COMPUTER AIDED DRAFTING (CAD)

INTRODUCTION

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. As the design improves and undergoes changes, the final form of design must be the scaled manufacturing drawings with finer details included. These drawings are two-dimensional representations of _three-dimensional objects designed.

COMPUTER AIDED DRAFTING

A part to be manufactured is defined first in terms of its geometry which also includes dimensions, tolerances, surface finish, and in some cases the type of fit between two mating parts. The two-dimensional representation of a part, called an engineering drawing or a blueprint, shows three orthogonal views of the part. Sometimes, when three views are not enough to define the part, additional sectional views, auxiliary views may have to be added for conveying the right information.

ADVANTAGES

The advantages offered by computerized drafting systems can be summarized as:
(a) It increases the accuracy and productivity of designer.
(b) It allows design alterations to be made easily.
(c) It offers better drawing visualization through colours.
(d) It improves the quality of drawings produced.
(e) Drawings are easier to store and retrieve.
(f) Storage space required is less.
(g) Transfer of drawings is faster and cheaper.

COMPUTER

A computer system consists of
(a) Central Processing Unit (CPU), also known as processor
(b) Main memory
(c) Input devices
(d) Output devices
(e) Secondary storage devices.

INPUT DEVICES

Keyboard: This is the most common input device. It is preferred for entering commands, text or value such as coordinates of a point or radius of a circle.
Mouse: The mouse is a pointing device which is moved across a flat surface (usually on a mouse pad) by hand to indicate X-Y movement.

CAD SOFTWARE

The CAD system creates an environment to prepare drawings interactively. Most CAD systems available commercially are menu driven. Commands can either be typed directly with the help of a keyboard or can be picked-up from the screen menu or from toolbar with the help of a mouse

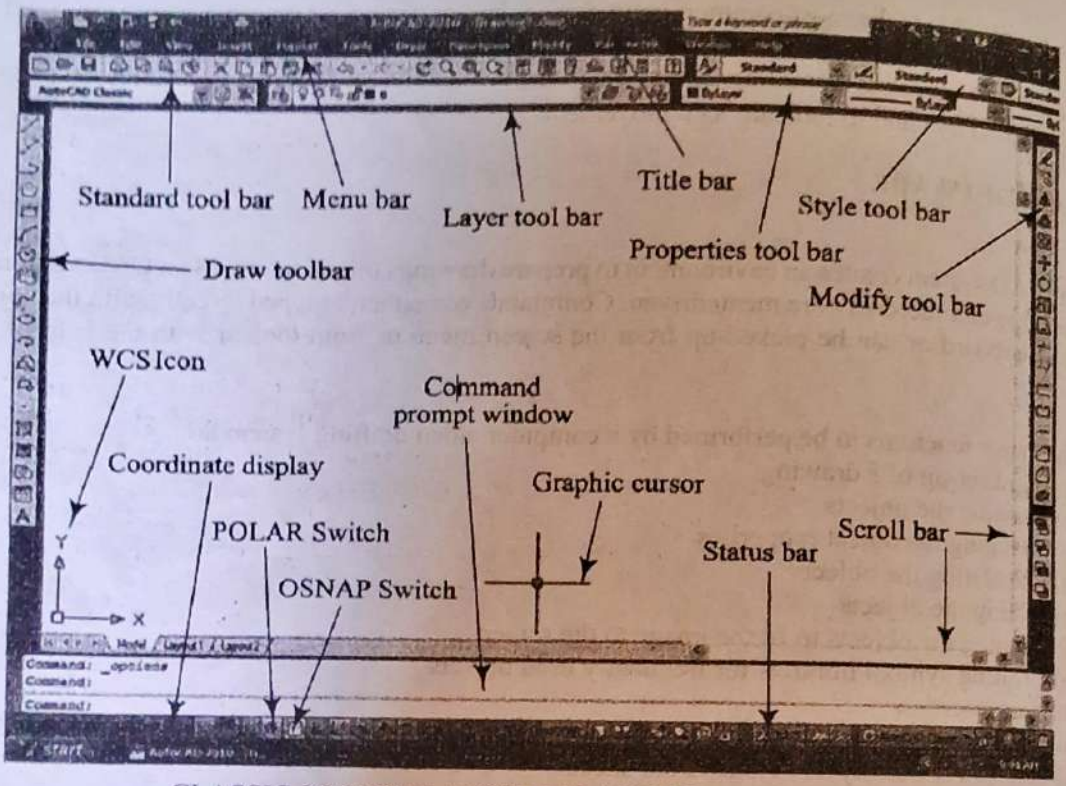
The major functions to be performed by a computer aided drafting system are:
(a) Basic set-up of a drawing
(b) Drawing the objects
(c) Changing the object properties
(d) Translating the objects
(e) Scaling the objects
(f) Clipping the objects to fit the image to the screen
(g) Creating symbol libraries for frequently used objects
(h) Text insertion
(i) Dimensioning
(j) Creates various layers (Transparent sheets)
(k) Allows zoom-in and zoom-out of any components drawing
(l) Creates different numbers of print/plot layouts.

AUTOCAD

AutoCAD (a product and registered trademark of Autodesk Inc., USA) is a low cost yet very effective computer aided design and drafting software. AutoCAD is accepted as the industry standard, and it is preferred by a large community of CAD users in the world.

