawing Views

Drawing



Relationship

Manage

Fig. 1.39 Tool Bars

1.11.5 Navigational Tools

The different navigational tools generally used are Pan, Zoom, Fit, and are shown in Fig. 1.40.

Pan  2. Zoom  3. Fit 

Fig. 1.40 Navigational Tools

1.12 COMMANDS

The commands used to create geometric figures are shown in Table 1.3

Table 1.3 Commands for Geometric Figure Creation

Sl. No.	Command	Icon
1.	Straight Line and Poly-Line	
2.	Axis	
3.	Square and Rectangle	
4.	Polygon	
5.	Spline	
6.	Circle / Ellipse	
7.	Text	
8.	Select	
9.	Tangency	
10.	Parallelism	
11.	Inclination (Obliquity)	
12.	Perpendicularity	
13.	Smart Dimension	
14.	Distance between command	
15.	Co-ordinate dimension command	
16.	Angular co-ordinate dimensioning	
17.	Symmetric diameter command	
18.	Chamfer Dimension	

1.13 ILLUSTRATIVE EXAMPLES

The following problem are to be worked out using a 2D Computer aided drafting package.

Problem 1.1 Draw the sketch shown in Fig 1. 41 as per the given dimensions.

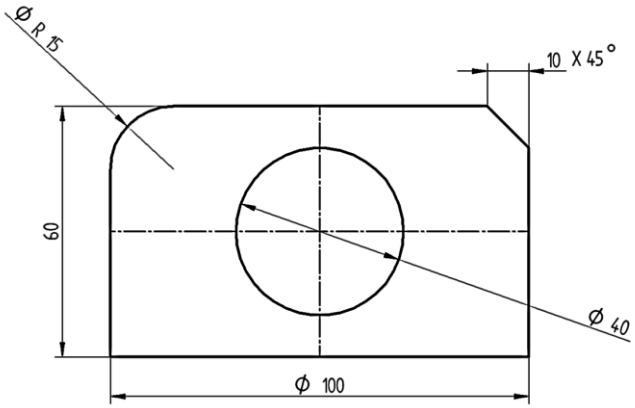


Figure 1.41

Solution

1. On the Draw toolbar, click the Line button  .
2. Click where you want the line to begin. Enter the length of line, 100 mm and then click where you want the line to end. This defines the line length.
3. Move the cursor line vertically upward, enter the length of line, 60 mm and angle as 90° press enter button in keyboard or left button on mouse.
4. Continue, move the cursor line left side, enter the length of the line, 100 mm and angle as 180° click left button on mouse to get the line.
5. Finally move the cursor line downward, enter the length of the line as 60 mm and angle as -90° This forms a rectangular shape.
6. On the Draw toolbar, click the Fillet button  .
7. Enter radius 15 press enter button in keyboard. Now click on corner of rectangle to get radius as shown.
8. On the Draw toolbar, click the Chamfer button  .
9. Enter angle as 45°, setback A as 60 mm and setback B as 60 mm Select the corner of rectangle and click inside the rectangle shape to get chamfer as shown.
10. On the Draw toolbar, click the Circle by Center button  .
11. Select center point and radius as 60 mm to get the required geometry.
12. Select dimension command  select the required line and geometry to dimension the features as shown in the FIG. 1.41. The output is shown in Fig. 1.42

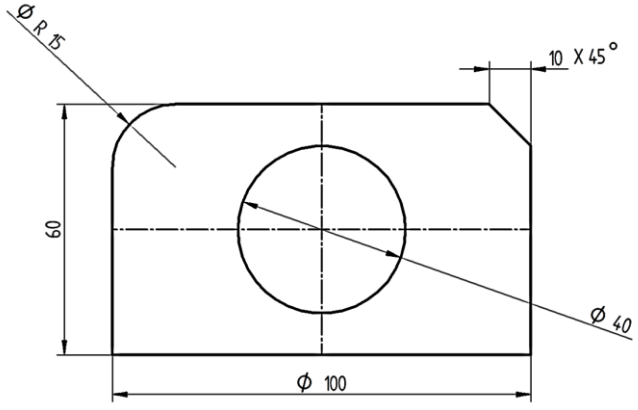
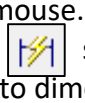


Figure 1.42 Computer Output

Example 1.2 Construct a pentagon of 30 mm sides with one of its sides horizontal and the corner opposite to that edge above it.