HARDWARE REQUIRED FOR AUTOCAD 2023

(1) Intel processor and motherboard
(2) 160/320 GB Hard disk
(3) 4 GB/8 GB RAM
(4) Microsoft Window XP Operating system software.



CLASSIC SCREEN LAYOUT OF AUTOCAD SOFTWARE

FUNCTION KEYS/SHORT CUT KEYS

F1 Online Help

F2 Toggles between Drawing screen to text screen

F3 Toggles between OSNAP

F4 Toggles between Tablet

FS Switches among lsoplanes Top, Right and Left

F6 Toggles between Coordinates

F7 Toggles between Grid

F8 Toggles between Ortho Mode

F9 Toggles between Snap Mode On and Off

F10 Toggles between Polar Tracking On and Off

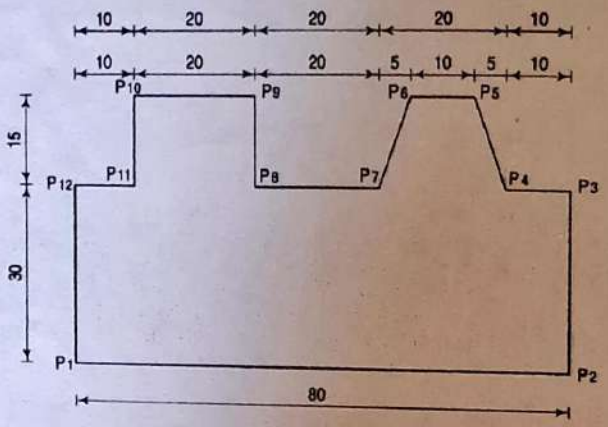
F11 Toggles between Objects Snap Tracking On and Off

UNIT-1

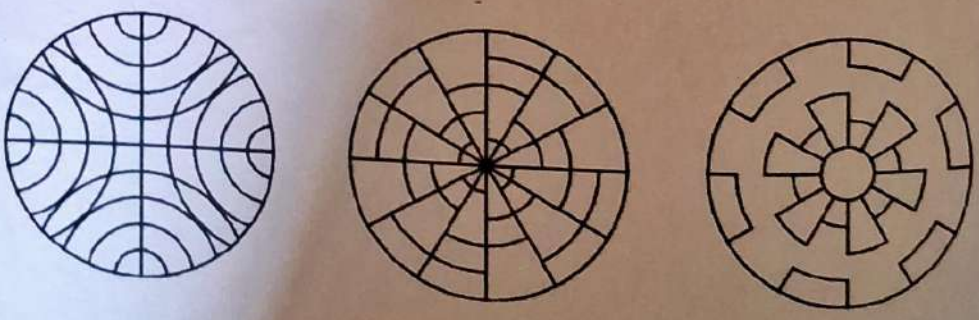
Self-learning practice modules to generate two dimensional drawings covering all possible 2D commands.

Module 1

(i) Draw a line diagram as shown in fig. Use Limits, Zoom, Line commands. Take initial point P_1 (20,20) from UCS.

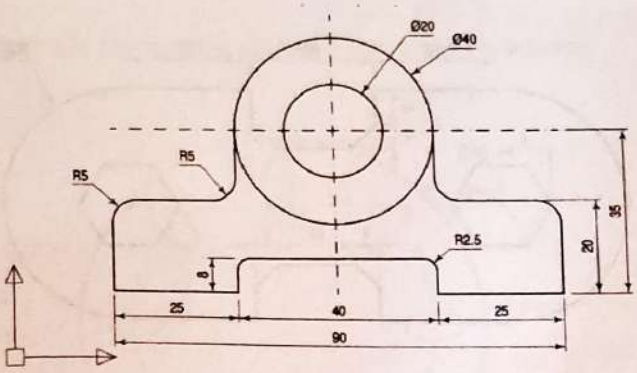


(ii) Use necessary AutoCAD commands to draw the following diagrams in a circle of diameter 100mm.



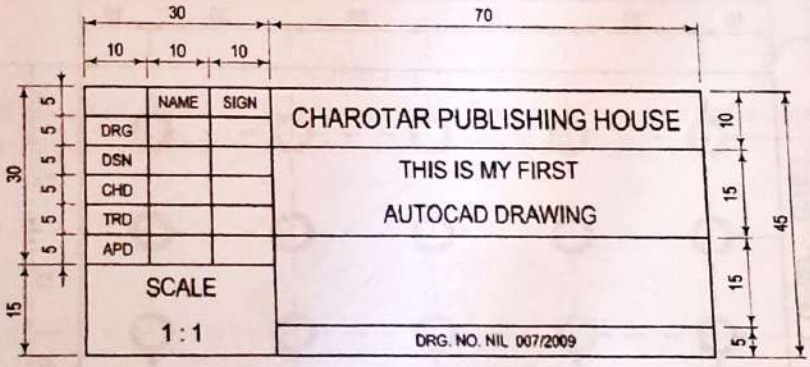
Module 2

Draw a line diagram as shown in fig. Use Circle, Offset Trim and Fillet commands.



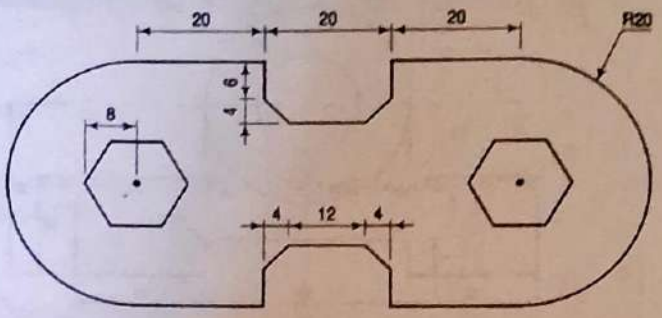
Module 3

Draw a title block as shown in fig. Use Explode, Text and Copy commands.



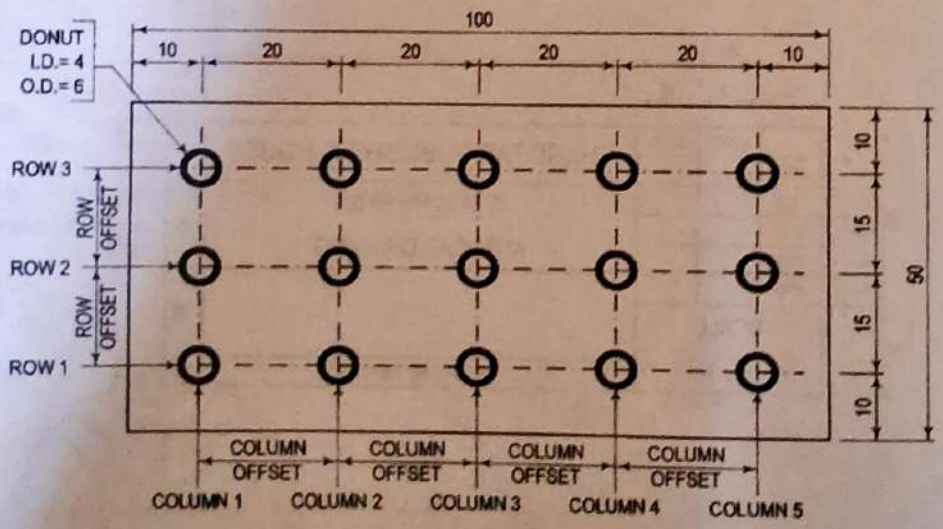
Module 4

Draw a line diagram as shown in Figure, Use Polygon, Chamfer, Arc and Mirror Commands.



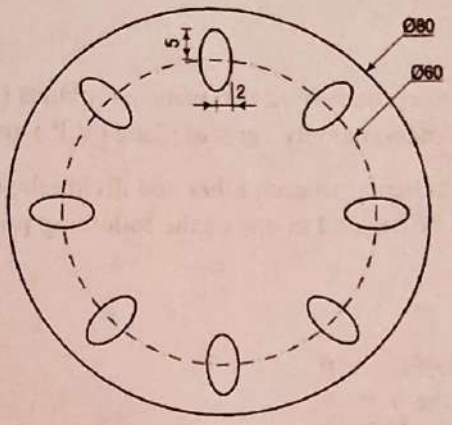
Module 5

Draw a line diagram as shown in Figure. Use Donut and Rectangular Array, commands.



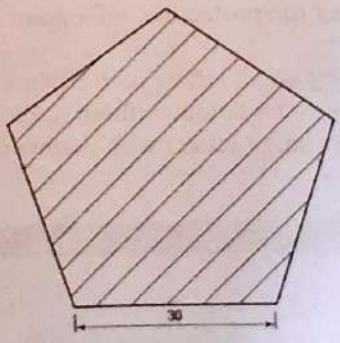
Module 6

Draw a diagram as shown in Figure, Use ellipse, Polar Array commands.



Module 7

Draw a line diagram as shown in fig. Use of Hatch, Rotate, Stretch and Scale commands. Show output diagrams separately for hatch, rotate, stretch and scale.



UNIT-2

PROJECTIONS OF POINTS

INTRODUCTION

A point is defined as a geometrical element that has no dimension. In engineering drawing, a point is represented by a dot. This chapter deals with the projections of points.

LOCATION OF A POINT

The orthographic projections are obtained on two principal planes (also known as reference planes) having negligible thickness, namely vertical plane (V.P.) and horizontal plane (H.P.)

The principal planes are perpendicular to each other and divide the space into four quadrants. A point lying in the space can be defined in one of the following positions with respect to the principal planes.

1. Above the H.P. and in front of the V.P.
2. Above the H.P. and behind the V.P.
3. Below the H.P. and behind the V.P.
4. Below the H.P. and in front of the V.P.
5. On the H.P. and in front of the V.P.
6. Above the H.P. and on the V.P.
7. On the H.P. and behind the V.P.
8. Below the H.P. and on the V.P.
9. On both the H.P. and the V.P.

CONVENTIONAL REPRESENTATION

The conventions used to represent the projections of a point are as follows:

1. The front view is represented by small letters with dashes such as a', b', c', etc.
2. The top view is represented by small letters without dashes such as a, b, c, etc.
3. The side view is represented by small letters with double dashes such as a'', b'', c'', etc.

Self-learning practice modules to generate Orthographic views using simple 2-D commands.