Solution Figure 1.43 Computer Output

1. On the Draw toolbar, click the Line button  .
2. Click where the line is to begin. Enter the length of line 30 mm and angle as 0° and then Click to end line. This defines the length of the line.
3. Move the cursor, line continues, now enter the length of line 30 mm and angle as 72°, press enter button on keyboard or left button on mouse.
4. Move the cursor, line continues, now enter the length of line 30 mm and angle as 144°, press enter button on keyboard or left button on mouse.
5. Move the cursor, line continues, now enter the length of line 30 mm and angle as -144°, press enter button on keyboard or left button on mouse.
6. Move the cursor, line continues, now enter the length of line 30 mm and angle as -72°, press enter button in keyboard or left button on mouse.
7. Select dimension command  select the required line and geometry to dimension the pentagon as shown in Fig. 1.43.

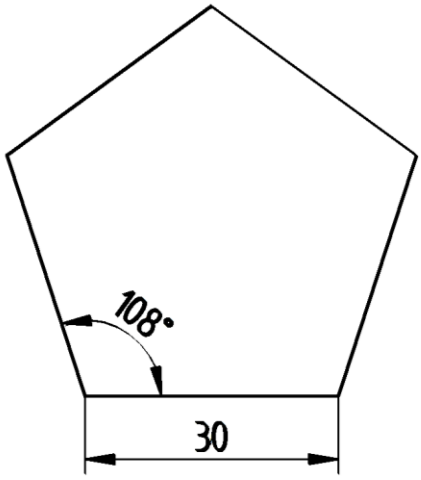


Fig. 1.43 Pentagon

Example 1.3 Construct a hexagon of 30 mm side.

Solution

1. On the Draw toolbar, click the Line button  .
2. Click where the line is to begin. Enter the length of line 30 mm and angle as 0° and then click where the line to end. This defines the length of the line.
3. Move the cursor, line continues, now enter the length of line 30 mm and angle as 60° press enter button on keyboard or left button on mouse.
4. Move the cursor, line continues, now enter the length of line 30 mm. and angle as 120° press enter button on keyboard or left button on mouse.
5. Move the cursor, line continues, now enter the length of line 30 mm and angle as 180° press enter button in keyboard or left button on mouse.
6. Move the cursor, line continues, now enter the length of line 30 mm and angle as - 120° press enter button on keyboard or left button on mouse.
7. Move the cursor, line continues, now enter the length of line 30 mm and angle as -60 ° press enter button on keyboard or left button on mouse
8. Select dimension command  select the required line and geometry, to dimension the hexagon as in Fig. 1.44.

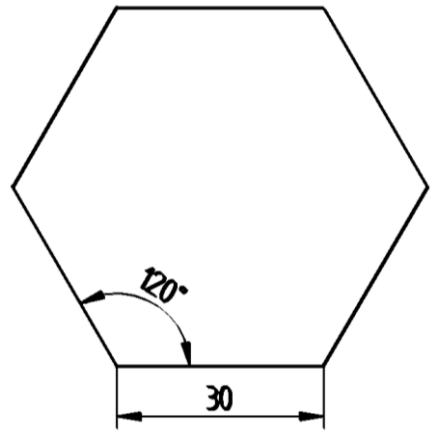


Fig. 1.44 Hexagon

Example 1.4 Divide a circle of 50 mm diameter into twelve equal parts.