Module 1

Draw the projections of the following points on a common reference line keeping the distance between their projectors 30 mm apart.
(a) Point A is 20 mm below the H.P. and 50 mm in front of the V.P.
(b) Point B is in the H.P. and 40 mm behind the V.P.

Module 2

Draw the projections of the following points on a common reference line keeping the distance between their projectors 25 mm apart.

(a) Point A is 40 mm above the H.P. and 25 mm in front of the V.P.
(b) Point B is 40 mm above the H.P. and in the V.P.
(c) Point C is 25 mm in front of the V.P. and in the H.P.
(d) Point D is 25 mm above the H.P. and 30 mm behind the V.P.
(e) Point E is in the H.P. and 30 mm behind the V.P.
(f) Point F is 40 mm below the H.P. and 30 mm behind the V.P.

Module 3

Draw the projections of the following points on a common reference line keeping the distance between their projectors 30 mm apart.

(a) Point P is 35 mm below the H.P. and in the V.P.
(b) Point Q is 40 mm in front of the V.P. and 25 mm below the H.P.
(c) Point R is 45 mm above the H.P. and 20 mm behind the V.P.
(d) Point S is 30 mm below the H.P. and 45 mm behind the V.P.
(e) Point T is both in H.P. and V.P.

UNIT -2

PROJECTIONS OF STRAIGHT LINES

INTRODUCTION

A straight line is defined as the locus of a point which moves unidirectionally. The straight line can also be defined as the shortest distance between two points.

ORIENTATION OF A STRAIGHT LINE

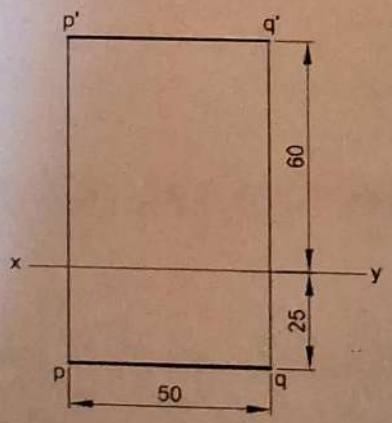
A straight line may be in one of the following positions.
1. Line parallel to both horizontal plane (H.P.) and vertical plane (V.P.).
2. Line perpendicular to H.P. (and parallel to V.P.).
3. Line perpendicular to V.P. (and parallel to H.P.).
4. Line inclined to H.P. and parallel to V.P.
5. Line inclined to V.P. and parallel to H.P.
6. Line situated on H.P.
7. Line situated in V.P.

Self-learning practice modules to generate Orthographic views of straight lines using simple 2-D commands.

Example Module

A 50 mm long line PQ is parallel to both the H.P. and the V.P. It is 25 mm in front of the V.P. and 60 mm above the H.P. Draw its projections using necessary AutoCAD commands.

Solution:



Module 1

A 60 mm long line PQ has its end P 20 mm above H.P. The line is perpendicular to the H.P. and 40 mm in front of the V.P. Draw its projections

Module 2

A 60 mm long line PQ has its end P 20 mm in front of the V.P. The line is perpendicular to the V.P. and 40 mm above the H.P. Draw the projections of the line

Module 3

A 80 mm long line PQ has end P 20 mm above H.P. and 40 mm in front of the V.P. The line is inclined at 30° to the H.P. and is parallel to the V.P. Draw the projections of the line

Module 4

An 80 mm long line PQ is inclined at 30° to the V.P. and is parallel to the H.P. The end P of the line is 20 mm above the H.P. and 40 mm in front of the V.P. Draw the projections of the line

Module 5

A 60 mm long line PQ lying on the H.P. is inclined at 30° to the V.P. Its end P is 20 mm in front of the V.P. Draw the projections of the line

Module 6

Draw the projections of a 70 mm long line PQ, situated in the V.P. and inclined at 30° to the H.P. The end P of the line is 25 mm above the H.P.

Module 7

Draw the projections of a 60 mm long line PQ, which is situated both on the H.P. and the V.P.

Module 8

60 mm long line AB is parallel to and 20 mm in front of the V.P. The ends A and B of the line are 10 mm and 50 mm above the H.P., respectively. Draw the projections of the line and determine its inclination with the H.P.

Module 9

An 80 mm long line MN has its end M 15 mm in front of the V.P. The distance between the end projectors is 50 mm. The front view is parallel to and 20 mm above reference line. Draw the projections of the line and determine its inclination with the V.P.

Module 10

The top view of a line measures 60 mm. The line is parallel to the V.P. and inclined at 45° to the H.P. One end of the line is 25 mm in front of the V.P. and lies on the H.P. Draw its projections and determine the true length.

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UNIT -3

PROJECTIONS OF PLANES

INTRODUCTION

Planes have length, breadth, and negligible thickness.(2D Objects)

ORIENTATION OF PLANES

The surface of a plane may be in one of the following:

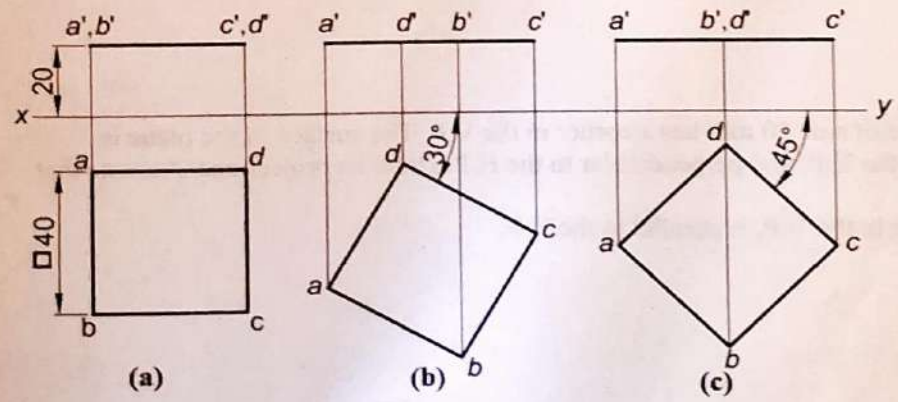
1. Parallel to H.P. (and perpendicular to V.P.).
2. Parallel to V.P. (and perpendicular to H.P.).
3. Parallel to profile plane (i.e., perpendicular to both H.P. and V.P.).
4. Inclined to H.P. and perpendicular to V.P.
5. Inclined to V.P. and perpendicular to H.P.

Self-learning practice modules to generate Orthographic views of plane figures using simple 2-D commands.

Example Module

A square plane of side 40 mm has its surface parallel to and 20 mm above the H.P. Draw its projections when (a) a side is parallel to the V.P., (b) one side is inclined at 30° to the V.P. and
(c) all sides are equally inclined to the V.P.

Solution



Module 1

A hexagonal plane of side 25 mm has its surface parallel to and 20 mm in front of V.P. Draw its projections, when a side is (a) parallel to the H.P., (b) perpendicular to the H.P., (c) inclined
at 45° to the H.P.

Module 2

A triangular plane is in the form of an isosceles triangle of base side 30 mm and altitude 40 mm. Its surface is perpendicular to both H.P. and V.P. Draw its projections when the base
side is parallel to the V.P.

Module 3

A hexagonal plane of side 30 mm has an edge on the H.P. The surface is inclined at 45° to the H.P. and perpendicular to the V.P. Draw its projections.

Module 4

A circular plane of diameter 50 mm is resting on a point of the circumference on the H.P. The plane is inclined at 30° to the H.P. and its centre is 35 mm in front of the V.P. Draw its projections.

Module 5

A hexagonal plane of side 30 mm has an edge in the V.P. The surface of the plane is inclined at 45° to the V.P. and perpendicular to the H.P. Draw its projections.

Module 6

A hexagonal plane of side 30 mm has a corner in the V.P. The surface of the plane is inclined at 45° to the V.P. and perpendicular to the H.P. Draw its projections. Assume that the diagonal
through the corner in the V.P. is parallel to the H.P.

Module 7

circular plane of diameter 50 mm is resting on a point of the circumference on the V.P. The plane is inclined at 30° to the V.P. and the centre is 35 mm above the H.P. Draw its projections

UNIT -4

PROJECTIONS OF SOLIDS

INTRODUCTION

Three-dimensional objects are called solids. However, only those solids are considered the shape of which can be defined geometrically and are regular in nature.

ORIENTATION OF SOLID

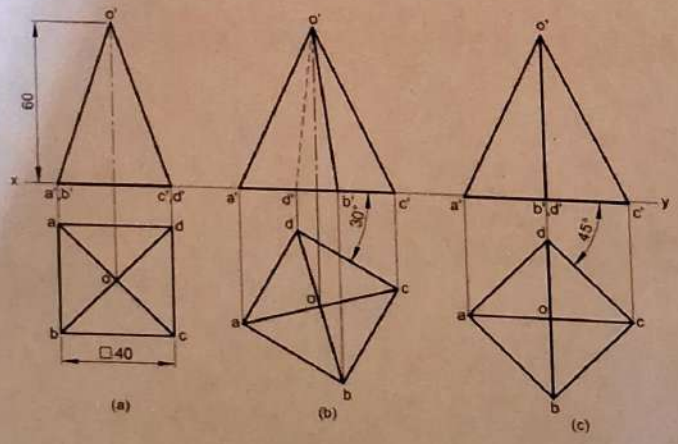
The solid may be in one of the following positions:
1. Axis perpendicular to the H.P.
2. Axis perpendicular to the V.P.
3. Axis parallel to both the H.P. and the V.P. (i.e., perpendicular to the profile plane)
4. Axis inclined to the H.P. and parallel to the V.P.
5. Axis inclined to the V.P. and parallel to the H.P.
6. Axis inclined to both the H.P. and the V.P.

Self-learning practice modules to generate Orthographic views of solid objects using simple 2-D commands.

Example Module

A square pyramid of base side 40 mm and axis 60 mm is resting on its base on the H.P. Draw its projections when (a) a side of the base is parallel to the V.P., (b) a side of the base is inclined at 30° to the V.P., (c) all the sides of the base are equally inclined to the V.P.

Solution



Module 1

A square prism of base side 40 mm and axis 60 mm is resting on its base on the ground. Draw its projections when (a) a face is perpendicular to the V.P., (b) a face is inclined at 30°
to the V.P., (c) all the faces are equally inclined to the V.P.