Solution

1. On the Draw toolbar, click the Circle by Center button .
2. Select center point and diameter as 50 mm or radius as 60 mm to get the required circle (Fig. 1.45).
3. On the Draw toolbar, click the line button .
4. Draw line passing through the center of the circle.
5. Click the Rotate button .
6. Select the line to divide the circle into 12 equal parts.
7. Select the center point of rotation i.e. center of the circle.
8. Enter rotation angle as 30°, position angle as 0 and step angle as 30°.
9. Rotate and click the mouse clockwise or anticlockwise 5 times or until it divides into 12 parts.
10. Select text command to represent the numerical on divided parts.
11. Select dimension command select the required line and geometry to dimension the figure as in Fig. 1.45.

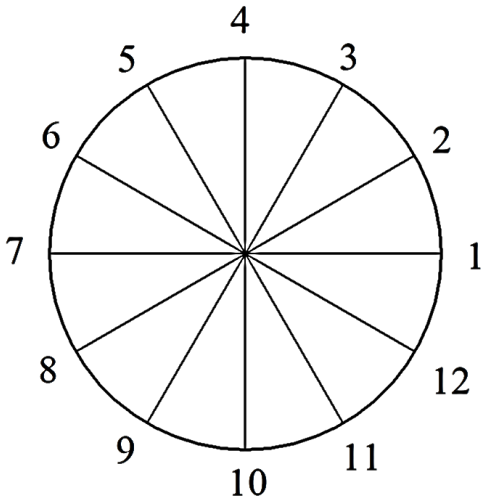


Fig. 1.45 Circle Divisions

Example 1.5 Divide a straight line of 70 mm into eleven equal parts.

Solution

1. On the Draw toolbar, click the Line button.
2. Click where the line is to begin. Enter the length of line 70 mm and angle as 0° and then click to end the line. This defines the length of line.
3. Select line button draw a line of any length at an angle less than 90°.
4. Divide the angled line into 11 equal parts of any equal length by selecting an arc by center point icon .
5. Click the line button Join last point of angled line to end point of line.
6. Draw the parallel line to pervious line draw till it gets divided into 11 equal parts.
7. Select text command to represent the numerical on divided parts.
8. Select dimension command select the required line and geometry to dimension the figure as in Fig. 1.46.

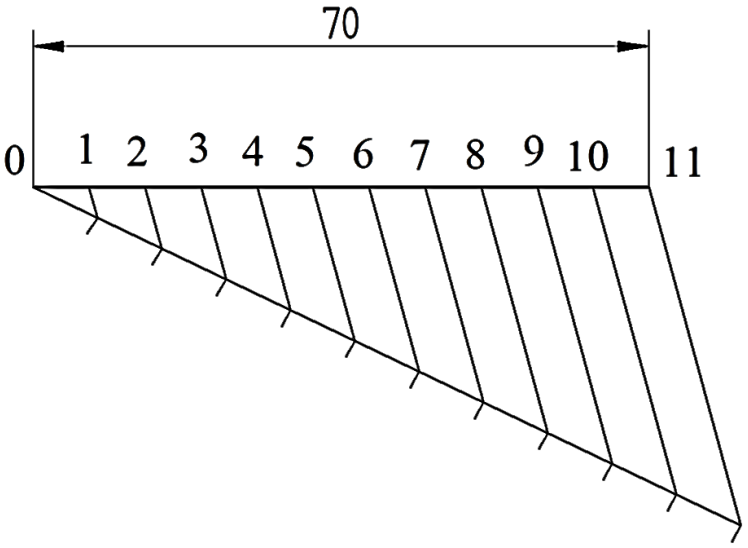


Fig. 1.46 Division of Line

Example 1.6 Assemble the following the geometric figures shown in the Fig. 1.47 concentrically using necessary commands viz. Extend, Trim, Copy, Paste etc.