Module 2

A pentagonal prism of base side 30 mm and axis 60 mm has one of its bases in the V.P. Draw its projections when (a) a rectangular face is parallel to and 15 mm above the H.P., (b) a
face is perpendicular to the H.P., (c) a face is inclined at 45° to the H.P.

Module 3

A pentagonal prism of base side 30 mm and axis 60 mm is resting on one of its rectangular faces on the H.P. with axis parallel to the V.P. Draw its projections

Module 4

A pentagonal prism of base edge 30 mm and axis 60 mm rests on an edge of its base in the H.P. Its axis is parallel to V.P. and inclined at 45° to the H.P. Draw its projections.

Module 5

A hexagonal pyramid of base side 30 mm and axis 60 mm has an edge of its base on the ground. Its axis
is inclined at 30° to the ground and parallel to the V.P. Draw its projections.

Module 6

A hexagonal pyramid of base edge 30 mm and axis 60 mm, has a triangular face on the ground and the axis parallel to the V.P. Draw its projections.

Module 7

A hexagonal pyramid of base edge 30 mm and axis 60 mm, is lying on a slant edge on the ground with the axis parallel to the V.P. Draw its projections when the face containing the resting

edge are equally inclined to the H.P.

Module 7

A cylinder of base diameter 50 mm and axis 70 mm has a generator in the V.P. and inclined at 45° to the H.P. Draw its projections.

Module 8

A hexagonal prism of base edge 30 mm and axis 70 mm has an edge of its base in the V.P. such that the axis is inclined at 30° to the V.P. and parallel to the H.P. Draw its projections.

Module 9

A cone of base diameter 50 mm and axis 60 mm has a generator in the V.P. and the axis parallel to the H.P. Draw its projections.

Module 10

A pentagonal pyramid of base side 30 mm and axis 55 mm has a triangular face in the V.P. and the base edge contained by that triangular face is perpendicular to the H.P. Draw its
projections.

Module 11

pentagonal prism of base side 30 mm and axis 60 mm has one of its rectangular faces on the H.P. and the axis inclined at 60° to the V.P. Draw its projections.

Module 12

Create the following mechanical parts:

(a) Threads (b) washers (c) keys and (d) springs

UNIT-5

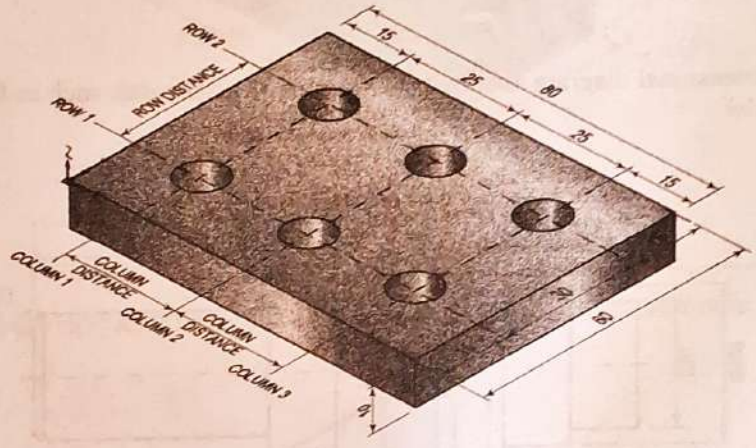
ISOMETRIC VIEWS

INTRODUCTION

Isometric projection is used to create a pictorial drawing of an object. It is defined as a single-view parallel projection obtained by keeping the object in such a position that all the three mutually perpendicular geometrical axes are equally inclined to the plane of projection

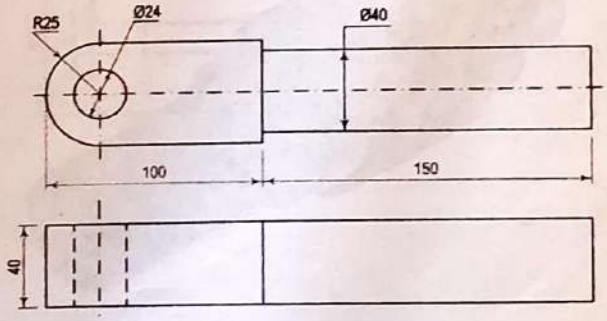
Module 1

Draw a three-dimensional diagram as shown in Figure. Use 3D rectangular array.

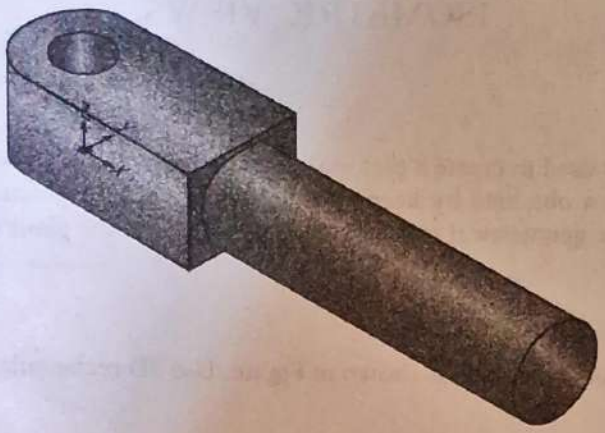


Module 2

Draw a three dimensional diagram as shown in Figure. Use 3D commands such as region, extrude, subtract and Union.

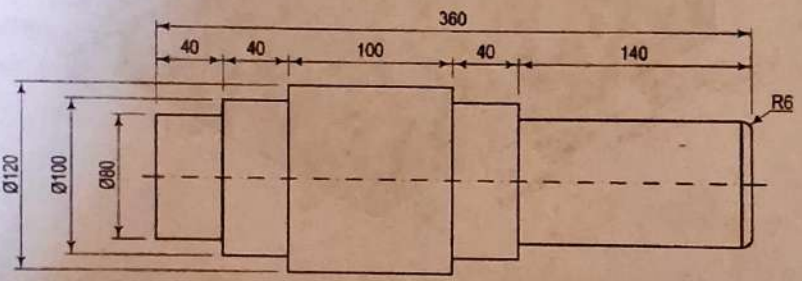


Solution Figure:



Module 3

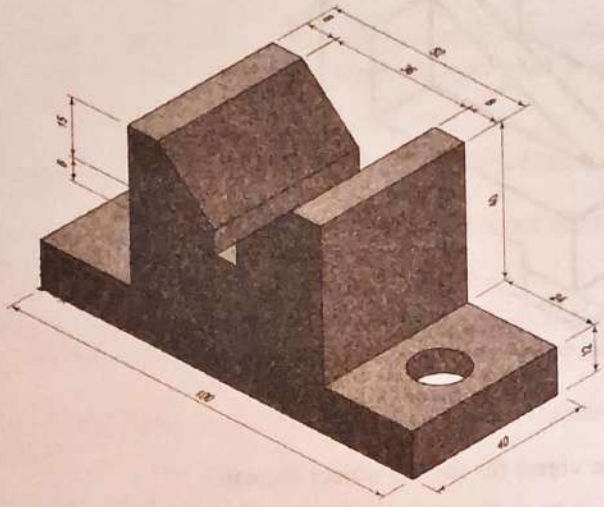
Draw a three dimensional diagram as shown in fig.. Use 30 commands such as Region, Revolve and Fillet.



Solution Figure

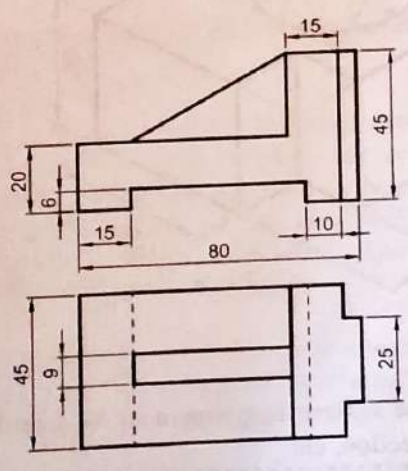
Module 4

Draw a three-dimensional diagram as shown in fig. Use 3D commands such as Region, Extrude and Subtract.

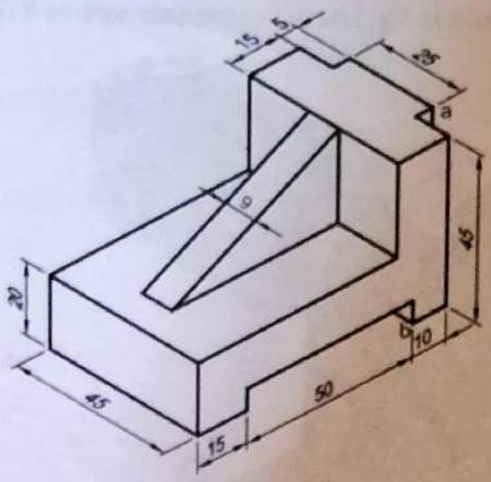


Module 4

The front and the top views of an object are shown in Fig. Draw its isometric view.

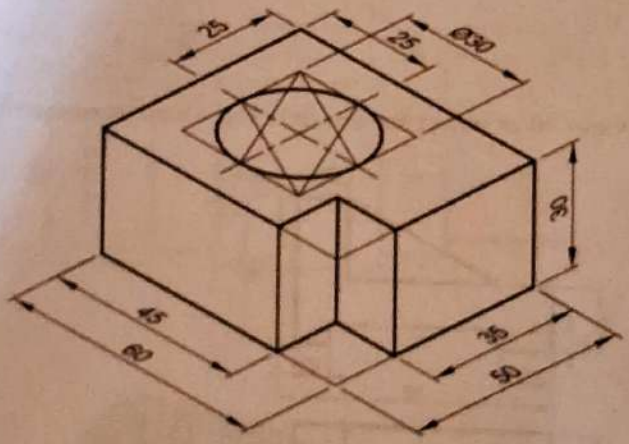


Solution figure:



Module 5

Draw any two orthographic views for the 3D object shown.



Note: students are requested to save the answer diagrams in an A4 size sheet layout with title block indicating their roll no , name, section, etc.

*The fundamental commands to edit a drawing are:

(1) Move: Moves selected objects to another location about a base point.

(2) Rotate: Rotates selected objects through a specified angle about a base point.

(3) Copy : Creates one or more copies of selected objects at another location. The function of COPY command is similar to the MOVE command except that it preserves a copy of the objects selected at the original location.