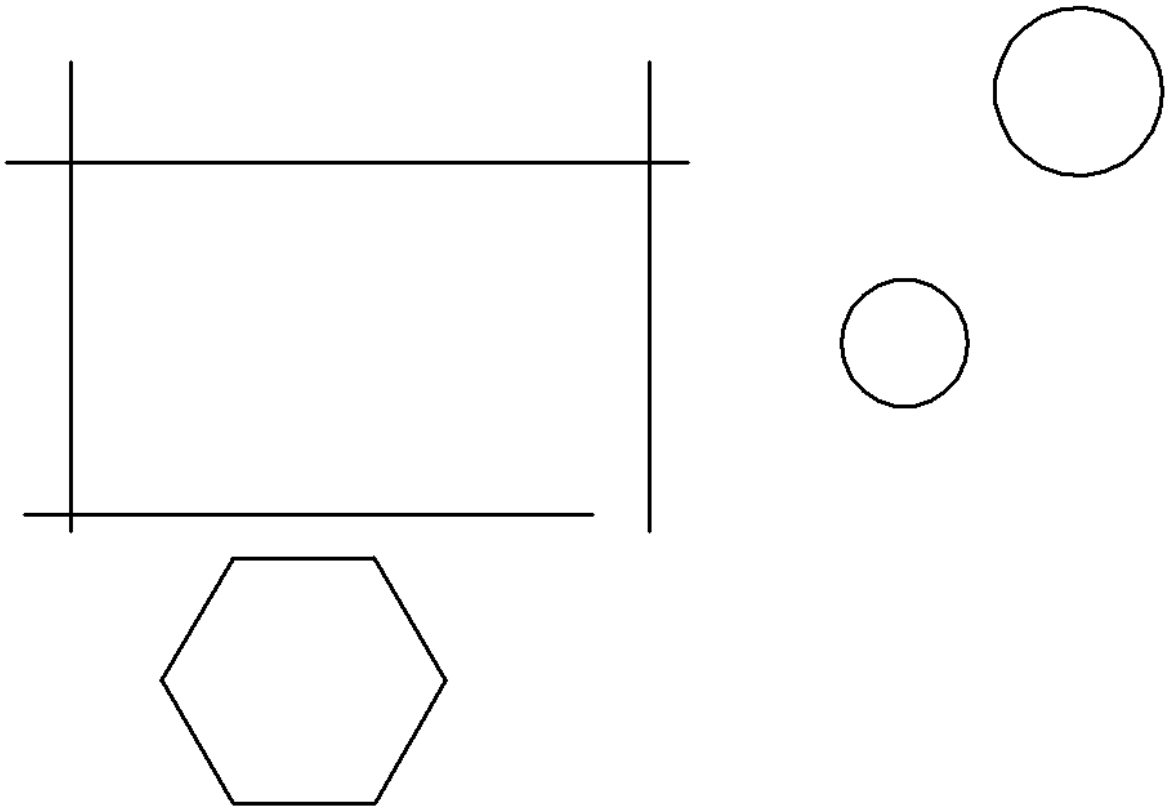


Fig. 1.47 Figures to Assemble

Solution

1. Select the trim button  to remove the excess lines.
2. Select the line which has to be extended till the target by select the extend button  .
3. Select the move button  click on the circle to select and select center point now move the cursor to the required position and click.
4. Select the concentric button  select the circle to be concentric to the circle which has already been moved.
5. Select the copy command  select the hexagon and paste as shown in Fig. 1.48.

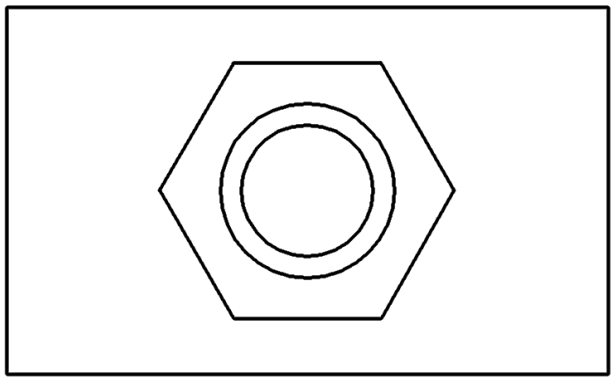


Fig. 1.48 Assembled Figures