(4) Mirror: Creates a mirror image of the selected objects about a specified line.

(5) Array : This command creates multiple copies of selected objects in rectangular or polar form. This is a form of COPY command.

(6) Erase : This command deletes the selected entities. A record of entities erased is always maintained. The most recent entity can be unerased by OOPS command.

(7) Oops: This command retrieves all objects erased by the last Erase and after executing Block or Wblock command.

(8) Break: This command erases a portion of line, arc, circle or a 20 polyline between two selected points.

(9) fillet: This command is usedtocreatearoundcornerbetween two lines. The lines are shortened or extended to fit a tangent arc of specified radius. FILLET works on any combination of two lines, arcs, circles, non-parallel lines, or a single polyline.

(10) Chamfer (Refer module 26-8): This command works on two lines or a single polyline to create a bevelled edge.

(11) Extend (Refer module 26-11): This command extends the lines, polylines and arcs to a boundary edge which can be a line, polyline, arc or circle. A closed polygon cannot be extended. When you invoke this command, you will be prompted to select the boundary edges. These edges can be lines, polylines, circles, arcs,, ellipse, xllines,rays,splines etc. After the boundary edges are selected, you must select each object to be extended. An object can be both a boundary edge and an object to be extended.

(12) Offset (Refer module 26-5): This command creates a parallel single copy of line, arc, circle, rectangle, polygon, or 20 polyline at a given offset distance. Each offset creates a new entity with the same linetype, color and layer settings.

(13) Stretch (Refer module 26-12): The STRETCH command can either lengthen entities or shorten them, and thus alter their shapes. The centre points of arcs or polyline arcs are adjusted accordingly.

(14) Trim (Refer module 26-5, 26-13): This command trims the objects that extend beyond a required point of intersection. When you invoke this command, you will be prompted to select the cutting edges. These edges can be lines, polylines, circles, arcs, ellipse, xlines, rays, splines, text, blocks or even viewports. After the cutting edges are selected, you must select each object to be trimmed. An object can be both a cutting edge and an object to be trimmed.

(15) Scale : The SCALE command allows to shrink or enlarge the already existing drawing objects about a base point by specifying a scale factor.

(16) Pedit: A polyline is a single entity which is made up of a continuous series of line and arc segments. The PEDIT command is exclusively used for editing of polyline properties. The selected line, arc and polyline can be added to an existing polyline by a JOIN option. A smooth curve passing through all vertices of a polyline can be created by using FIT option. Similarly, a spline can also be constructed by using SPLINE option.

(17) Explode : This command breaks a polyline into its individual segments. These segments can then individually be edited, and rejoined again to form an edited polyline.

***Engineering Drawing by ND Bhatt.**

GOKARAJU RANGARAJU INSTITUTE OF ENGINEERING AND TECHNOLOGY
GRAPHICS FOR ENGINEERS/SYLLABUS

Course Code: GR22A1011 **L/T/P/C: 1/0/4/3**
I Year I/II Semester

Course Objectives

1. Provide basic conventions and standards used in Graphics for Engineers.
2. Impart knowledge on different projection methods.
3. Draw multi views of a plane object located in different orientations.
4. Identify and draw 2d views of a solid objects in different positions.
5. Apply solid modelling features and concepts to draw and develop industrial components like springs, gears etc.

Course Outcomes

1. Interpret industrial drawings and read working drawings.
2. Draw engineering objects like springs using AutoCAD.
3. Imagine and create multi-views of 2-d plane figures.
4. Construct and interpret multi-views of 3-d solid objects with proper dimensioning, scaling etc.
5. Draw and create pictorial views and model the industrial objects like gears and bearings with solid modelling commands available in AutoCAD tool.

UNIT I
Engineering Graphics with CAD– Introduction engineering graphics and significance of computer aided design CAD software, advanced commands, dimensioning and tolerancing, fundamentals of 2-D construction.
UNIT II
Orthographic projection – Introduction, definition, and classification of projections; pictorial and multi-view, significance of first and third angle methods of projections; **Projections of points** (in all quadrants) and **straight lines** (inclined to one reference plane only).
UNIT III
Projections of planes - definition and types of plane figures (triangle, square, pentagon, hexagon, and circle); projections of plane (inclined to one reference plane only).
UNIT IV
Projections of solids - definition and types of solid objects (prism, cylinder, pyramid, and cone); projections of solid (axis inclined to one reference plane only); creation of threads, washers, keys, and springs.
UNIT V
Isometric views – construction of isomeric views of planes (polygons) and solids (prism, cylinder, pyramid, and cone); fundamentals of 3-d drawings, world coordinate system, solid modelling and commands, creation of gears and bearings; conversion of 3-d to 2-d views and construction of 3-d view from 2-d views (simple objects)

Text Books:

1. Engineering Graphics and Design by Kaushik Kumar / Apurbakumar Roy / Chikesh
2. Engineering Drawing by N.D.BHATT/CHAROTAR PUBLISHING HOUSE PVT LTD

Reference Books:

1. Engineering Graphics Essentials with AutoCAD 2018 Instruction by Kirstie Platenberg/SDC publications.
2. Engineering Drawing by Basanth Agrawal/ C M Agrawal/ McGraw Hill Education
3. Engineering Drawing by K.Venu Gopal/New Age Publications.

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